Computer Graphical Interfaces, Reflection and the Teaching and Learning of Music Composition – A Holistic Study.

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Declaration

I declare that the work described in this dissertation is, except where otherwise stated, entirely my own work and has not previously been submitted as an exercise for a degree at this or any other university.

Signed…………………..........................

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SUMMARY

Technology, Reflection and the Teaching and Learning of Music Composition – A Holistic Study.

This thesis is a holistic study in the area of teaching and learning of music composition for children in the age range eight to eleven years. It investigates the role of graphical computer technology within the framework of a reflection-in-action model for teaching, learning and research. Its primary aims are firstly: to examine if reflection-in-action provides a valid model for description of the behaviour and interactions of teachers, learners and researchers in a technology-enabled environment, and secondly; to investigate how technology enables/facilitates this model in the case of each. This is done through both examination of both childrens and teachers behaviours, processes and strategies as they work together with graphical music software, and also by analysis of childrens compositional products.

Two pieces of software were developed, one designed solely by the author (*DrumSteps*), the other in collaboration with research students at MIT (*Hyperscore*). Each piece of software was extensively deployed in a wide range of settings with children in the 9-12 year age range.

Qualitative data were collected by intensive examination of selected teaching and learning situations, using digital video capture to providing a complete record of all learner and teacher actions. Analysis of the resulting data indicated that Schon's reflection-in-action model is applicable to technology-mediated teaching and learning of music composition. The graphical interfaces were observed to provide a valuable empowering mechanism for both teachers and learners, facilitating music learning interactions that would not be possible otherwise. Learner interactions progressed through clear stages and learners exhibited definable, context-related behaviours.

Both pieces of software were made available to the public via the TCD, MIT and BBC websites and users were invited to submit examples of their work, yielding over ten thousand pieces, of which two hundred and fifty were selected for analysis. A marked difference was noted in the nature and quality of childrens pieces produced in mentored workshops and those collected via the web, indicating that the presence of a teacher is a necessary component for deeper musical learning and reflection. Effective technology-mediated teaching strategies were identified. Use of graphical software in tandem with digital video capture was further demonstrated to be an effective vehicle for researcher reflection, yielding unique insight into music teaching and learning.

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The teacher who is indeed wise does not bid you to enter the house of his wisdom but rather leads you to the threshold of your mind.

Kahlil Gibran, The Prophet

"*Would you tell me, please, which way I ought to go from here?"*said Alice.
"*That depends a good deal on where you want to get to"* said the Cat.
"I don't much care where" said Alice.
"Then it doesn't matter which way you go" said the Cat.
"As long as I get somewhere," Alice added as an explanation.
"Oh, you're sure to do that," said the Cat, *"if you only walk long enough.*

Lewis Carroll, Alice in Wonderland

"It would seem that you have no useful skill or talent whatsoever" he said. "*Have you thought of going into teaching?"*

Terry Pratchett, Mort

For Clair, Daire, Oisin and Kelan, and for my parents.

“You are the bows from which your children as living arrows are sent forth.”

Kahlil Gibran, The Prophet.

CONTENTS

CHAPTER ONE. INTRODUCTION.

1.1 Background and Context

The current dissertation arises out of a research project carried out in collaboration between the Centre for Research in IT in Education, Trinity College Dublin, and Professor Tod Machovers's Hyperinstruments/Opera of the Future research group, based in the MIT Media Lab, Cambridge, Massachussetts, USA, over the period 1999 to 2004. During the course of the project, a variety of music interfaces, both physical and screen-based were developed and tested with children in both Ireland and the US. These interfaces then formed the core technologies for a public performance project called Toy Symphony[1], which involved children, music technology and professional performers and composers which took place in locations in Ireland, the United Kingdom, Europe and the United States in 2001 and 2002.

During the course of the Toy Symphony project, the author acted as director for a series of workshops in each location, where children used the various technologies as composers and performers, each workshop series culminating in a public performance with a local professional orchestra. Composing activities were carried out primarily through the medium of the Hyperscore software, which was designed by Mary Farbood and Egon Pazstor at the MIT Media Lab, with some design input from the author.

In parallel with these activities, the author designed a second piece of graphical music software called DrumSteps, which was subsequently implemented by James Bligh and Conor McCarthy at CRITE, Trinity College. This software was also subject to initial informal observation and testing with children in Ireland and the UK, and a version of the software was developed for the BBC music website[2]. While Drumsteps and Hyperscore are very different pieces of software, they may be characterised principally by the manner in which they seek to facilitate music composition by the use of non-standard representational systems.

During this initial testing and observation process, the author variously informally observed and actively taught more than two hundred children composing with one or other software application. Most of the children involved were between the ages of eight and twelve years old and many had little or no prior formal music education. Almost none had ever composed a piece of music before, yet it seemed that in a relatively short space of time, most of them could not only master the complexities of the software interfaces in question, but use them to produce a musical outcome.

Arising out of these initial informal observations, a number of questions seemed to arise. Firstly, while the children clearly enjoyed working with the software, and there were musical outcomes, it was not

[1] http://www.toysymphony.net
[2] http://www.bbc.co.uk/music/childrens/games/drumsteps

always entirely clear to what extend these outcomes were a function of the childrens musical intent. This was especially true in the Hyperscore interface, which provides the user with a significant degree of automated help. Secondly, while it seemed that children were engaged in some sort of learning process, it was not immediately apparent exactly what was being learned or to what extent this learning was a function of either the interface or the teaching approach. Thirdly, while the author is a practising musician and music teacher, with considerable experience in teaching music in a wide variety of contexts, it was not clear either before or during the workshops what might constitute an appropriate and effective methodological approach in teaching with these software interfaces.

While there were in many cases positive outcomes, and these outcomes were clearly linked to some aspects of the software and the teaching, the nature of the workshop situation made it impossible to pinpoint the exact nature of the many complex activities and relationships which manifested themselves. The author therefore set about carrying out a more formal investigation of the nature of the teaching and learning which seemed to occur in contexts facilitated by the two software applications in question, one of the outcomes of which is the current document.

1.2 Why the Current Study is Needed

There is a considerable lack of knowledge about the role of technology in the teaching and learning of music generally and specifically about its function in enabling music composition activities. Most studies in the field have concentrated on existing technologies that for the most part have been designed for professional rather than educational use and make use of conventional representations of musical information. Many of these have been concerned with constrained compositional tasks rather than composing in the holistic sense. With the exception of Jeanne Bamberger, the author is aware of no studies available in the music-learning sphere in which the researcher has designed software to enable specific musical interactions and examined these in a learning context, nor where non-standard representations of musical information are used. The author is unaware of any body of literature concerned with the specific effect of graphical computer interfaces on the teaching and learning of music composition.

Furthermore, most available studies attempt to distance the researcher from the subject under examination. While this may represent good research practice, it makes a thorough examination of the nature of technology-mediated teaching almost impossible. The author is again unaware of any studies that examine explicitly the relationship between non-standard graphical music interfaces and childrens musical processes, nor of any studies that look closely at the effect of, and relationship between these interfaces and teaching methodology and approach.

The current study attempts to address this gap in current knowledge by first designing two music computer based tools specifically for children with a view to enabling music composing and constructing activities. These tools are then examined in a holistic manner, enabling the researcher to address questions relating to the efficacy of the tools themselves, the children's compositional processes and learning with respect to a variety of musical concepts and ideas, and the nature of technology mediated teaching and learning in the area of music composition.

1.3 Context for the Development of Specific Research Questions

Initially two pieces of software were designed, one by the author solely, and one in collaboration with colleagues at MIT. Each piece of software was created specifically to enable musical construction behaviours without the need for prior musical training or music notation skills on the part of the user. Theoretical underpinning on the design side was provided by the work of both Seymour Papert and David Jonasson. Practical aspects of the design were informed by both the structure of the musical domain and the perceived needs of children working within this domain.

Having designed the software, a theoretical model was sought which might explain user behaviour, including both teachers and students as users. While a variety of general models exist to explain aspects of teaching and learning, the Schon reflection-in-action model was chosen as the underlying theoretical base for the study. This model was seen to provide a holistic and multi-layered description of teacher, learner and researcher actions and interactions and seemed to encompass a variety of other models proposed in the areas of both general learning theory and music composition. Close examination of this model yielded the notion that in order to be applicable in a learning context, a mutually well-understood medium of interaction was a requirement. The current study proposes that in the context of music composition, the graphical computer interfaces under examination might provide such a mediating tool by affording clear and intuitive representations of musical objects, structures and relationships, and by enabling the user (learner and teacher) to reflect on and manipulate these objects.

These propositions then yielded a broad research question and a number of sub-questions that the current study proposed to address.

1.4 The Research Questions to be Addressed

The over-arching research question addressed in the current study is:

Do graphical music software tools support learner and teacher reflection-in-action and reflection-on-action while engaged in the process of learning and teaching music composition?

Concomitant with this is the question:

To what extent is the Schon reflection-in-action theoretical model appropriate to describe the behaviours of learners (specifically children) and teachers engaged in computer-graphical technology-mediated music composition?

A related question considers the function of these tools as facilitators of a research approach. As the Schon model proposes the teacher-as-researcher, the role of the technology in facilitating this approach is addressed.

Does the combination of graphical computer technology and digital video facilitate teacher as researcher reflection in- and on- action?

Arising out of these broad questions, a number of sub-questions arise:

Are there definable categories of behaviours apparent in children while engaged in the learning of music composition facilitated by graphical interfaces?

Are there definable teacher interventions and strategies that are effective in this context?

Can the combined-technology research approach yield particular insight into childrens compositional processes and strategies and aspects of their musical perception and cognition?

1.5 The Structure of the Thesis.

1.5.1 Overview

This dissertation then, will seek to make a contribution to understanding broadly in the area of computer-mediated music teaching and learning. It will first present aspects of the relevant literature in the areas of technology and learning; musical structures, perception and cognition; music notation systems and music composition as viewed by composers, educators and researchers in the field. It will then a outline research methodology suitable for the examination of this broad area and develop the specific research questions to be addressed. It will describe two novel software applications for the teaching and learning of music composition. Data presented will include both close descriptions of case studies involving children and teachers working with the software, and musical compositions submitted anonymously via the internet. Based on the observed data, inferences will be drawn concerning the nature of technology mediated teaching and learning with respect to music composition. Relationships between both learner and teacher behaviours and software affordances and structures will be explored. Finally, the Schon theoretical model will be considered in a manner which will seek to unify these insights into the processes of both learning and teaching within a single framework and demonstrate the crucial mediating role of the software and its associated affordances in enabling and faciltating this model.

1.5.2 Review of Relevant Literature

As the thesis inhabits a variety of separate but related domains, a range of sources is considered. General perspectives on the design and deployment of technology-enabled learning tools are provided by the work of both Papert and Jonassen. Sources outlining the structure of the music domain are presented. Literature in the area of music perception and cognition indicates points of contact between music domain structures and how these structures are represented in the mind, while also revealing gaps in current understanding, especially in respect of children's music cognition.

As the thesis is concerned primarily with the learning and teaching of music composition, a number of related bodies of literature are considered. Composers own writings provide descriptions of composing in terms of musical forms and structures, the compositional process itself and the teaching of composition. Music educators provide viewpoints on the teaching and learning of composition, while studies of children actually engaged in music composition yield insight into how children engage with music in this manner. This latter group of studies is further divided into those studies where children compose using traditional media and those where computers and technology-mediated methods are employed. Gaps in current knowledge are identified, most importantly relating to both the effect of graphical interfaces on children's perception and processes and the nature of effective teaching and pedagogy in technology enabled music composition.

1.5.3 Reflection-in-Action, Affordance and Notation

While a variety of standpoints on learning and teaching are available that might explain observations made during the course of the work, Schon's theory of reflection-in-action was chosen for a number of reasons. Firstly, the theory itself presents a broad view of learning, and as such may be viewed as containing, or at the very least not conflicting with, a variety of other perspectives, from general education perspectives such as Kolb's experiential learning model or the Constructivist and Constructionist schools, to specific models for composing such as that presented by Webster. Secondly, Schon's work offers compelling descriptions of a pedagogic approach and specifically the role of the teacher across a range of subject domains, making it especially applicable to a holistic study such as this. Thirdly, Schon links the notion of reflection-in-action to the availability of a supporting medium. In the current study, it is suggested that computer-based graphical interfaces may provide such a medium for music composition. Finally, reflection-in-action proposes a view of the teacher-as-researcher, which not only informs the approach to teaching and learning contained herein, but also seamlessly links this teaching approach to the underlying research methodology.

Chapter three elaborates on this core theoretical viewpoint underpinning the current work. It outlines the key role that a facilitating medium may play in engendering reflection-in and reflection–on action for both learners and teachers. It also explores the notion of affordances with respect to this facilitating medium, and suggests that interface affordances have a profound effect on the nature of both the learner experience and the manner in which teachers work in technology enabled contexts. This effect, in part, is a function of the manner in which graphical interfaces may act as music notation systems. Therefore, an overview of the role of music notation systems in music learning and in particular in music composition is presented and the suggestion made that computer-based notation systems may have a role in both enabling and exploring children's music compositional processes.

1.5.4 Research Methodology

The current study is a broad-based inquiry into the nature of music composition teaching and learning as mediated by computer graphical interfaces. The methodological approach draws on elements of naturalistic inquiry and action research as well as Schon's theory of reflection-in-action, in order to craft a research approach appropriate to the pertinent issues. The specific mode of inquiry used was the participant multiple-case study. Data collection was primarily by the use of digital video. Case study data was supported by a large body of children's work submitted via the internet. Theoretical relevance specific to the context of the inquiry was induced from qualitative data in a manner informed by grounded theory and supported by *ex post facto* analysis of the larger submitted data set. Chapter four outlines in some detail the methodological approach taken. The suggestion is made that this broadly qualitative approach is particularly suitable to the nature of the study.

1.5.5 Software

Both pieces of software under examination were designed with the intention of enabling users to engage in music construction and composition, without the need for prior musical training, ability to play an instrument or read standard music notation. DrumSteps is concerned exclusively with rhythm and percussion while Hyperscore enables pitched composition, although only two instrumental timbres are supported. While the two software applications are very different in their design and functionality, there are some common characteristics, in that each of provides a non-standard representation of musical information, allied to the facility to manipulate this information in various ways.

While technical aspects of the implementation of the software are not of interest in the current context, chapter five provides a full description of functional aspects of the software, and details the manipulations and affordances which each provides the user in respect of music composition.

1.5.6 Case Studies

In order to address the research questons, two controlled workshop series were held, one for each piece of software under examination. During these two distinct workshop series, the author made formal observation of a number of children, each composing a single piece of music over between five and eight sessions. In the case of both software applications, workshops were conducted during school time but outside of the normal classroom setting, with children in the ten to twelve year age range.

Hyperscore workshops were conducted twice a week over a five week period and involved ten children, in sessions of between fifty minutes and an hour. DrumSteps workshops were everyday over a single week, in sessions of between fifty minutes and an hour involving six children.

During the workshops, the author acted as both researcher and teacher. No *a priori* pedagogic approach was adopted. Rather, the workshops were allowed to unfold as naturally as possible with a view to capturing and identifying key aspects of the teaching and learning process and the relationship between these and the software.

Each session was videotaped in its entirety using digital video cameras trained on the computer screen. This yielded over one hundred hours of digital video, providing a complete record of children's work for later analysis. After initial analysis of this complete video record, three students from each workshop group (Hyperscore and DrumSteps) were chosen as exemplars of specific identifiable behavioural types. Complete transcripts were prepared of each of the six case studies which were then analysed in detail and further condensed in two iterations so as to provide rich case study descriptions which form the core of the data set presented in chapter six.

Complete descriptions of the cases are presented in Appendices B and C, while excerpts which illuminate aspects of the argument are presented directly in the text. Discussion in chapter six procedes on two levels. Specific issues are addressed including compositional process, musical interaction and learning and teaching interventions and strategies. A range of interface-related behaviours are identified and broadly characterised as musical, visual/graphical, kinaesthetic and proceedural. In tandem with this discussion, case excerpts are also considered from the perspectives of interface affordance and reflection-in-action, which comprise the key themes of the study.

1.5.7 Online data

Both pieces of software under examination were also made generally available over the internet and received publicity in the media. In the case of Hyperscore, the software was made available via the Toy Symphony website. The software was publicized via the American Public Broadcast television show, "Scientific American Frontiers", presented by Alan Alda, premiered April 8, 2003[3] and repeated a number of times over the following two months. The launch of the software was also accompanied by a full-page leader article in the New York Times arts section. Following this publicity, the software was downloaded in excess of twenty-five thousand times. Users were invited to submit scores to a gallery on the Toy Symphony website. Of these pieces, one hundred and five were randomly selected for analysis.

[3] http://www.pbs.org/saf/1309/index.html

In the case of DrumSteps, the software was made publicly available in collaboration with the BBC. A Shockwave version of the software was built and placed on the BBC website[4]. The software was publicised on the BBC Radio 3 programmes 'Making Tracks", a music show aimed at children in the eight to fourteen year age range and "The Big Toe Radio Show", a general magazine show aimed at children in the same age range. A follow up competition was held in conjunction with the CBBC 'Xchange' television programme. Children were invited to submit pieces they had made to the competition and for display in an online gallery. Over five thousand users submitted pieces to the BBC website. A random selection of one hundred and fifty-six pieces was made available by the BBC for analysis.

Chapter six also presents a brief account of these selected pieces. Based on particular characteristic gestural features and musical organizing factors, pieces are assigned to those categories developed during the case studies and the prevalence of each behavioural type in this wider data set is assessed. Examples of work in each category and a fuller description and discussion are presented in appendix D,

1.5.8 Discussion and Analysis

Chapter seven is concerned with discussion and analysis of data presented in the previous chapters. Initial discussion focusses on musical interaction and learning, considered from the perspective of the structure of the musical domain. Students are shown to have engaged with a variety of both basic musical rudiments and higher-order musical concepts. Links are made between the nature of this engagement and various acts of manipulation of the musical materials. Key elements of the childrens musical composing processes are identified.

Having established that musical engagement and learning did, in fact, occur, key factors impinging on the learning process are considered, in particular the nature of the affordances provided by the mediating interfaces, and the role of the teacher. Clear links are made between interface affordances and the observed categories of learner behaviours. Teacher interventions are characterised in terms of type and mode, and these are again associated with particular interface affordences.

Finally, the data set is considered through the lens of Schon's reflection-in-action model. Children are shown to have engaged in a variety of behaviours characteristic of reflection-in-action, including problem framing, move-testing and reflection-on-action. The teaching intervention types and strategies are also shown to be manifestations of the reflection-in-action model and the suggestion is made that this model not only adequately describes, but provides an especially appropriate theoretical underpinning for technology mediated music composition teaching. The role of the teacher as researcher is considered. In conclusion, it is suggested that the affordances provided by the graphical interface are crucial in mediating the multi-layered reflective cycle that underpins the observedlearning, teaching and research.

[4] www.bbc.co.uk/music/games/drumsteps

1.5.9 Conclusions and Future Work

Chapter eight directly addresses the research questions outlined above in the light of analysis of the data generated in the course of the study. Suggestions for future work that might broaden and deepen the scope of the current study and further validate its conclusions are made.

CHAPTER TWO. LITERATURE REVIEW.

2.1 Introduction

This chapter outlines aspects of various bodies of literature and prior work that are relevant to the current dissertation. As the dissertation is interdisciplinary in nature and is concerned with a holistic examination of music teaching and learning using technology, a range of sources is explored in order to inform the work. These include sources relating to the use of technology in education, the structure of the music domain itself, music perception and cognition, the role of standard notational forms, the views of both composers and music educators on composing and learning composition and a variety of field studies on children composing both with and without technology. As the range of sources is broad, they are necessarily examined only in sufficient depth as to inform current work. These specific sub-domains relating to this thesis are prefaced with a brief examination of relevant thinking on the general application of technology in teaching and learning situations.

2.2 Technology in Education

2.2.1 Introduction

Over the past number of years, increasing emphasis has been placed on the application of computers and technology in education and learning. This emphasis has not always been accompanied by rigorous examination of exactly what the role of this technology should be. A variety of approaches have been suggested and tried in different subject domains and settings, with varying degrees of success. These have included internet and web based learning exercises, multi-media based approaches and the deployment and use of commercial software. At this point there is still surprisingly little evidence to indicate whether these types of approaches are more or less successful than traditional teaching and learning methodologies.

A variety of models have been applied to the design of learning software, including drill-and-practice, tutorial, educational games and simulations (Alessi & Trollip, 2001; Richmond, 2002). Other technology based approaches have included adaptive environments, where the software presents material to the user and, based on user responses, attempts to make decisions about which material to present next (Brusilovsky & Peylo, 2003), networked systems that attempt to have users engage in collaborative learning through a variety of techniques including dissemination, creating and sharing materials via bulletin boards, shared workspaces, and a variety of other distance learning approaches.

What many of the above approaches share (with the possible exception of simulations) is a view of learning that is based on the notion of delivery and mastery of content. While this may be a valid and useful approach in certain curricular contexts and subject domains, it is less valuable in the creative arts, where mastery of a body of content is not the primary aim of the process. A variety of other approaches exist which may be more relevant to the area of creative music learning.

2.2.2 Microworlds

An alternative vision of how computers might be deployed in educational settings arises out of the work of Seymour Papert (Papert, 1993a). Building on earlier work of Piaget, he postulates that one of the reasons children have difficulty in mastering the concepts of a given domain is that very often these concepts are based on principles which fall outside the range of their normal 'real-world' experience. He suggests an approach based on the idea of a 'microworld'.

A microworld is an immersive environment (real or virtual) that enables the child to interact with the elements of a given domain and carry out operations appropriate to that domain, thereby gaining intuitive knowledge as to the precepts that govern it. The microworld serves as an intermediate, a mediating tool between the learner and the domain, facilitating the construction of learning paths from real world experience and knowledge into that needed for understanding in the abstract world of the domain.

In Papert's vision, the most appropriate use of computers has nothing to do with the transmission of information. Rather he sees computers as a tool to enable children to do things that they couldn't otherwise do. Learners build, make or manipulate objects or artefacts and in so doing are confronted with the results of their actions, learning as they go. The physical or virtual 'building' acts as an external manifestation of the internal process of constructing knowledge that takes place in the course of completing the task. The underlying philosophy is commonly referred to as 'constructionism', the external manifestation of constructivism.

2.2.3 The 'Design Space'

A similar approach underlies the work of Rafael Granados (Granados, 2001) in the domain of mathematics education. Much traditional learning takes place in what he calls a 'problem space'. This is a conceptual space which consists of a well defined problem statement for which there is a clearly defined set of actions leading to a correct answer.

The idea of a 'design space' stems from problems of a different nature. In a design problem, there is no clearly defined problem statement, action set or answer. Rather, learners are required to build their own criteria for deciding on the most useful approach to an open ended problem for which there is no clearly defined solution. Solutions are only better or worse in various ways when compared to one and other. Learners will go through cycles where they continuously refine their understanding in order to arrive at progressively more satisfying solutions. This concept may have relevance to activities in the creative arts, particularly in the area of music composition, where the right/wrong paradigm may not be appropriate.

2.2.4 Mindtools

Jonasson (Jonassen, 2000) asserts that computers can enable people to think more productively by 'offloading' certain lower level tasks. He uses the term 'mindtool' to describe any technology that might be used to enable this process and outlines the key characteristics of these tools. A computer-based mindtool should be readily available and affordable. It should allow for knowledge construction and be generalisable across different subject areas. It must entertain both critical thinking and a degree of transferable learning. The principles of operation of the tool itself should be easily learnable by the beginning student.

What the mindtool approach shares with the others described above is a rejection of the notion of 'technology as conveyor of information'. Neither microworlds (which Jonassen regards as a mindtool) nor Jonassen's mindtools themselves are concerned with the delivery of content. Rather, knowledge is built by the learner during a process of active engagement and construction with the materials. The computer becomes a tool to learn 'with' and not 'from' (Kommers, Jonassen & Mayes, 1992). These mindtools facilitate what Jonassen calls 'cognitive apprenticeship' (Jonassen, 1994), a process involving both tool and teacher which is designed to "…scaffold the all-important processes of articulation and reflection, which are the foundations of knowledge construction."

These approaches assume that knowledge is situated in authentic experience. Unlike traditional approaches, learning is 'ill-structured'. The role of the technology is to facilitate exploratory behaviours (Jonassen, Peck, Wilson & Pfeiffer, 1999) and to support, guide and extend the thinking development of their user (Derry & LaJoie,1990). The emphasis is on learners creating their own their knowledge, rather than receiving it from the teacher.

In this respect, the role of technology is neither to deliver content, nor to replace the teacher. Derry and LaJoie (Derry & LaJoie, 1993) argue that "the appropriate role for a computer system is not that of a teacher/expert, but rather, that of a mind-extension 'cognitive tool'". Planning, decision-making, and self-regulation of learning are the responsibility of the learner, not the computer. However "computer systems can serve as powerful catalysts for facilitating these skills assuming they are used in ways that promote reflection, discussion, and problem solving" (Jonassen, 1995).

2.2.5 Discussion

There are a number of common threads running through all these visions of the role of technology. Most important of all of these is the notion of learner autonomy, so that "the best learning takes place when the learner takes charge" (Papert, 1993).

There is agreement that learning should arise naturally out of a process of exploration, which Papert terms ‘bricolage’, and that this exploration should take the form of actual manipulation of the elements of a domain. The path through the learning process may be as a result of a negotiation between learner, teacher or mentor and the material in hand.

Technology itself becomes an ‘object to think with’ (Papert, 1993a), an extension of the users own cognitive processes rather than a conveyer of information. The underlying philosophical approach is constructionist, implying that learning is situated in real concrete experience and involves the learner making, building, designing or otherwise actively constructing something. The computer acts as a vehicle for construction activities and thereby provides a vehicle for the outward expression of the users understanding and cognition (Sugarman, 1992). This notion of the computer as a means to externalize internal understanding is fundamental to the current study, which in part explores the use of graphical interfaces as a tool with which a teacher may interrogate the students’ cognitive processes.

The current study is concerned with two pieces of software for music composition. In their design, they both draw on principles underlying mindtools, microworlds and the notion of a design space. They are ‘content-free’ and facilitate design and construction activities within the musical domain. They are specifically not designed to engender cross-domain behaviours (although, as will be seen, cross-domain behaviours do in fact ensue) and in this regard may deviate from Jonasson's definition of a mindtool. However, they do meet many of his other criteria with respect to facilitating planning, decision-making, reflection and learning by doing.

In designing the tools, it was envisaged that they would be used in a context that included a competent mentor. This does not preclude their use in other contexts, but for the purposes of this study, this is the context that was assumed. As one of the aims of the study was to examine the role of these tools in facilitating reflection-in-action (see chapter three) in a musical context, a prescriptive approach to actual teaching methodology was not specified at the outset. Design was informed by both the perceived needs of the children and the nature and structure of the musical domain itself, which is discussed in the next section.

Finally, each tool is founded on the notion of construction. Users create, manipulate and aggregate entities on the screen which represent musical sounds or objects, and by so doing create pieces of music. The nature of the resulting musical construction and the process by which it comes about will be a function of a number of factors, including the users’ intuitive musical perceptions and priorities, the structure of the musical domain, the input of a mentor or teacher and the structure of the software itself. It is the relationship between these various factors that this thesis proposes to explore.

2.3 The Structure of the Music Domain

2.3.1 Introduction

Both computer interfaces examined were designed to enable users to interact with music through acts of musical construction and composition. The following section briefly defines terms of reference with respect to core components of the music domain so as to facilitate later analysis of the teaching and learning process. As music may be subdivided into any number of sub-domains, it is considered most relevant to broadly outline those aspects of music that are made accessible through either of the software artifacts in question. The DrumSteps software is entirely concerned with rhythm and percussion. Hyperscore, while clearly supporting rhythmic work, adds layers of melody, harmony and counterpoint. This section will concern itself simply with a brief description of these relevant areas.

2.3.2 The Elements of Music

A large number of treatises adequately cover the basic structures of music. White (White, 1984) is representative of the approach taken in many of these. He presents a comprehensive hierarchic outline of the structures of music at various levels of detail. At each level, music is considered under the broad headings of rhythm, melody, harmony and sound. At the lowest level of granularity (micro-analysis), musical structures are identified as including: rhythm, including details of rhythm at the motivic level, harmonic rhythm, density and relationship to text; melody, which is subdivided into intervals, conjunct vs disjunct motion, tessitura, range, pitch profile, cadential figures, density and relationship to text; harmony, which is subdivided into details of harmony (chord analysis), consonance and dissonance, cadences, contrapuntal or polyphonic techniques, relationship to text; and sound, which includes such elements as orchestration/instrumentation, texture, dynamics, relationship of voices to sound, relationship of text to sound.

At the next level of analysis, which he calls middle-analysis a further set of factors are considered, which include metric and rhythmic structure of phrases and other formal units and their interrelationships, melodic shape in phrases and other formal units and harmonic effects in phrases and other formal units. At the highest level of analysis more global factors are considered which include meters, tempii, overall rhythmic style, primary rhythmic motives, durations of sections, general melodic style, broad pitch profile, use of scales, frequent use of intervals, recurrence of melodic ideas, unity and contrast of harmonic ideas, broad tonal and harmonic relationships.

2.3.3 Rhythm

The divisions adopted by White are reflected in the writings of many other music theorists who delve more deeply into the nature of specific sub-domains. A broad definition of rhythm might be that which is concerned with the "steady, orderly recurrence of audible sounds" (Sachs, 1953). Cooper and Meyer

(Cooper & Meyer, 1963) describe a hierarchical structure for rhythmic organization. The rhythmic structure of music is constructed as an organic whole, where smaller rhythmic units, while possessing their own internal structure, also serve as integral parts of a larger whole. Three basic modes of temporal organization in music are pulse, meter and rhythm. A pulse is a series of regularly recurring, equivalent stimuli. Meter is the measurement of the number of pulses between more or less regularly recurring accents. Tempo, while modifying these three, is not itself a mode of organization. Accent is a function of a variety of factors that include duration, intensity, melodic contour and regularity (ibid). As accent occurs when a note event stands out or is set off from other notes in a series, while at the same time being similar and near enough to these so as not to be perceived as an isolated not event.

Rhythm is commonly defined in terms of grouping of note events (ibid). Repetition of a simple rhythmic fragment will tend to identify that fragment as a coherent group (Howell, Cross & West, 1985). Howell et al also identify patterning as an important element in music. Groupings that are symmetric may be divisible into smaller regular groups. The term meter is used to refer to regular alternation of accents with one or more weak beats, while rhythm is used to refer to the grouped organization of relative durations without regard to periodicity (E.F.Clarke, 1985; Kramer, 1988; Clarke & Krumhansl, 1990). Christopher Hasty acknowledges the interplay between fixed metric order and internal rhythmic variety, stating that "rhythm means, on the one hand, lawfulness, regularity and measure and on the other hand, expressive or compelling motion, gesture or shape"(Hasty, 1997).

2.3.4 Melody

Melodies composed of discreet pitch levels are universal throughout all musical cultures. Pitches are commonly divided into pitch classes or scales repeated through several octaves, founded on tonal centres. Functional harmony arises in melodies out of the relative stability of a tonal centre, generating tension through movement away from the centre and resolution through returning to it, such that "knowing where you are in the tonal structure is part of understanding the piece". (Dowling, 1991)

There are two broad types of melodic structure; conjunct and disjunct (Meyer, 1973). Conjunct melodies tend to be linear and to continue to a point of relative stability. Disjunct melodies are those which either 'skip over' notes (gap-fill melodies) usually presenting these missing notes in what follows, or those which are based on triadic interval patterns (third, fourth or fifth) and may imply continuation of the pattern until a point of stability is reached. Most melodies will in fact show characteristics of both types. Relationships between melodic structures are based on repetition, continuation, contrast of function or symmetry.

2.3.5 Harmony

At its simplest, harmony consists of vertically constructed chords or sets of notes and their relationship to each other (Pratt, 1996). While there is a considerable range of harmonic styles and genres that might be considered, for the purposes of this dissertation, harmony will refer to what is commonly called ‘western tonal harmony’. This is a set of generally agreed systems and structures that underpin much of western music over the past four hundred years. It is the system most relevant to both the cultural experience of the children involved in the studies described and to the software with which they are working.

Static harmony may be described in terms of triads (sets of three notes called root, third and fifth, drawn from an underlying major or minor scale), inversions of these triads (by placing notes other than the root in the bass), consonance and dissonance and modulation (shifting the tonic). Key movements are described in terms of first, second and third level dominant-tonic relationships, gradually moving from the main key via a circle of fifths (Warburton, 1967; Pratt 1996) .

The frequency and rhythmic quality of chord changes is frequently referred to as harmonic rhythm (Piston, 1949). Cadences are those harmonic patterns that define, or commonly occur in tandem with, points of rest or phrase endings. Chords may then be arranged in progressions, which create a sense of harmonic movement towards or away from points of rest. Within these progressions, chords may have functional relationships with respect to harmonic movement and direction (Forte, 1974).

2.3.6 Sound

It is self-evident that music consists of sounds, usually ordered in various ways. The ways in which sounds may be organized are commonly described in terms of rhythmic, melodic and harmonic parameters. Sounds themselves may be described in terms of broad parameters such as tone-colour, volume, duration, attack, location and pitch (Self, 1986). As the sounds experienced by the children in the current study were produced by computer using MIDI technology, the parameters over which they had direct control were pitch, volume and duration. There was control over tone colour to the extent that they could choose particular timbres and combinations of timbres, but not to the extent that expressive manipulation of the sounds themselves was possible.

2.3.7 Summary

There is agreement among music theorists that the basic structure of music is comprised of rhythm, melody, harmony and global factors including tempo, timbre, texture and instrumentation. Emphasis is places on how these basic elements are combined to form groups, patterns and structurally meaningful units. A sense of hierarchical order from basic note groups to large-scale structure is common to many descriptions. Each of the broad categories described may be broken down in to lower order sets of elements and relationships, while the categories themselves do not operate independently but rather in a state of mutual interdependence.

The current study examines how and at what level children interact with these various elements of music while engaged in computer-based composition. Of the two pieces of software used, DrumSteps operates exclusively in the area of rhythm, while Hyperscore facilitates interactions with and through rhythm, melody and harmony. In each case, appropriate sets of descriptors will be brought to bear based on the relative aspects of the relevant sub-domains as outlined above.

2.4 Music Perception and Cognition

2.4.1 Introduction

The current thesis is in part concerned with children's musical engagement and learning in technology-mediated environments. While the primary focus of the study is not children's music cognition *per se*, sources on music cognition and perception are clearly relevant to the extent that they inform the examination and analysis of research outcomes with respect to learning.

2.4.2 The Relationship between Music Theory and Perception/Cognition

Music theoreticians are interested in understanding the musical structure and interpretation of actual music compositions. Cognitive psychologists are generally interested in researching mental theories of how specific musical events are perceived. Much of this latter body of work is based on the study of discrete musical parameters rather than a holistic study of the musical experience. The applicability of findings from work of this nature may be compromised by "the tendency for psychologists to use test materials that are so musically impoverished that they do not really provide a context for musical perception at all" (Cook, 1994).

There is evidence that musicians and non-musicians seem to attend differently, or attend to different things in their listening. Musicians may attend to structural features of rhythm, melody and harmony, while non-musicians may attend to more superficial features such as timbre or melodic contour (Wolpert, 1990, 2000). Theories of musical structure may tell us about what composers did, but not necessarily about what people hear. Cook argues that there needs to be a clear distinction between abstract music theory and the study of music perception, and a careful translation of concepts from one discipline into the other

This points to the difficulty in teaching naïve musicians in the absence of a clear understanding of what they are attending to, and no shared formal language of description that may be used to guide their attention. The current study seeks to demonstrate that graphical interfaces as mediators of musical reflection may bridge this gap between childrens musical perceptions and objective musical structures.

2.4.3 Perception of Rhythm, Melody and Harmony

Conventional music notation may offers clues as to what relationships are actually perceived in listening to music. Specifically with respect to rhythm, beat, meter and bar are of central importance (Longuet-Higgins & Lee, 1982). Rhythmic repetition and tempo are important in determining perception of rhythmic grouping (Drake, 1998; London, 2002). Perception of rhythmic features is closely allied to melodic perception (Steedman, 1977). Features that may be used to describe a melody include contour, interval pattern, pitch set and key (Dowling, 1994). Listeners will generally recognize melodies which share the same contour, despite differences in the precise intervallic structure (Dowling & Fujitani, 1971; Dowling, 1978). Contour does not function independently of other melodic attributes. Rather it is integrated with both tonal and rhythmic context (Dowling, 1994; Bartlett & Dowling, 1980). Perception of contour may also be a function of melodic length (Edworthy, 1985). Rhythmic factors may also be important, especially for naïve musicians, who will attend to rhythm as the primary factor in identifying similarity between melodies (Halpern, Bartlett & Dowling, 1998). Melodic perception may be influenced by a variety of other factors, including harmony (Povel & Jansen, 2002).

The interrelated nature of those musical parameters which of necessity are often separated out for individual study is particularly apparent with respect to harmony and perception of tonality. Listeners extract a sense of key from successive chords perceived in relation to one and other. Key changes are perceived relative to both the distance between the two keys and the relative directness of the modulation path, while the sense of the prevailing key is stronger than that of the last heard chord in isolation (Krumhansl & Kessler, 1982). Perception of hierarchies of pitch with respect to a tonal centre is also dependent in part on rhythmic pattern (Hershman, 1995). Perception of harmony and harmonic movement may also depend on the time span over which these events occur, with tonal closure only affecting listeners when the piece is significantly less than a minute in length (despite the fact that the notion of tonal closure underpins most models of tonal music) (Cook, 1994). Non-musicians exhibit little sensitivity to tonal factors in forming segments when engaged in a holistic listening, instead focusing on surface factors in the music such as change in registration, density, temporal discontinuity or repetition in choosing points of reference within the piece (Deliege, Melen, Stammers & Cross, 1996).

2.4.4 Accent, Grouping, Patterns and Perception of Boundaries

Many listeners use accents as musical landmarks in the construction of understanding of time structure of music. Complexity in structure arises from perception of accents at varying degrees of hierarchical importance (Pfordresher, 2003). Listeners have a tendency to impose pattern-based organization on musical information, so that “people appear to have strong propensities, whether innate or learned, to discover patterns in temporal sequences presented by the environment” (Simon & Sumner, 1968).

Patterns may exist along dimensions of rhythm, melody, harmony and form or may arise as a result of the interaction between these. Patterns are identified as involving periodicity, that is to say repetition at periodic intervals. Listeners abstract pattern information from music with reference to rhythmic, melodic and harmonic cues such as accent, note duration and orderly progression. In forming patterns, grouping of elements is important, predicated on a number of principles including temporal proximity, proximity along the pitch dimension, loudness, timbre and spatial location Other factors which may influence grouping include continuance, contour and repetition of pitch contours while grouping with respect to temporal placement has been found to outweigh tonal structure (Deutsch & Fereo 1981).

Studies of children clapping and notating simple rhythms and of children re-constructing known melodies using Montessori bells show that children attend to grouping of note events into figures based on position and function rather than on formal definition of each note event by property (Bamberger 1991, 1994). Children constructing melodies using Montessori bells pass through a number of stages identified as figural, transitional and formal (Bamberger, 1991). The figural stage is characterized by a reliance on enactive or kinaesthetic techniques – the physical orientation of the bells, the actual pitch structure of the tune and the child's "felt path' over the bells in playing the tune are intertwined. In the transitional phase, the 'felt-path' through the tune is decoupled from the physical orientation of the bells (the 'bell-path'). Finally in a fully formal description of the tune, the configuration of the bells is fixed and invariant and the tune constructed by an 'action-path' over the bells which produced the desired pitch sequence. This formal representation is one in which the note events are formally classified, in this case according to their position in a scale.

2.4.5 Discussion

There are a number of characteristics that imbue much of the literature on music perception and cognition. With the exception of Bamberger, many of the studies quoted were carried out in artificial circumstances, for example using probe tone or other non-contextualised stimuli. Many tests involved subjects listening to stimuli of various types and responding in various ways. In general the subjects were not actively engaged in musical activity other than listening. Most of the studies were carried out using adult subjects rather than children. There is a clear need for further work which addresses children's music cognition as they engage actively in real musically-meaningful tasks.

While this study is not directly concerned with an examination of children's music cognition and perception, it is clear that those factors outlined above have a bearing on the current work. As the study is concerned with use of music software for music teaching and learning, what the children attend to and the extent to which the software both facilitates and directs their attention are of considerable importance. Furthermore, the extent to which the software makes aspects of their process available for description and examination is of relevance to an evaluation of both the teaching approach adopted and software itself as a teaching and research tool. So, while the dissertation will not explicitly analyse children's musical cognition and perception, it will refer to these in so far as they relate to teaching and learning interactions and will also seek to demonstrate the value of these interfaces as research tools in the area of children's music cognition.

2.5 Music Composition

2.5.1 Introduction

Historically the teaching of composition has been largely concerned with rules based method. In other words, music is governed by sets of rules and so in order to compose properly, these rules must be learned. This method is commonly grounded in a sense of musical style. In the renaissance era, certain basic premises were understood and followed by the vast majority of composers, likewise in the baroque period, the classical and so on. In modern compositional teaching, most of which happens at third-level with adult students, it is generally accepted that students will follow a path that involves first learning to compose in a variety of historical styles, absorbing the conventions of the style and demonstrating this with pastiche composition before beginning to develop their own voice. At this point, the student commonly moves to study with a mentor or master composer, who guides him/her in finding and developing this voice.

Many treatises on composition exist. The emphasis in most of these works is on 'what to teach" rather than "how to teach". In the main, they consist of formal descriptions of the structure of music with instructions as to how melodies should be structured, how harmony works, how voices go together contrapuntally in various styles allied to formal exercises, often based on given seed material. The approach is typically domain-centric and rules-based. The student must become familiar with the materials through a series of programmed exercises before engaging in real creative composition.

This approach is clearly neither meaningful or appropriate for children, who are often not specifically engaged in the formal study of music and who do not have the necessary grounding in music history, musical analysis and rudiments. The current study seeks to take an alternative approach, by providing computer-based environments that enable children to construct an understanding of musical fundamentals while simultaneously engaged in acts of musical construction.

During these acts of musical construction, many kinds of learning may occur. Students may learn directly the important musical concepts underpinning music composition. They may also learn something about the compositional process itself, what kinds of strategies and working methods may be most effective in realizing their musical vision. On another level, they may engage with fundamental musical principles and rudiments. This study will seek to observe children's learning on all these levels, to make connections between these and the structures and affordances of the facilitating interfaces and to demonstrate an underlying reflection-in-action dynamic.

In order to inform discussion of the nature of the children's learning, the current section first seeks to outline the nature of composing and the composing process with reference to the writings of practicing composers. It examines the writings of both composers and music educators with respect to teaching and learning of composition. Finally it summarises a number of actual studies of children engaged in music composition for insight into how children engage with music in this manner. This latter group of studies may be divided into those studies where children compose using traditional media and those where computers and technology-mediated methods are employed.

2.5.2 Composers on Composing

Eminent American composer Roger Sessions (Sessions, 1970) provides a concise view of composing in terms of a number of broad general principles; association through repetition or variation, contrast, cumulative movement/continuity, balance/proportion and articulation contributing to a unified whole. Arnold Schoenberg (Schoenberg, 1967) uses very similar language to describe his compositional priorities. He emphasizes "clear and distinctly phrased formulations, logical continuations, characteristic contrasts and constructions, accommodated and changed in response to various purposes" (Schoenberg, 1967)

The importance of achieving unity contrasts with the need to maintain continued interest throughout the piece. "The cardinal problem, is that of achieving unity" while "the factor of change is essential to retain interest" (Smith Brindle, 1986).

Composing is a practical activity. "The composer is, first and last, a practical musician" (Sessions, 1970). Some element of craft is essential. Craft implies a familiarity with the materials at hand to the point of complete fluency in shaping them to whatever is the desired purpose. Musical materials include not just groups of pitches and rhythms, but also the musical ideas that they embody. Berio states, "For me, musical material means thought, musical concepts" (Berio, 1985).

Musical compositions spring from an initial idea.

> Every composer begins with a musical idea – a musical ideas, you understand, not a mental, literary or extramusical idea….. It may come as a melody…or…as a melody with accompaniment…or, on the other hand…the theme may take the form of a purely rhythmical idea. (Copeland, 1957)

Cage characterizes the search for this initial idea as a process of discovery, stating "I always want to start from zero and make, if I can, a discovery" (Kostelanetz, 1988). The nature of this initial idea then informs everything which follows so that "the real beginning of a musical composition occurs when the composers imagination is set in motion by a musical pattern which has taken hold of"'(Berio, 1985).

The composer has this initial idea and then related ideas. At some point he becomes aware of what these ideas are and has established their relationship with the total design. The process then becomes one of execution, “and requires of him a constant awareness of not only everything which has been done up to the point at which he has arrived, but of what is to come” (ibid).

Composers must make choices with reference to their specific intentions. These choices are made in a particular context, not on the basis of ‘good’ or ‘bad’ but rather in terms of what is right in this context. Each choice leads to the next and, as the process evolves, the outcome becomes more and more predetermined, so that “his choices are made within a specific framework, which, as it grows, exerts an ever greater influence on what is to come” (Sessions, 1970).

There is a sense in which the process of composing involves becoming familiar with the materials and the possibilities they offer for further manipulation. As this familiarity grows, so does the piece. “Every composer keeps in mind the possible metamorphoses of his succession of notes. First he tries to find its essential nature and then he tries to find what might be done with it – how that essential nature may momentarily be changed.” (Copeland, 1957)

Finally, in common with many of the music theorists mentioned earlier, Sessions emphasizes the need for awareness of the hierarchical structure of music. Pieces of music are made up of “various levels, groups of smaller units which are so designed that on another level they combine into larger units, and so on until the overall design is reached” (Sessions, 1970).

There are remarkably few research studies that offer independent observation of composers and the precise manner in which they pursue their craft. Graf (1947) suggests that there are four stages to the composition process (1) creating a productive mood or sense that composition is immanent, (2) musical conception, when subconscious themes or ideas break through into the conscious mind (3) a sketch phase, in which ideas are extended and developed (4) the composing process itself where ideas take their final form and the piece is worked out to a conclusion. Bennet (1976) develops an expanded version of Graf’s process description which represents the elements most agreed upon in interview with composers (Figure 2.5.1).

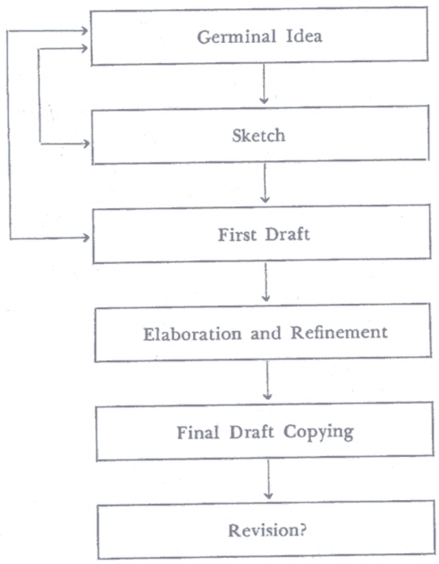


Figure 2.5.1 Bennett's Composing Model

Bennet's model alludes to the iterative nature of the process. Composers make sketches and develop initial drafts of music, which might then suggest other key ideas, forming the basis for a reworking of the draft. This description, and those provided by composers themselves may be analogous to Schon's notion of reflection-in-action. Seeking and generating initial ideas, examining materials to understand the ways in which they may be transformed, finding balance between local interest and overall form and successive iteration may alternately be described in Schon's terms including task framing, move-testing, reflective conversation with the materials and talk-back. The current study will in part seek to demonstrate the relevance of these descriptors in the context of computer-mediated composition by novice composers.

2.5.3 Composers on Teaching Composition

Composition can only be learned by actually doing it, or as Scoenberg puts it, "you can learn only the things you can do" (Schoenberg, 1975). Training in the basic structures of music through composition will have benefits for both performer and listener. While we might not want to hear the products of everyone's compositional attempts, the act of composing will lead to greater understanding on the part of the student (ibid). The correct attitude on the part of the teacher is to "..convince his students that the study of composition will not make them experts or acknowledged judges, that its only purpose is to help them understand music better, to obtain the pleasure which is inherent in the art." (ibid)

There may be a distinction between what can and should be taught and what cannot. Those aspects that can be taught include objective aspects of the task relating to the nature of the materials themselves, form and balance and structure and also the development of a sense of critical judgment with regard to the value of various musical ideas.

> A teacher cannot help a student to invent many and beautiful themes, nor can he produce expressiveness or profundity. Instead he can teach structural correctness and the requirements of continuity; he may also train a sense for the expansion and broadness, or, on the contrary, for brevity and limitation of the presentation, and a judgment of the productivity of an idea. (ibid)

The teacher should be able to solve compositional problems in a variety of ways and should model these solutions for the student.

> A true teacher must be a model of his pupils: he must possess the ability to achieve several times what he demands of a pupil once. It does not even suffice here to give direct advice for better procedures; he must work it out in the presence of the student, improvising several solutions to a problem, showing what is necessary. (ibid)

2.5.4 Some Problems with Teaching Composition

> …in composition teaching, as in any other form of teaching, there have to be points of reference in common between teacher and pupil……Once the instrument was the vehicle of thought….Nowadays the instrument can no longer offer a meeting point. (Berio, 1985)

In teaching composition, it cannot be assumed that students will have the high level of instrumental skill that might make the instrument a useful mediating tool in the teaching process. While Berio is referring to the training of professional composers, this point is all the more valid in the context of composing with children.

Smith-Brindle (Smith Brindle, 1986) points to another drawback of composing at an instrument. He says that it is important "to guard against the automatism of our fingers". A composer's creative imagination may be limited by what he or she can accomplish technically at the instrument.

A number of composers, in particular John Cage, point to the problem of notation as a vehicle for musical activity and especially for composing.

> The ideas that a small child should be put in front of a piano and made to read notation which is the equivalent of Greek or Latin is ridiculous……The first thing that happens is that his eyes are engaged and his ears are shut. So that playing music in terms of music education has absolutely nothing to do with ears or the enjoyment of sound. (Kostelanetz, 1988)

Notation may act as a distraction from what is really important.

> Conventional music notation is an extremely complicated code and years of training are necessary for its mastery. Until it is mastered, it is an impediment to confidence. (Schafer, 1976)

Alternative forms of notation may provide a solution.

> Ideally what we want is a notation that could be mastered in ten minutes, after which music could be returned to its original state - as sound…..A special task of music educators ought to be to invent a new notation or notations, which, without departing too radically from the conventional system can be quickly mastered.” (Schafer, 1976)

2.5.5 Discussion

In general, composers emphasise the importance of global ideas such as movement and rest, balance between small-scale idea and larger form, unity and variety, development, transformation and change. There is emphasis on familiarity with materials and the ways in which they might be extended and transformed. The generation of an initial idea or ideas is followed by manipulation and extension of these ideas. A process of iteration and critical reflection leads to a growing understanding of the overall structure of the piece until its final shape becomes manifest. There is agreement among composers that learning to compose must be done by practice. Teachers should place emphasis on the objective aspects of the craft with respect to musical fundamentals while communicating the more global concepts outlined above. They should be flexible enough to generate and model solutions to problems and should set appropriate constraints on the task as a means of stimulating creative activity on the part of students. Finally, students should be encouraged to develop their analytical and critical abilities and apply them to the products of their own work.

Professional composers then, are in agreement on the importance of learning by doing, the iterative nature of the process, the key importance of manipulation and transformation of material, and the need for a well understood notation system. The teaching approach should include an emphasis on aspects of structure and form, modeling, a flexible approach and a willingness to engage with students on the basis of their own work in progress. There are clear parallels between many of these ideas and the principles underlying the reflection-in-action model, which will be explored in more detail in chapter three.

Of fundamental importance to this model is the notion of a mutually well-understood medium of engagement. Many composers recognize the difficulties in using standard music notation as a medium for teaching. These difficulties are especially acute in working with children or naïve musicians. Children cannot use conventional music notation as a tool in the way that trained musicians do. Even if they compose at an instrument, their ideas will be limited by their lack of skill. Furthermore, the ability of the teacher to help them explore their musical ideas may be severely hampered by both the notation problem and the children’s limited instrumental skill. There is a clear need for a more suitable medium through which the student-teacher dialogue may take place. The value of computer-based systems such as those examined here may lie in their ability to present alternative, intuitive notational forms as a vehicle for directly manipulating sound without the need for note reading or instrumental skills, facilitating musical reflection and action for both student and teacher.

2.6 Educators on Music Composition

2.6.1 Introduction

While composing activities form part of most music curricula, in many cases composition takes second place to performing and even to an extent to listening, historical and analytical work. Educators have long been concerned with questions surrounding the role of composing activities in the broader musical spectrum of activities offered to children. Questions relating to when to introduce composing activities, in what context to situate them and what potential benefits these activities may offer have been of general concern to a variety of music educators. This section describes some of the predominant models for general music teaching and learning. It discusses how these models situate composing activities, the nature of the compositional process itself and how these models may inform approaches to teaching methodology.

2.6.2 The Swanwick Model

Swanwick (Swanwick, 1979) proposes a general model for music teaching and learning based on the mnemonic C(L)A(S)P.

C – Composing
L – Literature studies
A – Audition
S – Skill acquisition (aural, instrumental, notational)
P – Performing

Composing, audition and performing are identified as the key parameters for musical interaction. Swanwick considers music to be primarily composed of materials, by which he means the sounds themselves, and elements, which are those sounds or aggregations of sounds presented in a musical context. In order for the sound materials to be transformed into elements, he defines three necessary conditions; selection of sounds from the total set available, relation of those sounds to each other by combining, preceding or following each other in time and the intention on the part of the composer to make music. The notion of intention is especially important here, both in the sense of intention to make music generally and with respect to the specific intent underlying particular gestures. In the context of the graphical environments under consideration, it will be demonstrated that while in most cases musical intent is present, in other cases, gestures may be made at the level of interface affordances and may not embody any specific musical intent.

2.6.3 The Paynter Model

Paynter (Paynter, 1992) outlines a network of interrelated components which contribute to a holistic view of music learning and teaching.

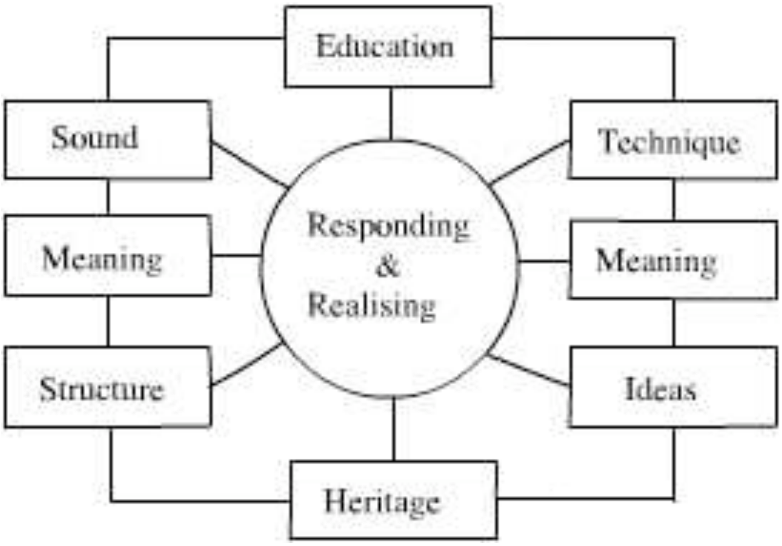


Figure 2.6.1 Paynter's Model for Music Learning (1992)

He identifies "Responding and Realising" as the core activities which bind the others together. Responding includes performing and listening while realizing is primarily associated with composing. He suggests that there are multiple paths by which the various elements might be accessed while composing a piece of music. For example, students may begin with Sound, exploring and listening to various timbres and gaining understanding the various ways they might be transformed. This in turn may lead to a study of musical ideas, leading to development of the technical means of artistic control and eventually the production of whole pieces. Alternatively, students may begin by analyzing existing pieces (Structure) and their context (Heritage) and move from there to develop their own ideas and so on. While recognizing the importance of music listening and performing, Paynter advocates active involvement in the creation of music as fundamental to the musical experience, and identifies the four key areas of sound, structure, technique and ideas as fundamental to the composing experience.

2.6.4 The Composing Process

Composition is ultimately a convergent process. "Every experienced composer knows that, as a composition grows, the music itself appears to take over, and when the work is finished, it is often difficult to remember how it came into being" (Paynter, 2000). This process typically includes elements of manipulation, extension, transformation and development of musical material. There may be stages which children will typically go through in producing a composition, which may include some or all of; devising an initial idea; actually composing the music (moving through processes of exploration, drafting, developing, refining and fixing: performing the music or making it available for listening in other ways and reflecting on the music during and after the composition process, evaluating ones own composing. (Glover, 2000)

The act of composition is an iterative, bi-directional process between composer and material, "so as the artist works on the material, the material immediately works on the artist, and the artist with her sensitivity and craftsmanship responds and decides and carries the act forward" (Reimer, 1989)

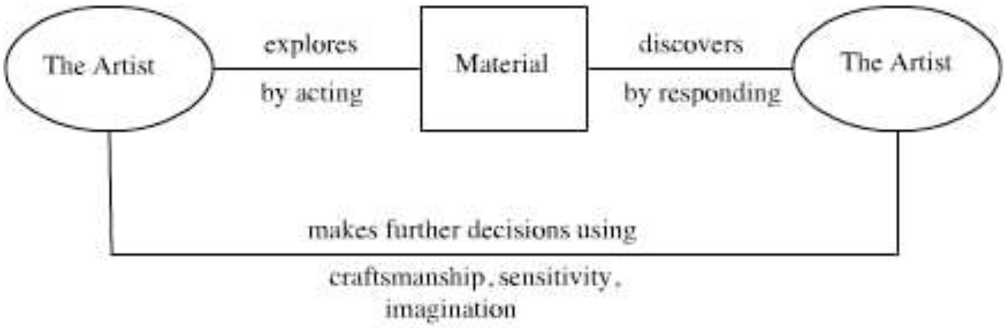


Figure 2.6.2 Reimer's Composing Model

The process is characterized as one involving exploration, discovery and decision-making, (Reimer, 1997) which description is again analogous to many aspects of the reflection-in-action model suggested here. There are limitations that have made this kind of process difficult in the past, notably the necessity to learn an elaborate notation system and also the need to master the complexities of musical instruments. Computer technologies may offer an approach to tackling these problems. "The developing computer technologies are providing people with the capacity to do something that only the tiniest fraction of people in Western cultures could do previously – to compose" (Reimer, 1989a).

2.6.5 Composing as Creativity

Music composition is generally regarded as a creative act and as such, involves an element of creative thinking. A number of models for creative thinking exist, many of which are based on the work of Graham Wallas (Wallas, 1926). He saw four major phases to creative thinking: preparation, incubation illumination and verification. Drawing on this early work by Wallas, JP Guilford (Guilford 1950; Guilford 1957; Guilford 1967; Guilford & Hoepfner, 1971) defined the notion of creativity as the ability to carry out various 'divergent production operations'. Guilford and Hoepfner (Guilford & Hoepfner, 1971) described the attributes or parameters of creativity as fluency, flexibility, elaboration and originality. A more recent model for creativity based on a variety of sources is described by Calkins & Welkowitz (Calkins & Welkowitz, 1984) and reflects a convergence of thought on broad stages in the creative process.

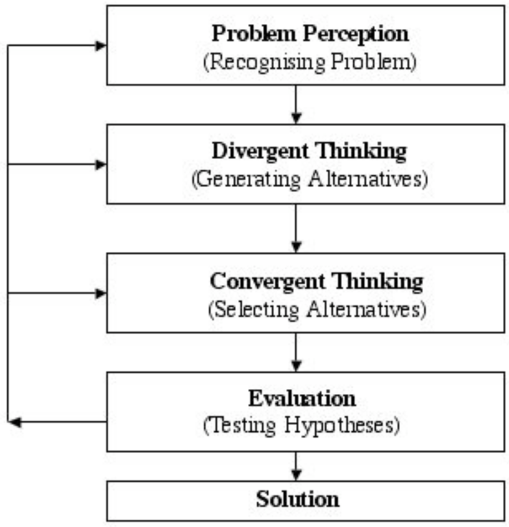


Figure 2.6.3 Calkins & Welkowitz Creative Process

Translating these general characteristic of creativity into the musical domain, musical creativity may be characterized in terms of musical fluency, musical flexibility, musical elaboration, musical originality and musical quality (Gorder, 1980). The process of musical creativity may be divided into a number of distinct stages (Webster, 1994, 2002). The preparation stage is characterized by divergent thought processes and the generation of ideas. A period of reflection on these ideas is followed by periods of working-through and verification where earlier ideas are worked out in a more convergent, linear manner. Webster's model is characterised by elements of reflection and iteration. It encompasses Gorder's categories of fluency and flexibility creativity in the preparation stage, while Gorder's notion of elaboration may correlate with Webster's working-through and verification stages to the extent that this is the point in the process where the composer is most likely to explore and develop complexity in previously formed ideas.

Both Webster (1990) and Hickey (2001a) suggest that 'thinking in sound' is a key aspect of musical creativity. The ability to imagine sounds or sound structures is a necessary part of all stages of the composing process and should be encouraged by teachers. Webster also suggests that a problem-solving context leading to a real product is essential to the process. Children should feel that they are working on a real composing task and should have ample time for exploration, experimentation and reflection. Task framing is important in encouraging children to engage creatively (Hickey 1997; Burns 1986). A mixture of tasks ranging from those that are structured and convergent to those that are open ended and divergent may be useful in engendering creative engagement. Both Webster (1991, 1994, 1998, 1998a, 2002) and Hickey (1997, 2001) strongly suggest that use of computers and technology can be a valuable tool in enabling and enhancing creative music composition by children.

2.6.6 Approaches to Teaching Composition

Music may be conceived as discourse characterized by the internal representation of actions and events, recognition and generation of relationships between things, systems of signs and vocabularies and the sharing of our thinking with others (Swanwick, 1999). This view of music leads Swanwick to outline three broad principles that should inform the teachers approach to the work of music teaching.

Firstly, the teacher must care for music as “multi-layered discourse” requiring complete attention to the musical materials at hand.

> Whenever music sounds, whoever makes it and however simple or complex the resources and techniques may be, the music teacher is receptive and alert, is really listening, and expects students to do the same. (Swanwick, 1999).

The teacher should have a strong sense of musical intention and educational purpose, allied to technical, historical and cultural knowledge, all brought to bear for musical purpose. Secondly, the teacher should care for the musical discourse of the student. He should be aware of students’ achievements and autonomy and respect their natural curiosity and desire to be competent. He also notes that students will frequently want or need to emulate others. In this respect the teacher should attempt to model sensitive musical behaviour. Finally, the teacher should encourage the development of musical fluency. He makes a clear distinction between fluency and literacy, indicating that a fluency in making musical manipulations of various kinds should take primacy over notational or other literacy skills.

Teaching of composition should be done on the basis of the children’s own composed material (Paynter, 2000; Harris & Hawksley, 1989).

> By teaching from what is offered, we can draw attention to the possibilities in children’s music, which, because it is their own, will be important to them, but which can also help them to discover similar things in other peoples music. (Painter, 2000)

A questioning approach may be effective.

> …when anyone has tried putting sounds together and is pleased with the results, enough to remember them, then the teacher can start to teach – mainly by asking questions about what is presented. (Paynter, 2000)

Decision-making is a key componant of the process (ibid). Paynter recommends asking questions that challenge children to recognize and justify the decisions they have made. They should be encouraged to recognize when the music sounds “right” but according to their own criteria rather than any external measure, so that “they have only themselves to convince” (Paynter, 2000) and “the first people who must be satisfied with finished pieces of music are those who compose them” (Paynter, 1992).

Concepts and ideas which teacher should introduce and discuss with young composers include particular melodic or rhythmic features, textural and timbral combinations, unifying features, acquiring a holistic sense of the piece, the relationship between duration and character and whether and how to expand and transform musical materials.

It is not enough to systematically introduce the elements of music to children (Glover, 1990). Rather, children must be actively involved in exercising their musical understanding by taking musical control for themselves. Teachers may gain insight into children's processes by both observing and joining in with children as they work. Glover further stresses those teachers focus should be on children's process as they work and not on analysis of the finished products of the work.

A key issue in teaching composition is the need for balance between student freedom and teacher intervention and control (Harris & Hawksley, 1989). Teacher intervention should be based on a close observation of the children's work as well as discussion with the children themselves so as to best identify the most appropriate intervention. Issues of task-framing and constraint also arise. While teachers will often assign constrained composing tasks with the intention of having the child engage with some specific musical parameters, there is a danger of hampering the child's innate creativity (Wiggins, 1999).

> Music teachers who ask students to compose a piece that is twenty notes long should remember what it was like to write a hundred word essay and spend more time counting words than thinking about its content. (Wiggins, 1999)

The lack of a clearly defined problem may itself act as a debilitating factor. Wiggins distinguishes between enabling and disabling parameters, and suggests that enabling parameters are those that outline one broad overarching idea such as a particular form, textural structure or metric design.

There are difficulties inherent in the use of formal notation systems. When children compose freely at an instrument or by other means, they 'think in sound' so that their ideas are unconstrained. When they are required to write down their musical ideas, they will frequently try to force them to fit into their limited musical literacy, often losing the uniqueness of the ideas in the process (Wiggins, 1999). Swanwick makes a similar point.

> Such 'power' of notation is overwhelming and it soon takes over, and the time allowed for creative 'playing around' on the instrument is gradually reduced and replaced by 'playing middle C'. (Swanwick, 1999)

2.6.7 Discussion

There is remarkable agreement between the views of the professional composers quoted above and those of the educators mentioned with respect to the composing process. Again, the process is described iteratively in terms of an initial 'ideas' stage, a process of expanding and developing these ideas and a refining and editing phase. Difficulties facing novice composers include both a potential lack of instrumental competence and issues around notation. The current dissertation will argue that both of these problems may be overcome by the use of appropriate graphical music software.

Furthermore, it will seek to demonstrate the ways in which the affordances of software may itself fundamentally affect childrens composing process.

There is also broad agreement among a variety of sources on the manner in which composition teaching should occur. Teaching should aim to combine a development of children's technical fluency with musical materials and manipulations with a growing sense of expressive and artistic control. Where possible, composing tasks should be holistic, and material used in the teaching process should be that generated by the children themselves. Teachers should be able to model composing behaviours for students and encourage them to generate their own criteria for informed decision making. Teaching should strive to find an appropriate balance between freedom and control with respect to task-framing and the imposition of constraint. Emphasis is placed on reflection on, and manipulation of musical material. The importance of the facilitating medium for learner-teacher interaction is crucial to the success of the teaching and learning process. The current study will demonstrate that the software under examination may provide just such a medium. Further, it will suggest reflection-in-action as an appropriate theoretical model to describe these teacher and learner interactions, capable of encompassing the wide range of approaches and techniques described above.

2.7 Studies In Children Composing

2.7.1 Non Technology-Based Studies.

The literature on children composing is remarkably sparse and fragmented, with little in the way of comprehensive empirical study. Perhaps the most complete single study is that of Swanwick and Tillman (1986). This is a developmental study of children's composition across the age range three to eleven years. Over five hundred pieces were collected and analysed for developmental trends based on the Piagetian concepts of mastery of the materials, imitation (accommodation) and imaginative play (assimilation). In the case of each child a range of musical opportunities were offered, and the results of the child's work recorded on audio tape. Based on the analysis of the pieces, Swanwick and Tillman propose a model for musical development based on a spiral through four distinct phases, shown in figure 2.8.1.

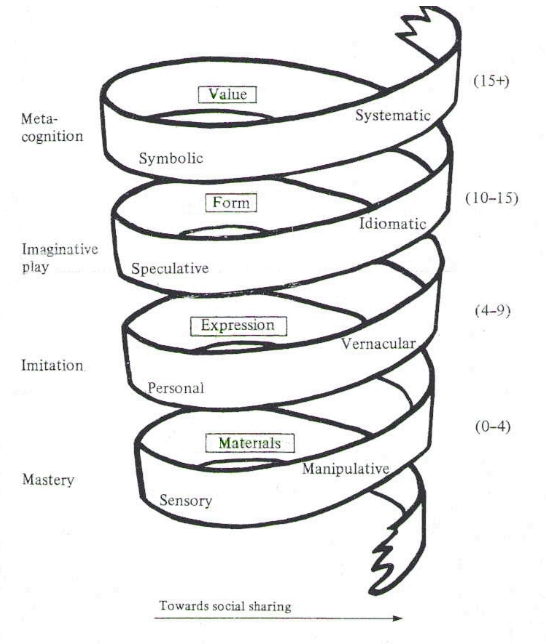


Figure 2.8.1 Swanwick & Tillman Developmental Model

The Swanwick and Tillman study is worthy of comment in a number of areas. Their definition of composition is as broad as could be imagined and is defined as "the freedom to choose the ordering of music". They specifically include improvised pieces, including the briefest musical utterances. All pieces collected were created on physical instruments and recorded on tape. Pieces were not notated. The authors state that "we are observing relatively undirected musical processes rather than the products of polished performances."

In fact, the paper is entirely concerned with analysis of the finished products and makes no comment on the processes by which they were produced. The notion of composing as a process characterized by reflection and iteration is fundamentally different from the process of improvisation at an instrument that characterizes some or all of the pieces chosen. That is not to say that the children studied did not reflect on their work. However no evidence or description of a reflective process is presented. The role or value of a notation system as a means of engendering this reflection is not explored.

A later study by Swanwick and Franca (1999) applied Swanwick and Tillman's developmental categories to assess children's compositions as measures of general musical understanding. Children were observed to be better able to demonstrate understanding of musical form and structure through composition than through performance. The argument is made that this is because the activity of composing is one that allows a greater freedom for imaginative play and personal musical expression than traditional performing activities.

It is always difficult to separate out a musical utterance from the means by which it is produced. In this respect, both the Swanwick and Tillman and Swanwick and Franca studies were primarily based on pieces composed at physical instruments. Pieces composed by means other than those involving kinaesthetic interactions may show different characteristics from those presented here. The current study, while not developmental, aims to remove the necessity for physical interaction with a view to enabling a variety of alternative processes, opening the possibility for deviations from the Swanwick-Tillman model.

Studies designed to examine the compositional processes of children aged seven to eleven years indicate distinct phases of activity which might be characterized as exploration, development, repetition and silence (Kratus, 1989). Development and repetition behaviours are more marked in the older nine to eleven year age range. Younger students, while able to produce a variety of musical ideas, do not seem to be able to either develop or review these. A further distinction may be made between those students who are primarily process focused (produced a variety of ideas but did not achieve closure on their piece) and those who are more product focused (produced less ideas initially but developed them into a finished product),

More successful child composers are observed to exhibit strategies such as: use of stepwise and skipping movement to extend melodic figures; development of musical patterns by changing pitches and rhythms and by extending patterns; use of repetition of both pitches and melodic fragments; closure on a final melody within the allotted time. Less successful composers frequently continue to generate new musical ideas throughout the allotted time, by comparison to more successful composers, who spend most of their time working with fewer initial ideas (Kratus, 1991) .

Younger children (nine to ten years) often spend more time exploring sound sources in various combinations before assembling the music in its final form. Children in the fourteen to fifteen year age range tend to be more concerned with creating finished pieces but are also more concerned with approximating traditional musical structures (Carlin, 1997). Childrens' group compositions also typically evolve in broad stages including planning, development of motivic ideas and reassembling and practicing (Wiggins, 1994). The inability to engage in musical development on the part of some students may be a function of their difficulty in engaging in reflective musical thought (van Earnst, 1993).

There is a significant correlation between reflexivity and success in carrying out tasks requiring convergent thinking (moving towards a single solution) but no correlation with success in divergent tasks. This suggests that more impulsive students would have some degree of success in generating initial ideas but find difficulty in carrying them through to a single musical solution (Schmidt & Sinor, 1986). Students who perceive few choices in the given problem situation tend to repeat the initial sound events, with little development of material, while students who perceive a greater variety of initial choice tend to explore musical ideas in greater depth and continually revise and adjust elements of the emerging composition (DeLorenzo, 1989).

These studies broadly suggest a relationship between particular compositional strategies and successful outcomes. Kratus (1991, 1994) suggests that composing is a fluid and complex process. He argues that efforts in research into composition and composition pedagogy might be better focused on the nature of the composing process itself than on analysis of the outcomes. He underlines a number of approaches which teachers might take to engender successful composing strategies in children. These include instruction in techniques for developing musical ideas, scheduling sufficient time for ideas to be worked out, drawing attention to the importance of testing work in progress, modeling of various strategies for children, a process of sharing ideas with other children and devising meaningful ways to evaluate children's work.

DeLorenzo's work supports that of Kratus in so far as the most successful compositions were the result of exploration of a smaller number of musical ideas but at a greater depth. She echoes Wiggins (1999) thoughts on the nature of guidance that should be given to student composers. Teachers have a role in helping students to recognize the character of particular musical ideas and the ways in which they might be developed. However, there is a danger in imposing a prior structuring device rather than allowing the nature of the child's own musical ideas to dictate the form of the piece.

A variety of factors including informal musical experiences and intrinsic motivation are greater predictors of compositional success than formal music training (Auh, 1997). Students composing with graphical notations may demonstrate a higher degree of creativity than those composing by traditional means (Auh, 1999). Students considered more successful also exhibit a wider variety of compositional strategies than those considered less successful.

Student composers may be characterized as either adaptors (like to do things better) or innovators (like to do things differently). There is no significant difference between both groups in compositional success in both 'ill-defined" and "well-defined" musical problem solving situations. However, there is a marked preference for unprompted or open composition among students, regardless of personal working style (Brinkman, 1999). Moore (Moore, 1990) alternatively characterized learners preferred learning styles as concrete sequential (effective sensory abilities, linear thought processes), concrete random (hands on experience, trial and error), abstract sequential (logical, sequential, preference for instructional materials) and abstract random (imagination, intuition, preference for unstructured contexts). Significantly, he found that abstract random learners performed least well in a variety of musical composition tasks, while concrete sequential learners performed best. This would seem to suggest that while the ability to generate ideas is undoubtedly important, structured linear thinking is a better predictor of success.

Open-ended compositional tasks allowing freedom for imaginative musical play and experimentation have been found to produce the greatest variety of musical expression (Hamilton, 1998; Burnard 1995). However, even those students who gravitate towards more open-ended tasks frequently generate their own constraints (Burnard 1995). Willingness on the part of the teacher to give up some control of the process and allow children a degree of autonomy may be an important factor in achieving a successful outcome (Hamilton, 1998).

Children's bodily intention and instrumental competence affect the generation of musical ideas at an instrument (Burnard, 1999). Children make a clear distinction between improvising (which was viewed as an immediate, single-event performance) and composing (which involved a process of revision), although in some circumstances, improvisation may be a related activity which is subsumed into the composition process (Burnard, 2000, 2000a). Listening to and confirming ideas is perceived by children as one of the central features of the composing process (Burnard, 2000a).

Children's compositional processes and strategies may differ widely, according to their approaches to problem finding, setting and solving (Burnard, 2004). Student's pathways to composition may be characterised as "floater vs linear", "serial vs staged" and "recursive vs regulated". Free movement between Webster's 'phases' of creativity (preparation, incubation, illumination and verification) is noted as being of particular importance (Burnard & Younker, 2002). Other factors which contribute to children's composition process may include: a capacity to assimilate and respond to other peoples ideas, especially those of established composers; the ability to communicate and thereby analyse ideas; the ability to develop broad strategies to guide the development of a piece, and; the ability to develop, grow and add complexity to initial ideas (Bunting 1987, 1988). Bunting alludes to the tension inherent in the teaching of composition between the natural desire on the part of the teacher to pass on knowledge and values while at the same time allowing space for the student to develop an individual voice.

There are differences between naïve and experienced composers in their compositional approach. Experts are better able to take a global view of their work and solve local problems in this context. Novices are more likely to tackle each local problem in isolation and work sequentially through the composition. Experts typically have a larger knowledge base and repertoire of procedures, tend to spend time planning and are better at identifying and imposing constraints on their own work, while novices are more prone to begin immediately and in an unstructured fashion (Colley, Banton, Down & Pither, 1992). Inexperienced composers do have the capacity to generate and evaluate ideas, define problems and make conscious choices within the boundaries of the task. However, they may discard ideas which seemed to have been previously well established and be less aware of initial explorations of sounds and patterns as part of the composing process (Freed-Garrod, 1999).

2.7.2 Composing with Technology

The literature on children composing with technology is very sparse, and such studies as there are frequently concentrate on obliquely related issues rather than attempt a holistic approach. However, as this is the specific area inhabited by the current dissertation, such studies as there are will be examined in some detail.

An early position paper by Rena Upitis (Upitis, 1989) suggests the potential benefits that computer technologies may bring to the process of teaching and learning composition. She points to the ability to manipulate musical sounds and forms and to learn through the actual creation of musical works as key benefits of technology. Further, she identifies flexibility and aesthetic quality as two key components in order for a learning tool to provide the user with a positive experience. A flexible tool is defined as one that will "have many possible uses, both imagined and unimagined" (Upitis, 1989). Aesthetic quality is essential in order to make the tool attractive and pleasurable to use. Computer-based tools may provide ease of use with respect to creation and manipulation of musical patterns and also to musical form while computer graphical representations may play a role in enabling children to engage with musical concepts.

> …the immediacy of computer notations makes it easier for children to grasp a larger sense of form……..when one can see form by watching patterns emerge and relating them to one another as a graphic score is created on the screen while a piece is played. (Upitis, 1989)

At the time when the foregoing was written, the MIDI technology, which forms the basis for many current music software packages, was relatively new. In the intervening time, a small number of studies have examined children composing using computers and MIDI technologies.

Children aged seven and nine, engaged in using MIDI technology may be able to internally represent the formal structures of music with respect to melody and rhythm (Wilson & Wales, 1995). Children were given "unstructured time, in which they could use the software any way they wished". However, observation of the samples of children's work presented seem to indicate a high degree of randomness, in that it is unlikely that children in the age range studied would be capable of intentionally creating or indeed externalizing musical fragments of the complexity presented. No specific composing task was assigned and in fact there is no evidence that the children received any specific instructions to use the software as a means of interacting with musical material. It cannot be assumed, therefore, that children were in fact trying to make a piece of music as opposed to simply exploring or 'surfing' the interface. For example, the presence of melodic contour or symmetry might easily be a function of user actions based on visual criteria rather than specifically musical ones. Grouping of notes into rhythmic units cannot be considered to be completely reliable as the software itself may be active in this respect (quantizing notes, filling empty spaces in bars with rests etc). No specific interventions were made to interrogate the meaning in the childrens interface-gestures.

The important point to be taken from this study is the difficulty of drawing conclusions about children's processes or cognition in music composition based solely on products or superficial observation. This problem is compounded when working in computer-mediated environments, where the interface itself may affect the outcome.

A number of other studies have investigated children composing using computers and associated technologies as a facilitating medium. Hickey (Hickey 1997, 2001) has carried out studies investigating aspects of children's (ages nine to eleven) creative process while composing with computers. The first two studies primarily focused on applying Amabile's consensual assessment technique (Amabile, 1996) to the analysis of creativity on the basis of compositional product. The 2001 study also collected qualitative data by using the facilitating software (Music Mania, a sequencer application) to intermittently record student interactions as they worked. Conclusions are drawn regarding the relationships between intrinsic and extrinsic motivation and the nature of the task. Of more relevance to the current study is the basis on which these conclusions were drawn. Again, intent is ascribed to musical outcomes without any attempt made to ascertain if there was in fact intent. Musical examples given show complex rhythmic content (including 1/8th note syncopations and 1/4 note triplets) which might well be the result of a combination of random improvisational gesture and the 'quantising' function which almost all notation software applies to music recorded from the keyboard.

Folkestad (Folkestad 1997, 1998) made a more holistic study of children composing at keyboards connected to computers. Fourteen children in the 15-16 age range with no prior experience of composition worked at keyboards connected to computers running Master Tracks Pro sequencing software. A topology of compositional strategies used by children when composing at the computer is defined. Children's working practices are characterized as 'horizontal' or 'vertical' based on computer MIDI files saved at intervals as they work along with interviews of the participating children. The horizontal and vertical divisions were then variously subdivided. As children primarily composed at a keyboard, their compositional output was to some extent a function of instrumental skill. Folkestad quotes Sloboda (Sloboda, 1985), who suggests as a method of studying the composition process, "the live observation of composers during a session of composition", although this may be difficult to do in practise. Folkestad suggests that the computer might be a tool to do this, by saving midi data at intervals. In fact, the observation process here is 'quantised', that is to say, the continuous working process has not been observed. Rather the final results of small segments of activity are observed (intervals of between twelve and thirty minutes are quoted as the intervals between saving work).

The study provides little evidence of use of the computer to facilitate development, transformation or extension of musical ideas. This may relate to the fact that students are not composing by using a representational system, but rather by a process of 'structured improvisation'. Folkestad himself recognizes this, posing the question as to "how different software, not based on traditional transfer of data via a keyboard" might affect the outcome with respect to ways of creating music and how the computer is used. Neither Folkestad nor Hickey engaged in any formal way with students as they worked and neither set of studies offers any data relating to the teaching of composition as facilitated by computer.

Other studies have attempted the sort of direct observation suggested by Sloboda. Younker (Younker, 2000) observed nine children in the eight to fourteen year age-range composing using a keyboard/computer/sequencer software (Musicshop v.1.0) combination. Data were collected by verbal reports and responses while composing (think aloud protocol), interviews after each session and general interviews at beginning and end of experiment along with video and audio recordings. Differences in thought processes and strategies among children of different ages were noted. Younger students were more likely to consider material in isolation while older students were more likely to consider it in the context of previous material. Younger children were also more likely to incorporate 'known' material into their compositions. There was not necessarily congruence between what students said they did and what they actually did. Younger students were more linear in their approach while the older ones were more likely to exhibit exploratory behaviours – they were also more likely to 'plan' the piece. Strategies exhibited included exploring, recording, practicing, evaluating editing, although Kratus's (1989, 1991) findings that these factors were age-dependent was not supported. Melodic range was found to decrease with age, while rhythmic regularity was found to increase with age. Older students showed more concern for tonal fit between parts. Students were found to engage with three of Swanwick and Tillman's (1986) four transformations – attraction to and mastery of sound entities, perceiving and producing with the elements of music, creating and responding to relationships among elements.

Prior experience of formal instrumental music tuition may affect childrens perceptions of their own compositional products. Children with prior instrumental instruction rate their compositions more highly than those without. Teacher's ratings of the two groups indicate a greater fluency in both melodic and rhythmic composition in children with prior experience. More interestingly, children's ratings of their own and their peers' compositions show no significant correlation with either specialist or non-specialist music teachers, strongly indicating that the children were using different criteria for evaluating the compositions. In general, teacher criteria seemed to relate more to demands of the curriculum and generally accepted criteria based on their own formal training (Seddon & O'Neill, 2004). Music specialist teachers on the whole rated compositions lower than the non-specialists (Seddon & O'Neill 2001; Seddon 2002, 2002a, Seddon & O'Neill 2003), suggesting that specialist music teachers attend to specific musical characteristics, while non-specialist adopted a more global approach.

An alternative approach to that apparent in the studies outlined above is to be found in the work of Jeanne Bamberger (Bamberger, 2003). Using a piece of software which she designed called 'Impromptu' she observed two musically untrained college students as they engage in melodic composition activities. Activity took place on the computer screen without the use of either formal staff notation or a connected instrument. Bamberger identifies the importance of music representation systems, and suggests that access to multiple representations of musical information allied to immediate sound feedback enables even untrained students to explore and reflect on their intuitive criteria for compositional decision making.

2.8 Assessment of Children's Compositions

2.8.1 Introduction

The current study is concerned largely with qualitative observation of childrens compositional work in computer-mediated environments. Specific foci of the study include children's musical learning on multiple levels, their compositional and reflective processes, classification of behaviours when working in these environments and the effect of both interface structures and various teaching approaches and strategies. While the nature of the observation is qualitative, the quality of children's compositional output is not of primary interest. However, this begs the question as to whether it is possible to examine children's musical learning without engaging in some process of assessment of these composing outcomes. This section outlines a variety of viewpoints on assessment of children's musical compositional products and describes the position with respect to assessment adopted for the purposes of this study.

2.8.2 Formal Measures of Musical Creativity

The issue of assessment of student compositional efforts has generated considerable debate in the literature. J.P. Guilford based a battery of tests on his own work on the nature of creativity (Guilford 1950, 1957). He identified those abilities most relevant to creativity as those concerned with divergent thinking and scored creative ability along the axes of fluency, flexibility originality and elaboration. Further work on assessment of creativity was done by E.P. Torrance (Torrance, 1966), who devised a set of instruments using Guilford's criteria to assess creativity which form the basis of many such instruments still widely used today. A more recent instrument for the specific measurement of creativity in music is that of is Peter Webster. His Measures of Creative Thinking in Music (MCMT) (Webster 1979, 1983, 1987, 1987a; Webster & Hickey, 2000) uses rating scales and a list of criteria to rate children's creative responses as they carry out a variety of musical production tasks.

2.8.3 Consensual Assessment

The principle objection to tests such as those described in section 2.8.2 is that they are based on theoretical constructs and are not validated against any external measure of creative productivity or the real-life processes and products of creative people. An alternative approach is the Consensual Assessment Technique (Amabile 1982, 1983, 1996). Amabile argues that it is not possible to find objective criteria for creativity. She defines proposes a definition of creativity such that "A product or response is creative to the extent that appropriate observers independently agree it is creative" (Amabile 1996). Amabile outlines a series of protocols for task definition, procedure and judging. In essence, a number of students are exposed to the same task under the same conditions. Judges with an appropriate degree of expertise in the domain then rate the products of students work for creativity using their own criteria, which need not be explicitly defined. An aggregation of a number of judges is taken to secure a final result.

A number of studies have adapted Amabile's technique for the assessment of musical creativity. Bangs (Bangs, 1992) studied task motivation and its effects on a creative product. She assessed the music compositions of third-grade children using an assessment tool based on consensual assessment and studied the effects of intrinsic and extrinsic motivational treatments upon the creative output. Intrinsic motivation was found to be beneficial to musical creativity, while extrinsic motivation had an adverse effect. Hickey (Hickey, 2000; Hickey & Webster 2001) refined the consensual assessment technique for use in music in order to study which judges were most appropriate to assess musical creativity. Groups of judges consisted of music teachers (both instrumental and 'mixed'), music theorists, composers and both seventh grade (ages eleven and twelve) and second grade (ages seven and eight) children. Interjudge reliability was highest among teachers and lowest among composers. There was relatively high inter-group correlation between teachers and music theorists, but no positive correlation between composers and other groups. While these results are undoubtedly tentative due to small sample sizes, the initial impression given by this study is that teachers may actually be the most reliable judges of children's creative output. Furthermore, it might be the case that experienced composers may be the least reliable, at least in the context of a consensual assessment test.

2.8.4 Criteria for Teacher Product-Based assessments

Swanwick (Swanwick, 1997) distinguishes between formal assessment and the kind of informal assessments that music teachers make in the course of ongoing work.

> …all teaching involves responding appropriately to what students do and say. And responding appropriately suggests that we can in a sense "read" what is happening. It is when things move towards formality…….that things start to get tricky. (Swanwick, 1997)

In making an appraisal of students' effective music making, teachers should look for evidence of musical understanding and awareness under four broad headings:

- Awareness and control of sound materials.
- Awareness and control of expressive character.
- Awareness and control of musical form.
- Awareness of the personal and cultural value of music.

Swanwick suggests that these categories might be used to generate formal statements of attainment by pupils working in a curricular context and gives examples of how they might be applied to student compositional product. However, the importance of 'awareness' and 'control' as indicators of understanding is paramount. Neither of these parameters necessarily implies an assessment of the quality of the final product. In fact, observation of these qualities in children as they work might provide evidence of musical understanding without the need for formal assessment of the product. In this respect, the teacher is undoubtedly the person best placed to make these sorts of observations. Swanwick himself cautions that these broad criteria will require specific interpretation depending on the context and alludes to the fact that in some cases, only the teacher who has had personal interaction with the student may be in a position to make a valid assessment. "One does not know whether this composition has been autonomously refined (something only their teacher can know)" (Swanwick 1997).

2.8.5 Qualitative and Case based Assessment

Loane (1984) echoes Swanwick's position with respect to ongoing teacher assessment.

> ….it might be that the value of thinking about children's work as art, and as the intersection of skill learning and creation, could only be confirmed in months or years of daily contact with young composers. (Loan, 1984)

In so far as assessment of children's musical output is valid, Loane argues that it should be done by comparison of the achievement inherent in a students work with their needs and interests. He suggests a three-stage assessment process that involves the teacher acting as a receptive open-minded audience listener, reflecting on the music so as to identify what is musically important and finally communicating the resulting insights to the student. He recognizes that different teachers may well attend to different features of the music and hence make different assessments, but as the point of the assessment process is primarily to feed back into the students learning, this in itself is not viewed as a particular problem.

Bunting (1987, 1988) made extended case-studies of four students, aged fifteen and sixteen, engaged in free composition. In the course of these studies, he acted as teacher and mentor to the pupils as they worked. He argues for a teaching role that, insofar as it involves assessment, consists of:

> …noting how deeply they draw on their resources as performers and knowledge of the repertoire – considering extended composition as a problem-solving process in which the quality of the thinking interests us more then the aesthetic value of the final product – and looking for unique yet coherent patterns of development over an extended period. (Bunting, 1988)

He argues that while it is entirely possible to make an assessment of children's compositions by observing the technical features of the finished pieces, assessments of this nature may not in fact be a true reflection of the learning that takes place during the composing process.

Bunting represents the goal of the composition teacher as to try to really understand the child's composition in process and product. His suggested assessment methodology outlines a variety of questions that teachers might apply to the assessment process. However, these questions are not solely for the purpose of an independent final assessment of the product, but rather should inform the work of teaching and learning. The act of teaching is one of posing these and other questions to the student, so that ultimately the student may become the arbiter of his own work and ultimately take control of his own learning.

2.8.6 Assessment in the Current Study

The current study is, in part, concerned with the close observation of a small number of students as they compose. Of all the various studies quoted it is perhaps closest in spirit and intent to that described by Loan, above. In this respect, it is not concerned with making formal assessments of the products of children's composing work. In so far as there is an element of assessment, it is carried out on an ongoing basis by the teacher. Such assessment is informal, situated in the particular context and has as its sole aim to enhance the students learning experience. This ongoing assessment attempts to take account of the particular needs of the student at any given moment and its specific musical focus shifts in accordance with the teachers' perceptions of these needs. It is primarily articulated by questioning and close observation of the children's ongoing work, while its function is to inform that work, so that it feeds back into the compositional progress from moment to moment

In so far as assessment of the online pieces is concerned (section 6.3.5), the point here is not to make a qualitative independent assessment of musical worth. Rather, having closely observed a series of musical gestures, their underlying motivation and the learning that accompanied them, it seeks to find similar gestures in a larger number of pieces, and ascribes similar motivations to them, based on the close observation. In so far as there is qualitative assessment, it confines itself to observation of specific musical gestures, which may indicate engagement with underlying musical principles and ideas, and seeks to demonstrate links between these engagements and interactions and aspects of the design of the software.

2.8.7 Discussion

The two features that pervade most studies of children composing are that: (i) composition is usually facilitated by an instrument, and that; (ii) if a representation system is used or manipulated, it is standard staff notation. The extent to which the children are able to manage the instrument is a factor here, as are either note reading skills or musical memory, especially with regard to the various manipulations and transformations that might be characterized as compositional 'development'. With the exception of Bamberger's work, many of the studies examined above have in common the manner in which technology was used. In each case, a keyboard was connected to a computer running sequencer software or notation software functioning as a sequencer. Composition was carried out at the keyboard and recorded, either periodically or finally using the sequencer. In fact, most of these studies might be better characterized as 'composing at the keyboard, recording on the computer'.

The studies in most cases use the technology to facilitate the compositional process so that a variety of associated factors may be examined, typically relating to children's cognitive or creative processes.

However, they do not engage with the effect of the technology itself on either the composing or teaching process. Most studies treat the technology as value-neutral and have the implicit assumption that it does not in fact impinge on the focus of the particular study. It is not clear, given this value-neutrality issue, if these results will in fact translate into other, non-computer mediated contexts. The specific software packages used vary from study to study, so that it is not clear whether results obtained with one piece of software would be replicable with another. Children's interaction with the various visual or graphical representations used is not described in any detail nor is the nature of these representations specifically considered as a factor in any study mentioned.

While some studies (notably Younker) use digital video as a mechanism for data capture, in the main, analysis of results with respect to process is not based on close observation of students as they work from moment to moment, but rather on either final product or snapshots of work taken at intervals allied to interviews and students own descriptions.

Many teachers express a positive view towards the use of technology based resources in the classroom (Byrne & MacDonald, 2002), but there is a lack of clear evidence as to what their role should be in this regard. The studies quoted in the main examine children's work in a detached way. With the exception of O'Loan, the researchers have not acted as teachers or mentors in the course of the study, and no evidence is offered or conclusions drawn regarding effective teaching strategies while working in computer mediated environments.

There is a clear need for studies such as the current one, which:

- Examine the nature of various non-standard computer graphical representations of musical information and their effect on children's compositional processes.
- Examine the effect of computer mediation on the role of the teacher and the teacher-student relationship.
- Place these factors in the context of an appropriate theoretical framework.

CHAPTER THREE. THEORETICAL PERSPECTIVES.

3.1 Reflection-in-Action

3.1.1 Introduction

Review of the literature on technology in music learning indicates that while various studies examine sub-aspects of the area, there is an absence of holistic studies that include a view of both teaching and learning, underpinned by a strong theoretical viewpoint. The current study addresses this need by suggesting Schon's reflection-in-action model as a theoretical framework within which to consider learner and teacher interactions. It seeks to demonstrate that this does in fact provide an appropriate viewpoint, and shows that elements of this theoretical viewpoint manifest themselves naturally and spontaneously in technology mediated environments.

While a variety of more general standpoints on learning and teaching are available that might explain observations made during the course of the work, Schon's theory of reflection-in-action was chosen for a number of reasons. Firstly, the theory itself presents a broad view of learning and embodies a variety of other perspectives, from general education and learning theories to specific models for music composition suggested by both composers themselves and music educators. Secondly, Schon's work offers compelling descriptions of a pedagogic approach and specifically the role of the teacher across a range of subject domains, making it especially applicable to a holistic study such as this. Thirdly, Schon links the notion of reflection-in-action to the availability of a supporting medium. In the current study, it is suggested that computer-based graphical interfaces may provide such a medium for music composition. Finally, reflection-in-action proposes a view of the teacher-as-researcher, which not only informs the approach to teaching and learning contained herein, but also seamlessly links this teaching approach to the underlying research methodology.

This chapter outlines the essential elements of Schon's theory of reflection-in-action. It outlines the key role that a facilitating medium may play in engendering reflection-in and reflection–on action for both learners and teachers. It explores the notion of affordances with respect to this facilitating medium, and suggests that interface affordances have a profound effect on the nature of both the learner experience and the manner in which teachers work in technology enabled contexts. Finally, as the mediating role of the technology is predicated on its capacity to act as a music notation system, the role of notation systems in facilitating music composition is explored.

3.1.2 Distinction between Reflection-in-Action and Technical Rationality.

The common view of the professions divides the kinds of professional knowledge into three types.

1. The underlying discipline or basic science, on which the practice is based.
2. An applied science component, which yields diagnostic or problem solving techniques.
3. A skill and attitudinal component, which is concerned with the actual performance of the profession in the service of the client.
   (Schon 1983)

There is typically a division between theoretical or research based knowledge and its practical application to solving real world problems, with the greatest degree of prestige an authority inherent in the former (ibid).

However, the kind of knowledge that resides in academic situations is typically not the same as that which manifests itself in the real world practice of professionals. Academic problems used for the purposes of teaching professional knowledge are typically well bounded and convergent in nature. Problem situations encountered by professionals in the real world are considerable less clear and are often marked by a degree of uncertainty with respect to both the situation itself and the desired outcomes. In fact, the real world job of the professional is often more concerned with problem setting than problem solving. In order to move from a problematic situation to an actual problem, the practitioner must first note which things impinge on the problem at hand and then frame the context within which they will be attended to.

Having framed the problem, the practitioner must then decide which approach from the available repertoire of theory and technique is appropriate to the case in hand. In many cases, there will not be a clear match and so the practitioner must attempt to map characteristics of the various approaches onto aspects of the problem. In many cases there is not one clear solution, but rather a variety of possible solutions depending on how the practitioner chooses to frame his role and to what he chooses to attend. The traditional model of professional training and practice, based as it is on technical rationality, has little to say about how professionals should negotiate these divergent problem situations (ibid).

3.1.3 Reflection-In-Action and Reflection-on-action

Schon (1983) proposes an alternative model to account for how professionals actually think and operate in real-world practice. In doing so, he attempts to legitimize the kind of knowledge inherent in the spontaneous intuitive performance of tasks that is largely ignored by the technical rationality model. Schon argues that there are many instances where knowledge is embodied in action. This 'knowing in action' is characterized by the ability to make judgments, recognitions and actions spontaneously without the necessity to think about them either prior to or during their performance. In many cases, the skills involved have been learned intuitively and without conscious awareness. It is often very difficult to describe the nature of this embedded knowledge that is revealed in action (ibid).

This is not to say that this 'knowing-in-action' is entirely devoid of thought. Schon notes two kinds of thinking with respect to this 'knowing in action', which he calls 'reflection-in-action' and 'reflection-on-action'. Reflection-in-action happens in the course of actually carrying out the task in hand. It is characterized by a sense of 'feel' for the situation, where the practitioner continually adjusts and readjusts his approach in the context of a fluid dynamic. Reflection-on-action occurs in periods of relative tranquility between bouts of action. Here, the professional thinks back on a project and explores new understandings arising from the handling of the situation which may inform future actions (ibid)

3.1.4 Characteristics of Reflection-in-Action

Schon characterizes reflection-in-action as a process of research. The professional approaches each individual case in a spirit of enquiry, desiring to illuminate the particular characteristics of the case so as to inform both current and future actions.

> When someone reflects-in-action, he becomes a researcher in the practice context. He is not dependent on the categories of established theory and technique, but constructs a new theory of the unique case. His enquiry is not limited to a deliberation about means which depends on a prior agreement about ends. He does not keep means and ends separate, but defines them interactively as he frames a problematic situation. He does not separate thinking from doing… (Schon, 1983)

Each move that the practitioner makes is in fact a mini-experiment designed to illuminate some aspect of the wider problem. Reflection on the results of this experiment yields further subjects for investigation.

Of vital importance in this experimental reflection-in-action process is the practitioner's ability to engage in this reflective conversation with the situation and the working materials (ibid). In the course of this conversation, the practitioner considers his working materials, makes moves or manipulations of these materials, listens to the situation's 'talk-back', and examines the consequences of these moves. Each intervention then:

> ….yields new discoveries which call for new reflection-in-action. The process spirals through stages of appreciation, action and re-appreciation. The unique and uncertain situation comes to be understood through the attempt to change it and changes through the attempt to understand it. (Schon, 1983)

While the experienced professional will bring to bear a repertoire of prior examples, images, understandings and actions, each situation is treated as unique and worthy of examination on its own merits. In this respect the notion of surprise is important. A move leading to a surprising outcome will often cause the practitioner to re-evaluate his framing of the problem and lead to a shift in stance, suggesting further moves. In fact it is this fluid web of decisions, actions and evaluations that is at the heart of the reflection-in-action process.

3.1.5 Teaching and Learning through Reflection-in-Action

Much of Schon's description of the reflection-in-action process is illuminated by case studies across a variety of professions. He looks in some detail at the case of a master architect and a student engaged in the design of a building. The design context is of particular relevance to the current study, in that the act of designing a building is in some respects analogous to that of composing a piece of music. While the architect faces externally imposed constraints relating to building size, intended use, the nature of the site and so on, the music composer also faces constraints such as genre, musical forces available, intended audience and so on, some of which may be externally imposed and some internally generated. Beyond that, the problem becomes one of generating and developing ideas, fitting sections together and solving local problems while maintaining a view of the whole. Students approaching either area for the first time are faced with something of a paradox.

> The paradox of a really new competence is this: that a student cannot at first understand what he needs to learn, can learn it only by educating himself, and can educate himself only by beginning to do what he does not yet understand. (Schon, 1987)

In a musical context the problem reduces to 'I cannot learn to compose without composing, but I cannot compose without learning how'. The novice composer is expected to plunge into composing from the outset, forced into trying to do what it is that he does not know how to do in order to gain the sort of experience that will help him to learn how to do it. In traditional music teaching methodology, this problem is commonly approached by prescribing a series of decontextualised exercises, designed to make the learner aware of a variety of musical rudiments and technical skills, before engaging in music composition *per se*. However, as Schon points out, the body of knowledge and technical skills that underpin the professions do not adequately describe what it is that professionals actually do. While this approach may prepare the student somewhat to begin the study of composition, it does not address this core question of how we can enable student composers to engage with music composition in the manner of a professional.

Schon's case examples discuss not just professionals in action, but a professional interacting with a novice as the novice attempts to navigate a particular problem. In doing so he engages with issues around how a professional can best communicate to a student the core values, skills, approaches and strategies that illuminate his own practice. Given that the essence of reflection-in-action is by definition not reduceable to a body of propositional knowledge or a set of easily described skills, the question as to how best to communicate this reflective art is not easily answered. Based on a variety of cases, Schon outlines some of the strategies employed by professionals working on a variety of design problems with students.

3.1.6 The Role of the Teacher

Schon points to the basic communication issues that face any new expert/novice learning relationship. From the outset, the teacher, mentor or coach will find it very difficult to help the student. At these early stages, the student has little experience and is quite simply not ready to understand what it is that the teacher is telling them, even at the level of the meaning of basic terms. Further, the reflection-in-action process at the core of the teachers own practice may not be accessible to the practitioner or even be clearly describable in words. Schon describes the problem in terms of the teaching of design.

> " At first their coaches cannot make things easier for them. They cannot say what designing is because they have a limited ability to say what they know, because some essential features of designing escape clearly stateable rules, and because much of what they can say is graspable by a student only as he begins to design. Even if coaches could produce good, clear, compelling descriptions of designing, students, with their very different systems of understanding, would be likely to find them confusing and mysterious." (Schon, 1987)

3.1.6.1 Telling and Listening

Schon identifies two broad kinds of interactions which may inform the student teacher relationship. The first of these he calls 'telling and listening'. Teacher 'telling' may occur at various levels including descriptions of the materials and their attributes, instructions as to how to proceed in specific instances and framing the problem in a specific context. While this approach is entirely conventional, Schon points to the difficulties inherent in giving instructions. Instructions may not be specific enough or may not have a level of specificity which matches the student's needs. The instruction may itself be constructed out of the teachers own in depth knowledge and so be misinterpreted or misunderstood by the student.

Schon suggests that teacher ''telling', rather than being an end in itself, should be viewed by the teacher as an opportunity to interrogate the student's level of understanding. Instructions or suggestions should be given in the context of the student's doing, i.e. while the student is actively engaged in the task. In carrying out the instruction, the student may reveal the meanings that he has constructed for it, thereby giving the teacher some insight into the level of understanding. The instruction then becomes a vehicle for the teacher to reflect on both the students understanding and the quality of the instruction itself, enabling the teacher to modify both the approach and its manner of delivery based on the students needs and the success of the previous intervention (Schon, 1987).

3.1.6.2 Demonstrating and Imitating

In a similar way to verbal instruction, demonstrations are necessarily ambiguous and incomplete**.** While the purpose of a demonstration is to show either what to do or how to do it, it may not be clear to the student exactly what part or how much of the demonstration should be imitated. The demonstration itself may be too complex or refined, so that its essential aspects escape the students attention. There is a further problem in creative design tasks, where students must discover their own expressive voice. In this context, an exact imitation of the teachers work is not a desirable outcome. Rather, the onus is on the student to abstract from the demonstration that which is useful or meaningful and incorporate it into their own work. However, there is no guarantee that what the student takes from the demonstration will be that which the teacher intended.

The real value of a demonstration lies in the extent to which it provides a vehicle for the student to reflect on the teacher's actions. The student may at first blindly copy some aspect of the teacher's performance. Having done so, he may reflect on his own actions and those of the teacher. This comparison may enable him to begin to abstract precisely which aspects of the teachers process, manipulations or patterns of actions have been copied and how these relate to the problem As he repeats this process a number of times, he may find that he has internalized something about the essential elements of the process itself.

3.1.7 The Ladder of Reflection

In real teaching and learning situations, the teachers telling and demonstrating are interwoven, as are the students listening and imitating. This offers both teacher and student the possibility of a variety of possible modes and objects of reflection. Many activities including questioning and answering, demonstrating and observing, listening and criticizing interact so that each intervention or response builds on the previous one. Schon proposes a 'ladder of reflection', which describes how both student and teacher navigate the various levels of action, interaction and reflection.

At its simplest, the reflection path may simply be:

Teacher demonstrates - Student observes - Student imitates - Teacher criticizes.

However, in ascending the ladder of reflection, any aspect of the process may itself become an object of reflection. For example, the teacher may reflect on the message inherent in his own demonstration. In general, moving up the hierarchy of reflection involves going from action to reflection on that action. Moving down the ladder involves moving from reflection to an action based on that reflection. Diagonal movement along the ladder may occur when one party's action triggers the other's reflection or when one party's reflection triggers the other's action. We then have a hierarchy of reflection that moves from action to description of action to reflection on this description to reflection on this reflection.

In the context of a musical composition task, one can imagine a student creating a small musical idea as the basis for a piece of music. The teacher may reflect on this idea and note ways in which it may be improved. He may even demonstrate examples of possible improvements. The student may then reflect on the teacher's demonstration leading to further student action. The teacher may encourage the student to express the reasoning behind this action. He may then reflect on this description leading to further intervention. At the highest level of abstraction, both parties may reflect on the nature of the dialogue itself, seeking to improve their level of communication. The process is one of fluid movement from action to reflection and back, in which the object of reflection may be the working material itself at various levels or ones own or the other parties actions, descriptions and processes.

3.1.8 Teaching as Inquiry

Implicit in this model of teaching and learning is the notion of the teacher as researcher. All teacher interventions are in fact inquiries designed to interrogate some aspect of the situation. At any given time, the teacher may be attempting to discover something about the students working materials, the student's perceptions, thought process and working methods or his own processes and the nature and effectiveness of his interventions. In this manner, each teaching situation becomes an opportunity for the professional teacher to add to his store of experiences, to refine his methodological approach and to gain a greater understanding of the process of teaching and learning. It might even be argued that this sort of reflective intervention is at the core of all good teaching. The aim of the teacher is not just to enable student learning, but also to engage in his own learning journey.

> Teachers need to take on the responsibility of investigating their own practice through their own action-reflection, in order to produce personal theories of education……In this sense teachers become learners, in that they may come to know themselves – that is, engage in their own personal process of education. (McNiff, 1993)

3.1.9 The Role of the Medium

Inherent in the description of reflection-in-action given above is that there is a medium through which both student and teacher can engage with the material. In the case of the architecture studio, the medium is that of pen and paper. The most immediately significant aspect of this medium is that it is in fact a virtual one. The architect does not actually move physical objects around on a building site. Rather he explores ideas through manipulation of graphical symbols.

This is significant for a number of reasons. The architect may conduct virtual experiments and test hypotheses while managing some of the constraints that might act as an impediment in the real world. Further, the symbolic representation may itself act as a source of ideas. "Because the drawing reveals qualities and relations unimagined beforehand, moves can function as experiments" (Schon, 1983).

The virtual environment facilitates spontaneity of action and reaction, enabling a fluidity of thought, experiment and reflection. The pace of action may be varied, allowing the designer to pause and reflect or act intuitively in the moment. The medium provides a record of actions for later reflection. Moves that appear to be unproductive may be easily discarded and new strategies tried. Finally, variables that seem inextricably linked in the real world may be broken apart and operated on separately.

It might be argued that the traditional medium of standard music notation or notation in combination with a musical instrument serve an equivalent function to the architects pen and paper. However for novice musicians this may not in fact be the case, for reasons very similar to those outlined by Schon. While a novice architect can draw shapes on a page and envisage some relationship, however rudimentary, between these virtual objects and the real world objects they represent, standard music notation operates at a further level of abstraction. The complexities of the notation system are such that it is impossible to use standard notation as a vehicle for musical reflection without a degree of expert knowledge as to how the notation system operates. This in turn requires a degree of expert knowledge of the domain itself allied to the ability to imagine the sounds that might be represented by the notational symbols. It is therefore extremely difficult if not impossible for a novice musician to use standard staff notation as a way into the domain.

Furthermore, in order to enable the various levels and degrees of reflection described by Schon, it is necessary for both student and teacher actions and reflections to be accessible, one to the other. This requires that actions made by each should be made manifest to the other in a form that may be clearly understood. Traditional staff notation cannot act in this capacity as it is a medium that is not equally well understood by both parties. Moves made by a professional musician in standard notation may be clear and transparent to him, but will not be so to a novice. In order to reflect on the substance of an action, a mutually well-understood medium is required. The suggestion is made here that certain computer graphical interfaces may serve this purpose, thereby facilitating reflection-in and –on action for both learner and teacher. However, while these interfaces may act as a medium through which various forms of reflection and dialogue may occur, they themselves will also, through the manner of their design, have an effect on these reflective processes. The manner in which an object or artefact (such as a computer interface) suggests or implies certain patterns of action and interaction on the part of the user is commonly referred to as affordance, described in more detail in the following section.

3.2 Affordance

While the current thesis is not primarily concerned with software design, it is concerned with the nature of behaviours exhibited by children and teachers as they compose with and through graphical music software. The software acts as a mediator, as described by Schon, serving to facilitate elements of the reflection-in-action process. The software affords actions, which, as will be demonstrated, may be musical or extra-musical in nature. It will be argued that behaviours exhibited by both teachers and learners cannot but be a function of the design and affordances of the software, to some extent at least. In this respect, the work of Donald Norman provides a framework within which to examine these behaviours and make connections between them and the affordances of the software that gives rise to them.

Norman (1998) describes the notion of affordance as associated with everyday objects.

> ….the term affordance refers to the perceived and actual properties of the thing, primarily those properties that determine just how the thing could possibly be used." (Norman, 1998)

The idea here is that most everyday objects have sets of properties which suggest their use to the user in the absence of any instruction. Hence, "affordances provide strong clues to the operation of things. Plates are for pushing. Knobs are for turning. Slots are for inserting things into. Balls are for throwing or bouncing" (Norman, 1998).

Norman also refers to the importance of causality, or rather the psychology of causality. Something that happens right after an action will often be ascribed as the result of an action, even if it is not. When an action has no apparent result, the actor may conclude that the action was ineffective.

In the case of simple physical objects, the connections between cause and effect are very often clear. It is very easy to see how a scissors works, for example. In the case of something as complex as a computer program, the situation may not be so clear. Of course, the various causes and effects that take place within the computer are of no concern to the user. However, when the computer acts as a mediating device to facilitate access to other causes and effects, a degree of transparency is necessary between user actions and results. Norman identifies both visibility (making the relevant controls visible and accessible) and feedback (giving each action an immediate and obvious effect) as key to the design of functional objects (ibid).

He describes two modes of interaction with computers, which he terms "command mode" or "third person interaction" and "first person interaction". The former refers to issuing commands to the computer via command language or code, the latter refers to using the computer to directly access some other task or domain. In the latter case, he stresses the importance of "making the computer invisible".

> When I use a direct manipulation system – whether for text editing, drawing pictures or playing games – I do think of myself not as using a computer but as doing a particular task. The computer is, in effect, invisible. The point cannot be overstressed: make the computer invisible. (Norman, 1998)

These points are especially important in the design of educational software and critically so in the area of music. Software that is designed to enable the user to engage in some active learning process must first make clear which elements of the domain in question are under the user's control. It must offer clear feedback indicating the result of each user action and enable direct engagement with the material in question in a manner that renders the computer 'invisible'. In many cases feedback may be purely visual. In the case of music software, while visual feedback is required to indicate a change in the state of the system, there must also be aural feedback. The user makes an action, sees a visual change and hears a corresponding change in the sound output, either in real time or on playback.

The complexity of the musical domain means that this simple requirement is in fact extremely difficult to implement. A wide variety of parameters need to be manipulated in order to achieve structural and expressive control within the music domain. This means that software designed for musical manipulations will itself be necessarily complex and contain a large number of controls. The situation will be further complicated if the users musical perceptions are such that they cannot clearly hear the result of their actions, even if such results are made clearly manifest. In this case, an approach that offers a clear one-to-one correspondence between a given visual control and a single musical parameter may offer the best chance of success.

Even if software is extremely well designed, it is impossible to predict the use to which it will be put. While the software may be designed to operate in the musical domain, by its very nature, it will contain a graphical user interface. Immediately, users have the option of interacting with aspects of the interface itself or with the musical objects it represents. The degree to which an interface serves either to facilitate or to inhibit musical action and interaction will undoubtedly be a factor in determining a successful user experience. The current study is concerned with children and teacher using graphical software for musical composition. It will argue that the composition process is underpinned by a process described by Schon's reflection-in-action model, and further, that the software in question mediates and affords both the composition process itself and the underlying reflection-in-action.

Both pieces of software considered in the current study attempt to offer clear visual metaphors allied to immediate feedback as a way of enabling musical learning through acts of composing or construction. The notion of interface affordances strongly suggests that it is neither desirable nor indeed possible to consider the user's learning experience in the absence of consideration of the enabling software. Therefore, in analysing both teachers and learners experience of the software, an attempt will be made to identify what sorts of activities or functions each interface affords the user, and which aspects or affordances seem to be useful in engendering productive learning experiences, both in general and specifically in the musical domain. In the latter respect, the mechanisms by which musical interaction are afforded are to some extent a function of how each interface acts as a representation or notation system for musical information. The following section will therefore consider relevant aspects of music notation systems, while chapter five outlines in detail the specific functionality of the software in question and relates this functionality to the notion of affordances.

3.3 Music Notation Systems

3.3.1 Introduction

The current study is in part concerned with the design and deployment of software-based alternatives to standard music notation systems, and the role that these may have in the teaching and learning of music composition. This section briefly summarises the functions ascribed to standard notation systems, outlines some of the drawbacks of the use of these systems with children and provides a rationale for computer-based alternatives.

3.3.2 The Function of Notation

Bamberger (2004) describes music notation systems as "systematic frameworks within which the noticeably invisible relations of pitch and time that are necessarily experienced as continuously going on, come to be represented as spatial, static, and invariant properties" (Bamberger, 2004).

While the experience of music is time dependent, it is suggested that a notation system may hold the music steady in a way which enables a variety of interactions therewith. Such music notation systems as have developed over many hundreds of years share the common purpose of preserving and safeguarding the music of a culture both by establishing the course of particular performances and by transmitting performing skills and musical conventions. Specific uses include:

- Allowing the writer to invent new music and to calculate effects in advance;
- Providing an exact timetable so that independent parts may be co-ordinated;
- Providing the performer with an artificial memory;
- Describing the sounds of performed music for the purposes of analysis or study.

(Cole, 1974)

The functions as described fall broadly into three categories: recording, transmission and as a tool for composing, although the latter is not spelled out explicitly.

3.3.3 Notation as a Cognitive Tool

The notions of 'allowing' the writer to invent new music and to calculate effects in advance and of providing 'an exact timetable' allude to the use of notation systems as a 'thing to think with' (Papert, 1993). "Notation is the servant of expression, but equally a medium of independent thought" (Maconie, 1990). While it is perfectly possible to compose music without a notation system, as music becomes more complex, the problem becomes larger, and at the very least there is a need to record work in progress. Further than this, the notation system serves as a vehicle for reflective thought. It affords the composer a means of holding in mind a multiplicity of musical ideas so that he might shift attention seamlessly from one to another, find connections between things and observe patterns and attributes of musical ideas, which may themselves suggest further ideas, manipulations or connections.

3.3.4 The Limits of Notation Systems

There are limits on notation systems in terms of what they may transmit. While exact pitches and rhythmic relationships may be transmitted effectively, other more subtle aspects of rhythmic inflection and articulation, timbre and expressive gesture may only be approximately portrayed (Cole, 1974; Read, 1980). Approaches to musical scores may be either reproductive (concerned with exact reproduction of the given musical instructions) or explorative (seeking out implicit meaning in the score based on individual musical judgement within a frame of agreed musical understanding) (Hultberg, 2002). In the latter case, problems arise with respect to the degree of shared cultural experience between composer and performer, the degree to which the notation system used is appropriate to convey the intended meaning and the degree to which the 'reader' of the notation is conversant with both the conventions of the notation itself and the musical conventions which underpin it.

With respect to standard music notation, current study is concerned with the limits conventional notation systems impose on the practice of composition, especially when carried out by musically untrained composers. The ability to reflect on a musical object depends on having a representation of that object to mediate the reflection process. The extent to which a particular representation affords a reflective process is not simply a function of the representation itself, but also of the ability of the user to parse the representation and access its underlying musical meaning. Conventional notation systems therefore do not afford the novice composer the same range of functions in terms of both reflecting on and manipulating musical materials as those afforded to trained composers. It is argued below that computer-based graphical representations of musical information may address this problem. The manner in which these computer-based graphical notation systems may represent to the novice composer various attributes of musical objects and afford manipulation of those objects are central to the current study.

3.3.5 Solutions to the Notation Problem

It is clear that different notational systems will surface some things and conceal others. Bamberger (2004) says of this problem:

> When events are "turned into objects" the representations of those events are necessarily partial and they are so in two senses: they are <u>incomplete</u>, and they favor, or are <u>partial to</u> certain aspects of the phenomena while ignoring others. (Bamberger, 2004)

As the notation system is necessarily selective with respect to what it communicates, it may well selectively direct the attention of the user. Properties such as functional meaning of pitches, groupings and boundaries may not be immediately accessible. Emphasis on teaching notation may discourage children's intuitive responsiveness to the changing meaning of musical events when they become embedded in new contexts. Bamberger poses the question:

> How can we give children the security and the communicability of pitch invariance as represented by a shared notation, while still helping them go beyond its limits to develop their musical responsiveness to temporally changing identities? (ibid)

and suggests the following solution;

> I propose that we embrace these tensions by embedding them in an environment where children are encouraged to confront and puzzle over the potential for multiple organizing schemata. (ibid)

Environments for music learning might support a variety of representational systems, or at least a representational system that provides for the consideration of the same musical object from a variety of perspectives and in a variety of contexts.

While the problems pointed to by Bamberger are valid for any notational form, they are especially true of staff notation. One alternative that has been suggested is that of graphical notation, and in particular, encouraging children to invent and make use of their own forms of graphical representations as a means of recording their own compositional efforts. A variety of studies have explored the area of children's graphical notations, both as a means of gaining insight into children's music cognition and as a way of enhancing teaching and learning.

There is evidence that introducing musical concepts through the use of non-standard notations can enhance children's ability to both understand these concepts and make use of them in their own compositions (Upitis, 1986). Children asked to find their own notations for melodies will commonly make use of a variety of symbols including pictures, abstract symbols, lines, numbers and words, with a greater tendency to use more abstract symbols for less familiar melodies (Upitis 1990, 1993). Their notations may represent a variety of levels of musical abstraction, some bearing little formal relationship to the music, others offering formal descriptions of musical features, groupings and sections (Elkoshi, 2002). Examination of children's spontaneous non-standard notations indicates that children's rhythmic perceptions may be either figural or formal (metric) (Bamberger, 1991). Many children engage with music in both figural and formal ways depending on context (Smith, Cuddy & Upitis, 1994).

Children as young as six years old are capable of using symbols to both represent musical objects and ideas and as a vehicle for musical manipulations (Gromko 1994, 1996, 1998). The sophistication and accuracy of their symbols is related to their aural perception and increases with age (Davidson 1988; Gromko, Eastlund & Smith, 1998). Children are capable of notating a wide variety of musical parameters including pitch, duration and rhythmic position, groupings, texture and expressive gesture (Burns, 1997).

3.3 Discussion

Reflection-in-action offers a subtle, fluid and complex view of how professionals act and how professional knowledge may be acquired. As such, it is in some respects difficult to reduce to a simple set of precepts or descriptors. However, the essential elements of the theory may be said to include the notions of action-as-experiment, task framing, move testing and material 'talk-back', bound together by the overarching idea of reflective conversation. Reflection may happen in the moment and be embodied in action (reflection-in-action) or may occur in a more considered manner after the fact (reflection-on-action). In the case of the music student, the materials reflected upon are essentially the musical materials in hand. For the teacher, the materials include not only the students' musical materials, but also the student himself. In both cases, the presence of a suitable symbolic medium for reflection is essential to facilitate the reflective process.

Students of a relatively young age can meaningfully use symbol systems to represent and reflect on musical information. Symbols are used in a variety of ways and for a variety of purposes, ranging from specific notation of musical information to more general indications of expressive effect. For the purposes of composing, one test of a symbolic notation system is the degree to which it accurately represents the composer's intentions at a variety of levels, in a way that might be accurately interpreted by someone else. In this respect, many children's spontaneous notations may offer only a partial representation of their intentions. Furthermore, even for the child themselves, there are limits created by their own notation systems. Children will spontaneously notate those musical parameters of which they already aware. It is not clear that this process will necessarily make them aware of other parameters or improve their understanding within those parameters of which they are already aware. Therefore, a notation or representation system that embodies a full range of musical parameters may provide a medium through which children may expand their musical understanding.

As a symbol system to facilitate children's music learning, traditional music notation has drawbacks. It is extremely complex, grounded in representation at the metric or formal level and frequently fails to represent clearly and at the surface those musical attributes of which children are most aware. This is especially true in the area of patterns, groupings and boundaries. Staff notation presents visual groupings at the measure level in a way that may not represent either actual note groupings in the music or perceptual groupings on the part of the child. As a composition tool, staff notation relies either on the ability of the user to internally represent or audiate the sounds it represents, or on instrumental and sight-reading skills in order to make these sounds manifest. The elements of a written score may not be 'moved around', transformed or re-grouped easily without actually rewriting the music. Therefore, while the process of music composition implies some degree of reflection, and this reflection requires a facilitating medium, it is not clear that, for the novice user at any rate, traditional score (paper or computer-based) can provide such a medium.

Computer based graphical notation systems may offer a solution. The question then arises as to how these notation systems should be constructed. Ideally they should reflect the objective aspects of music at all levels in a way that offers flexibility to both novice and expert user. This representation should represent these features in a way that accords with the children's musical perceptions and also afford exploration along a variety of musical axes. While individual musical entities need to be represented at the note level, clearly the ability to make and represent groupings, and boundaries at various levels of aggregation is important. Musical structures should be capable of being viewed and manipulated at a range of levels of detail and from a variety of perspectives.

In the context of the current study, the medium by which learners engage with musical composition and construction (and by which teachers engage with learners materials) is that of a computer graphical interface. These interfaces are not based on standard notational representations of musical information. Rather, by the use of intuitive non-standard representational forms, they attempt to offer a vehicle for musical reflection and operation that is accessible and transparent to the novice user. In this manner, they may enable users to engage in musical 'experiments' and act in a fluid manner, offering instant feedback and providing a medium for musical thought, making aspects of the musical materials and their interrelationships available for consideration and reflection in a way which would be not possible otherwise. In so doing they may provide a key component in enabling novice composers and professionals to engage in that process of mutual reflection-in-action whereby real learning may occur.

The current study will examine the role of two such graphical music interfaces. It will consider mutual acts of learning and teaching of musical composition and construction in the light of Schon's theory of reflection-in-action. It will attempt to address the question as to whether this theory adequately describes the computer-mediated teaching and learning of music composition, and the degree to which computer graphical interfaces for music enable this musical reflection-in-action process. It will examine the affordances, both musical and extra-musical afforded by these interfaces and identify relationships between these affordances and the processes of learning and teaching. It will also address the sub-question as to whether these technologies have a role in enabling teachers to embed the act of research in their teaching process.

CHAPTER FOUR. RESEARCH METHODOLOGY.

4.1 Introduction

This chapter outlines in some detail the methodological approach taken to the current study. A range of methodologies is described and the suggestion made that a broadly qualitative approach is particularly suitable to the nature of the study. This approach is informed by grounded theory, based on naturalistic methods of inquiry and instantiated by participant multiple-case studies. Specific details relating to the participants, context and data collection are provided.

4.2 Grounded Theory

There are essentially four kinds of knowledge that may be yielded by research in education: description, prediction, improvement and explanation. Simple descriptions may serve to increase knowledge about what actually happens in various educational settings. Predictive studies may yield information about potential for success or failure in educational initiatives. Research studies may be designed to test the effectiveness of various interventions in improving the quality of the educational experience for students. Finally, research studies may attempt to explain phenomena encountered in the field of education (Gall, Borg & Gall, 1996). To an extent, this latter case includes the previous three. Typically explanations are couched in the form of theories.

Theories may be proposed on the basis of prior research data and then tested by a three step process involving the formulation of a hypothesis, the deduction of observable consequences of the hypothesis and the testing of the hypothesis by observation. An alternative approach is suggested by grounded theory, which involves deriving constructs or theories from the immediate data set (Gall, Borg & Gall 1996). This approach holds that theory should follow rather than precede research. The theory should emerge from actual observation.

> Theory is emergent and must arise from particular situations; it should be grounded on data generated by the research act. Theory should not precede research but follow it. (Cohen, Manion & Morrison, 2000)

As theory is constructed, there is a concomitant effort to strive for verification of the resulting hypothesis during the course of the research project (Strauss & Corbin 1999). Theory developed must pass the test of 'fitness'. It should be carefully induced from data in a way which maintains its close relationship to the reality of what is actually happening so as to be better applicable to the area of study.(Glaser & Strauss, 1967).

As theory consists of plausible relationships proposed among concepts and sets of concepts, grounded theory researchers are interested in patterns of action and interaction among actors and elements, commonly in social settings. These patterns are illuminated by 'a thick concept of descriptive and conceptual writing' (Strauss & Corbin, 1999). Data analysis is concerned with discovering process, both in reciprocal changes of patterns of action and interaction within a bounded setting and in relation to changes of condition both internal and external to the setting itself.

Grounded theory is primarily concerned with analytic strategies rather than data collection methods, which are usually standard techniques including observations, conversations, formal and informal interviews, reports, journals, video tapes and observer reflections. Emerging data is coded and categorized as it is collected. Codes which account for the data begin to form theories which both explain the data and direct further data gathering and analysis (Charmaz, 2000). Grounded theories may be either constructivist or objectivist. Objectivist theorists attempt to address issues of reliability and validity by closely specifying controls and procedures with a view to developing reproduceable data and predictive theory. Constructivist theorists maintain that data is to an extent a function of the observer. The observer cannot be separated from the subject of the observation. What an observer attends to will necessarily shape what will be defined measured and analysed. (ibid).

This points to the principle drawback of grounded theory development which, in common with any theory developed out of qualitative and descriptive data, relates to the limits of the predictive value of such theories in settings other than those examined.

> Insofar as theory that is developed through this methodology is able to specify consequences and their related conditions, the theorist can claim predictability for it, in the limited sense that if elsewhere approximately similar conditions obtain, then approximately similar consequences should occur. (Strauss & Corbin, 1999)

In the context of the current study, the subjects under observation are individual learners and their teacher. While the teacher is common to all cases studied, this cannot be considered a constant, as the nature of the relationship between the teacher and student will inevitably vary from case to case. Therefore, it was difficult at the outset to envisage predictive theory with respect to many specific aspects of the various interactions inherent in the study. Having said this, the current study does attempt to validate Schon’s theory of reflection in action in the context in which the study was undertaken. However, the notion that this theory might be especially relevant to this context was not predicted at the outset, but rather emerged in the course of the observation process. To that extent the current thesis, while not formally employing grounded theory methods is informed by the notion of observation led theory.

4.3 Quantitative Research Methodology

Educational research methodology is typically divided into quantitative and qualitative techniques (Gall, Borg & Gall, 1996; Mertens 1997; Cohen, Manion & Morrison, 2000; McMillan & Schumacher, 2001). Quantitative techniques include experimental, quasi-experimental and single subject techniques. The first two of these are characterized by large sample sizes and clearly defined dependent, independent and control variables, with a view to establishing statistical validity of the results. The latter is often concerned with single test subjects, but observed in a similarly controlled manner to allow demonstration of clear causative relationships. (McMillan & Schumacher, 2001).

Quantitative techniques may not be appropriate in situations where control of the variables is difficult. The formal experimental method is best deployed in trying to determine a single causal effect of an isolated variable on something else. However, in educational setting this may not be possible. The necessity to create artificial settings in order to explore single variable effects may yield results that only have meaning within this artificial setting. Furthermore, the sheer number of variables to be controlled may make this approach impractical.

> Control is most easily achieved with research on humans only in restrictive and artificial settings. This is a weakness in education for two reasons. Humans react to artificially restricted manipulated conditions differently from the way they react to naturally occurring conditions, and if the research is conducted under artificial conditions, then the generalisability of the results (external validity) is severely limited. (McMillan & Schumacher, 2001)

In the context of the current study, quantitative methodologies were not felt to be appropriate for a variety of reasons.

It was felt that in order to generate research questions that might be amenable to the experimental method, the questions themselves would of necessity be so restrictive as to fail to address the pertinent wider issues. Control of variables was also problematic, in particular with respect to the difficulty of designing a research method that could show clear causation. For example, the use of pre- and post-tests may themselves skew the results. Exposure to good (or bad) music teaching experiences may itself produce effects independent of the technology-mediated approach under examination. Use of control groups for comparison purposes was also discounted because of the difficulties in presenting similar material in a similar way to both groups. Even if the same teacher presented to both groups, one could still not discount the possibility that teaching methodology may itself be a function of the medium and therefore not be constant in both control and experimental groups. While the subjects' prior experiences were broadly similar, it would not be possible to entirely discount this as a factor.

Use of a technology-mediated approach necessitates instruction in the use of the technology itself. In order to be meaningful, this instruction could not but deal with musical issues, further skewing any possible quantitative results. Furthermore, the time involved in giving each student appropriate technical instruction at appropriate intervals would represent a huge time commitment on the part of the researcher, effectively making it impossible to generate a large enough sample size for statistical validity. In the current study, children were engaged in music composition. There was no body of curricular material delivered before the composing workshops began, and therefore no basis for any conventional assessment of the degree to which any such material had been mastered.

Any quantitative assessment of the outcomes would invariably lead to the need for the application of measures to the children's resulting pieces. This begs the question, 'measures with respect to what?' The difficulties of product assessment in the creative arts are considerable (see section 2.9). Rigorous product analysis either by metrics or by some variant on the Consensual Assessment technique might well require a restriction in the number of cases which could be reasonably be dealt with, would certainly constrain the depth to which each case could be examined and may well produce a body of analytical data which would give little insight into the actual business of teaching and learning in technology mediated environments.

Finally, it must be borne in mind that the current study is concerned with software which is entirely novel and unlike any other software available either commercially or as described in the relevant literature. It is not unreasonable to speculate that both learner and teacher behaviour might therefore be considerably different from those exhibited even in other technology mediated contexts. The current study is therefore necessarily exploratory in nature. Its brief is to address broad questions and identify key themes with respect to the use of graphical interfaces for music teaching and learning. It is envisaged that arising out of this broad examination, a variety of more specific questions may emerge which would be amenable to a more objectivist quantitative treatment in future work. For these reasons, in the current study it was felt to be more appropriate to draw on a variety of qualitative methodologies to inform the research design.

4.4 Qualitative Research Methodologies

Cohen et al (2000) identify eight broad categories of educational research method. These are labeled broadly as naturalistic and ethnographic research, historical research, longitudinal, cross-sectional, trend studies and surveys, case studies, correlational research, *ex post facto* research, experiments, quasi-experiments and single case research and action research. Of these, the qualitative methodologies most relevant to the current study were identified as the Naturalist and Action Research approaches. In making a distinction between methodology (kind of research) and methods (instruments to be used for data collection and analysis), case study was considered to be a research method that might instantiate either methodological approach, rather than an independent methodology. In tandem with this, an approach based on *ex post facto* methodology was adopted in dealing with a large body of children's pieces collected via the internet. The broad characteristics of each of these elements making up the current research design are outlined below.

4.4.1 Naturalistic and Ethnographic research

Naturalist researchers hold that humans construct meanings by interpretation of situations. Behaviour is context dependent, so only context bound working hypotheses are possible. Inquiry itself is value bound, so that inquiries are affected by inquirer values with respect to choice, framing, bounding and focusing of both the problem and the object of the research. Inquiry is also to an extent a function of the choice of substantive theory used to guide the collection and analysis of data and interpretation of the findings. Research must include 'thick descriptions' (Geertz, 1973). These ethnographic descriptions have three characteristics: they are interpretive; what is interpreted is the flow of social discourse and interaction; and the interpretation itself seeks to abstract and examine the core elements of this discourse (Geertz, 1999). These examinations may then lead to the validation of existing theories or the generation of new ones.

Theory generation in naturalistic research tends to be derivative and grounded (Glaser & Strauss, 1967). This approach recognizes the complexities of any social setting and places the case itself as being of primary importance, suggesting that "the essential task of theory building here is not to codify abstract regularities but to make thick description possible, not to generalize across cases but to generalize within them" (Geertz, 1999). The description of the case itself contains within it the important message. The job of the researcher is to describe the case in sufficient and appropriate detail as to enable this message to be clearly perceived and understood.

In this respect, the researcher is the primary instruments of the research (Eisner 1985, 1991). The researcher may not know in advance what he is looking for or what he will see, therefore he must generate rather than test hypotheses. Each research situation is unique and the processes of research and behaviour are as important as the outcomes. All outcomes are open to multiple interpretations. Generalisability of results is interpreted as generalisability to identifiable, specific settings and subjects rather than universally.

These general characteristics lead to various implications about how research should be carried out (Lincoln & Guba, 1985). As context is heavily implicated in meaning, studies should be in their natural settings as far as is possible. The use of people as the primary research instrument implies a participant research model. While qualitative methods are more suitable than quantitative in naturalistic settings, purposeful sampling may be used to address the full scope of issues. Data analysis will tend to be inductive rather than deductive and theory is emergent rather than pre-ordinate. A degree of flexibility is common in naturalistic research design, allowing the design itself to develop organically over time in response to the needs of the situation. For this reason, the natural mode of reporting in naturalistic settings tends to be the case study. The notion of trustworthyness may replaces more conventional views of reliability and validity (Lincoln & Guba, 1985, 1986) (see section 4.7, Validity and Reliability).

4.4.2 Action Research

Action research is founded on the premise that research should not just seek to understand or interpret the world, but to change it (Cohen, Manion & Morrison, 2000). In education settings it may be undertaken by an individual teacher, a group of teachers or a teacher or teachers working alongside researchers. It is a form of 'self-reflective enquiry', undertaken to improve understanding of ones own practice (Kemmis & Mc Taggart, 1992). It may be used to improve teaching methodologies or to understand and improve learning strategies or evaluation procedures (Carr & Kemmis, 1986). Action research is a “disciplined inquiry conducted in the context of the development and/or the implementation of an educational product or program” (Bresler, 1996).

Action Research may also be concerned with changing both individuals and the culture of groups (Somehk, 1995). In research settings that are concerned with complex, multi-layered real world problems, a ‘rigour vs relevance’ dilemma frequently arises. Research designs that rigorously control for all variables may be so restricted as to have minimal real world application. Schon outlines the problem thus:

> … there is a high, hard ground where practitioners can make effective use of research-based theory and technique, and there is a swampy lowland where situations are confusing ‘messes’ incapable of technical solution. The difficulty is that the problems of the high ground, however great their technical interest, are often relatively unimportant to clients or to the larger society, while in the swamp are the problems of the greatest human concern. Shall the practitioner stay on the high hard ground……..Or shall he descend to the swamp where he can engage with the most important and challenging problems if he is willing to forsake technical rigour? (Schon, 1983)

Action research is designed to bridge this gap between formal research and actual practice. In so doing, it strives to overcome the perceived failure of research to improve practice (Rappoport 1970; McCormick & James, 1988). One of the functions of action research is to contribute to a theory of education and teaching which is accessible to other teachers, thereby making educational practice more reflective. (Elliot, 1991).

A variety of attributes are generally considered to be characteristic of action research Action research is held to be collaborative, undertaken in situ and designed to generate practical problem solving as well as scientific knowledge. It seeks to understand complex (often social) situations and focuses on problems that are of immediate concern to practitioners. It is usually participatory, uses feedback from data in a cyclical manner and seeks to improve the quality of human actions and to enhance competencies of participants. The methodological approach is frequently the case study (Hult & Lennung, 1980; McKernan, 1991).

A particularly important element of an action research approach is the degree to which reflective practitioners engage in a process of critical and self-critical collaborative enquiry and self-evaluation of their own practice (Zuber-Skerritt, 1996). In this respect, researcher practitioners need to be willing to attempt to understand their own taken for granted processes and submit them for critique, thereby risking disturbance of prior held belief systems. They must seek to engage in dialectical critique, becoming aware of the relationships between elements that make up the phenomena under consideration and attempt to disentangle these from their own perceptual bias (Winter, 1996).

Action research implies a self-reflective spiral consisting of planning, acting, observing and reflecting. Each cycle leads to another as part of an iterative, ongoing process (Kemmis & McTaggart, 1992). Data collection includes not only what actually happened, but also the teacher/researcher's own judgments, reactions and impressions about what happened. Kemmis and McTaggart make a distinction between action research and the normal thinking teachers do about their thinking. In this respect, they diverge from views of the teacher-as-researcher, which hold that teaching and research should not be viewed as separate pursuits. Rather, teaching is itself viewed as a form of educational research, rather than the object of research.

> To teach….is to inquire. As teachers conduct research, they formatively evaluate their work, theorise and test their ideas in practice. As they learn more about the subject of their inquiry, they also discover more about themselves and processes of inquiry. (Holly, 1993)
>
> Educational inquiry is not a separate process from the practice of education. It is a form of reflective practice. (Elliott, 1989)

Schon holds that the professional, in this case the teacher, does in fact act as a researcher in the normal course of his work. He defines experimenting in the broadest generic sense as "to act in order to see what follows" and identifies three kinds of experimenting behaviours in which professionals may engage. Exploratory action is taken only to see what follows, without accompanying predictions or expectations. Move-testing actions are taken with an end in mind or to produce a desired outcome. If the action produces its intended consequences, the move is affirmed, if not it is negated. Finally, action may be taken with a view to confirming or disconfirming a prior hypothesis or effecting a discrimination between competing hypotheses (Schon, 1987). Schon observes that the practitioner may engage in all three types of action simultaneously.

> When the practitioner reflects-in-action in a case he perceives as unique, paying attention to phenomena and surfacing his intuitive understanding of them, his experimenting is at once exploratory, move testing and hypothesis testing. The three functions are fulfilled y the very same actions. And from this fact follows the distinctive character of experimenting in practice. (Schon, 1987)

Schon does distinguish between formal research experiments and reflective practice in so far as in reflective-practice "The practitioner has an interest in transforming the situation from what it is to something he likes better" (Schon, 1987). In this respect, Schon's view is in accord with that of action research, which is also concerned with changing the object of the research for the better.

Finally, action research typically begins with small groups and small cycles, expanding to larger groups and longer cycles on subsequent iterations (Kemmis & McTaggart, 1992). The current study draws on action research to the extent that it is concerned with identifying and improving aspects of teacher practice. It provides rich description of relevant events in a broadly chronological narrative and attempts to blend these descriptions events with analysis thereof. The emphasis is firmly on both learner and teacher with a view to explaining their actions and understanding their perceptions by focusing on events of specific relevance or significance.

Where the current study diverges from more conventional views of action research is in the context in which the work is carried out. Much action research is carried out in school settings and typically involves collaboration between a number of researchers and teachers examining situations involving groups of learners. The current study is concerned with a single teacher working with individual children. As such it attempts a blended form of 'micro' action research informed by Schon's reflection-in-action model. The researcher/teacher engages in identifying problems, theorizing solutions, making interventions and testing their success in the course of working with a single student. This research cycle occurs over the shortest possible time-frame, in the moment of reflection-in-action. Solutions in one case may then become the subject of reflection-on-action. Those deemed successful may then migrate from one case to another, widening the reflective cycle. Finally, the practitioner reflects on the wider set of cases relating to both pieces of software examined, seeking to generate theories that encompass behaviour of both students and teacher in the wider sense.

4.4.3 Case Studies

The primary investigative tool of the action researcher is the case study. A case study may be defined as 'the study of a single instance in action' (Adelman, Kemmis & Jenkins, 1980). The case study is usually of a single, bounded situation and may be designed either to examine the particular situation (intrinsic) itself or as a means of illuminating a wider principle (instrumental) (Stake, 1994).

One of the powerful strengths of the case study is that it can establish cause and effect situated in the real context.

> It provides a unique example of real people in real situations, enabling readers to understand ideas more clearly than simply presenting them with abstract ideas or principles……Case studies can penetrate situations in ways that are not always susceptible to numerical analysis. (Cohen, Manion & Morrison, 2000)

Hitchcock and Hughes (1995) suggest that the case study may be most valuable when the researcher has little control over events. They note a number of attributes of the case study. It is concerned with rich vivid description of relevant events and provides a chronological narrative of these events. The study blends a description of these events with analysis thereof focusing on individual actors or groups and seeks to understand their perceptions of events. Analysis of the case seeks to highlight events of specific relevance. The researcher may be integrally involved in the case.

Case study designs may be single-case or multiple-case in nature. Single case studies may be appropriate where there are cases which might be identified as critical (a case which meets all the criteria and conditions for testing a specific theory), extreme or unique (where a particular case is so rare or striking as to be worth documenting), typical or representative cases (where the object of the study may be assumed to behave in ways typical of a class or group) or revelatory (where a chance to explore the particular circumstances of the case has not been previously available). Single case study models may also be appropriate in longitudinal studies to observe how certain conditions change over time (Yin, 2003).

In the current study, students came from broadly similar musical backgrounds. However, these were not well enough specified that any single student could be considered so typical of a definable group or cohort as to entirely represent it. Furthermore, as the software employed was entirely novel and part of the remit of the study was to attempt to characterize the behaviours of students as they engaged in music composition using this software, one could not assume that a single student might represent the entire range of possible behaviours. That said, the study was designed to shed some light on how these software solutions may enable a broad category of user to engage in music composition, so that cases could neither be critical nor extreme. For these reasons it was felt necessary to examine a number of case studies in respect of each piece of software.

In the examination of multiple cases, each case should be carefully selected so as to predict either similar results (literal replication), or contrasting results for predictable reasons (theoretical replication) (Yin, 2003). The current study documented a large number of cases, from which a smaller number were selected for analysis and examination on the basis of contrast rather than literal replication, with a view to validating a theoretical position with regard to student and teacher behaviour. In this respect, the aim of the study was primarily to identify the existence of various behaviours, not to quantify their prevalence.

Case studies may also be embedded or holistic. A case may be broken up into sub-units which are considered as individual elements within a larger study or may be considered as a unified whole (Yin, 2003). While the current study examines a number of students participating in a composition program, each student is considered as an individual case on its own merits.

Case studies may involve a variety of approaches and techniques. These broadly fall into participant observation and non-participant observation (Cohen, Manion & Morrison, 2000). Case studies may involve varying degrees of structure, ranging from entirely naturalistic settings over which the researcher has little control, to more structured settings that may involve a degree of artificiality in the context. In general, participant observation is more generally employed in more naturalistic settings. In fact, in these settings, the presence of the observer cannot but be noted by the participants and so may have a bearing on the outcomes, even if the intention is non-participatory. More artificial settings (in a laboratory for instance) allow the researcher to take a more detached, non-participatory role (Bailey, 1978).

Participant research was deemed to be most appropriate in the current context here for a variety of reasons. As this study is holistic in nature, the cases in question include not just a student, but a student and a teacher. The theoretical underpinning of the study suggests that teacher and student actions are interdependent and mutually informing. Therefore the intention is to observe and explain both teacher interventions and learner responses and how both child and teacher change over time. Observation is made a real learning and teaching situation. While the actual setting was somewhat artificial, observation over an extended period of time facilitates the development of a more normal teacher/student relationship, enabling more naturalistic observations. In this respect, the researcher-as-teacher is best placed to make interventions that not only have a teaching purpose, but also illuminate aspects of the research questions. Finally, given the time commitment involved in both becoming familiar with the software and conducting extended observation, it was not deemed practical to separate the role of researcher and teacher.

4.5 *Ex post facto* research

Studies of an *ex post facto* nature may be seen as "bridging the gap between descriptive research methods on the one hand and true experimental research on the other'(Cohen, Manion & Morrison, 2000). Spector (1981) suggests that *ex post facto* research is a procedure which is designed to transform a non-experimental research design into a pseudo-experimental form.

Ex post facto research occurs retrospectively and investigates possible cause and effect relationships by observing an existing state of affairs and looking for prior possible causal factors (Cohen, Manion & Morrison, 2000). The researcher is examining retrospectively the effects of a naturally occurring event on a subsequent outcome, with a view to establishing a causal link between them. Essentially the process consists of initially speculating as to these causes in the form of a hypothesis, identifying relevant variables in subjects in two or more groups and comparatively analysing data from these subjects (Gall, Borg & Gall, 1996; Spector, 1981).

There are broadly two types, co-relational or 'causal research', and criterion group or 'causal-comparative' research. The former involves the collection of two sets of data, one of which will be retrospective, with a view to determining the relationship between them. The latter is concerned with attempting to discover the possible causes of a phenomenon under investigation by comparing the subjects in which the variable of interest is present with similar subjects in whom it is absent.

The current study consisted of two parts. The first of these consisted of a series of extended participant observations of students using graphical software to engage in music composition and construction. The second part consisted of making both pieces of software available on via the internet and inviting users to download the software and then upload the results of their work. A variant on a causal *ex post facto* approach was therefore adopted in order to construct links between both data sets and thereby enable a degree of generalisability of the results of the case studies.

In the current study, a small number of learners were observed closely with a view to establishing behavioural patterns in their work. Certain gestural outcomes were noted in children's work, and theories generated about their procedural causes based on close observation of, and interaction with the children's work in progress. A large number of children's compositions were also collected via the internet. In these cases, the children were not observed, so direct evidence of the procedures resulting in certain gestures was not available to the researcher. However, causal *ex post facto* analysis of these pieces was carried out with a view to establishing links between these two data sets. Theories developed with regard to children's interactions and behaviours during the close observations were used to form a hypothesis which might be tested against this wider data set. Gestures observed in the wider set were assumed to have been formed by similar procedures to similar gestures in the close observation, providing a degree of validation of the initial data and an indication of the prevalence of the various behaviours described.

Ex post facto analysis is primarily used in situations where single cause and effect may be in operation but where control of the independent variable or variables is outside the control of the researcher or where control of all but a single independent variable may be unrealistic or artificial (Cohen, Manion & Morrison, 2000). Typically, research design based on causal *ex post facto* techniques will seek to define both dependent and independent variables and examine the data set for the former with a view to identifying the latter.

Couched in these terms, one might characterize the independent variable in the current study as some aspect of the computer software, producing a gesture on the part of the user, which might be termed the dependent variable. However, the situation is more complex than this. All users are exposed to exactly the same software and yet a variety of behaviours ensue. In this event, it might be more accurate to characterise the independent variable as an aspect of the interaction between user and software, specifically the manner in which the user attends to the software. Users choose either consciously or subconsciously to attend to different aspects or modalities inherent in the software, producing a variety of outcomes based on their preferred mode of attention. Ex post facto analysis here will examine the data for these characteristic gestural outcomes (the dependent variable) and seek to identify the particular mode of attention (the independent variable) which gave rise to them. This gestural analysis may then be compared to the case study data with a view to validating the wider behavioural theory underpinning the study.

4.6 Data Analysis

The analysis of a case study is never straightforward; there is usually a mass of complex data and there are no standard analytical techniques. Yin (Yin, 2003) recommends three general strategies:

- Relying on theoretical propositions.

Maintaining a focus on the initial research questions and theoretical positions may help the researcher to make appropriate choices with regard to which data to prioritise.

> The first and more preferred strategy is to follow the theoretical propositions that led to the case study ... The propositions would have shaped your data collection plan and therefore would have given priorities to the relevant analytic strategies ... the proposition helps to focus attention on certain data and to ignore other data…. The proposition also helps to organize the entire case study and to define alternative explanations to be examined. Theoretical propositions about causal relations - answers to "how" and "why" questions - can be very useful in guiding case study analysis in this manner. (Yin, 2003)

- Thinking about Rival Explanations.

This analytic strategy involves developing alternative explanations for the data especially with regard to questions of causality. This strategy may be related to the first in that the initial theoretical propositions may have included rival hypotheses. However, even in the absence of such clear initial propositions, generating alternative explanations may help to clarify a developing theoretical position.

- Developing a case description.

This is a widely used approach. It involves the researcher writing a narrative describing the case and its history. This 'thick description' may form the basis for analysis with a view to establishing causal links. The nature of the description itself may also convey tacit messages to the reader even in the absence of formal analysis.

Yin outlines several specific analysis techniques that may be applied to case study data. These include pattern matching, explanation building, time series analysis, logic model analysis and cross case synthesis. The three most relevant here are pattern matching, explanation building and cross case synthesis.

Pattern matching involves making predictions about behavioural patterns and comparing these to empirically observed results. The main problem with this approach (assuming the necessary data has been collected) is deciding the closeness of 'fit' of the data to a predicted pattern. It can leave a great deal to the interpretation or judgment of the researcher.

Explanation-building approaches attempt to analyse the data by building up an explanation about the case. This goes beyond pattern matching by specifying the nature of the causal links between the items that make up the pattern. The evidence for those relationships is then tested. Explanation building is usually iterative and involves first making an initial theoretical statement or proposition and comparing the findings of an initial case against this statement or proposition. This statement may then be revised and compared either to other details of the same case or to the facts of a second or subsequent cases. In this way the theoretical position may be refined so as to explain the range of cases (Yin 2003). This approach lends itself to multiple case studies and serves to strengthen any conclusions drawn

Cross-case synthesis may be performed whether the cases in question have been examined as part of the same study or as independent research studies. Points of comparison are drawn across two or more cases, enabling the study to address more complex and broader issues than would be possible in a single case design (ibid). Again there is reliance on the skill of the investigator in drawing out valid and meaningful points of comparison.

Finally, a number of principles underly all rigorous analysis of case based data. All the evidence must be attended to and rival interpretations should be considered. Analysis should address the most significant aspect of the case study in question. The researcher must use his own prior knowledge and awareness of the field in selecting and filtering data. This implies a degree of expertise on the part of the researcher in the specific domain under investigation.

4.7 Validity and Reliability

There are four basic questions that must be addressed with regard to any inquiry. These questions are commonly characterized as internal validity, external validity, reliablilty and construct validity (Gall, Borg & Gall, 1996) respectively. Internal validity represents the extent to which the variations in an outcome (or dependent variable) can be attributed to changes in an independent variable. External validity is the approximate validity with which we can infer that presumed causal relationship can be generalized to other persons, settings and times. Reliability relates to consistency, stability and predictability i.e. how replicable are the results. Construct Validity represents the degree to which operational measures are sufficiently developed so that the measurement instrument actually measures that which is intended (Mertens, 1997).

4.7.1 Trustworthiness

Lincoln & Guba (1985) acknowledge the philosophical nature of the difficulties facing naturalist enquirers. The only way to establish the absolute truth of a situation or event is to compare to with some known truth. This implies the logical positivist position that there are absolute truths which may be known. If, however, one takes the philosophical position that all truth is constructed by the observer, then there are in fact multiple constructed realities and therefore a test based on such comparative methodology will fail. The common approach to deal with this conundrum is to postulate a truth or hypothesis and then test it against nature. In this case, while the test cannot prove the absolute truth of an hypothesis, it can invalidate it. The situation is further compounded by the multi-layered constructivist nature of the research situation. While the inquirer is seeking to uncover aspects of the participants constructed reality, the results of the work are inevitably filtered through the observer's own reality.

Lincoln & Guba (1986) use the term trustworthiness to indicate the overall degree of confidence which one might have in the result of a naturalist enquiry. She suggests four questions that naturalistic inquirers should pose in reflecting on qualitative data.

1. Truth value – how can one establish the truth of the findings in respect of the subjects and the context within which the work was carried out?
2. Applicability – how can one determine the extent to which the findings of a particular enquiry have applicability in other contexts and with other subjects?
3. Consistency - how can one determine if the results would be repeated if the study was replicated with similar subjects in a similar context?
4. Neutrality – how can one establish that the findings are in fact determined by the subjects and settings and not by the biases, motivations, interests or perspectives of the observer?

They refer to credibility (internal validity), transferability (external validity), dependability (reliability) and confirmability (construct validity) as the naturalist enquirers equivalent to the more commonly used quantitative terms mentioned above. They suggest these trustworthiness criteria may be operationalised by a series of techniques and propose that the naturalist must "carry out the inquiry in such a way as that the probability that the findings will be found credible is enhanced and, second, to demonstrate the findings by having them approved of by the constructors of the multiple realities being studied" (Lincoln & Guba, 1985).

This may be achieved by prolonged engagement with the subject, persistent observation and triangulation of data sources. External checks on the inquiry process may be provided by peer debriefing. Hypotheses should be continually refined as more information becomes available, a practice she refers to as negative case analysis - a system where hypotheses are continually revised with hindsight until it accounts for all known classes without exception. Preliminary findings may be checked against raw data so as to provide referential adequacy. The notion here is that a portion of the initial data should be archived without analysis and recalled for comparative purposes when tentative findings have been reached. She quotes Eisner (1985) who asserts that videotape recordings provide a means for 'capturing and holding episodes of classroom life', that could later be examined at leisure and be compared to the critiques which had been developed from all the data collected. Finally, Lincoln suggests a direct test of the findings and interpretations with the human sources from which they have come, so as to assure accuracy of the data itself as well as any conclusions that might be drawn from it.

Gall et al (1996) use the term verisimilitude in a similar way to which Lincoln et al use trustworthiness. They suggest that verisimilitude might be achieved by writing descriptions of cases and situations so as to reconstruct the observed context in a way that is perceived as credible and authentic. On the notion of construct validity, Yin (2003) suggests the equivalent term objectivity. The usual criteria for objectivity is that of intersubjective agreement, that is, agreement of a number of observers. Yin suggests this question may be addressed by multiple sources of evidence, a well-established chain of evidence (this is a peer review technique where peers follows the chain of evidence looking for logical inconsistencies or evidence of observer bias) and peer review of the draft report as techniques.

As the current study was largely concerned with the behaviour and processes of individuals, there was no way to access these behaviours other than direct observation. In this respect, while observer bias may be an issue, the participant research model adopted enabled the researcher to interrogate the situation with a view to determining construct validity. Various interventions were made to ensure that those behaviours observed and chosen for analysis were actually those of interest with respect to the underlying theory. Value neutrality was addressed by informal discussion of samples of video clips recorded of various subjects and interactions with a number of experienced educators and researchers

The cases chosen for examination here were selected from a wider set of sixteen cases. Categories of user behaviour were identified across the wider data set and selection was made on the basis of which cases best exemplified these behaviour types. Attribution of causation was made on the basis of a variety of data sources including direct participant observation and researcher reflection-in-action, post hoc analysis and reflection on both user actions and teacher intervention, user verbal responses and actions and analysis of the resulting user compositions. Issues of external validity and reliability were addressed by ensuring that causal factors attributed within the cases described did in fact accurately represent the interactions of the wider set of cases from which they were chosen and by *ex post facto* analysis of the large data set collected via the internet. Analysis of the latter set was undertaken via a set of criteria based on objective aspects of the music domain. Pieces were categorized on the basis of their apparent organizing factors. These categorizations were then correlated with those behaviours observed in the case studies.

4.8 Summary

The current study is a broad-based inquiry into the nature of music composition teaching and learning as mediated by computer graphical interfaces. The methodological approach draws on elements of naturalistic inquiry and action research as well as Schon's theory of reflection-in-action, in order to craft a research approach suited to surfacing the pertinent issues impinging on this area of interest. The specific mode of inquiry was the participant multiple-case study. Data collection was primarily by the use of digital video. Case study data was supported by a large body of childrens work submitted via the internet. Schon's theory provided the theoretical base that informed the work. Theory specific to the context of the inquiry was induced from qualitative data in a manner informed by grounded theory and supported by *ex post facto* analysis of the larger submitted data set. Research questions were addressed both in the reflection-in-action process undertaken during the data collection process and in later researcher reflections on this data.

CHAPTER FIVE. SOFTWARE DESCRIPTIONS.

5.1 Introduction

The current study is concerned with two pieces of software, Hyperscore and DrumSteps. The Hyperscore concept was originated by Mary Farbood at the MIT Media Lab. Design was by Ms Farbood and Egon Pazstor with input from the author in respect of harmonization and harmony line operation. DrumSteps was conceived and designed by the author. Initial implementation was by the author in the Macromedia Director programming environment. Subsequent implementations in Java were carried out by Conor McCarthy and James Bligh at the Centre for Research in Information Technology in Education, Trinity College Dublin. A Shockwave version for deployment on the BBC website was implemented by Neil Farrell.

Each piece of software was designed with the intention of enabling users to engage in music construction and composition, without the need for prior musical training, ability to play an instrument or read standard music notation. Principles underlying the design process for each software application were broadly in line with both the ‘microworld’ and ‘mindtool’ concepts of Papert and Jonassen respectively, as outlined in section 2.2. Technical aspects of the implementation of the software are not of interest in the current context. The current chapter provides a functional description of the operation of the software and then considers each application from the perspective of the affordances offered to the user, pointing to similarities and differences between each application and more conventional notation and sequencing software.

5.2 Hyperscore

In order to enable the reader to understand the operation of the software, a relatively full description will be given. The Hyperscore screen is shown in figure 5.2.1.

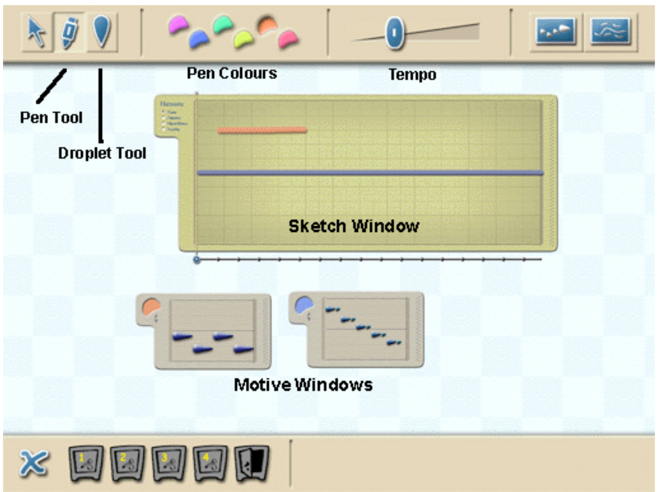


Figure 5.2.1 The Hyperscore Workspace

The Hyperscore interface consists of a ‘zoomable’ working area which may contain two types of ‘window’, which will be referred to as the ‘motive’ window and the ‘sketch’ window. Users may place as many motive and/or sketch windows in the working area as required. They may then hear the results of their work via MIDI playback.

5.2.1 The Motive Window

Composition activities in the Hyperscore environment proceed on the premise that the piece of music will be based on a number of short musical ideas or motives. Each motive is made by placing notes in the motive window (Figure 5.2.2), on a timeline from left to right with pitch top to bottom. The total pitch range available is two octaves divided in semi-tones, with the central horizontal line representing middle ‘c’. Notes may be resized from crochets (1/4 notes) up to semibreve (whole note) and down to demi-semiquaver (1/32 notes) and the motive window is marked by a series of vertical lines to indicate relative note values. While the example shown is one measure long, motive windows are extendable to six measures.

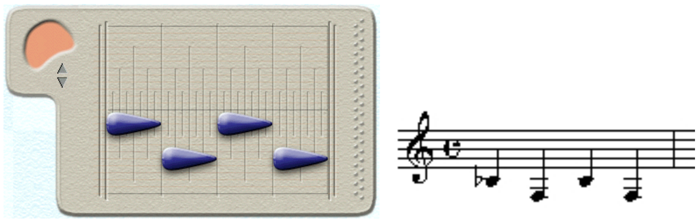


Figure 5.2.2 The Motive Window

5.2.2 The Sketch Window

Users may create as many short ideas, or motives as required. Motives, which are colour coded, may then be placed in the main sketch window by using the mouse to ‘draw’ them in with the appropriate colour pen. The line in the sketch window represents the motive of the same colour. In playback, the play head scrolls from left to right across the sketch window and as it passes over a line or stroke, plays the associated motive, repeating it for the entire length of the stroke. Figure 5.2.3 shows the effect of drawing the above motif in the sketch window. The number of times the motif repeats depends on the length of the stroke, in this case five-and-a-half repeats. The pitch at which the motif sounds is reset according to the height at which it is placed in the sketch window. While the motif shown above will sound below ‘middle c’ in the motive window, in the sketch window in figure 5.2.3, it will be transposed upwards as the stroke is placed in the upper part of the window.

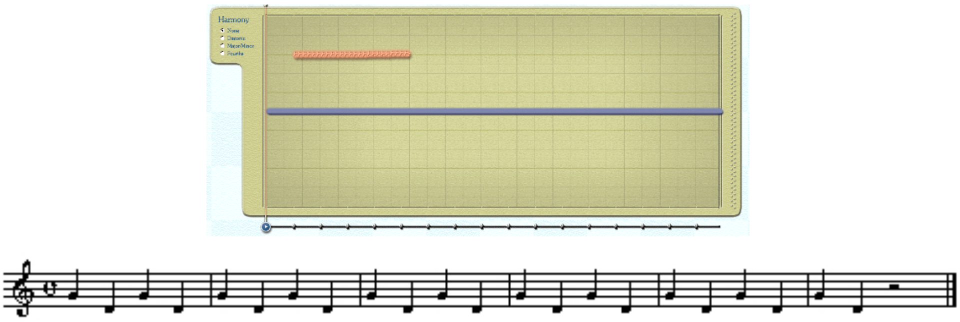


Figure 5.2.3 The Sketch Window

While the pitch range for playback is reset according to where in the sketch window the motive is placed, internal pitch relationships are maintained. Motives may be layered to create multi-part textures. At the time of the study, the interface supported string sounds only, both arco and pizzicato. Users may toggle between arco and pizzicato sounds for each stroke. The volume of each stroke may also be adjusted. The sketch window may be extended to allow the creation of pieces up to four or five minutes in length, depending on tempo. Pieces may be exported as MIDI files and viewed in standard music notation using any music scoring software.

5.2.3 Contour

Hyperscore enables the user to explore ideas of contour and melodic shape, again by using the 'drawing' metaphor. Users may draw their motives in the sketch window to some curve or contour. The software will then interpret these strokes according to a 'best-fit' between the content of the particular motive window and the overarching shape of the stroke. Figure 5.2.4 shows the effect of a curved line on the short motive described above.

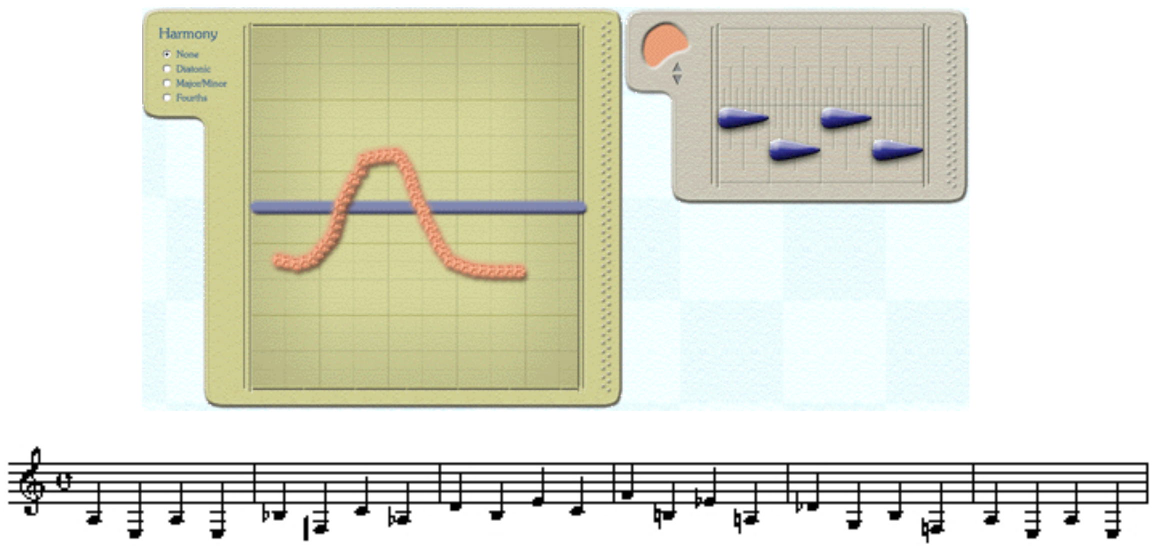


Figure 5.2.4 Contour in Hyperscore

5.2.4 Harmony

Users may create multi-part textures by sketching as many simultaneous parts as they like. In multi-part textures, a number of options to facilitate control of harmonic aspects of the music are presented. Users may choose from various harmony types (none, diatonic, major/minor or fourths) and then control harmonic gesture by using the 'harmony line'. This is the horizontal line which runs left to right across the centre of the sketch window. The following set of examples will illustrate how this works with regard to a short example in Major/Minor harmony mode. Figure 5.2.5 shows a short piece made with three simple motives.

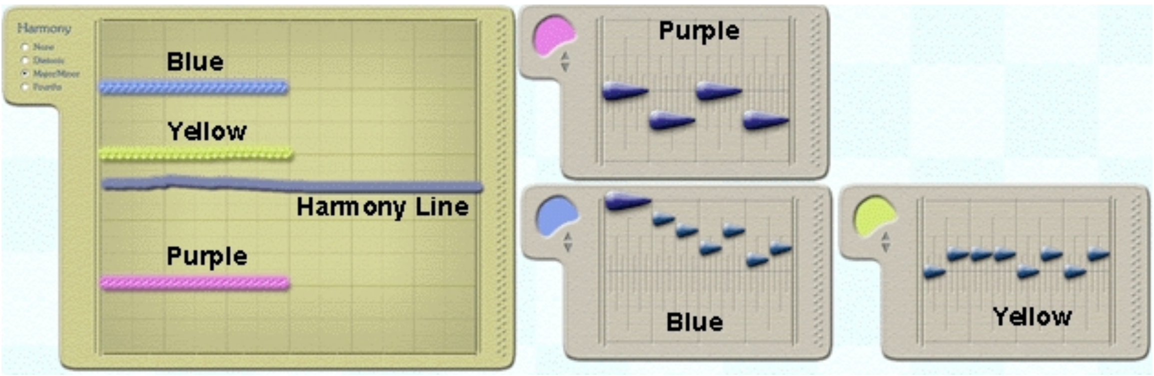


Figure 5.2.5 The Harmony Line (Example 1)

With no manipulation of the harmony line it will sound like this (figure 5.2.6).

Figure 5.2.6 The Harmony Line (Example 1 score)

It may be clearly seen that each motive is 'quantised' in pitch to the notes of a c triad (by choosing the Major/Minor harmony option) and that each motive simply repeats at the same pitch around an underlying C major chord. Using the harmony line it is possible to manipulate the harmonic underlay in two ways. The first of these allows for local harmonic progressions. In this instance the harmony line is redrawn so as to contain a gentle curve.

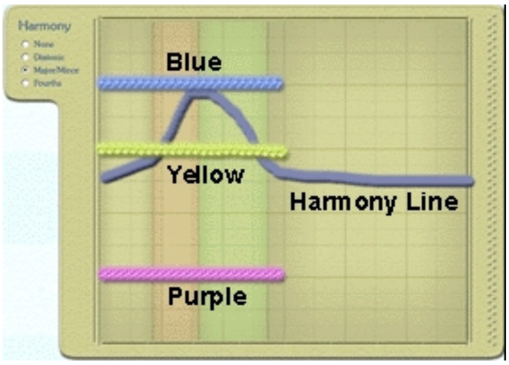


Figure 5.2.7 The Harmony Line (Example 2)

The rising portion of the curve creates harmonic movement away from the tonic C chord towards the dominant and falling section causes movement back to the tonic. The above piece will now sound like this (figure 5.2.8).

Figure 5.2.8 The Harmony Line (Example 2 score)

The second type of harmonic manipulation possible is carried out by drawing a sharp peak in the harmony line (figure5.2.9).

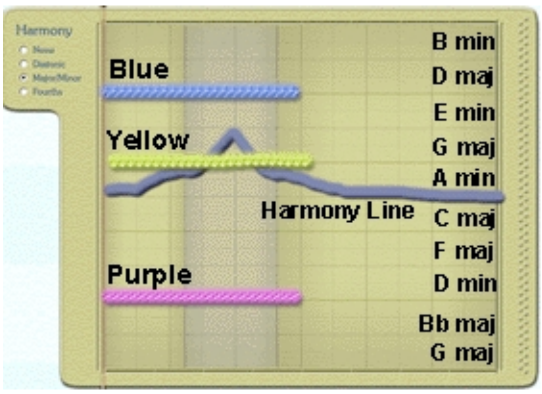


Figure 5.2.9 The Harmony Line (Example 3)

While a gentle curve will give rise to local harmonic colour, a sharper peak will instigate a key-change or modulation. The height of the peak controls the key into which the music will modulate as shown in figure 5.2.9. Figure 5.2.10 shows how this passage will sound, demonstrating the modulation to the key of G major in measure four.

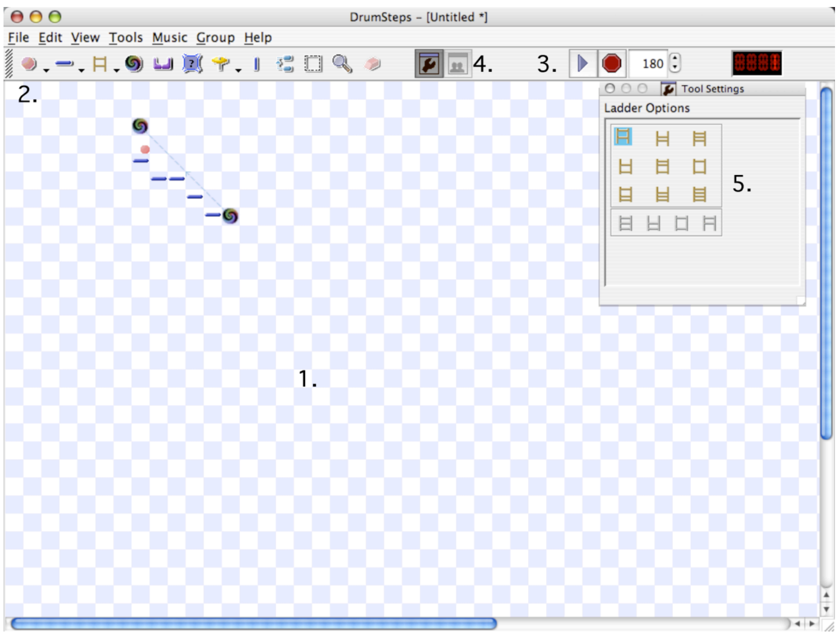
Figure 5.2.10 The Harmony Line (Example 3 score)

Users may create extended pieces (three to five minutes depending on tempo) with as many as thirty simultaneous parts. Pieces and their constituent motives may be saved in general MIDI format and converted to standard notation via any proprietary notation software.

5.3 DrumSteps

5.3.1 The Workspace

The software consists of a working area or grid onto which the user may place elements contained in a set of toolbar menus. The DrumSteps working window is shown in figure 5.3.1.



1. Working Space (Grid)
2. Menus
3. Transport (Play) Controls
4. Network Controls
5. Menu Options Window.

Figure 5.3.1 The DrumSteps Workspace

The premise of the Drumsteps software is that users construct sets of steps and various other static elements. Sounds are produced by allowing balls to fall through the construction colliding with these static elements. The function of each of the basic elements is explained below.

5.3.2 DrumSteps Tools

The Step Tool

The step represents the basic not unit in Drumsteps. Steps are ordered diagonally either left to right or right to left. A line of single steps will produce a simple regular pulse.

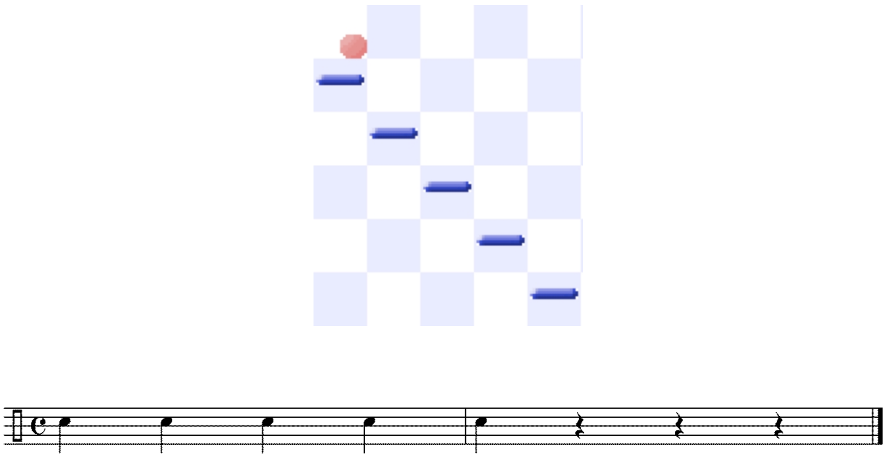


Figure 5.3.2 Single Steps

More complex step arrangements will produce a wide variety of rhythmic patterns based on the single step unit.

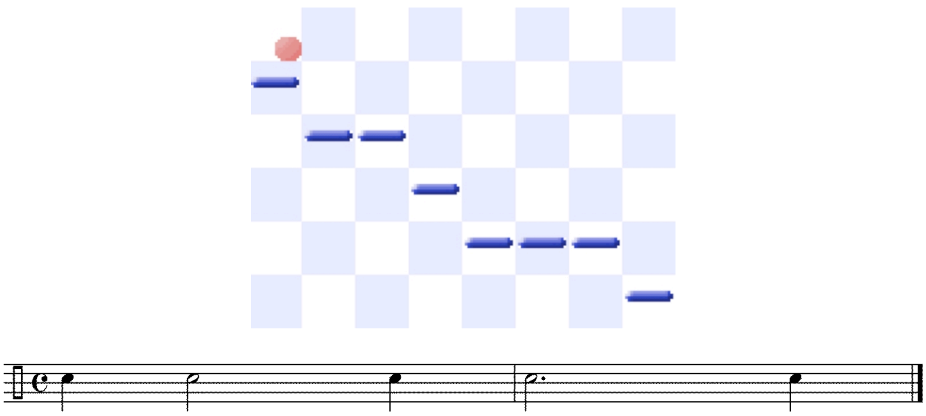
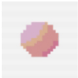


Figure 5.3.2 Multiple Steps

The Ball Tool



Sounds in DrumSteps are embodied in the ball. Users may select any one of thirty-five general MIDI percussion sounds from the pop-down menu. Sounds are organized into categories as shown in figure 5.3.3.

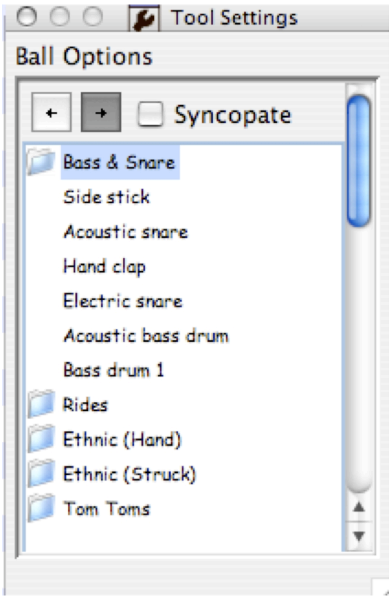


Figure 5.3.3 DrumSteps Instruments Options

On colliding with a step, wall or ladder element, the appropriate timbre will sound.

The Ladder Tool

The ladder represents subdivisions of the basic beat. Users may select from a number of ladder icons representing different subdivisions. Nine four-rung ladders and four three rung ladders are presented (see figure 5.3.4). In this respect, a selection was made from the complete set of all possibilities. The ladders presented represent those subdivisions most likely to occur in western music and so fall within the experience of the intended user group. Four rung ladders represent different ways of subdividing the basic step unit into four equal parts. Three rung ladders represent triplets or division into three equal parts.

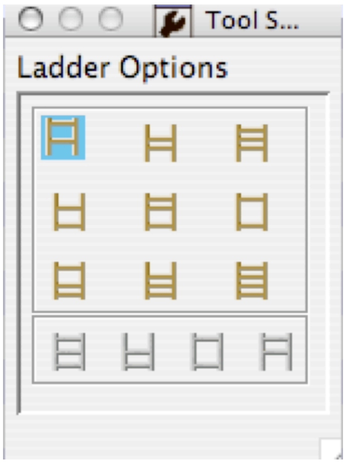


Figure 5.3.4 The Ladder Options

When a ball passes over a ladder, it sounds a note for each rung of the ladder. Examples of the effect of various ladders are given in figure 5.3.5

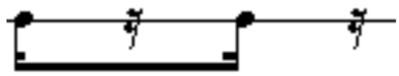
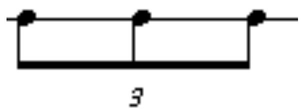
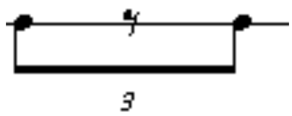
Ladder	Musical Effect
	
	
	
	

Figure 5.3.5 Ladder Rhythms

The Trigger Tool

This tool enables the user to access a range of further percussion sounds including cymbals, whistles and vibraslap. In the case of these sounds, as they are sounds which are more likely to be used as punctuations rather than in continuous patterns, the elements are placed on steps and triggered by the passing ball.

Figure 5.3.6 Triggered sounds

The Wall Tool

Walls are used in tandem with steps. Their function is to change the direction of the ball, while sounding the appropriate timbre. Ladder/step combinations may be used to create boxes within which the ball will oscillate producing a steady pulse.

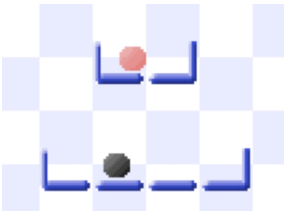
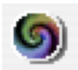


Figure 5.3.7 Metronome (Pulse) Boxes

The Wormhole Tool



Wormholes are a device to enable balls to instantly jump from one part of the screen to another. Their principle musical application is in generating repeating units. Wormholes are placed in pairs and linked so that a ball entering one on the pair will instantly emerge from the other. The number of repeats may be set in the wormhole submenu.

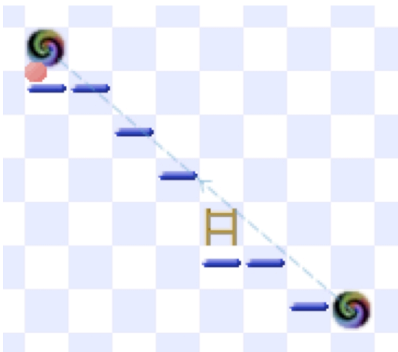


Figure 5.3.8 Wormhole Repeats

Wormholes may be chained for sequential repeating units. Multiple balls may be routed through the same wormhole with repeats counted independently.

The Trapdoor Tool

Trapdoors are used in combination with trigger steps. The trapdoor will contain a ball and will open when another ball passes over the trigger step to which it is linked. Musically this facilitates voices entering at various times based on cues in other voices. In figure 5.3.9 for example, the ball on the right will begin when the ball on the left reaches step five in the set.

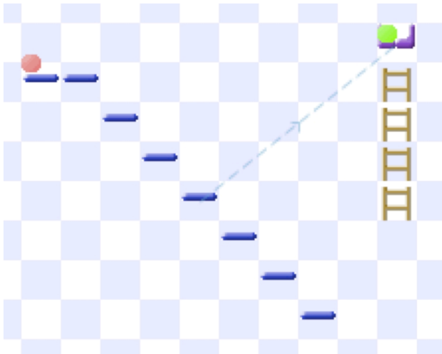


Figure 5.3.9 Trapdoors

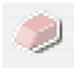
The Link Tool

The link tool is used to connect wormholes and to link trigger steps to trapdoors. Steps become trigger steps automatically on being linked to a trapdoor and are colour coded to indicate this relationship.

The Randomiser Tool

The randomizer tool causes balls which fall on it to randomly either go left or right. Its musical application is in enabling an element of aleatory operation. A ball may randomly take one path or another producing a different musical outcome in each case. In figure 5.3.6, the ball will either go left or right at the randomizer before returning to the start. As the overall pattern repeats, the second part may be different each time.

Figure 5.3.6 The Randomiser

The Zoom  and Erase  tools have their usual functions. The software supports multiple voices or parts. Multiple balls may traverse the same step set producing imitation effects. The volume of each ball or voice may be controlled individually. Tempo may be set globally in the range 60 to 240 beats per minute.

The software also supports networked collaborative operation. Multiple, geographically-remote users may log on and see the same working space, adding elements to a collaborative piece in real time. There is a favourites menu that enables users to highlight sections of music and save them to a favourites folder. The software also supports higher levels of granularity, allowing users to assemble whole pieces into a collection, arrange them in order and play them back as a single aggregated unit. As these aspects of the software were not the focus of the current study, they will not be dealt with in detail here.

The DrumSteps software was designed to facilitate engagement with as wide a variety of musical concepts as possible, given the non-pitched constraint. These include low-level concepts such as pulse, meter, tempo, rhythmic subdivision and hierarchies, timbre, texture and higher level concepts such as form, structure, relationships between elements and parts, boundaries and grouping, variation and change. In examining the use that children make of the software, these are the musical concepts which will inform the analysis of their work.

5.4 Interface affordances.

5.4.1. Introduction

In order to enable musical learning and construction, each interface was intended to provide the following capabilities:

- To reflect back to the user attributes of musical objects at a variety of levels;

- To provide a transparent mechanism for the manipulation of these attributes;
- To provide aural feedback on the results of these manipulations with a clear connection to the visual representation;
- Through these capabilities, to enable learners to make connections between musical attributes, parameters and manipulations at a variety of levels.

While these attributes are present to a greater or lesser extent in a variety of widely used music software packages, there are subtle but important differences between the approach adopted in more conventional music software and that of the interfaces in question here. The majority of computer based representational systems in wide circulation are based on either standard staff notation, or on a 'piano-roll' format. Both Hyperscore and DrumSteps present fundamentally different systems for representing and manipulating musical information from those adopted in these conventional systems. Central to the current thesis is the contention that the manner of representing and manipulating musical material afforded by the interface will profoundly affect both learner actions and the nature of the musical learning that occurs.

The remainder of this chapter will analyse each application from an affordances standpoint, focusing primarily on the manner in which each interface represents musical objects and groups of objects, and the nature of the musical manipulations that each interface facilitates. It will point to some of the differences between these applications and systems based on both standard staff notation and piano roll formats. Connections will be made between the structure and affordances offered by both the DrumSteps and Hyperscore interfaces and the potential actions of users as they work in each interface.

5.4.2 Representation of Musical Objects and Groups of Objects

5.4.2. 1 The Hyperscore Interface

As previously described, the Hyperscore interface broadly consists of two types of working space or window (motive and sketch), with associated representations and capacities for manipulation.

5.4.2.1.1 Representation in the Motive Window

The motive window is similar in principle to a standard piano roll representation, the difference being that the motive window is constrained to a single voice. This constraint, however, is fundamental to the Hyperscore composing process, in that it forces users to 'modularise' their work. Discreet chunks of melodies may be created in these motive windows, but these may then only be aggregated horizontally or vertically by drawing in the sketch window. There are a number of subtle but important differences between the nature of the Hyperscore motive window representational system and standard staff notation.

Note Duration

Note duration in Hyperscore is represented literally – that is, the physical length of the note icon from left to right represents the duration of the note. The basic shape of the note icon itself does not change for notes of different duration, with the exception of its length.

In staff notation, a series of different icons are used to represent duration, ranging from the breve or double-whole note, through minims (half-notes), quavers (quarter-notes), semi-quavers (eight-notes) and so on down the hierarchy. These note values and their staff notation representation along with equivalent rests are shown in figure 5.4.1.

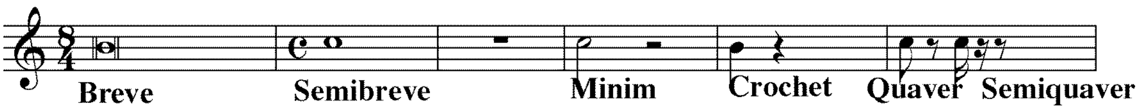


Figure 5.4.1 Note values in Staff Notation

While the system of note values itself is hierarchical, the representation of halving note durations is not consistent as one moves up or down this hierarchy. To move from a breve to a semibreve, note 'end-tags' are removed. To move from a semibreve to a minim, a stem is added to the note. From a minim to a crochet, the note head is filled in, from a crochet to a quaver, a tail is added to the note stem. Thereafter, additional tails are added for each halving of the note duration. This system is inconsistent and somewhat unintuitive (although an element of consistency is present for note values less than a quaver). There is nothing about the representations of a crochet and minim for example, that would necessarily lead one to conclude that one was twice the duration of the other. Furthermore, this simple analysis does not even consider the various permutations in note lengths that are possible when dotted notes and ties are introduced.

In order to understand note durations as represented in the staff system, the user must firstly be conversant with the hierarchic system of note durations, and secondly, have prior knowledge of the meaning of each of the symbols. For the novice, this system most likely will not reflect/surface durational attributes of the notes themselves, nor will it immediately make apparent durational relationships between different notes. Contrast this to the simple and immediate representation available in Hyperscore. The duration of a note event is directly related to its length as represented on screen. The durational relationships between different notes are immediately accessible. A note of twice the duration of another will be represented on the screen by an icon of twice the width.

Rests

Another point of contrast between low level note representation in Hyperscore and staff notation is in the nature of 'rests'. A rest in music is the absence of sound for some duration during the flow of any particular voice. The essential attribute here is that a rest is characterized by the 'absence' of something.

In standard music notation, this absence is indicated by the presence of a symbolic representation. The symbols for rests of various durations are analogous to those for note events and are similarly inconsistent and counter-intuitive. In Hyperscore, there is no specific symbol for the idea of 'rest'. If there is no note, there is a rest by default. The absence of a note event is represented by the absence of a "note-event symbol", rather than by the presence of a 'rest symbol"

Pitch and Pitch Relationships

The line/space metaphor for pitch in standard staff notation is well established. However, it also is inconsistent in some respects. For example, moving from a line 'b' to a space 'c' represents a pitch shift of one half step (semi-tone). However, the same movement from a line 'g' to a note 'a' represents a pitch shift of a whole-step (whole tone). The pitch 'grid' in staff notation is non-linear. In contrast, the Hyperscore motive window is divided in semitones. There is an absolute linear relationship between pitch and y-position.

In staff notation, it is also possible to indicate semitone pitch relationships by using 'sharp' and 'flat' symbols attached to notes. These symbols have no equivalent in Hyperscore. This of course means that while basic pitch relations are relatively clear, access to higher order pitch related concepts such as key and scale is not easily afforded by the Hyperscore interface.

5.4.2.1.2 Representation in the Sketch Window

The Hyperscore sketch window acts as the equivalent of a multi-part 'score' in traditional staff notation or piano roll. Each stroke represents a voice that plays back musical material based on the content of the motive of equivalent colour. However, there are many differences between this representational form and both standard score and piano roll notation.

Level of detail

A standard score shows all details down to the note level. In so far as there are visual groupings in standard score, these are bars, separated by bar-lines. While these represent metric division inherent in the music, they may not explicitly afford a clear visually accessable representation of groupings and boundaries along figural or other axes. Similarly, standard score may not make explicitly clear other higher-order organizing factors such as phrasing, sections or other groupings. This is especially true when dealing with novice musicians, who may not have sufficient musical knowledge to correctly interpret such information as is contained in the score.

Piano roll notation provides even less overt organization. Most of the sequencer software that uses piano roll view does so in the context of a 'tracks' paradigm. Individual voices or groups of voices appear as tracks (figure 5.4.2)

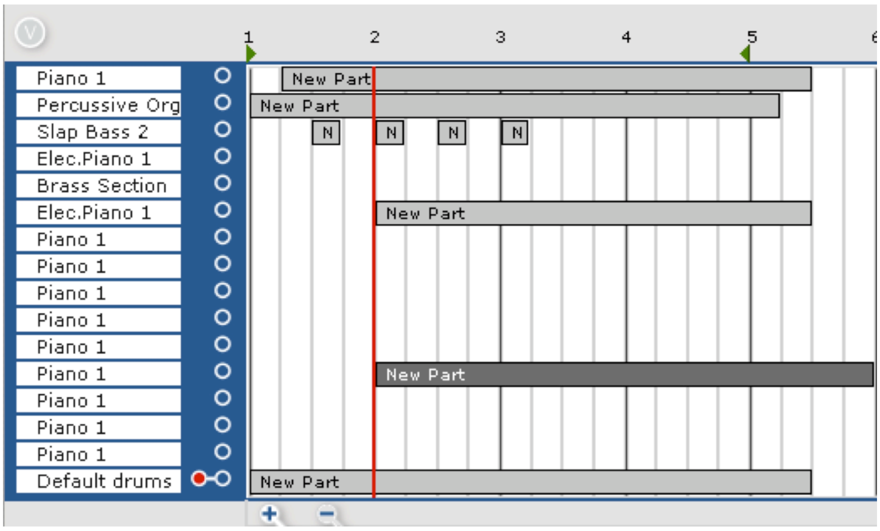


Figure 5.4.2 Tracks view in a sequencer (Sibelius Compass)

In track view, access to note level detail is not afforded. The track view usually gives no more information than the starting and stopping points of the content.

It is possible in most sequencers to view the note level detail of any given track, but typically it is not possible to access both this level of detail and the track view simultaneously, so relationships between the pitch and rhythmic content of different tracks are not made explicitly available to the user (figure 5.4.2).

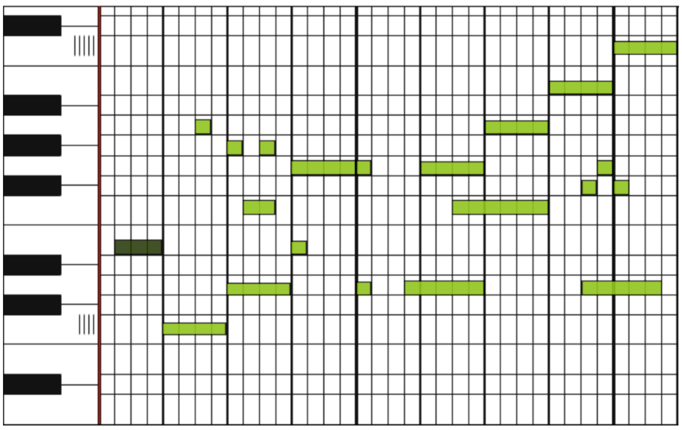


Figure 5.4.3 Piano roll view in a sequencer (Sibelius Compass)

Within a single track, it may also be difficult to perceive either meaningful note groupings or voice relationships between consecutive notes (see figure 5.4.3).

Hyperscore does not represent groupings or boundaries explicitly in the score. However, it is possible to see both the strokes in the Sketch Window and their motivic content simultaneously and so to an extent infer relationships between inner details of different voices.

Pitch ordering

As standard score represents absolute pitch, it is possible to calculate absolute pitch intervals between notes in different voices and on different staves. However, while within any instrument grouping the instrument ranges are ordered from bottom to top in ascending pitch, there is no consistent relationship between position on the score (page) and pitch. It is entirely possible for a note near the bottom of a staff system to be higher in pitch the one that is near the top. The same point broadly applies to the tracks view in a sequencer, in that the pitch content of a given track is unrelated to its position on the page. The situation is further complicated in staff notation by the use of a variety of clefs and the presence of transposing instruments, so that a note-symbol in a given line or space on one stave may mean something entirely different from a note-symbol in exactly the equivalent position on another.

In the Hyperscore sketch window, strokes placed at higher y-positions will generally sound higher pitches than those placed at lower positions (although as the pitch of the sounded notes is a function of both stroke position and note position in the associated motive, it is possible for two strokes placed at the same y-position to sound material at different pitches).

Melodic Contour

In approaching a standard score, it is in fact possible to broadly determine the pitch contour of a given voice graphically even without advanced score reading knowledge. Notes which move up in the “pitch space” indicate a rising melody, for example. The same is true in piano roll, except that in piano roll, the information is unstructured to the point where it may be unclear which notes belong to which voice within a given track (see figure 5.4.3 above).

This contour information is made much more explicitly available in Hyperscore. Even without playback, it is easy to infer general high-level characteristics of melodic movement from observation of the configuration of the strokes.

Expressive Gesture

Traditional score offers a range of ‘extra’ symbols that may be used for a variety of purposes. These include ties, phrase marks, relative and absolute dynamic indications (crescendo, decrescendo, f, mf etc) and a variety of text based instructions to the performer. In computer environments, for most purposes the computer itself is the performer. Such instructions as are possible will be interpreted literally by the computer in playback. Notation programmes typically offer the ability to have midi playback render standard score instructions, although the settings which control how these instructions are interpreted are often not easily accessible at the surface of the interface. Hyperscore confines itself to a single global tempo control and a volume control for each stroke.

5.4.2.1.3 Summary

The Hyperscore representational system is something of a hybrid form. In general, staff notation presents too much detailed note level information to be useful or meaningful to anyone other than a highly trained professional. The sequencer track/piano roll paradigm presents musical information in a more accessible way, but makes it difficult to simultaneously view low level information and higher level parameters. Hyperscore falls between these two positions, making some aspects of the contents of a given stroke available, while simultaneously showing the stroke itself, its contour and its rhythmic and pitch relationship to other strokes in the score.

5.4.2.2 The DrumSteps Interface

Drumsteps represents a radical departure from the standard notational conventions associated with both standard notation and piano-roll formats. The most notable difference is in the manner in which the Drumsteps interface represents time. In the other interfaces mentioned, time is represented from left to right (x-axis). Note events are represented by static objects, which indicate when an event will happen in time. In Drumsteps, the situation is somewhat different. While one might consider note events to be represented by steps or ladders, closer examination reveals that the situation is more subtle than this.

In DrumSteps, a note event occurs when a ball interacts with a static element. In other words, the note event is not represented by a single icon, but rather arises out of the interaction between two icons on the screen, one static, the other animated. The static elements may be positioned anywhere in the workspace. The default direction of motion of the ball is from top to bottom, so one might assume time is represented thus. However, when the ball intersects with a horizontal step, it then moves horizontally for the length of the step or series of horizontal steps. At the end of the step-set, it will again move vertically downwards. So, time is represented neither vertically nor horizontally, but is in fact embodied in the path of the ball.

There is no exact mapping between time and the underlying grid units. For example, all of the following configurations will last the same number of beats or time units.

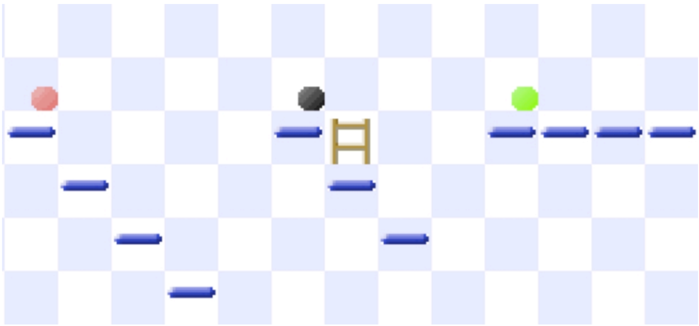


Figure 5.4.4 Time in DrumSteps

In so far as there is a consistent mapping between the underlying grid and time, it is that each grid square that contains a static element and is in the ball-path may be considered to represent a unit of time. The ball speeds up and slows down depending on the configuration of elements in its path. For example, in the case of a diagonal line of steps, the ball must traverse two grid squares in a single time unit. However, in the case of a ladder element the ball will move through a single grid square in the same time unit. The net effect is that each graphical element is perceived as a single unit of time regardless of its physical configuration, and the ball adjusts its speed so as to maintain this perception. So, in the first case above, two grid squares represent the basic unit of time, while in the third case, basic time units are represented as single grid squares. There is a clear contrast here with other standard notational systems (both paper- and computer-based), which almost universally represent time from left to right.

While the passage of time is not represented consistently with respect to direction, there is a consistent and reproducible connection between step configuration and the time interval between successive note events. Users interact via the interface in the first instance by placing basic step icons representing single beat units. The single-step unit is therefore perceived as the de facto duration unit against which all other note durations are measured. Thus, note duration and the relationships between the durations of different notes are made explicitly clear in a similar manner to Hyperscore. For note values smaller than the single step, notes are represented in groups or aggregations rather than as individual units. While preventing individual manipulation of note units of less than the basic step duration, it will be evident from the case studies that this does create a very strong sense of the relationship between these smaller units and basic duration unit.

The Drumsteps interface supports multiple voices. In each voice, all level of detail is shown, a feature the interface shares with standard score. There is no automation in terms of computer generated content, so the interface supports a greater degree of transparency than Hyperscore. However, as each voice may be located in any part of the screen and voices are not presented in parallel, specific internal relationships between voices may not be as immediately accessible as they might be to a trained musician reading standard score. It will be demonstrated during the course of the workshops that this was not found to be a particular impediment as children did manage to perceive time-position relationships between voices, and in fact may have even guided children towards enhanced perception of their work through the process of counting and examining individual voices as they constructed an understanding of inter- voice relationships. Other aspects of the interface may also focus the attention of users on these relationships. For example, use of the trigger function necessitates beat counting so as to ensure voice entries at the correct time.

Drumsteps supports a degree of grouping and aggregation at various levels. As mentioned, ladder units may be deployed to represent aggregations of smaller note values. At a higher level of aggregation, wormhole pairs may be used to create repeating units of any required length. These wormhole pairs are somewhat analogous to the 'double-dot' repeat symbol deployed in standard staff notation, with the difference being that in Drumsteps, each voice may be made to repeat independently of any other.

In so far as there is any automation in Drumsteps, it resides in the use of the randomizer. In this case, the content is generated by the user. However, the order in which the content is played is a function of a simple randomizer algorithm that the user may choose to employ.

Where Drumsteps differs most fundamentally from any of the other representations mentioned is in its procedural nature. Music is represented as a kinetic series of events caused by collisions between objects. Furthermore, collision events in one part of the workspace may be used to trigger events in another. The animated nature of the interface provides visual feedback to the user with respect to which collision events are associated with which sounds. This feedback is fundamentally different with that provided by other interfaces in so far as it implies a measure of causation. A sound is perceived as being 'caused' by an event. In a standard pitch time interface, there is frequently a play-head that scans the static representation, indicating which icon is associated with which sound. However, there is no implication that the play-head has 'caused' the sound.

This element of causation opens up a variety of teaching and learning paths and perspectives, not facilitated by other interfaces. For example, the learner might be asked to "imagine you are the ball" and to predict the sound outcome from a series of steps. This type of 'active' note reading may offer an alternative path for untrained children into successfully 'reading' abstract notational forms. While this issue was not a specific focus of the study, after the final session each of the children managed to clap unprepared a number of rhythms written in 'step notation' on flash cards to a reasonable degree of accuracy. While this is not conclusive, it may indicate that the step notation is at least as intuitive as formal staff notation, although further work in this area would clearly be required before any more definitive statement might be made.

5.4.3 Musical Manipulations in Hyperscore and Drumsteps

5.4.3.1 Introduction

While there are clear differences between these representational forms and standard notation with respect to musical objects and groups of objects from standard notation, it is perhaps in the nature of the manipulations afforded by each that these differences become most readily apparent.

In traditional staff notation on paper, the only manipulation of an object possible is to erase it and replace it with a different object. This supposes that in committing an object to paper, its musical manifestation has already been imagined and/or tested by playing on an instrument. It is entirely possible to 'write' a series of note events and to then examine attributes and relationships using the score as a facilitator of this thought process. However, in order to do so, there must be the ability to realize the sounds either on an instrument or in the "minds ear" along with an intimate facility with the notation system itself.

For the novice user, the capacity of this notation system to 'talk-back', to reflect attributes of the represented music, is severely limited. Furthermore, the ability to interrogate the situation by making alterations to the notation is also limited, both in the nature of the alteration and its manner of execution. The staff notation system is therefore a poor medium through which to build musical understanding. If one does not understand the note duration hierarchy, for example, it is difficult to see how interacting with standard staff notation might lead to such an understanding. The relationships between notes of various durations are unclear, and yet the only way to explore these through notation is to examine and manipulate the notation and realize the sounds, which presupposes the ability to both read the notational symbols and understand the musical concept or idea they represent. There is a clear paradox here.

All computer based notation systems, regardless of the specific representational system used, attempt to offer a way around this impasse. The user may change, manipulate or otherwise interact with the notational elements, thereby beginning to construct an understanding of both the musical objects represented and the representational system itself. This distinction is key. The value of a computer based representational system lies in the extent to which elements may be moved, manipulated or changed and which will playback the results of these changes.

5.4.3.2 Musical Manipulations in Hyperscore

5.4.3.2.1 Note-level manipulations

Hyperscore encapsulates musical events as static visual objects that may be manipulated. The nature of the manipulations which may be performed are in many cases fundamentally different from the manipulations which are afforded by computer-based staff notation or piano-roll environments.

Broadly speaking, the range of manipulations available to the user include creating and deleting notes, grouping notes and changing the size and content of a group, changing the pitch, duration, timbre and volume of a note or group. The interface also facilitates making comparisons between notes and groups of notes and observing relationships between these with respect to parameters such as pitch, duration, interval, contour and melodic direction, pattern and sub-pattern.

On a superficial level, these manipulations would seem to be equally accessible in a standard notation or piano roll format. However, closer examination yields small but significant differences in how these manipulations may be carried out. For example, in the Hyperscore motive window, a note may be placed anywhere in the window. By comparison, in a standard notation editor (such as Finale or Sibelius), it is not possible to place a note at the end of a measure, without first filling the rest of the measure with notes or rests. Similarly, it is not possible simply to 'grab' a note from one part of a measure and move it within the measure or into another measure.

These manipulations are possible to an extent in piano-roll notation. The principal difference here is in the monodic nature of the Hyperscore motive window. In Hyperscore, placing notes will automatically overwrite any previously placed notes with which they overlap. In piano roll, overlapping voices are possible. The effect here is to direct the focus towards melodic attributes of the material rather than on harmonic issues and to ensure clarity with respect to voicing.

The Hyperscore interface facilitates grouping of notes and making and changing unit boundaries on multiple levels. Groups of notes may be defined within the motive window and moved together. Drawing in the sketch window facilitates note grouping at a higher level of aggregation. This ease of grouping facilitates a kind of fluid thought and action that is difficult to replicate in other interfaces and will be shown to be fundamental to the composition process for participants in the Hyperscore workshops.

5.4.3.2.2 Higher Level Manipulations

Hyperscore also offers a set of 'high-level' manipulations, relating in particular to melodic contour and to harmony. Drawing curved strokes in the sketch window or bending existing lines causes the constituent motivic material to 'follow' the shape of the line, by making small alterations to the inner melodic detail. In this case, the configuration of the line represents the 'contour' of the melodic material at a gross level of description.

Bending the harmony line imposes a harmonic template or progression on the note content of the strokes, shifting concurrent note events up or down in pitch so as to follow standard harmonic progressions. In this case, two gestures are recognized – a smooth curve for local harmony and a spike for a modulation. As a representational form, the curve itself conveys no information as to the exact harmonic progression beyond the fact that there has been one. The colored areas underlying the curve indicate harmonic movement away from and towards the tonic chord. The spike gesture conveys more information, in that there is a literal mapping between the height or depth of the spike and harmonic distance from the default key. It is therefore possible to read the current tonal center by examination of the line, once the key change regions are known.

All of these drawing gestures are characterized by the manner in which they act on higher level parameters, with the software taking care of the note-level detail. The effect here is that users may both attend to and act on higher-level aggregations and parameters without having to attend to note level detail. The disadvantage lies in the extent to which the final state of the system is a function of user intent. There is clearly a tradeoff between access to these higher parameters and control at the lower levels. The compromise in the software is that note level manipulations are only available in the motive windows, while higher-level manipulations are confined to the sketch window.

In fact, the presence of these constraints within the system might be exactly what makes it useable to the novice user. Staff notation or piano roll based systems require all features of the music to be constructed from note-level detail up. Such unconstrained environments might at once provide too much undifferentiated note level feedback and require too much command of this detail to make higher level musical parameters readily available. Hyperscores' constraints (modularization and sketch window focus on gross descriptors) may well facilitate musical interaction at the higher levels of aggregation that would not be possible otherwise.

5.4.3.3 Musical Manipulations in DrumSteps

In so far as the manipulation of musical objects is concerned, Drumsteps occupies a mid-way position between Hyperscore and standard computerized representations. Objects representing musical note events may be placed or erased, and grabbed and moved freely around the workspace. A simple mouse click-and-drag action enables these actions to be performed on groups of objects as easily as on single objects. Objects may be converted into other objects in an unconstrained manner. This contrasts with most staff notation based software, which constrains such object switching with respect to the measure unit (for example, in a full measure, a note may not be replaced by a note of longer duration, as this would not 'fit' in the measure).

A striking difference between Drumsteps and staff notational forms is the degree of independence between voices. In both staff notation and piano-roll formats, the temporal relationships between voices are fixed, unless entire blocks of notes are moved with respect to each other. In Drumsteps, while the step icons do not move, the ball may be placed anywhere, effectively changing the rhythmic position of the entire step set with respect to other voices. Two or more balls may be placed on the same set, effectively creating rhythmic cannon. Voices may be delayed with respect to each other and balls may be easily routed from one position to another, changing the order in which material is played. In fact, as DrumSteps does not make use of the standard left-to-right timeline paradigm, chunks of musical material (represented by sets of steps) become temporally unconstrained entities that may easily be deployed in any configuration or order.

Ultimately, the Drumsteps interface is less complete than either Hyperscore or more standard forms, if for no other reason than the fact that it does not support pitched sounds. However, within the more constrained area of rhythm and percussion, it does offer a means to construct complex and meaningful musical objects in an intuitive and direct manner.

CHAPTER 6 CASE STUDIES AND ONLINE DATA.

6.1 Introduction

The primary data set mechanism in the current study consisted of a series of case studies involving children working in both Hyperscore and DrumSteps in the presence of a competent mentor. In tandem with this, a supplementary block of data was collected, consisting of pieces submitted by unmentored users via the internet. The current chapter presents excerpts from the descriptive case study data along with initial analysis of the online pieces. Case excerpts are chosen and presented in a manner designed to illumiate aspects of the teaching and learning process, while giving some initial insight into the core themes of affordances and reflection-in-action underpinning the work. Case data for each software application is presented separately so as to clearly demonstrate the emergence of similar themes and issues across both workshop series. Fuller descriptions of the Hyperscore and Drumsteps cases and examples of the various categories of online pieces may be found in appendices B,C and D respectively.

6.1.1 Conditions for the Case Studies

Participants in the study consisted of children (four girls and six boys) in the ten to twelve year age range at two Irish primary schools. The Hyperscore study was conducted in Newtown National School, Crettyard, Co Laois. This is a rural school with a total enrollment of sixty-two pupils divided across eight year groups. The school does not have a music specialist teacher and students do not receive much formal instruction beyond informal song singing and music games. Ten children in the ten to twelve year age range participated in the study. None of these participants in the study had any significant level of prior music instruction outside school.

Each participant had between eight and ten sessions of between forty-five minutes and one hour duration which occurred twice a week during the normal school day over a five week period from 22/10/02 to 22/11/02. Participants were taught two at a time, each at the opposite end of a large hall. The teacher divided his time between participants as required. Each student worked on a laptop machine with loudspeakers attached. Each workstation was observed via a static digital video camera trained on the screen for the entire duration of each session. Headphones were not used as there was a requirement that the videotape would pick up both video and audio data. Participants were each informally exposed to the others work in progress at intervals throughout the process. Two group discussion sessions were held, one in the middle of the process and one at the end, where students heard each others pieces and commented. Subjects were also given a short interview at the end of the project. All interviews and interactions were videotaped.

The DrumSteps study was conducted in Lucan Educate Together National School, Lucan, Co Dublin between 4/01/03 and 8/01/03. This is a large suburban school with approximately four hundred and fifty pupils in eighteen class groups. Participants in the study were again in the ten to twelve year age range and consisted of six students (four girls and two boys). The study was again carried out in pairs, in this case in a small room adjoining the school special needs centre. Again, two computer workstations and digital video cameras were used for data capture. Arising out of the experience of the first study, it was decided for logistical and analysis reasons to examine a smaller number of students over a shorter time frame. Consequently each participant had five sessions over the course of a single week. Participants were again individually interviewed and participated in a group session at the end of the project. All participants had permission from parents/guardians to take part in the study. Permission was also given for video tape recordings and for the resulting videotapes and children's pieces to be used both in data analysis and in conference and journal reports. Names of the participants have been changed.

6.1.2 The Researcher

Research was carried out by the author, who is a trained musician and music educator. He has primary degrees in both music and applied science, postgraduate qualifications in music and education and has over fifteen years experience in music education at a variety of levels from individual instrumental teaching to running a large fine arts department. The author has had training in composition at undergraduate degree level and has composed informally but not at a professional level. He has taught composition in a variety of educational settings. Before beginning the current study, the researcher had engaged in informal observation of over two hundred children using both Hyperscore and Drumsteps in a variety of school-based and non-school based contexts.

In approaching the workshops it was decided initially to adopt a non-directive approach. As the study was designed to examine the role of graphical interfaces for composition learning for novice composers, participants were not given any prior training in music rudiments or the principles of composition through any other medium. The teacher/researcher adopted a reactive role, initially offering minimal guidance to students beyond what was necessary to begin the compositional process and thereafter making interventions as deemed necessary. While this is in fact an a priori pedagogic approach, the intention was to allow the perceived needs of the individual students to dictate the nature and type of intervention. It was hoped that this strategy would be broad enough to allow a variety of unscripted interactions, therefore providing a window into not only the childrens processes but also those of the teacher.

6.1.3 The Data

The resulting initial case study data set comprised approximately ninety one-hour digital videotapes. Based on participant observation and review of the tapes, six cases were selected for detailed analysis. Selection was made on the basis of observed behaviours over the course of the workshops. Each case selected for detailed analysis was chosen so as to best represent a clearly delineated behavioural type.

In each of these cases, a full transcript was made of the entire process, noting student actions, teacher interventions, all teacher-student conversations verbatim and researcher reflections on the tapes. (see appendices B and C). The online data set comprised a total of two hundred and sixty-one pieces. In the case of these pieces, no user data was available with respect to age, gender, prior musical training or the presence of a qualified mentor or teacher.

6.1.4 Supplementary data - Online Pieces

Both pieces of software were made available to users via the internet. In the case of Hyperscore, the software was made available via the Toy Symphony website. The software was publicized via the American Public Broadcast television show, "Scientific American Frontiers", presented by Alan Alda, premiered April 8, 2003[5] and repeated a number of times over the following two months. Launch of the software was also accompanied by a full-page leader article in the New York Times arts section. Following this publicity, the software was downloaded in excess of twenty-five thousand times. Users were invited to submit scores to a gallery on the Toy Symphony website. Of these pieces, one hundred and five were randomly selected for analysis.

In the case of DrumSteps, this was done in collaboration with the BBC. A Shockwave version of the software was built and placed on the BBC website[6]. The software was publicised in collaboration with the BBC Radio 3 programmes 'Making Tracks", a music show aimed at children in the eight to fourteen year age group and "The Big Toe Radio Show", a general magazine show aimed at children in the same age range. A follow up competition was held in conjunction with the CBBC 'Xchange' television programme. Children were invited to submit pieces they had made to the competition and for display in an online gallery. Over five thousand users submitted pieces to the BBC website. A random selection of one hundred and fifty-six pieces was made available by the BBC for analysis.

All pieces collected are contained on the accompanying CD (see appendix A). Categorized examples of submitted pieces are described in appendix D.

6.2 Hyperscore Case Studies

6.2.1 Introduction

Three children were chosen for close analysis from the ten who participated in the Hyperscore workshops with in order to demonstrate the full range of behaviours observed. These were Kevin, Emer and Stacy. Kevin was chosen to exemplify instances of musical interaction and learning and to provide a clear contrast to the less musically oriented behaviours exhibited by children in the other cases. Emer and Stacy were chosen to both support inferences drawn from Kevin's case and to illustrate contrasting

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[5] http://www.pbs.org/saf/1309/index.html
[6] www.bbc.co.uk/music/games/drumsteps

modes of interaction, broadly characterized as visual/graphical (Emer) and kinaesthetic (Stacy). Fully comprehensive accounts of these cases may be found in appendix B, including a full chronological description of Kevin's case and more extensive description of the other two.

In including excerpts of the case studies in the body of the document, the intention is to describe in some detail events that illustrate key themes which emerged from consideration of the case transcripts, offer some initial analysis and give the reader a general sense of the rich, multi-layered and interdependent nature of the experience. This description will proceed along three main strands: Composing Process; Musical Interaction and Learning; Teaching Intervention and Strategy. The aim will be to illuminate each of these themes by example and discussion, while pointing to those aspects of the observed behaviours which are relevant to the main thrust of the thesis in the areas of interface affordances and reflection-in-action. These core issues will then be considered in more detail in chapter seven.

6.2.2 Composing Process

This section outlines examples which give some insight into the childrens composing processes, how these processes may have changed over the course of the workshops, and in particular which aspects of these processes are related to the nature of the interface or are indicative of an underlying reflection-in-action dynamic.

6.2.2.1 Task Framing and Re-framing

One of the themes to emerge from a consideration of the cases was the manner in which students conceived of the task in which they were engaged, and the parameters to which they attended in going about the task. Students tended to move from initial, interface-driven activity to engagement with musical concerns.

In the first session Kevin is introduced to the software. He is told that he will be using the software to compose a piece of music, and is introduced to the idea of 'motivic' composition as embodied in the software. He is shown how to make motives by dropping notes into the motive window, how to change their pitch and note length, how to playback and edit. The sketch window is not introduced at this stage. He is given an introductory task, to "Make four musical motives that you like and that are different from each other."

Kevin works at this task unaided for approximately twenty-five minutes. During this time he produces four musical motives, two of which are shown in figure 6.2.2.1.

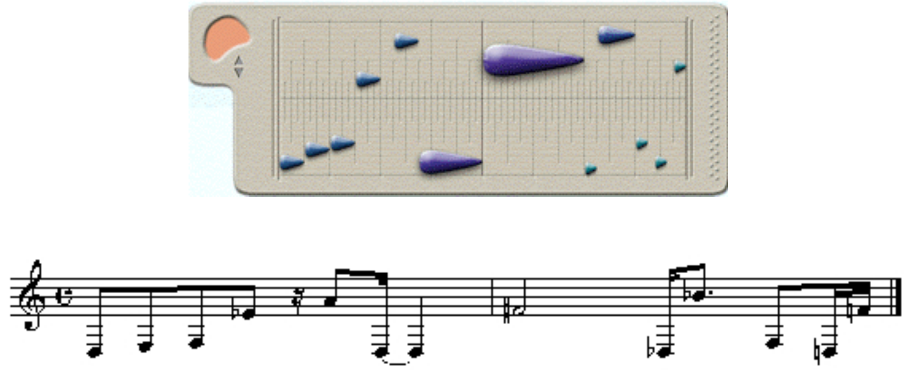


Figure 6.2.2.1(a) Orange motive

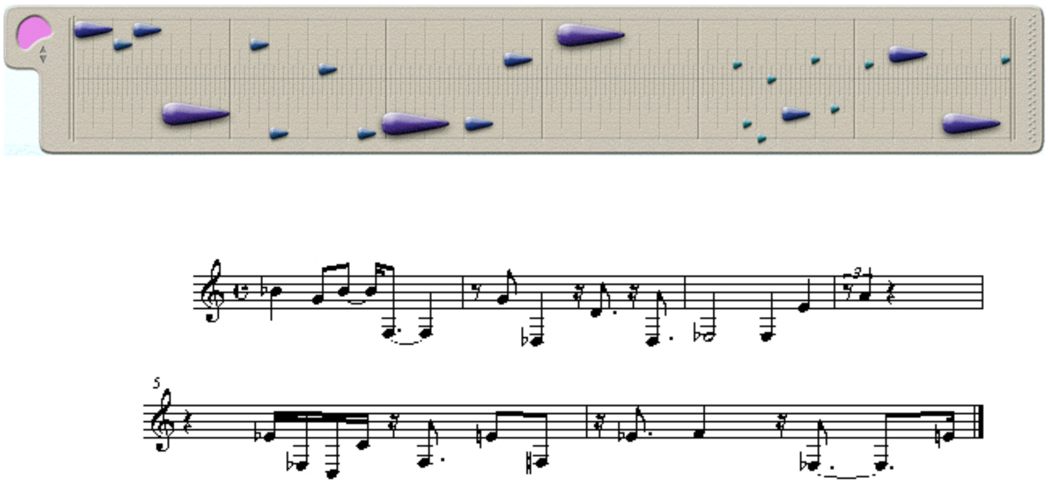


Fig 6.2.2.1(b) Purple Motive

Kevin's working process seems almost completely arbitrary. The motives themselves seem to have no clear melodic or rhythmic structure. While he is making these, Kevin listens to two of the motives once each but does not revise or edit. The other two motives are not listened to at all. At this point it could not be said that Kevin is engaged in any form of musical reflection.

Towards the end of the session, the teacher returns and engages Kevin in conversation about his work. He asks Kevin to describe his motives. Kevin responds by describing the motives in terms of the number of notes, the kind of notes (long or short) and the overall length of the motive. He says nothing about pitch, melodic contour, pulse or rhythmic structure. In talking about the purple motive, Kevin says:

K - (laughs)…… I made a really long one.

T – That's good…

K - I haven't played it yet.

T - You haven't played it yet? So you made it all before you played it?

K - Yes…..(plays back purple motive)

T – So you made it all but you haven't listened to it yet?

K – Yes.

Reflecting on Kevin's work, the teacher clearly perceives that there is an issue of musical intent. He teacher then questions Kevin as to his motivation for particular note placement.

T – OK. (points to a note) so why did you put that note there? Because it looked good or because you thought it looked right, or because you thought it might sound right, or….or for some other reason?

K - No, I was just messing around with them like, 'cos like I was just putting them to see what it sounded like.

Although Kevin says he was 'messing around' with the notes to 'see what they sounded like', he has not listened to them to find out. After further conversation however, Kevin comes to the following realisation.

K - Because if you don't know what it sounds like, then you don't know whether it'd be good or not, so……so, you need to test it first, so as you know what it sounds like, build it up, you know…..

Kevin has made two fundamental discoveries, one about the nature of the task and the other about strategy. Firstly, he has understood that the point is to make something that sounds 'good', and secondly he has realised that in order to do this he needs to listen, to 'test it first'. His use of the word "test' is revealing in that it implies some sort of criteria to decide if something sounds good and also indicates the possibility of action based on the test.

Kevin's next moves indicate the degree to which he has reframed the task. As he places notes in the motive windows, he continually plays back and listens to his work. The motives he produces are fundamentally different in character from those he made in the first session (figure 6.2.2.2).

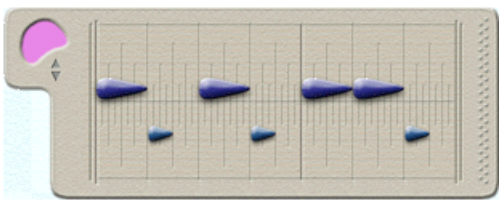


Figure 6.2.2.2(a) Purple motive

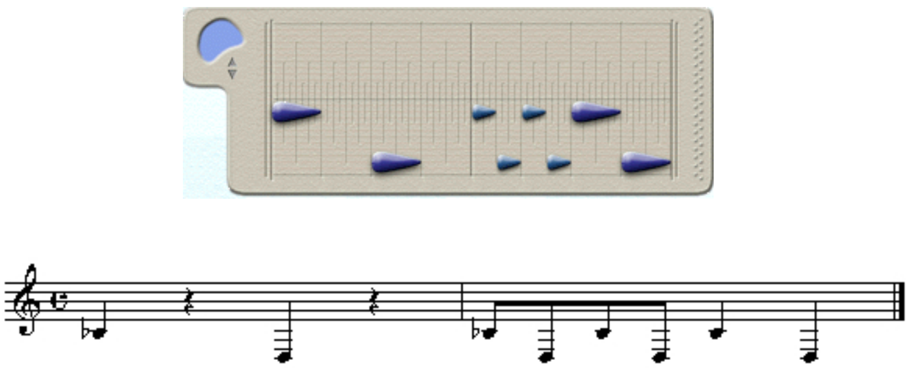


Figure 6.2.2.2(b) Blue Motive

Both motives are intervallic (perfect 5th and minor 6th respectively), have a clear pulse and strong internal rhythmic structure and are clearly the result of musical concerns. In conversation with the teacher, Kevin indicates a clear internal representation of each motive by singing both of them correctly in terms of pitch and rhythm.

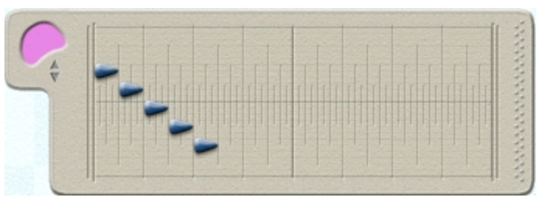
In making these motives, Kevin demonstrates that he has reframed the task in a fundamental way. There is no longer any question about his intent regarding pitch or rhythmic placement and he demonstrates a strong internal representation of the motives.. His reframing of the task has had a clear impact on his working process, particularly in respect of his use of the playback feature. This task-framing and reframing is a crucial element of reflection-in and –on action, and has been facilitated both by the interface itself and the nature of the teaching intervention.

6.2.2.2 Convergence

One noteworthy aspect of the childrens compositional process was the manner in which they gravitated towards a broadly convergent compositional process, despite markedly different initial strategies. Kevin achieved this compositional process in making his third motive, which evolved in clear stages, which are illustrated below with brief comments.

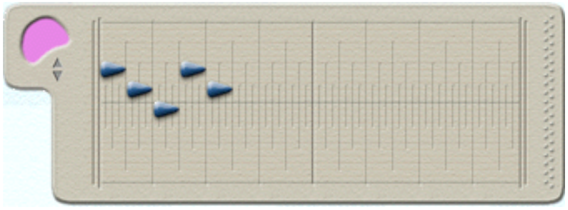
He experiments for a time eventually settling on a descending five-note figure.

(a)



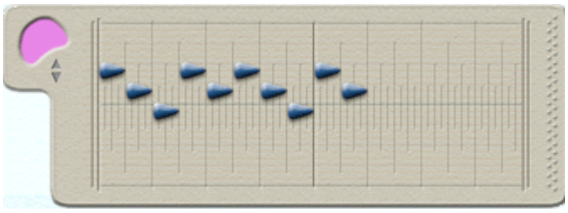
He then highlights the last two notes as a unit and moves them both up in pitch.

(b)



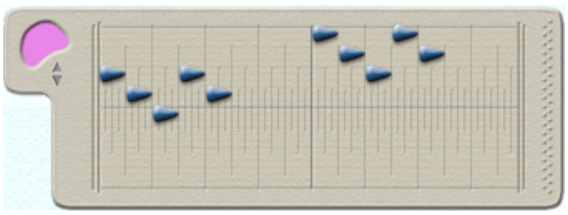
He copies the entire figure and pastes it in a second time, applying the strategy he was shown at the start of the session, but in the context of his own musical idea.

(c)



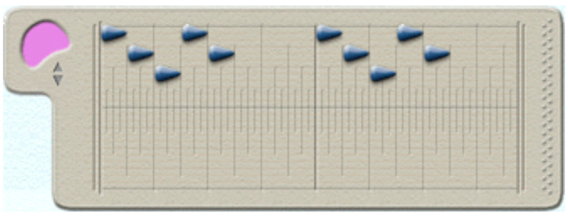
He then highlights the second figure as a group and shifts it right and upwards.

(d)



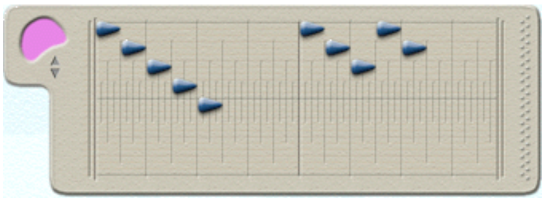
He shifts the initial figure up to match.

(e)



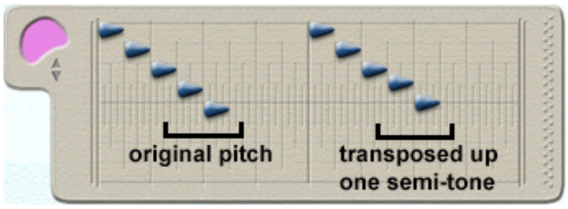
For these last three moves, his working unit, what Jeanne Bamberger might term his 'unit of perception' (Bamberger, 1991) is a five note group. He then focuses on a two note group at the end of the first figure and moves these two notes down as a unit to revert to his initial melodic idea, although transposed in pitch.

(f)



He then does the same for the second group. However, he shifts the last two note figure up a step so as to make a variation on the first group. He tests this by listening, moves them back down, listens again and then shifts them back up again.

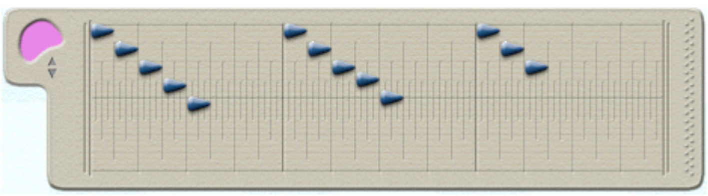
(g)



He has clearly understood the concept of variation, which had been previously modelled by the teacher, and deliberately applied it.

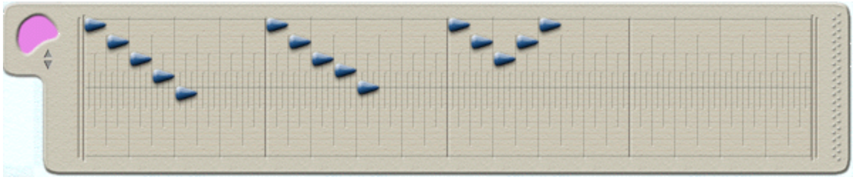
He then carefully places three notes to match the pitches of the first three notes in each of the preceding figures.

(h)



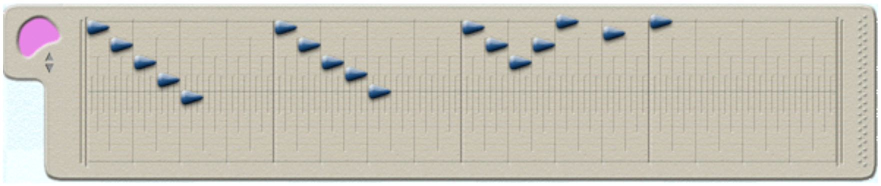
He places two more notes and experiments with several pitch positions before settling on the symmetric figure shown.

(i)



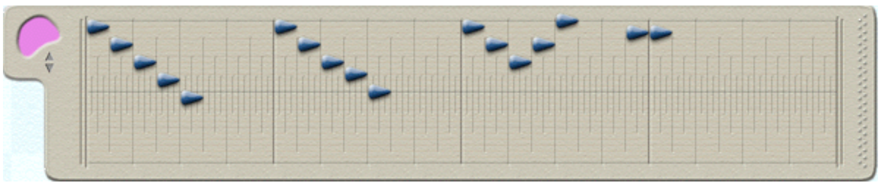
He places two more notes, but seems unhappy with the pitches. At this point the teacher arrives. He asks Kevin what he is doing. Kevin responds by describing the ending and then singing exactly what he wants. In doing so, Kevin demonstrates that he has gradually moved from a divergent process (Webster, 1994) to a point where he is converging on a definite idea. The teacher suggests that he methodically move the penultimate note up by step until it matches the pitch he is imagining. Kevin does this, listening each time. He passes the pitch he had sung. He says 'just down one there' and moves the note back down a step.

(j)



Having got both pitches as he wants them, he then moves them as a unit right by step until he has the required rhythm.

(k)



Finally, he adjusts the lengths of certain notes to produce the final motive as shown (figure 6.2.2.3).

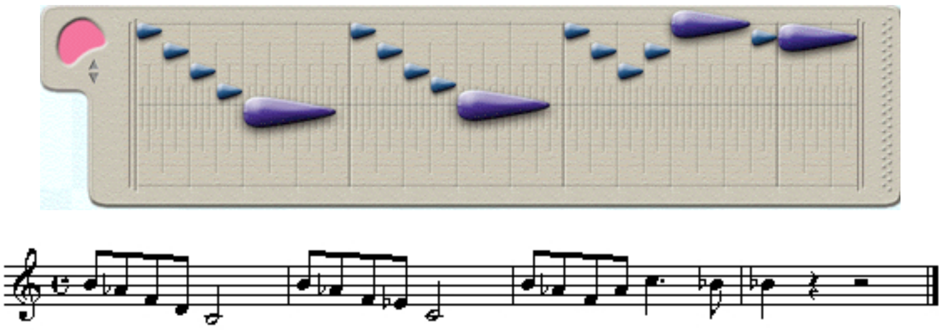
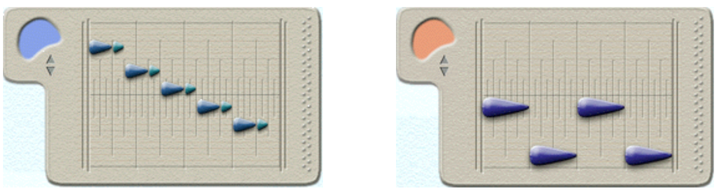


Fig 6.2.2.3 Red Motive Final

Kevin has clearly undergone some sort of process analogous to that described by professional composers, in that "his choices are made within a specific framework, which, as it grows, exerts an ever greater influence on what is to come" (Sessions, 1970).

Each step has suggested something about what might come next, gradually moving towards what can ultimately be the only resolution. While this is a comprehensive description of something small that happened in one session, it is revealing both as an illustration of Kevin's working process and of the nature and level of observation throughout the study. John Sloboda (1985) suggests that the best way to understand the way composers work is to observe them throughout the process. Kevin starts with a blank screen. He begins with initial experimentation until he settles on an idea. He then plays with different variations on this idea, gradually working towards the final form of the motive. His movement from an initial experimental phase, through the development of his idea to final certainty is indicative of a process similar to that described by both Sessions (1970) and Webster (1987, 1884). Various aspects of interface affordances have been fundamental in facilitating Kevin's progression towards convergence, in particular the ability to select and operate on note groupings at various levels of aggregation. His move-testing behaviour is a clear example of another key element of a reflection-in-action process.

Stacy's initial work somewhat different from Kevin's in that it is characterized by random experiment until an idea occurs. Each motive seems to be the working out of a single idea. She does not yet exhibit the sort of convergent behaviour engaged in by Kevin. Her motives have a clear sense of organization with respect to pitch, rhythmic placement and tonal factors (figure 6.2.2.4).



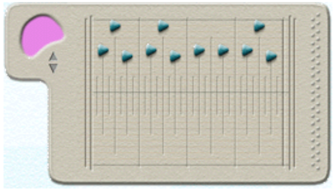


Figure 6.2.2.4 Stacy's First Motives

Later Stacy seems to move towards a more convergent approach, making clear use of software functionality to aid her thinking processes (figure 6.2.2.5).

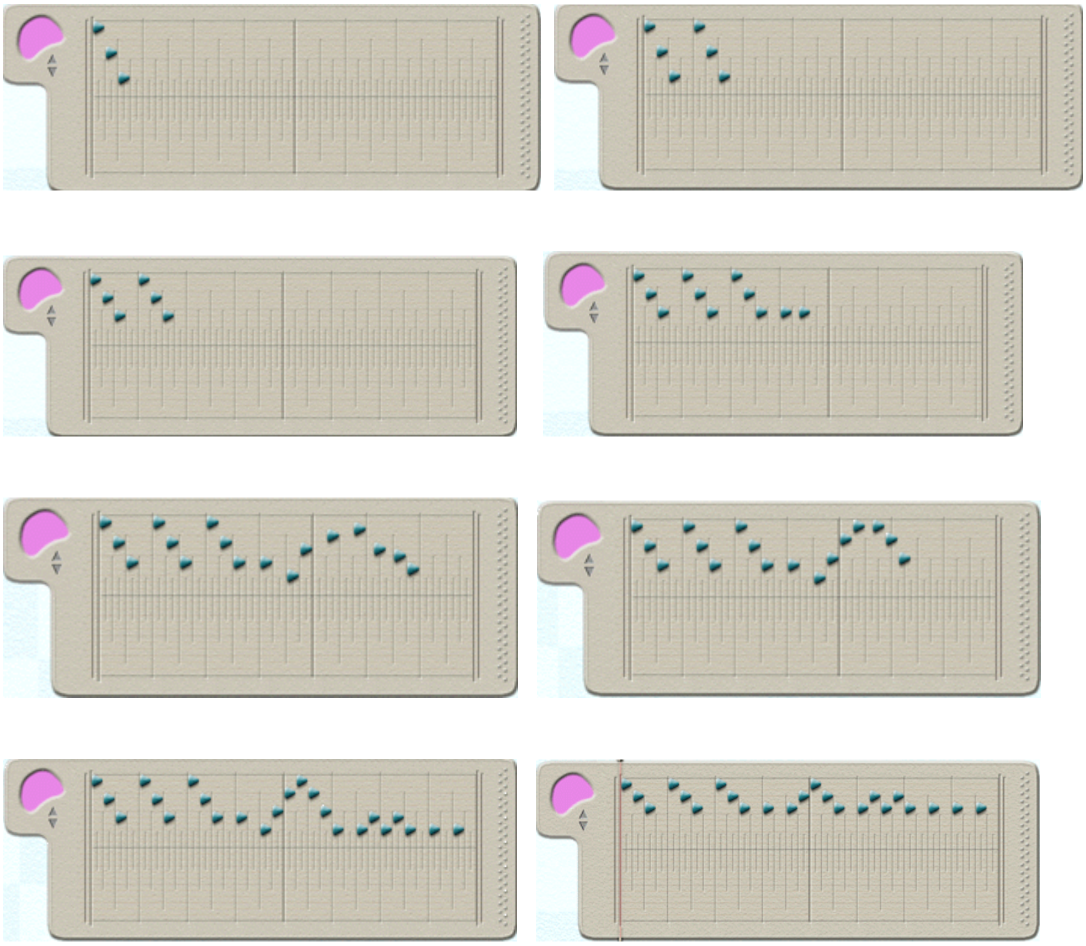


Figure 6.2.2.5 Fully Developed Convergent Process

Emer also appears to eventually adopt a more convergent style similar to that shown by Kevin. She makes a series of moves which seem to evolve in a natural and fluid manner (figure 6.2.2.6).

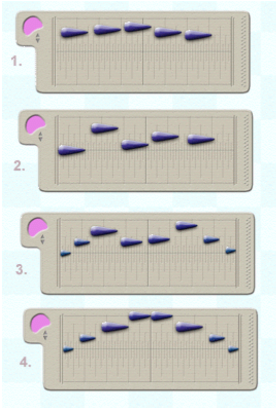


Figure 6.2.2.6 Convergent Process - Emer

Over the course of a number of sessions, both Emer and Stacy's approaches to making motives undergo a shift, from realising simple, preconceived ideas to a gradual process of feeling their way towards a solution based on a fluid interaction with the materials as they works. The manner in which their process emerges bears a striking resemblance to Kevin's more developed motive-making, and represents a more fluid and coherent process than their own earlier efforts.

While the interface seems to support a variety of compositional processes, all the students to varying degrees seem to make progress towards a more convergent style, with the implication that at some level they are engaging in a reflection-in-action like process, making new moves on the basis of the current state of the attributes and implications inherent in their working materials. To this extent, one might suggest that something about the interface is supporting or possibly even generating this process.

6.2.2.3 Composing Process and Visual Affordance

While students did attend to musical parameters throughout the process, it could not be said with any degree of certainty that their work was exclusively the product of musical intent. In many instances, actual outcomes were observed to be as a result of a convergence of factors that included both students' musical concerns and functionality afforded by the interface itself. The nature of the Hyperscore interface seemed to lend itself to gestures that were at times motivated by visual or graphical concerns. Emers motive-making in the first session provides a clear example of this.

This motive seems to emerge in two distinct moves or sections, with little experimentation. She quickly completes both figures, doing the opposite in the second part to what she did in the first. She listens once and moves on.

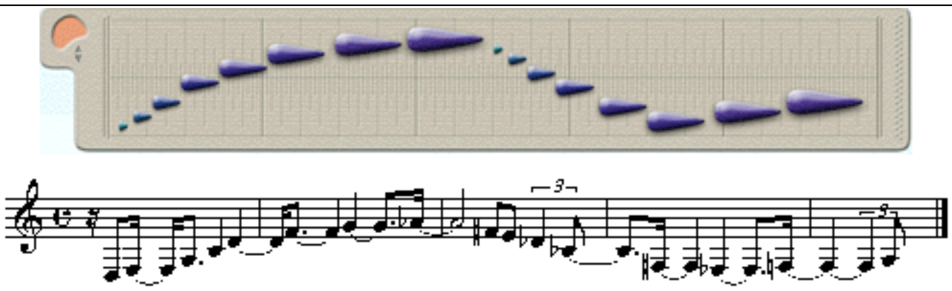


Figure 6.2.2.7 Orange Motive

This motive (figure 6.2.2.7) has a sense of pitch contour and a symmetric rhythmic structure in terms of note value, but placement and the exact relationship between the note lengths is approximate. It is clearly visually motivated, and while it does appear organised at the level of the visual affordances of the interface, it lacks a coherent musical structure.

In the sketch window, Emer again shows evidence of graphical concerns. She makes extensive use of dots (figure 6.2.2.8).

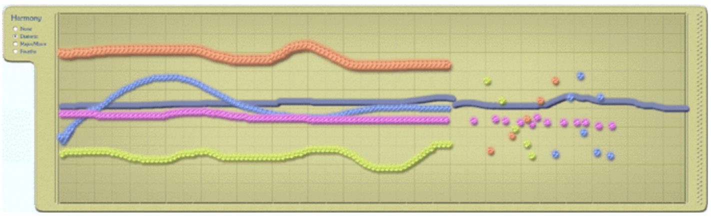


Figure 6.2.2.8 Visual Gesture (Dots)

These are arranged in sets of crossing lines but do not produce rhythmically or melodically coherent result despite their visual organisation.

In her final section (figure 6.2.2.9), Emer again deploys a clearly visual style. Her long, crossing strokes (top and bottom) are symmetrical. The blue (middle) stroke is a ‘zig-zag’ pattern, with the surrounding dots placed so as to partly mimic the shape. The four short strokes at the end are symmetric around the central axis (outer are purple, inner are both blue) while the final lines of dots are initially also symmetrical, although the lower is later extended.

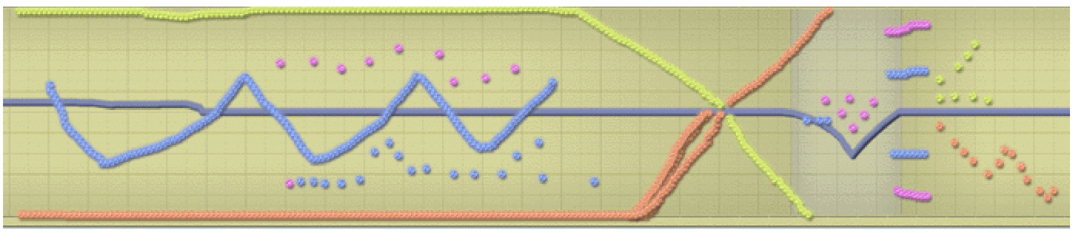


Figure 6.2.2.9 Symmetrical Gesture

While there is a definite visual aspect to her work, Emer is to an extent aware of the effect of the contoured strokes on the pitch content of her motives and later uses this to manipulate melodic contour.

T - Well, what changed about it - was it still doing this? (pointing to motive window)
E - It was still doing that, like, but a different kindof...tone....
T - Different tone....like what, did it go...some direction?
E – Higher.
T - You think it went higher? Well let's listen to it again....
E - (Laughs).....Lower.
T - It goes lower...and the reason it does that is this...
E - Cos it's going down, the line, as well.

This is quite typical of the students in the workshops. Students are clearly making moves and reflecting on the outcomes. However, it is not always entirely clear whether this reflection is musical in nature, or whether it is operating at the level of visual or kinaesthetic affordances. While there are certainly questions about the musical intent associated with many of the moves students make, it does seem likely that in some cases they do understand on some level the musical implications, even in the case of moves that seem to be primarily motivated by graphical or kinaesthetic impulses.

6.2.2.4 Composing Process and Kinaesthetic Affordance

The particular nature of the sketch window in Hyperscore also seemed to lend itself to gestures which originated in physical action rather then any conscious musical thought. Students using the mouse to control the 'Pen Tool' produced strokes similar to those which might result from spontaneous action with actual pen and paper.

Emer's initial attempts in the sketch window consist of several wavy lines. These are clearly the result of an intuitive physical gesture rather than any musical, or even visual intent (figure 6.2.2.10).

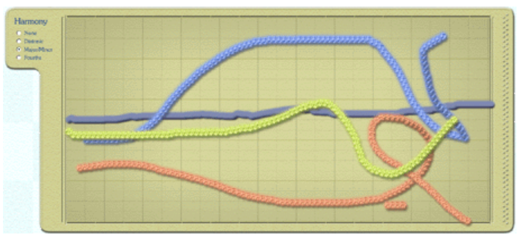


Figure 6.2.2.10 Physical Gesture

Stacy's initial work in the sketch window also seems to be primarily gestural.

She draws in three wavy lines, each representing a different motive (figure 6.2.2.11). Each is drawn with a fluid gesture from left to right.

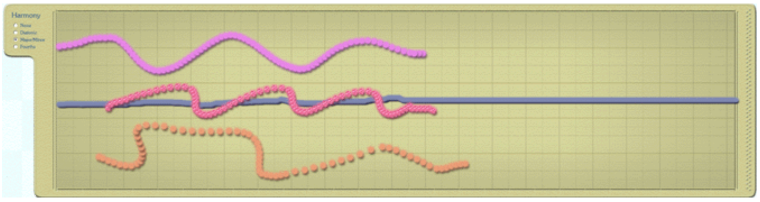


Figure 6.2.2.11 Kinaesthetic Drawing

In a later section of the piece we see evidence of a similar approach (figure 6.2.2.12). She makes a series of u-shaped gestures, drawn first and positioned later. She fills in the middle of the pitch range with a series of diagonal lines, again drawn with a single fluid gesture.

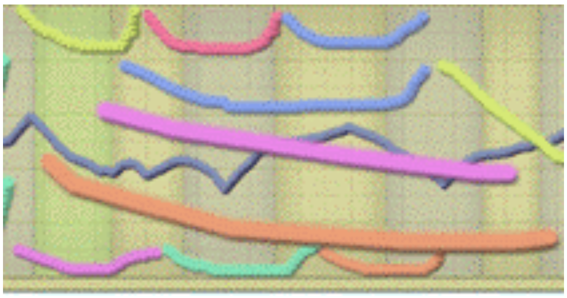


Figure 6.2.2.12 Further Kinaesthetic Drawing

The teacher asks her about her drawing;

T - Right, so you've got these kinds of shapes like this....why that shape?
S - (Laughs)...I just drew lines. (accompanied by 'shrugging' action with hand).

There is again a question of musical intent here. Students made decisions regarding which motive to use and placed strokes horizontally and vertically with respect to others, engaging with sequential placing of the motivic content and pitch range. In some instances (especially in Stacy's case) there seems to be a clear idea of differentiating parts, in so far as the lines do not generally overlap and inhabit particular regions in the pitch range. There is also growing awareness of rhythmic alignment between strokes, both their beginnings and the internal rhythmic alignment of notes. However, students clearly do not know what the exact pitches will be in any stroke, nor does they have any clear idea how this pitch content will interact vertically. There may be some intention with respect to melodic contour on a gross level of description. It seems more likely though, that the shape of some strokes is more a result of the sort of intuitive drawing gesture afforded by the interface, and does not embody any particular musical intent.

6.2.2.5 Affordance and Intent

In some instances, simple interface affordances such as copy-and-paste, made it difficult for the student to pursue their musical intent and equally for teacher to devine such intent as existed.

The teacher introduces Emer to the idea of pattern. He and demonstrates how to copy and paste melodic fragments from one motive window to another and make variations on them. Emer tries to employ the same technique but with considerably less success. She attempts to copy a three-note unit from one of her motives and paste it into a new window. However, she clearly makes an error at the copy stage, as the material pasted is that remaining on the clipboard from the teacher's demonstration. She doesn't appear to notice, and pastes it in a second time, then attempts to create variation by moving the last note of the figure up a step.

She then makes multiple moves, shifting single notes around the window, re-pasting the initial three-note figure a number of times and making several accidental erasures.

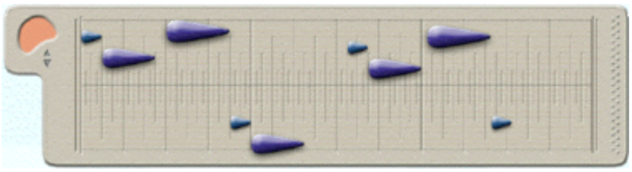


Figure 6.2.2.13 An 'Accidental' Motive

The final structure of the motive (figure 6.2.2.13) is almost entirely without musical intent, despite its tonal and rhythmic coherent, and is largely a function of accidental copy-and-paste. Furthermore, in making her variation, Emer is following literally the procedure demonstrated by the teacher – her interpretation of his demonstration appears to be 'variation means move a note up'. In this instance, she seems to have understood the teacher's demonstration at the level of the interface, but not its musical meaning.

This excerpt demonstrates the manner in which an interface may facilitate actions which, although producing musical outcomes, are not primarily musically motivated, and clearly points to the difficulty of trying to ascribe motivation or intent to children's computer-mediated compositional work based entirely on analysis of outcomes. It also indicates one of the problems with teacher modelling (alluded to by Schon). In making the demonstration, the teacher is concerned with musical issues. However, Emer has not understood the demonstration at the level the teacher intended, but rather at the level of simple interface gesture.

6.2.2.6 Move-testing and Criteria

Characterised in Schon’s terms, the entire compositional process might be regarded as a sequence of ‘move-tests’. Students make moves in the interface and reflect-in and –on their actions and associated outputs. The exploratory nature of the compositional process to which these interfaces seem to lend themselves was clearly visible in the students work. It also seemed to influence the teaching approach, in so far as the teacher regarded student ‘moves’ as an opportunity to both test the students understanding (his own ‘move-testing’) and raise rleated musical and expressive issues.

Kevin’s work is characterised by a series of explorations. He seems to be able to analyse what he has done so far, pick out some of its attributes or salient features, and then find ways to change his approach. He is continually ‘breaking-out’ of his self imposed discipline in a manner similar to that described by Schon. Thus far he has used thin textures but in his next ‘move’ he experiments with thicker texture. He first places a single green line in the bass register. He then places five parallel lines, one for each motive evenly spaced in the pitch range. Initially all lines are in pizzicato voice and of equal length and volume (figure 6.2.2.14).

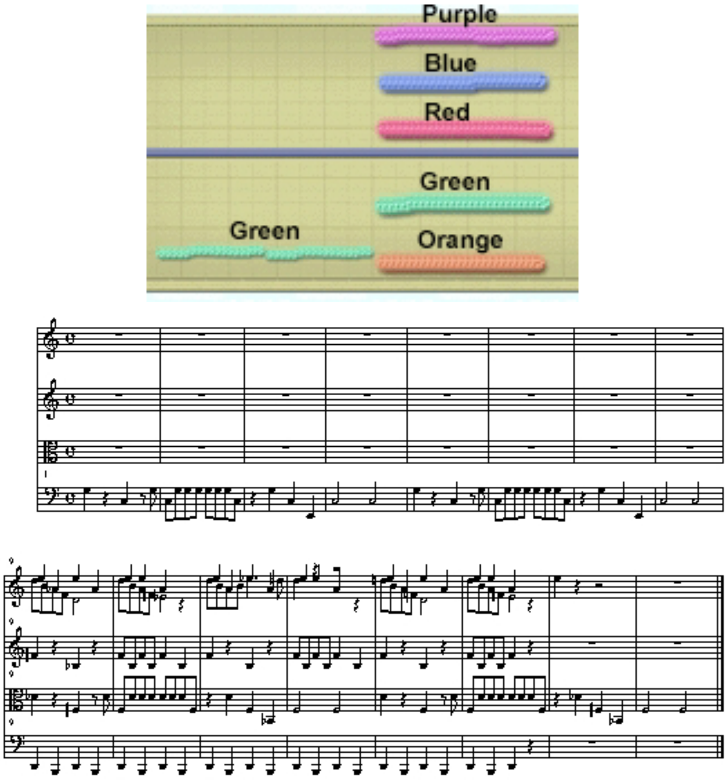


Figure 6.2.2.14 Texture

In the course of listening to the new section, as playback gets near to the sudden thickening of texture, Kevin says;

> K – I don’t think that people will be expecting it in the audience.

Reflecting on the sudden thickening in texture, he clearly perceives it as an expressive gesture designed to catch the audience off guard. The teacher suggests that Kevin might think of various ways that the effect of this surprise might be heightened.

T – What could you do?
K – Highlight it...
T – Highlight it and do what?
K – Pump it up louder.

The teacher then asks Kevin if he wants any one voice to stand out, and if so how might he achieve this. After a little discussion Kevin makes a suggestion.

K – You could make it sound a bit different.

Further discussion leads to the idea of changing the timbre of a given voice as a way of making it 'stand out'. Kevin plays with various combinations of pizzicato and arco voicings and dynamics and settles on the green voice as the main focus. He sets its volume as loud as possible and its timbre to arco, while all other voices are left pizzicato and quieter. He also extends the green line so as to continue beyond the accompaniment parts.

Kevin has made a definite compositional 'trial' here – let's put everything together and see what happens. He has a clear idea of the effect he wants and experiments with combinations of sounds until he achieves it. This move-testing approach is a defining characteristic of a reflection-in-action process.

Throughout her work, Emer also makes moves which are characterised by musical intent and predicated on some internally realised priorities.

T - So what are you thinking about there?
E - I'm thinking (unclear) so it'll sound real low at the end of it.
T - Oh you want to work it down till it sounds real low at the end of it?
E - Yeah.
T - With these little dots like bom bom bom...(going down) - that kind of thing?
E - Yeah.

In this instance she manipulates elements of texture, melodic contour and harmony to create her ending section, making moves and reflecting on the outcomes.

T - Tell me what this is doing
E – It's going up in stairs, but they're supposed to finish at different ones here but I wanted them to finish at the same time.

T - And then just as they end...
E - That one starts.

T - Did you say to me that there were some bits of this that you liked and some bits that you didn't like?
E – Yeah.
T - Which bit didn't you like?
E - The purple one.
T - (Plays back section with purple stroke muted).
T – It's definitely a lot better - will we take the purple one out?
E – Yeah.

Emer has also discovered the importance of testing. She learns to listen to her work and make decisions based on her listening.

6.2.3 Musical Interaction and Learning

There were many examples of musical interaction and learning exhibited by all participants throughought the workshops. These included discovery of various musical concepts and ideas, techniques for manipulation of musical materials, development of musical perception and interaction with basic musical rudiments. Learning which occurred was characterised by a process of experiment and reflection facilitated by the interface, allied to specific teaching interventions and strategies (detailed below and in chapter seven). A small number of examples which exemplify interactions of this nature will be given here.

6.2.3.1 Musical Concepts

Many of the learning events seemed to emerge naturally from the interaction of a number of factors including the nature of the task, a process of exploration, specific interface affordances and reflective conversation between student and teacher. The description given below of Kevin's discovery of the meaning of 'rest' is a good example of the fluid manner in which these various factors interacted, leading to a moment of insight.

Kevin has earlier made two motives (see figure 6.2.2.2 above). The teacher introduces the sketch window and asks Kevin to 'draw' each motive where he thinks it should go (figure 6.2.3.1). They then playback the two motives and listen together.

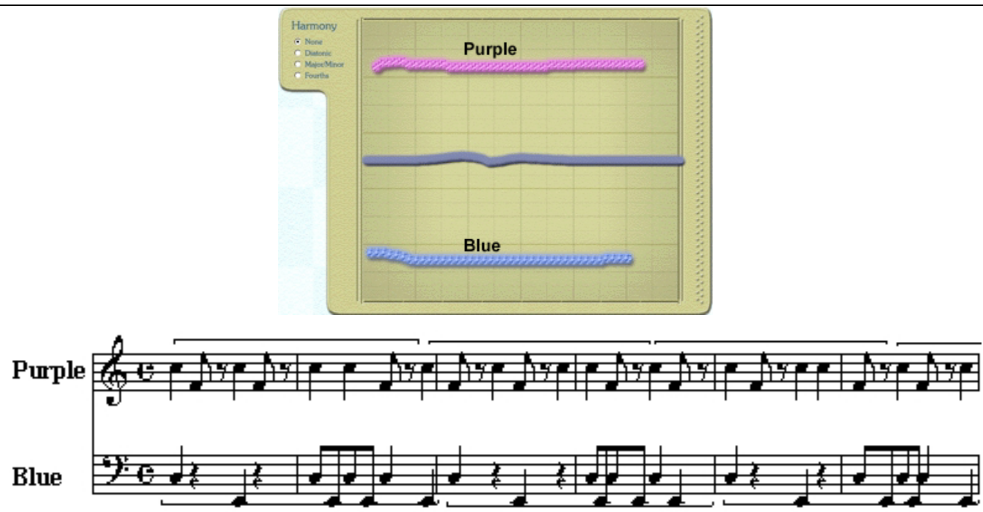
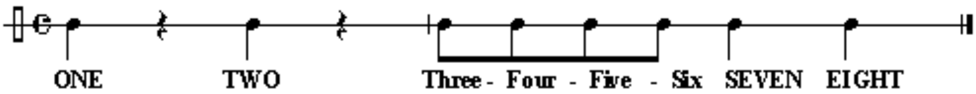


Figure 6.2.3.1 Motive Synchronisation

As the motives play back together, they get progressively out of sync with each other, owing to the fact that one is seven beats long (Figure 6.2.3.1). Kevin looks quizzical, as if the result was not quite what he expected, but doesn't say anything. The teacher tries to focus his attention on the problem. His initial strategy is to have Kevin count the number of beats in each motif. For the purple motive, Kevin counts seven beats accurately on the second attempt. In the second motive however, Kevin counts notes rather than beats, e.g. he counts:



He fails to count anything on the rests, placing a count on each note rather than on each beat. He has confused pulse and rhythm and does not have the concept of a rest as a beat unit. The teacher indicates the 'gap' in the motive window representing the first crochet rest in the blue motive.

T - See that….count it or don't count it?
K – Ehhh…..don't count it…
T – Why not?
K – Because there's no…there's no notes there…..

The teacher suggests that he think of the rest as an 'imaginary' or 'invisible' note and count again. After two attempts, Kevin laughs and says:

K- It was eight….

Kevin has begun to internalise the rest concept and has established the relative lengths of each motive. The teacher then returns to the problem of synchronisation between the two motives, suggesting the addition of a ‘rest’ at the end to extend its length to eight beats.

T- But, we said, that that’s a silent note (pointing to rest in the blue motive), why couldn’t there be just a silent note at the end? (pointing to the end of the purple motive).
K – Yeahhh?
T - But it would still count?
K – Yeah.

The purple motive is window is extended so as to have a quarter note rest at the end (figure 6.2.3.2) and then played back.

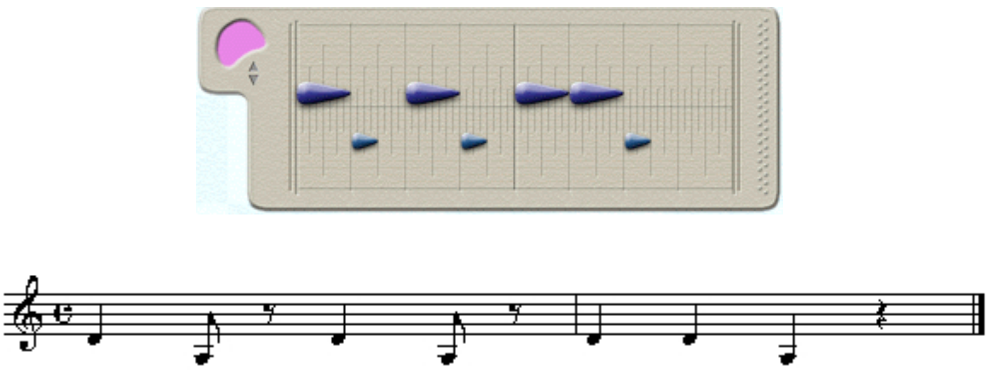


Fig 6.2.3.2 – Purple Final

T - Well let’s hear what it does (he plays the purple motive in the sketch window).
K – (spontaneously counts along evenly)…one, two, three four five six seven eight (and laughs on eight).

Kevin has understood the concept of ‘rest’. He has also understood something about the rhythmic factors involved in having multiple parts play together. Furthermore, he has acquired a process for testing motives to check their respective lengths, which he uses spontaneously in later sessions. Kevin’s learning in this session has ‘fallen out’ of the real musical task in which he was engaged, that of making two musical ideas which ‘go together’. The interface has afforded him a vehicle to explore his ideas (in fact the drawing aspect of the interface has been instrumental in surfacing the motive-synchronisation problem which lead directly to the discovery) while the teacher has helped him to frame potential problems and find strategies for their solution.

Later Kevin explores various combinations of motivic material in the sketch window, eventually settling on the combination of red and orange. He nods his head in time as they play, but then seems to stop as if something has disturbed him. The motives are getting out of time with each other, owing to a slight irregularity in the length of the red motif. He adjusts the length of the red motive, but the problem is not solved. The teacher arrives back and Kevin immediately states the problem.

K - (Points at screen) I tried to put a rest....I tried to put a rest in it 'cos it didn't sound good.

Kevin has tried to apply the strategy learned earlier in the context of the blue/red motive alignment problem. He has clearly reflected-on-action, added the 'rest' technique to his store or repertoire of techniques and tried to apply it in this new situation.

6.2.3.2 Form and Structure

Again, interface functionality affords actions which embody musical ideas, in this instance relating to overall form and structure.

In creating an ending for his piece in the sketch window, Kevin goes back to the start of the piece and copies the 'red' stroke then pastes onto the end. He is reusing material from the start although this has not been suggested to him. He is probably aware that this stroke already contains an even number of repeats, so saving work of redrawing. He positions this stroke so that it seems to begin as green ends, then listens and finds it does. He edits timbre to arco and adjusts the volume. He now copies the green stroke he made above and pastes it again onto end. It appears to be overlapping the red motive so he shifts right to begin as red ends.

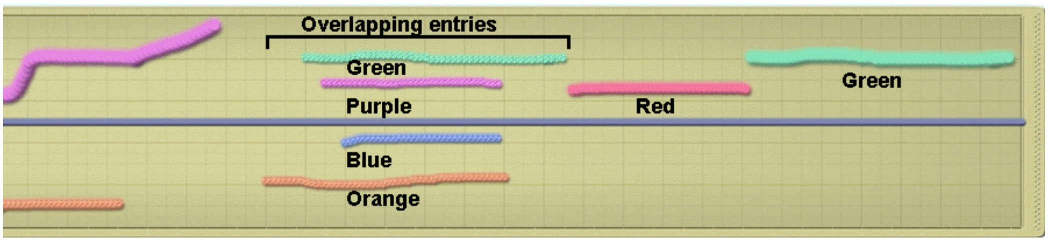


Figure 6.2.3.3 Kevin's Ending

Kevin listens to the last two strokes, then stops after the red and adjusts volume. He clearly has intent here regarding not only what should happen, but also how it should happen. He changes the final green stroke to arco and raises the volume then listens again.

K – There we go, that's it!!

Kevin's considers the piece as a whole and decides to re-use material from the beginning at the end without being prompted to do so. This action seems to have a clear structural intent and is facilitated by the 'colour coding' affordance of the interface. During the session, it is clear that he is using the software intuitively and almost without thought and that his focus is on musical issues throughout. His actions in the interface are seamless, and embody his reflective musical intent.

6.2.3.3 Musical Rudiments

Interface mediated interactions were observed to bring students into contact with a variety of rudimentary musical entities and ideas. Initially student's repertoire of description and action was limited, but was observed to expand throughout the workshops. This expansion was to an extent a function of teacher intervention, and was frequently characterised by a shift in perspective, giving new insight into the attributes of familiar material.

In making her initial motives, Emer seems to attend to a restricted range of musical features. Describing her motives, she refers to note length (big/small notes), pitch (high/low notes) and contour although she does not refer to her motives in terms of any underlying scale template or key.

T - What is different about all of these from each other?
E - Different sizes.
E - Some have big notes and some have small notes.

T - What kindof notes does that use? (points to first note) It starts with a ......?
E - A low note....
When asked to describe how two motives (figure 6.2.3.4) differ from each other, Emer again describes the differences in terms of contour and note value.

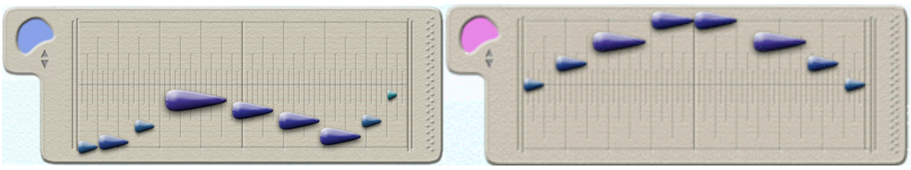


Figure 6.2.3.4 Motive Contour
E - They just sound the same.
T - The same how?
E – They're both going up and then back down.
T - So they both have the same shape, don't they?
E – Yeah.
T - And what about the kind of notes they have?
E- This one (second) has more smaller notes than this one....this has very small notes (second) and this hasn't (first).

Stacy engages with a similar range of musical fundamentals. In the first session, after she has made two motives (figure 6.2.3.5), the teacher engages her in conversation regarding what features of each she is attending to.

Figure 6.2.3.5 Attention to Structural Features

Stacy refers to both note-pitch and melodic direction, but not note length or rhythmic factors. When asked about the blue motive;

T - Ok, now, how many different kinds of notes are in this one (blue)
S – Five.

She is clearly attending to pitch rather than rhythm. The teacher draws her attention to the rhythmic aspects of the motive.

T - If I said don't think about pitch, think about length of notes, how many different kind of note lengths....
S – Two.
T - Two, there's kind of a smaller one and a bigger one?
S –Yeah.

She now perceives the motive as having two kinds of notes. She has shifted her perspective so as to view the same material from a different standpoint.

In both of these cases, the interface provides a medium for students to both surface and describe attributes of the musical entities with which they are working. Musical knowledge which has been tacit becomes explicitly available through a process of manipulation, reflection and discussion.

6.2.3.4 Musical Perception and Reflection

While the thrust of this study is not directly concerned with an examination of childrens musical perception and cognition, it is clear that these aspects have relevance in so far as the childrens musical learning is to an extent a function of their ability to attend to, perceive and process musical objects. To this extent, a demonstration of these abilities along various musical axes serves as an indication of the extent to which the interface affordances and associated teaching strategies are instrumental in engendering learning processes. Some brief examples will be given here which make connections between childrens perception and cognition, reflection and interface-afforded behaviours.

Grouping and Boundaries

Stacy demonstrates a reflective shift in considering a motive she has made (figure 6.2.3.6).

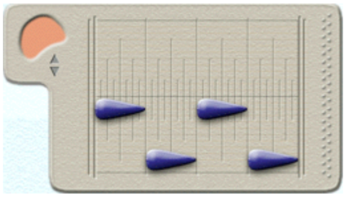


Figure 6.2.3.6 Perception of Sub-Units

T - So play it and show me what bit repeats and how many times
S - (Points to two higher notes) Them two repeat..
T - If you were to split it, and say, here's a bit and here's the same bit again, where would you split it?
S – (Makes diagonal gesture with her finger indicating a separation between the first two notes and the second two)

Initially, she is attending to pitch – she conceives of the motive as a higher note which repeats and a lower note which also repeats. As a result of the reflective converstaion with the teacher, she then refocuses her understanding to consider it as a two note unit repeating in time. This sort of perspective shift is characteristic of learning, and could only happen through a clearly understood visual medium.

Rhythmic perception

Emer makes progress in alignment and rhythmic perception. Initially she has difficulty perceiving whether notes are aligned with the underlying pulse or not, but as she works her perceptions begin to sharpen. In working on one of her motives, there is one note mis-aligned with the underlying pulse. The teacher has Emer listen while clapping the pulse.

T - Is there a little pause in there before any of these notes happen?
E – (points to the gap between two notes).
T - So how could you move them so they might start on a beat?
E - Move them left.

Emer immediately points to the relevant note, and then moves the notes in question to address the problem. Up to this point, Emer had failed to notice such rhythmic inconsistencies. Now she notices the problem and finds a solution herself.

Pattern

Working with Stacy on one of her motives (figure 6.2.3.7), the teacher returns to the idea of repeating sub-units.

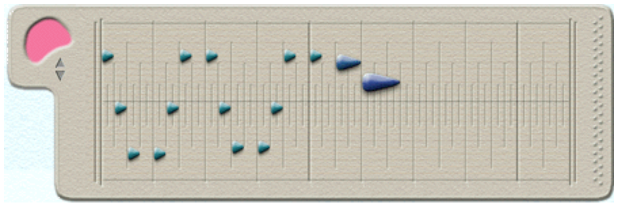


Figure 6.2.3.7 Perception of Pattern

T - But you obviously are thinking about patterns....Aren't you? Are you?......what's a pattern?
S - Something that goes over and over again....
In describing her pattern later she says…

S - It goes down and up (Contour/Inversion).
S – It's going backwards (Noticing the inversion in the first section).

In her conversation, Stacy again demonstrates the ability to gradually break-apart her motive into its constituent units. She considers the six-note repeating unit, describes its contour ("down and up") and notices the pitch difference in the repeat. However, she then changes the size of her working unit of description and considers a three-note unit ("it goes backwards"). This is very similar to the perceptual 'zooming' behaviour exhibited by Kevin (section 6.2.2. earlier). Stacy is considering the same material from multiple perspectives and at different levels of granularity. She is clearly using the representation as a vehicle for reflection and reformulation of specific aspects of the musical material.

Harmonic Perception

The overall area of harmony and students harmonic perception was one which presented difficulties in the course of the workshops. This may have been to do with the fact that, while the interface afforded a degree of harmonic control with respect to both local harmonic gesture and control of the tonal centre and did facilitate some dialogue in these areas, there was no clear system in the interface for surfacing or labelling either chords, chord progressions or tonal centres. The teacher attempted to overcome this problem by using verbal labels for various tonal effects, but with limited success. This indicates that for complex, second and third order concepts such as those relating to harmony, provision of simple manipulations to facilitate exploration may not be effective in the absence of a labelling system which makes clear the connections between these concepts and their origins in discreet pitches.

The following excerpt demonstrates aspects of teaching and learning the area of harmony, and illustrates some of the associated problems.

When Stacy first deploys textured material in the sketch window, which is set to the default 'no-harmony' mode, she dislikes the results.

T – You don't like it?
S – No.
T – What don't you like about it?
S – The music is sort of all over the place.

Stacy values organization, both rhythmic and melodic, as clearly seen in her motivic work. The teacher demonstrates the effect of each of the options on the piece he has made. Despite the fact that the options are presented in the interface in order – no harmony, diatonic, major/minor and fourths, the teacher presents the major/minor option last, each time asking Stacy whether this sounds better then the previous (This seems to be a clear case of teacher bias, which may have affected Stacy's response - Alternatively, it might be that the teacher's intuition was to introduce the options with increasing perceived imposed order). Stacy expresses a clear preference for the major/minor option.

The teacher explains the action of the harmony line in terms of its effect on the notes that comprise each stroke. He makes a red/green, I-V-I cadential section and sings a continual tonic note through the I-V-I change, asking Stacy to say when the note he is singing sounds 'wrong'. Stacy notices where the change takes place.

S - Oh yeah.
T - What I was singing started being wrong.....
S - (Interjects, pointing at the screen) It goes up, and that's how you're getting further away from it.....its flat and it goes up and it goes down.

Stacy has an intuitive understanding of key, and makes use of the harmony line to express her understanding. However, chord function has not been formally discussed, neither have the concepts of key or modulation. Stacy opts to work in major/minor mode. She expresses her reasons for this.

S - It changes the music sort of....the sound of it.
T - Even though it changes your bits of music?
S – Yeah.
T - But they still sound like your bits of music, don't they?

S - They go better together.

Stacy seems to have a keen harmonic sense. It might be that this has a higher priority for her than any perceived small changes to the motives themselves. She is choosing to prioritise 'go together' harmonically rather than exact repetition of the motives. This is an interesting contrast to Kevin, who chooses not to use the harmony line at all so as to maintain as much control as possible over the output.

In working on her ending, Stacy demonstrates a clear preference for a tonal ending and indicates a developing sense of key. She now understands the function of the green and red sections in terms of a tonic or 'home-note'.

T - And this orange, green and orange business...can you remember what effect they have on the music?
S - The orange made it go from the.....farther away from the home note.
T – Ok.
S - The green goes back down to the…
T - The green goes back down to the home note.
T - You finished the piece in an orange section.
S - Yeah, I was trying to get a green section.

She spends some time adjusting the harmony line to achieve the desired harmonic effect. She then tries to make a two-note soh-doh tonal ending. After repeated listening and move-testing with a range of pitches, she eventually creates a V-I tonal ending.

In this instance, Stacy has begun to make connections between the nature of the representation and manipulations afforded by the interface and their harmonic meaning. The interface has started to become for her a medium for harmonic perception and reflection. However, the degree to which this has occurred is limited in terms of precise musical understanding. Stacy associates a 'home-note' with a green background section. This sort of association is somewhat imprecise, especially in terms of temporal placing of the actual harmonic events, and more importantly, is couched in terms of interface-specific language. It is not clear to what extent any harmonic understanding developed here would transfer out of the context of the particular interface.

6.2.4 Teaching Interventions and Strategies.

6.2.4.1 Introduction

As the Hyperscore workshops proceeded, a variety of teaching strategies and interventions emerged. These strategies were observed to be a function of teacher concerns, the perceived needs of the student and the affordances of the interface. Some examples of these are presented below, and initial connections are made to both the affordances of the interface and the teacher's underlying reflection-in-action process. More formal analysis of the teaching process will be presented in chapter seven.

6.2.4.2 Teaching as Investigation

Teacher reflection-in-action involves experiment, move-testing and a reflective conversation with the materials which, for the teacher, include the students' materials and the students themselves. Fundamental to this conversation is a shared understanding of the meanings inherent in the materials. This shared understanding requires a mutually well-understood medium. In these workshops, the interface-medium served not just as a vehicle for conversation, but also as a tool through which the teacher could probe the students understanding before making further intervention. During the workshops, the teacher frequently used the interface to try to investigate into students' understandings and processes.

In the excerpts below, the teacher moves to establish Emer's concerns and have her identify and perceive aspects of the structure of her motives. These interventions also have the simultaneous aim of allowing the teacher to interrogate Emer's perceptions of her motives. He does this by focused questioning, using the representation as a point of reference.

T - What kindof notes does that use? (points to first note). It starts with a ......?
E - A low note....
T - A low note, and what size of a note is it?
E – A small one.
T - So it starts with a low small note, and then it goes....? (traces curve of melody on screen)

Throughout his work, the teacher tries to become familiar with his 'working materials', which include both Emer's musical materials and Emer herself. He tries to become aware of her perceptions, needs and priorities so as to be able to make informed interventions.

.

T - You took those three notes, and you put them in high and you put them in low......but....
E - I took out the last one.
T - You took out the last one...did you do that deliberately or by accident?
E – Deliberately.

T - Are you happy with that ending?
E – It's just, like, there's something missing, but I cant, I can't get it like.....
T - There's something missing....like what missing...
E - Like another dot but em..better sounding.
T - There's some particular note that you're looking for at the end that you can't find?
E – Yeah.

T – Ok.

Such interventions are primarily information gathering on the part of the teacher, before making a more pointed intervention. As he works, the teacher attempts to establish Emer's needs and concerns at any given moment and respond on that basis. In fact, interventions of this type are necessary to ensure that any further interventions are correctly directed. The following excerpt illustrates this.

In working on her blue motive Emer again attempts to create a more rhythmically aligned structure at the teacher's suggestion. After several attempts, she figures out how to move notes so that they are all aligned regularly. In doing so however, she alters the pitch of some notes. She recognises this and tries to move the notes to their previous pitches. She can't seem to find the correct pitches and so uses the Ctrl-Z (step-back) function a number of times to try to reset the motive to its original, unaligned state. When the teacher returns it appears to him as if she has not made progress and therefore not understood the alignment issue.

T - You didn't do this one yet (the motive in question).
E - I did but it sounds very weird....(points to the notes where the pitch alteration is apparent)....them two...

The teacher again helps with the rhythmic realignment, but doesn't engage with the pitch issue.

Later analysis of the videotape shows that Emer clearly understands the alignment principle - she has successfully realigned both motives, but then upset their rhythmic alignment again in an attempt to engage with pitch. The teacher has not perceived this and has repeated the intervention unnecessarily. A more fruitful approach might have been to spend some time interrogating Emer's understanding rather than assuming she needed a further demonstration. In this instance, the demonstration has failed, to the extent that it has contributed to Emer's focus on rhythmic aspects to the exclusion of pitch. The teacher's analysis of her 'product' here has indicated that she has not understood but later analysis of the video shows that she has. This is a clear demonstration of the value of digital video as an aid to researcher reflection, as well as an illustration of one of the dangers of attempting to make an assessment of children's learning based on outcomes alone, especially in computer mediated creative work.

6.2.4.3 Modeling

Teacher demonstration and modeling formed a key element of the pedagogic approach. Modeling took place through the medium of the interface, and took advantage of the affordances offered. Frequently, demonstrations were given spontaneously, in response to the perceived needs of the moment. The following excerpt illustrates.

Kevin has made two motives he has but thinks he may need to add another one or two to have enough to make a piece. The teacher suggests that in making his new motives, he think about the idea of pattern.

T – What would you mean....what would you understand by patterns?
K – Kinda like....the same thing....
T – Something that you'd recognise......?

Without formally defining the idea of pattern in music, there is agreement that there is some element of repetition involved. The teacher spontaneously decides to use the interface to illustrate how this notion might be used in composing. He makes a semi-random motive (figure 6.2.4.1) and then asks Kevin to listen to it and see if he can pick out any bits of the motive that sound interesting and might form the basis for a pattern.

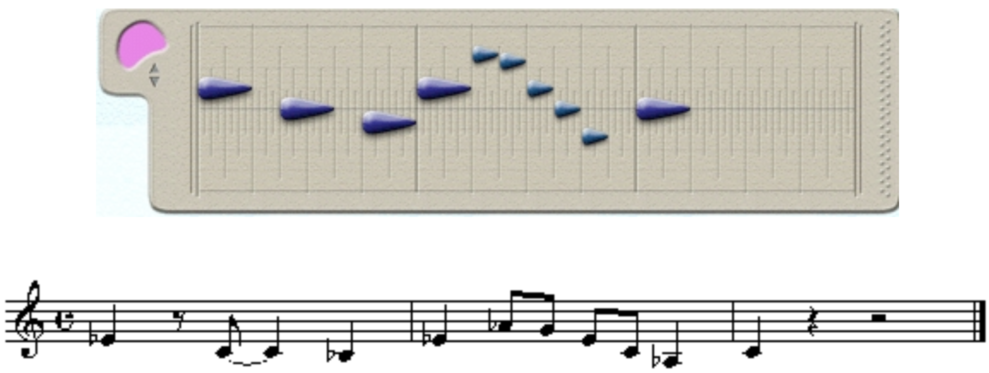


Figure 6.2.4.1 Pattern Example

The teacher then uses the copy-and-paste function to make a new motive consisting of three repeats of this figure. He then makes small variations to the figure (figure 6.2.4.2). .

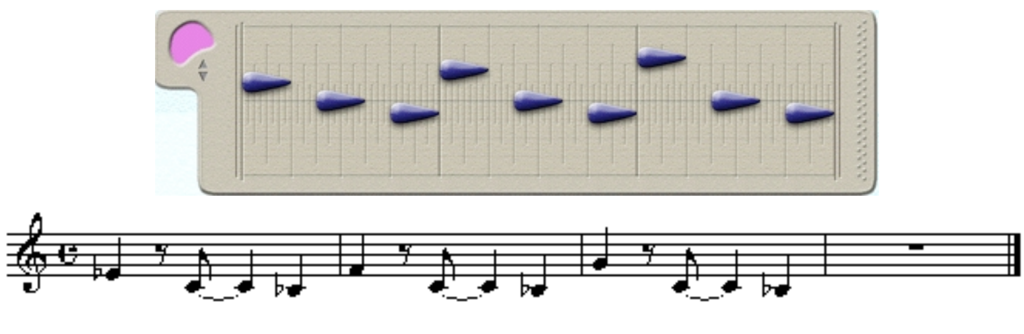


Figure 6.2.4.2 Variation Example

The teacher subsequently repeats this illustration twice more, taking different sub-units of the original, 'copy-and-pasting' to make a new repeating motif and making variations. In this instance, the teacher is modelling a strategy for creating new material based on previous material. While modeling itself is not a function of the interface, the manner of its execution is clearly a function of the interaction between the teacher's reflection-in-action and the functionality afforded.

6.2.4.4 Interface Affordance, Problem Finding and Problem Solving.

Often the interface serves to surface and focus problems, to which the teacher may then direct the student's attention. In the following example, there is an issue with they rhythmic alignment of Kevin's motive. The teacher surfaces the problem by using the interface to make comparisons between motivic units, and then suggests a strategy whereby Kevin may find a resolution.

Kevin has made a complex motive (figure 6.2.4.3).

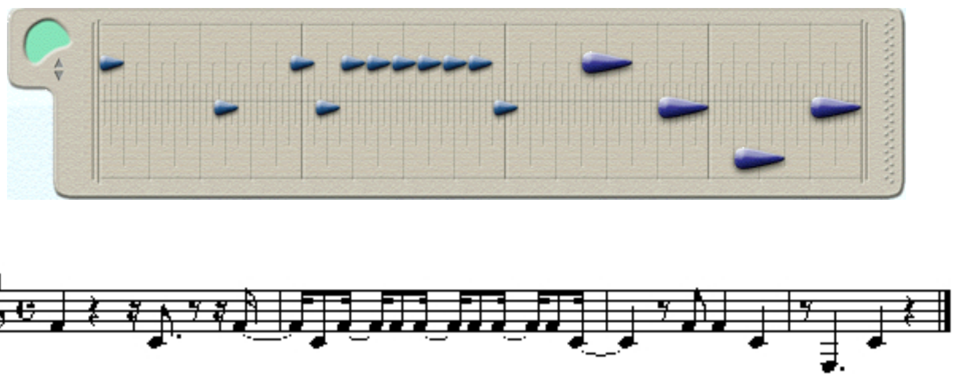


Fig 6.2.4.3 Three-part motive

This motive seems to have three distinct sections; the initial two note opening, the repeated note grouping in the middle, and the four longer notes at the end. While each unit seems to have an internal rhythmic coherence, in combination the effect is somewhat arrhythmic. Kevin has not considered the motive in the context of how it would sound against a pulse or another motive.

The teacher first has Kevin clap a steady beat and points out the function of the rhythmic divisions in the motive window, explaining how they break up the beat. Next he adopts the strategy of having Kevin 'line up' two motives in parallel on the screen and trying to figure out what would happen if they were played together. Initially Kevin doesn't understand the point of the comparison. The teacher explains further by pointing to notes in each motive and indicating which ones would sound at the same time.

T – Well, those two notes would sound at the same time, then this one would play… (pointing to relevant note in green motive), but nothing would play in this motive.. (the orange motive).
K – Oh yes.

T – Then, these two notes would play together, then this one would play, and nothing would play here, and then these two would start at the same time…
K – But that one would be longer...

Now that Kevin understands the point of the process, the teacher lines up his new green motive with the purple one composed previously and asks Kevin to explain what might happen if they were played together. Kevin accurately describes this new case.

Kevin having clearly understood that there is an issue to resolve, the teacher demonstrates a possible approach to solving it. Without substantially altering the pitch or rhythm content of the green motive, he highlights the centre short-note grouping and moves it both left and right, demonstrating how it can be made to fall into alignment with the beat division as a section rather than note by note. He demonstrates several different options for alignments that might work. Again, interface functionality colours the strategic approach adopted. Having made his point he returns Kevin's motive to its original state and leaves Kevin to work on figuring out the alignment issue. When he returns Kevin has substantially reworked the rhythmic aspects of the motive and added a note at the end (figure 6.2.4.4).

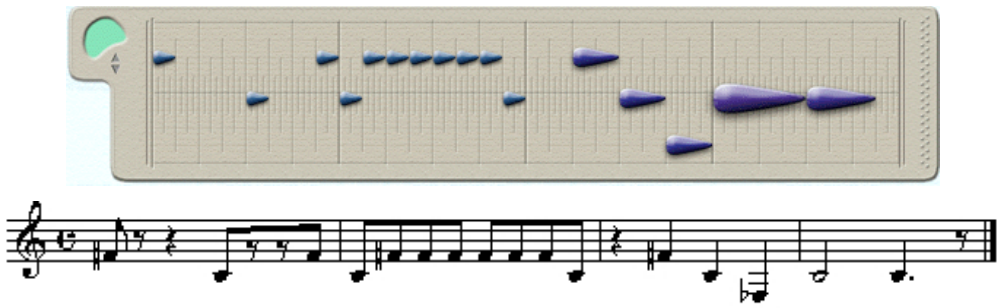


Figure 6.2.4.4 Motive re-aligned

Kevin has finally produced a motive with considerable rhythmic coherence and yet has not substantially altered the constituent musical ideas.

In the case of both motives, Kevin has again expanded his horizon. He has made a motive which is more complex and less repetitive than his previous work. Again we see teacher intervene to help Kevin to sharpen his rhythmic perception and surface potential problems with his material. In making this motive, Kevin has attended to aspects of melodic shape and overall form, but needs help in fine tuning rhythmic details. The teacher has not suggested solutions, but rather helped define the problem and suggested strategies by which a solution might be found.

6.2.4.5 Task Framing

Many teaching interventions were concerned with helping students to frame the task at hand. In some instances (such as that of Kevin, described in section 6.2.2.1 above), students managed to generate task descriptions for themselves with minimal intervention. However, in others, students had difficulty both in choosing what to attend to in framing the task and in managing the balance between local and global task focus. In these cases, the teachers approach seemed to be that of gradually reducing the scale of the immediate task and narrowing the range of musical parameters in question, until a task-unit was arrived at which was within the scope of the student. The following excerpt illustrates this.

Working with Emer, the teacher initially introduces the overall task, that of composing an entire piece of music. However, when Emer struggles with this, he intervenes and attempts to have Emer break the task down into a series of separate questions relating to specifics of her material (What pitch do you want it? Do you want it to go up like that? How many times? Do you want something else to happen while that's happening? What other motive do you want to go with that?). The intention here is clearly to have Emer focus on a range of simpler, narrower tasks as a way of achieving some progress. When Emer still appears to have difficulty, the teacher becomes even more proactive. He begins a 'guided' composition exercise during which he asks Emer a very specific set of questions relating to how she might want to use her material.

T - How many times do you think that will repeat?
E – Four.
T - Do you want to hear that on its own at the start?
E - Emm, no.
T - What do you want to go with it?
E - Em.....the yellow one.
T - So where's the yellow one going to go?
E - A bit lower.
T - A bit lower, so it's going to match up with, it's going to go along with the....now do you want it to happen after it or at the same time as it?
E - Ehhh....(unclear)..in the middle of it.
T - OK, so put it in there - Ok now lets hear what the effect of those two together is.

As her work proceeds, it becomes clear that Emer has difficulty breaking down the task at hand and separating out the various threads that comprise it. She can usually identify when she doesn't like something but has real difficulty in identifying exactly what it is she doesn't like and which parameter might be appropriate to manipulate in order to solve the problem. She also thinks locally and has difficulty in planning ahead. The teacher perceives this and continues to adopt a more proactive role than was necessary with Kevin or Stacy, breaking the overall task down into a series of simple decisions. At the same time he tries to encourage Emer to experiment and explore at this more local level. In this respect he is engaged in a delicate balancing act between helping Emer to complete the task and allowing her as much freedom as possible to express her own ideas. The process is one where he tries to have her identify and describe some aspect of the music, become aware of some of the ways in which it might be changed, notice the results of the change and make decisions on that basis. He is at once engaging in helping her to frame the task, and to engage in move-testing experiments in order to surface aspects of the character of her materials.

6.2.4.6 Imagination, Perspective and Kinaesthetic Techniques

It is clear from many of the teacher's interventions that he is concerned with the fact that the bulk of the activity takes place in and through a virtual medium, and also that the medium itself may in some way be driving the process. At various points he makes interventions that seem to be designed to ground the work in a context that is not completely interface-dependent. He does this in a variety of ways, including trying to have students generate musical ideas internally, attempting to have them shift or broaden their perspective to include the notion of real musicians and audience, and using kinaesthetic techniques to both ascertain childrens internal representation of their musical outputs and help them have some physical interaction with their work. The following examples illustrate examples of each technique.

At the start of the fourth session, the teacher looks at what Kevin has done so far, sings through each of his motives in turn and suggests a strategy for Kevin to try.

T - Ok, so what I want you to do now is to....play that back....not yet!!...play it back, and listen really hard...and try, before you do anything....try and imagine in your mind....what's gonna happen next……

In suggesting the 'imagine' strategy, the teacher encourages Kevin to begin to think more globally about his piece, to try to have a sense of overall structure and direction.

At several points in the workshop process the teacher also asks Stacy to try to listen and imagine what might come next.

T - Make something that sounds like a tune, with a combination of long and short notes....that you might sing...(later)...see if you can imagine the tune in your head and see if you can make it on there....

He tries to help Stacy stand back from the interface and develop a sense of making a real piece of music. He does this by referring several times to a potential audience, trying to have Stacy evaluate her work from a more detached perspective.

T - …so what I want you to think about is.... how would this piece start?...what would be the first thing that someone would hear, what would be the second thing that they would hear, what would be the third thing they would hear...how is this gonna capture their attention?....

The teacher makes use of kinaesthetic techniques. Working with Emer, he both both has her physically trace the shape of her motive and engages her in clapping exercises. Again, he fluidly combines the physical aspect of the exercise with reference to the interface.

He asks her to clap a steady beat - she does. He then asks her, pointing to a motive: T - Does that have a steady beat? E - No it's not a steady beat. T - So it's kind of uneven, the beat, is it? E – Yeah.

Similarly, he tries to have Stacy engage with the music on a kinaesthetic level.

In the discussion about 'gaps' or 'rests' referred to earlier, the teacher has Stacy clap along the pulse while her motive plays. Initially she claps four times and leaves a silence in the gap, but as it progresses, she begins to clap in the gap. The teacher asks her if she should count the gap. She's not sure, or at least doesn't answer, so the teacher has her repeat the exercise, but count out loud as she claps. Stacy counts 'one two three four …', counting notes but not the rest. The teacher tells her to: T - 'Go back to one whenever it starts again'. This time Stacy counts first 'one two three four (gap)' but on the second attempt, she clearly counts 'one, two three, four, five' repeatedly, counting 'five' on the rest.

Stacy's physical actions have helped her to reformulate her understanding.

6.2.4.7 Developing Criteria and Learner Autonomy

The teacher frequently engages students in a fluid conversation about the various options available, stimulating them to develop criteria for decision making.

T - Ok so now were starting to think - where do we want it exactly. E - It starts a bit too soon (again, definite response in terms of ideas about structure). T - (moves new figure to more rhythmically coherent place) If you were to put another note on the end, would it be the same or different? E - It would be the same place like. T - Well, which is better? To do the same or different? E – Different.

This engagement with criteria and decision-making is fundamental to many teacher interventions and relates to the notion of learner autonomy. The teacher is concerned that as far as possible the children should be encouraged to pursue their own agenda as composers and tries to balance this concern with the need to make more proactive moves.

Working with Stacy, the teacher tries to introduce both rudiments and formal concepts suggested by Stacy's work. He models the various ways in which Stacy's material might be manipulated. In doing so he seems to want to present as many options as possible. As he works he is careful to try not to impose a solution

T - See, this is the way I think...it's not necessarily the way you think....

In trying to help Stacy find an ending for her piece he says:

T - You definitely think it doesn't need anything else at the end? Like (sings a sample ending).

From a tonal point of view, in so far as it is possible to be objective, Stacy's attempted ending would not be considered satisfactory. The teacher sees a number of possible solutions that might work. He tries to balance his desire to 'tell' Stacy these solutions with his awareness of the need to respect her autonomy as a composer.

T - I'm not saying it needs it, I'm just asking...'cos there's lots of different ways to end...I'm just curious about how people think about endings.
S - Yeah I'll try one.
T - You don't have to…

This is a little disingenuous. Stacy may well realise that if the teacher didn't think there was a problem, he wouldn't be asking such repeated and focussed questions, and so feel that there must be something 'wrong'. Even though the teacher is saying 'you don't have to', the subtext may be 'you do have to'. This illustrates another tacit problem with both teacher-telling, and teacher-modeling, especially in working with students who are accustomed to a didactic teaching approach and may not yet have the confidence to define and hold to a personal viewpoint. Suggestion may be interpreted as instruction, thereby undermining learner autonomy, despite the teachers best efforts to the contrary.

6.2.4.8 The Interface and Reflective Musical Conversation

In a small number of interactions, student action, teacher intervention and the interface itself seemed to merge into a fluid, reflective whole.

One characteristic of Kevin's work in the sketch window so far is that all of his strokes contain a complete number of repetitions of their respective motives. In this instance the green line initially contains an uneven number of motives and there is a gap between it and the next purple stroke. The teacher has him play back the section and simply taps the pulse, accenting the beats in the gap.

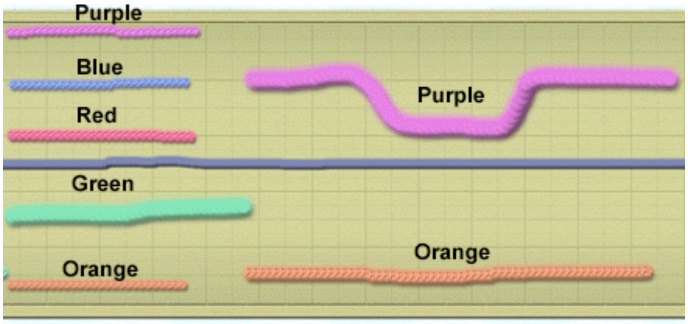


Figure 6.2.4.5 Contour

Kevin immediately says;

K – Oh yeahh, yeahh.
T – What do you notice?
K – That, that there's a gap….

Kevin moves the purple and orange left so as to start immediately after green (figure 6.2.4.5)

In this case, the teacher does not say anything, he simply spontaneously taps the beat, but Kevin immediately gets the point – the conversation here is not about music, it takes place through the medium of music. A musical gesture on the part of the teacher elicits both a verbal and a musical response on Kevin's part. The interface has clearly facilitated this but is not itself the focus of the interaction. It has become a transparent medium for both student and teacher reflection-in-action.

6.2.5 Summary

The above sections set out to describe and explore some of the behaviours that emerged in the course of the Hyperscore workshops. Students were exposed to the software over ten sessions and asked to compose a single piece of music, in the presence of a musically and technically competent mentor. The teacher attempted to adopt an unplanned approach to the workshops and responded to the perceived needs of the students as they arose. In the course of these workshops a number of themes and behaviours seemed to emerge.

Students showed evidence of convergent compositional process, although this was more strongly in evidence in the motive window then in the sketch window. There was evidence of musical intent with respect to manipulation of musical parameters, Functional affordances of the interface clearly not only facilitated but, in some instances, guided these manipulations and interactions. There was a lack of musical motivation underlying certain student actions. At times, it appeared that students were more concerned with interface-motivated rather then musically-motivated actions. Some gestures were clearly the result of visual concerns or were kinaesthetically motivated. Emerging from both of these observations is the notion that the interface itself may not be a passive medium for interaction, but rather plays a more active role in shaping the musical and other outcomes.

There was also clear evidence of the manner in which interface affordances shaped the teaching approach. The teacher focused on those musical aspects that seemed best supported by the interface, and spontaneously made interventions that were to a degree a function of interface affordances. Student's musical engagement and learning was observed to be a function of a variety of factors which included the teaching approach, their own musical and extra-musical concerns and the structure of the interface itself.

Underlying both the students' processes and those of the teacher, it was possible to see the gradual emergence of a reflection-in-action dynamic. Both students and teachers were observed to engage in key elements of reflection in action, including move-testing, reflective conversation with materials, task framing and reflection-on-action. The importance of interface affordances in mediating these interactions was noted.

What is not clear from the foregoing is which of the various interactions described were a function of the particular interface, as opposed to having more general relevance in the area of graphically mediated music teaching and learning. The next section will describe a similar set of workshops carried out with different children using a very different piece of graphical software, with a view to identifying those characteristics that seem common in both contexts.

6.3 Drumsteps Case Studies.

6.3.1 Introduction

As in the Hyperscore case studies, a number of children made use of the software to construct a single piece of music over several sessions. From these studies, three were chosen for close analysis as representing aspects of interaction type – Conor, Ciara and Becky. As the Drumsteps software is different from Hyperscore in many fundamental respects, one might expect that the nature of these interactions would differ from those observed in the Hyperscore workshops. Specifically, kinaesthetically motivated actions were not observed. However, elements of procedurally motivated work were apparent, as well as both musical and visual interactions. The intention here is to describe interactions that both contrast with or reinforce observations made in the Hyperscore studies, again presented in terms of Composing Process, Musical Interaction and Learning and Teaching Intervention and Strategy. Later discussion will then seek to demonstrate the shared underlying reflection-in-action dynamic of the interactions across both software applications.

6.3.2 Composing Process

6.3.2.1 Task Framing and Bricolage

Initially each student was given a brief demonstration of basic interface functionality and set an initial task designed to have them explore the various possibilities it offered. Students initially worked to explore the interface itself, but progressed towards engagement with musical concerns. The following descriptions demonstrate how, through the course of the first two sessions, students gradually moved beyond the interface and began to frame the task in terms of the musical ideas it represented.

> Initially the teacher sets Conor a simple task – to make a single line of steps.
>
> T - Ok so just make one line of steps....all I want you to do today is use maybe some steps and some ladders....and you've got different kinds of ladders...and a ball, and make one line of stuff....and then make a second line of stuff in a minute, but just do that for the moment.
>
> Conor immediately seems to understand the 'diagonal' movement inherent in the software.
>
> C - Can I make it go down like that? (he indicates a diagonal line running top to bottom, left to right by pointing at the screen).

Conor begins work. He starts to add in steps. He makes twenty-three moves, creating a long diagonal line of elements, starting in the top left-hand corner. He uses normal, silent and accented steps and a variety of four and three rung ladders, plus one triggered cymbal. He goes to the ball menu and auditions a variety of sounds. He settles on an open triangle sound, listens twice more to the sound and places the ball on the top step.

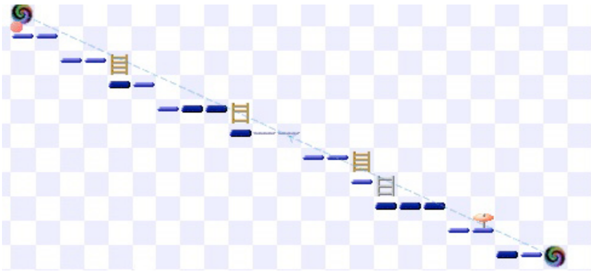


Figure 6.3.2.1 Conor's First Attempt

Conor has no problem manipulating the screen elements. He understands the principle of operation of the software immediately but at this point seems to have little idea what the musical result of his construction will be.

T - Ok, now, do you know in your head what this sounds like?
C - Mmmm, no, not really.
T - Not really....if i say, could you clap that?
C - Would I be able to?
T - Would you be able to clap it?
C - Probably not.

The teacher asks Conor to say what he thinks his construction might sound like.

T - Ok, fair enough, so tell me what....what do you think it's going to do? Describe to me what sort of sounds you're gonna hear as the ball goes along.
C - (points with mouse to cymbal near end) Well down here you're gonna hear a sort of clang, and (uses mouse to trace path down steps) lots of little pings as it goes.....down, the ball.

While this is not a very clear description of the music, it does indicate a beginning of using the graphical score as a reference and extracting some information from it. Conor doesn't read any music notation and so this may be the first time he has used any sort of symbol system to reference sound.

Ciara undergoes a similar process of 'bricolage. Having been introduced to the software, she spends some time in experimenting. She is set an initial task by the teacher.

T – Make a line of stuff using the ladders and cymbals and so on and just see what it sounds like.

She doesn't initially appreciate the operation of the software. She questions the teacher.

C – Do you have to go in a step way (meaning diagonally)?

Her initial working style is impulsive. She has not thought through the implications of her moves. She has not yet made the connection between the path of the ball and the sound produced. She puts in elements and then sees what happens, rather than specifically trying to produce a sound output.

By the end of the second session however, both students have moved to a position where they are beginning to engage with musical aspects.

Conor notices a problem with the length of one of his lines of steps.

C - This ball (pointing to the second line of steps) always falls off.

He suggests a possible reason for this.

T - Before the other one is finished...well can you figure out why that is?
C - (points to first line of steps) Because that one's longer.

He then finds a solution.

T - Before that one.... so if you wanted them to finish together, you'd have to make sure they had the same number of......the same number of what?
C - Eh bars.
T - Bars or....?
C - Beats, beats.

He has made a connection between the number of units in his construction and their underlying musical meaning.

Ciara also starts to move beyond superficial engagement with the interface and makes decisions on musical grounds.

Her line of steps is seven beats long. The teacher asks her to make something that goes with it. She makes a line of steps that has six beats. A discussion ensues regarding numbers of beats.

T – I said to you this one to go with that one – so what does that mean – I don't know, there's lots of ways it could go with it…I'm asking you what you…
C – They have to sort of be the same…
T – The same?
C – Yeah.
T – How the same, the same in what way?
C – The same…….how many beats are in it.
T – You think there should be the same number of beats in it?
C – Yeah.

Asked how she could make this happen, she says;

C – Just add a beat.
T – And maybe add a beat….and then see what happens when you loop them together.

Ciara has attended to unit length, framed the problem in musical terms and decided to make an adjustment to her piece.

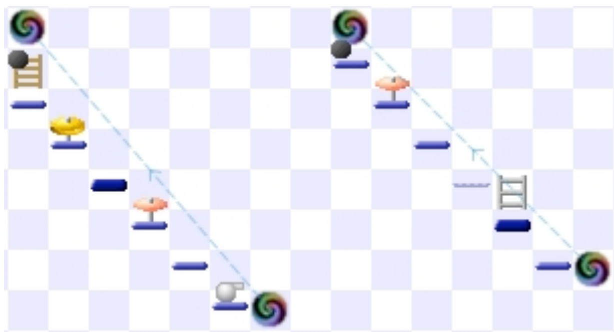


Figure 6.3.2.2 Ciara's Seven Beat Figures

6.3.2.2 Developing Criteria

As students engaged in a more musical manner, they began to frame the task in musical terms and apply musical rather then interface-driven criteria to their work.

Ciara is asked to make a piece for a number of drummers to play. She has some clear ideas about what this should be like before she starts.

T – So how many drummers do you think might reasonably play together?
C – Three.
T – And are they all going to play the same thing?
C – Nope (very definite).

T – So they’re probably going to play different stuff?

C – Yeah.

T – Is there something about the number of beats that each of them will play….?

C – They have to play all the same…

T – Play the same – your saying so if one person is going to play an eight beat something, someone else is going to have to play an eight beat something.

C – No no no – they just have to be the same length, they wouldn’t have to be the same beat…

Ciara shows signs of beginning to reflect on her work and apply some criteria to it. As she works she stops and counts regularly pointing at each screen element in turn. She is clearly working with a purpose. She has an idea about the required length of each new step set and is counting elements to make sure she achieves this. She is applying criteria with respect to the length of her step set and its relationship to the previous set. In doing so she has also reflected-in-action on her previous discovery regarding relative lengths of step paths in each voice and has incorporated this into her ongoing work.

Later, as she works to complete her piece, Ciara applies criteria at a more aggregated level, considering her piece in a holistic way. The teacher questions her about how she will make an ending

C – The two…I just like the drums. That’s all….I didn’t do any more of those cymbals.

T – You didn’t do any more of the cymbals.

C – Yeah, ‘cos I didn’t like them.

T – What you’re going to have to do is you’re going to have to figure out what’s the ending going to be.

C – I’m going to do cymbals at the end.

T – Cymbals at the end...ok.

C – And the start…see that’s going to be my start, cos there’s two much cymbals in the first three….first four.

T – Too much cymbals in the first four…so then you didn’t do so many cymbals in the rest of them.

C – Yeah…that could be the middle bit and at the end I’ll do more cymbals.

T – Cymbals at the end, ok.

Ciara is aware of the need for variety through her piece. She has tried to differentiate between sections by using different unit lengths. She has now discovered a second technique, using cymbals for expressive effect as another way of distinguishing sections from each other.

Later she says:

C – I’m making an ending…..I’m making eight.

T – (Counts one to eight).

C – But these are all going to be cymbals…no ladders, 'cos there's loads of ladders in the middle bit.

Ciara does have some initial ideas with regard to unit length and relationships between parts, although there is some question of her intent with regard to the specific internal structure of the units and subdivisions though. At this level of granularity, she may primarily be manipulating graphical elements rather than musical units. She seems to move freely between a consideration of her work in terms of the onscreen elements themselves and their musical meaning. Notwithstanding this, she demonstrates a growing ability to plan, to apply criteria to her work and to test the outcomes.

6.3.2.3 Reflection-on-action

In the second session, Conor makes a step set which is twenty beats long. He completes two other sets of steps which 'go with' this in respect of length (a fuller description of his construction process is found below in section 6.3.3.2). The set on the right is clearly a five beat repeating unit.

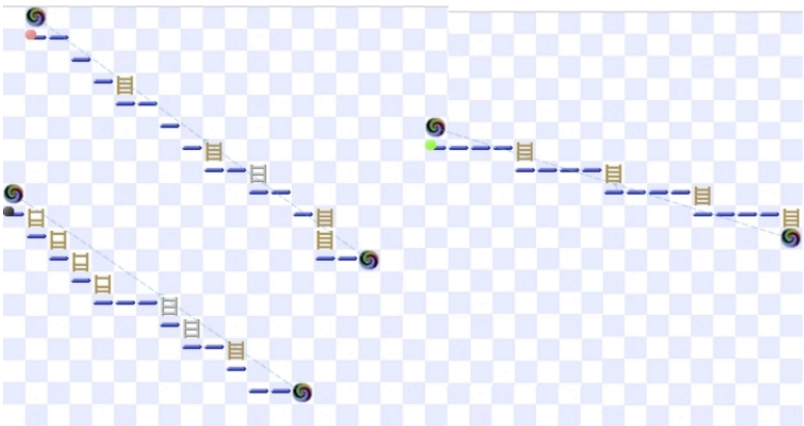


Figure 6.3.2.3 Conor Continues initial idea

In conversation with the teacher, he realizes that he can simply make this sub-unit once and set it to repeat four times, so as to make a total of twenty beats. This simple realization informs all his future work. His next piece is clearly based on repeating units.

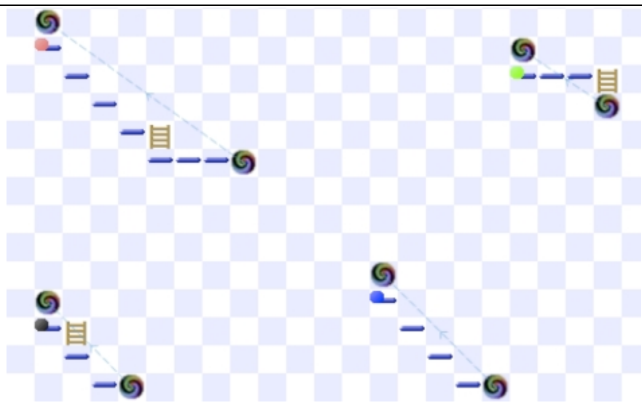


Figure 6.3.2.4 Conor's 8 beat piece

Furthermore, as he extends his piece, he balances eight beat units that repeat four times against four beat units that repeat eight times.

Conor has clearly reflected on his initial five-beat unit, understood its significance and incorporated the underlying principle into his store of experience. He then brings this knowledge to bear in a variety of new situations.

6.3.2.4 Affordance, Problem Finding and Problem Solving

The animated action of the interface frequently serves to surface musical problems, especially with respect to relative unit lengths.

Conor continues to extend his piece by completing a fourth, and then a fifth section in each of the four voices. Again his working unit is a four beat group. As the piece has developed, one voice has eight beat sections, while all the others have four beat units, repeating twice as often. After he has built his new section, he tests it by listening. One of the balls seems to finish later then the others. He listens again and hovers the mouse over the relevant section, as if he is aware of the problem. The teacher tries the strategy of having Conor imagine himself as the ball to see if he can figure out the problem.

T –….try and imagine in your mind what the ball will actually do….imagine you're the ball…so you're falling out here, your going across here and you're going down there…try and imagine in your mind how many beats that's going to take….
C – There's too big a gap.
T – There's too big a gap – so that means what, it's gonna take the ball..?
C – Longer.
T – Longer to fall there, so is that going to put like an extra beat or something?
C – Yeah.

T – So it wouldn't be the same as the others…ok, good, so maybe that's the problem, so what's the solution?
C – To move it……up a bit.

Focusing on how the screen objects behave, Conor sees the issue and suggests a solution. Furthermore, he understands that the empty grid square through which the ball falls adds a beat to the section, effectively acting as a rest.

In situations such as that described above, it is not immediately clear whether the students are initially framing the problem in musical terms or in terms of interface functionality. However, as they engage with the problem, they frequently become more obviously concerned with musical issues, and use the interface to generate musical strategies.

6.3.2.5 Convergence and Meta-Awareness of Process.

Students in the Drumsteps sessions did not show the same sort of clear-cut convergent process demonstrated by students working in Hyperscore, and in particular in the motive window. One reason for this may simply be the bounded nature of the Hyperscore motive window. This window provides the opportunity to engage in a single discreet task that may lend itself to a more convergent approach. This construction of discreet local entities, while possible in DrumSteps, is not specifically surfaced by the interface and so was not evidenced as clearly. However, in the overall, there was some evidence of convergent process, as students moved from initial experimentation and the generation of ideas, to more focused completion of their pieces. The students themselves indicated some awareness of this shift in their own approach.

Early in the workshops, the teacher questions Conor as to his composing process, specifically with respect to his use of the interface. Conor refers to his work as an experiment – putting elements in to see what they would sound like.

T – As you're building your piece, as you're putting stuff in, are you concentrating more on what you think you might sound like when you're building it, or are you trying to build something because it looks a certain way, or some combination of both….
C – I'd be putting them in to see what it would sound like as well.

Later, Conor states a definite musical intent with regard to the lengths of individual rhythmic units, the number of times they repeat and their relationship to each other.

C – Yeah, well I wanted it all to be, three of them I wanted to be eight beats, four eight beats, and another one I wanted to be eight beats and repeat four times.

Initially Conor is more experimental, but as he gains an understanding control of the medium, he moves towards a more convergent mode of operation. He seems to have an awareness of his own process and how it has changed as he worked.

T – What percentage of the time were you just messing around to see what things sounded like, and what percentage of the time were you saying "I want to make this do this"?
C – Most of the time I'd be deciding I want this to do….
T – Most of the time you were deciding, and did you find when you first started, there was more goofing around…
C – Yeah.
T – And then as you went on you started to…?
C – Yeah.

6.3.2.6 Non-Musical Affordances and Compositional Process

The case of Becky, the third DrumSteps student chosen for close analysis, is remarkable for the contrast it presents to all the other cases detailed above. Her work is marked by a lack of musical interaction or engagement, despite proactive intervention on the part of the teacher. Such engagement as does take place alternates between process driven interaction and the construction of visual shapes. Clearly she is engaging at the level of interface affordances, rather then at any deeper musical level. Excerpts from the transcripts indicating the manner of this interface-afforded engagement are given below.

Becky is first introduced to the software and asked to make a short piece. She builds a set of steps (figure 6.3.2.5).

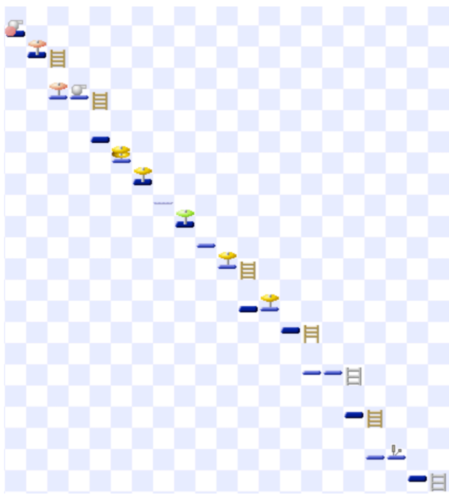


Figure 6.3.2.5 Becky's first attempt

As she works, it becomes clear that she is not operating out of any musical plan. There is no evidence of a deliberate sense of meter or repeating unit, nor is there any sense in which she is deploying the various elements in any functionally meaningful way. As she works, she plays back her piece several times, but it is not clear that she is listening to the result or making decisions on any musical basis. It is not clear if she has internalized any part of the piece. It seems to be more about randomly using all the available elements.

The teacher questions Becky as to her intent. She indicates that she has no particular musical intent.

T – Right, so tell me something about this mad sounding piece that you made.
B – I just made anything.

In the second session, Becky continues to work in a similar, apparently random fashion and produces an outcome very similar to that in the first session. At this point it is clear that Becky is still interacting with the interface, without any definite musical purpose. The teacher defines a more constrained task, to make a line of steps with a specific number of beats, and engages Becky in a variety of clapping exercises so as to establish that she understands the meaning of the task. Becky eventually makes first one, and then a second line of steps that meet the teachers criteria, and seems to understand the concept of beat and how it relates to interface elements (figure 6.3.2.6).

Figure 6.3.2.6 Becky eight beats

In the third session, however, Becky has no clear idea as to how to proceed with her piece.

T – The next question is, do you want something to happen at the same time as that, or do you want to say, 'that's the start' and now make something different happen…
B – I don't know.

Repeating the approach from other workshops, the teacher asks specific questions in an attempt to frame the task. Despite his proactive approach, Becky is still at a loss as to how to proceed.

T – Ok if you're going to make something else happen, is it going to be kind of the same or kind of different?

B – Kind of different.

T – Ok so what ways is it going to be different?

B – There could be a bit more ladders or something…

Becky's language is that of the interface not of music. She says 'put ladders' not 'put shorter notes'. She still has no plan.

T – Now is there any other way that it could be different?

B – You could put more black holes.

Again Becky is suggesting adding more elements. In this case, the suggestion to put in more "black holes" has no musical function. She is clearly thinking in terms of the interface and the screen objects rather than any associated musical meaning.

After a protracted period of time adding and deleting elements from the left hand step set, she seems to have an idea. She builds two intersecting sets of steps and changes the direction of the ball on right-hand set so as to make the balls converge (figure 6.3.2.7).

Figure 6.3.2.7 Becky's initial convergence idea

The effect of the construction is that the two balls will converge at the bottom, and then follow each other around the left-hand step set repeatedly. Becky is clearly thinking about, and in terms of the functionality of the interface. She is building a structure or a dynamic set of events or a path that is not necessarily related any musical outcome. She is asked to describe what she has done. Her work seems entirely concerned with placement of graphical elements and how the balls will animate rather then the musical outcome. Becky describes her work in terms of how the two balls will follow each other.

B – Yeah….it's a game of chasing…

For the first time, Becky seems to have a plan as to how she will proceed, again described in terms of the animation.

B – I was thinking of actually doing a third tune.

T – To go along with this?

B – Yeah put them in there (indicating with the mouse in the gap between the two step sets).

B – Then I could put a ball there and it would start going down (indicates the ball path with the mouse, down the right hand set.)

T – Put it in the middle?

Her motivation is clearly animation rather than music.

B – That would be three ones chasing each other.Becky quickly adds one, and then another sets of steps to her piece, all causing balls to converge as before (figure 7.4.5).

Figure 6.3.2.8 Convergence extended

The effect is that all the balls follow each other into the wormhole and reroute back to the start of the left hand set. Two of the balls merge at the wormhole. Their path lengths to reach this point are the same. After several abortive attempts to engage Becky in a musical conversation, the teacher suggests that she think clearly about the path length of each step set. Becky quickly completes a variety of steps and balls, all designed to create an animation where balls converge sequentially at the wormhole and then follow each other to the top of the first step set (figure 6.3.2.9).

Figure 6.3.2.9 Becky First Section Completed

Thus far, Becky's work is entirely procedural. She is taken with the notion of creating an animation where the balls move in a particular way over the interface. She has a clear intent, but it is not with respect to any musical outcome.

In the second part of her piece, she takes a different approach. In this instance she seems motivated by graphical concerns.

B – I've an idea for something to do?

T – You have an idea for something to do? What's your idea….?

B – I'm gonna shape it kind of like a diamond….then the two would go down… (she makes pointing gesture with her finger indicating the two different paths, one left and one right) then.. they'd both converge and fall down there (again she indicates the converging by bringing here index and second fingers together and making a downward pointing gesture)

Becky quickly makes a follow on section, shaped like the first part of a diamond (figure 6.3.2.10).

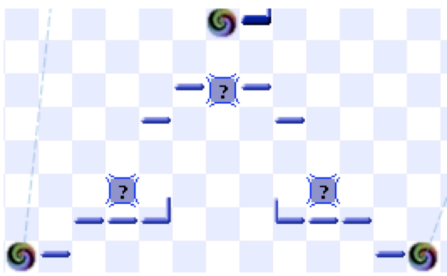


Figure 6.3.2.10 Becky Diamond Shape

Her use of the randomizer is interesting. Its musical function would be to send balls over different paths so as to create a sense of variety. Both of her paths are symmetrical, so in fact the randomizer serves no musical function here. She is treating it as a physical 'router' rather than a musical instruction.

Becky completes her piece as shown (figure 6.3.2.11).

Figure 6.3.2.11 Becky Second Section

While she doesn't maintain an exact symmetry, the ending section is broadly diamond shaped. She routes all balls into a series of boxes in the end. Having made the diamond shape, she reverts to procedurally motivated actions. She places wormholes in her diamond shape that reroute the balls back to the start. She plays her piece and says.

B – I…got it!!

As she works, her moves are concerned with causing the balls to move in various directions so as to achieve this goal. She shows no musical intent.

Becky doesn't seem to use the software as a means of engaging with music. Her work is unconcerned with the sound output. In the very early stages of her work, she seems to begin to engage with unit length as a motivating factor, but quickly abandons this in favour of an approach based on animation, process and graphical form. She does engage in quite complex reasoning relating to ball paths, path lengths, cause and effect and shows the ability to predict and solve potential problems. Her initial process is random until she frames the task in these terms, after which she works purposefully to achieve her goals.

6.3.3 Musical Interaction and Learning

Throughout the workshop series there were clear instances of musical learning. This occurred with respect to both basic musical rudiments, and broader conceptual issues. These learning events seemed to fall out of a complex interaction between students, the interface and the teacher. In many cases the fluidity of these interactions makes it impossible to identify any single cause for a specific learning event. The following descriptions will simply seek to demonstrate some examples of the kind of learning that did occur, with a view to exploring the underlying dynamic in chapter seven.

6.3.3.1 Attending to Musical Parameters

Clearly an essential part of the leaning process is that the students begin to become aware of a range of discreet musical parameters. The interface affords this awareness through a process of manipulation and experiment – essentially that described by Schon as 'move-testing'.

Ciara makes a line of steps that is seven beats long. The teacher asks her to make something that goes with it. She makes a line of steps that has six beats. A discussion ensues regarding numbers of beats.

T – I said to you this one to go with that one – so what does that mean – I don't know, there's lots of ways it could go with it…I'm asking you what you…
C – They have to sort of be the same…
T – The same?
C – Yeah.
T – How the same, the same in what way?
C – The same…….how many beats are in it.
T – You think there should be the same number of beats in it?
C – Yeah.

Asked how she could make this happen, she says;

C – Just add a beat.
T – And maybe add a beat….and then see what happens when you loop them together.

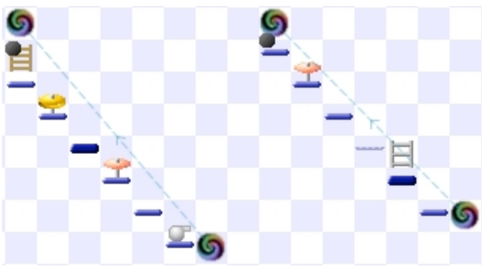


Figure 6.3.3.1 Ciara's Seven Beat Figures

Ciara has attended to unit length and decided to make an adjustment to her piece. This is the first time she has made a decision on clearly musical grounds.

6.3.3.2 Perception of grouping and boundaries

As in the Hyperscore workshops, issues of perception with respect to grouping of note events and boundaries between groups emerged as a recurring issue.

Conor uses a combination of steps and ladders to make something that appears to be twenty beat units. He puts in a wormhole pair, links them, then counts the elements from top to bottom, pointing with the mouse. At this point it is very clear that he is associating each element with a single beat unit, so that ladders now get only one count, despite making multiple sounds.

T - OK so you're doing that - how many beats have you got here?
C - Fifteen I think......fifteen or twenty
T - Well which is it - fifteen or twenty - fifteen or twenty are not the same, are they?
C - Twenty!

Conor has correctly identified the number of beats in his piece. He then goes on to make another set of steps. It also has twenty beats. As he works he stops several times and counts the number of beats. It is not clear if he has begun to conceive of these twenty beats as broken down into a series of sub-units.

In his next move, it quickly becomes apparent that Conor is building a repeating unit consisting of four flat steps and a ladder - a five beat unit in all - and that he is making four of these in a row (figure 6.3.3.2). He clearly understands the effect of this – that the five-beat unit repeated four times has the same length as his previous undifferentiated sets.

C - They all have twenty.

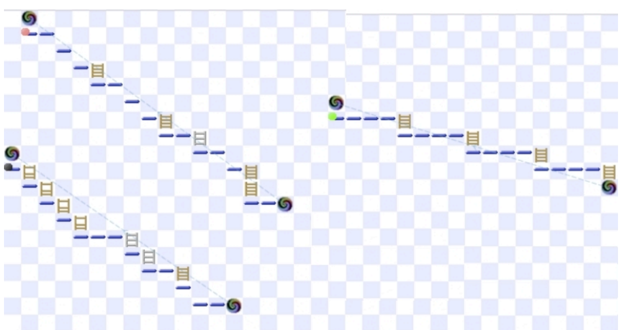


Figure 6.3.3.2 Conor three parts

Conor has demonstrated intent with respect to at least some aspect of the internal detail of the rhythmic patterns he has made. His construction of boundaries within his five-beat groups is also interesting.

The teacher traces the path of the ball over the steps with the mouse, saying 'babababaBom' at the junction between a ladder and the following step. He points to one of these junctions and says;

T - How many claps in that?
C – Five.T - Five - four in the ladder and one in the bottom, so it's like the ladder is 'babababa' and.......
C - (claps and says..) Bom
T - And then the next step is bom.

Conor associates the four-rung ladder and the step that follows it as a natural five-note grouping. However, when questioned, he can reconfigure his viewpoint to consider it as a four-note group followed by a single note. This ability to view the same set of musical events from different perspectives is fundamental to his learning.

Next, the teacher formalises the idea of repetition and ostinato with respect to Conor's third set of steps. He takes Conor's five beat unit and encloses it in two wormholes.

T - This is doing..(traces with mouse and chants the rhythm - the same thing four times)….so it's doing the same thing four times, isn't it?
C – Yeah.
T - So could you make it do all of that by just doing this... (he makes a single five beat figure) and if I put a wormhole there and a wormhole there...
C – Yeah.
T - And then what would happen?
C - It...it'll do the same.
T - It'll do the same but....
C – It'll finish before the other ones.
T - It'll finish before the other one....so how many times would I have to make that go, to be the same as this going once....?
C – Four.

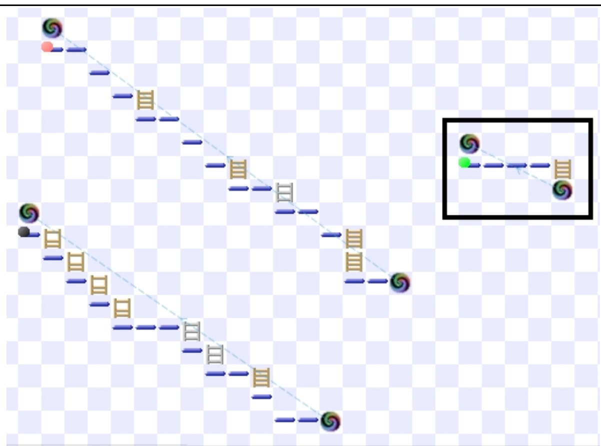


Figure 6.3.3.3 Reframing of Boundaries

Conor sees the relationship between the smaller five-beat group repeating four times and the larger, twenty-beat aggregations. The teacher further extends the comparison by asking how many times the five-beat unit might need to repeat in order to match with the longer units if they themselves were also repeating.

T -.....if all of this was going to play twice.......?
C – You'd need eight of those.

While the teacher has manipulated Conor's material in order to introduce the ostinato/grouping concept, Conor has clearly understood, and later applies this principle throughout the rest of his work.

6.3.3.3 Affordance and Relationships Between Things

In many cases, the nature of the interface seemed to highlight events that serve to clarify relationships between musical entities.

Early in the workshop series, Conor makes two lines of steps that play in parallel. When he plays back his piece, he notices something about the relative lengths of the two parts and how they relate to each other.

C - This ball (pointing to the second line of steps) always falls off.

He suggests a possible reason for this.

T - Before the other one is finished...well can you figure out why that is?
C - (points to first line of steps) Because that one's longer.

He then finds a solution.

T - Before that one.... so if you wanted them to finish together, you'd have to make sure they had the same number of......the same number of what?
C - Eh bars.
T - Bars or....?
C - Beats, beats.

Conor may be using the word 'bar' here to indicate a step rather than a musical bar. He has identified an important aspect of each part, that of overall length. He has also specified something about the relationship between the parts in order for them to 'go together'.

Later Conor again demonstrates an awareness of the internal relationship between different parts.

C – See that cymbal there, that one there and that cymbal there (he points to the cymbals in voices '2','3' and '4').
T – Oh, what do you notice about them?
C – They're all playing at number three, I did that on purpose!
T – So you have all those three cymbals happening at the same time deliberately?
C – Yeah.
T –Very good, so you knew exactly where to put them to make them sound at the same time?
C – Yeah.

This clearly indicates that Conor not only has begun to build some knowledge of the internal structure of each unit and voice separately, but also knows something about the manner in which they interact as they play. He has expressed this knowledge by making a deliberate gesture - having a cymbal sound in each of the three voices simultaneously.

Similarly, Ciara also starts to build an understanding of inter-voice relationships**.** She identifies this to mean units in different voices having the same overall length, but not necessarily having the same content.

T – You think there should be the same number of beats in it?
C – Yeah.
T – But would it do exactly the same thing, with all the exact same ladders and cymbals and everything?
C – But then it would just be exactly the same…..
T – So you think it might have exactly the same number of beats but it might have different stuff inside it?
C – Yeah

6.3.3.4 Musical Concepts and Rudiments

There were many interactions that indicated engagement with a variety of basic musical rudiments and concepts. These learning events seemed to arise out of the confluence of the task, manipulations and affordances provided by the interface and teacher interventions. Evidence for learning at this level is to be found both in the nature of student actions in the interface and in the expression of their growing understanding in conversation with the teacher. A number of short examples are presented here.

Ciara builds a formal understanding of the idea of rest**.** In a manner similar to Kevin working in Hyperscore, she initially says that a rest, represented by a silent step, should not be counted. She has already demonstrated an enactive understanding of this by clapping the rhythm correctly. However when asked to say how many beats are in the unit, she doesn't count it.

T – Do you count that one, as a beat?
C – Oh,….no, because you cant hear it can you?

After a conversation consistent with that described in Kevin's case, she reformulates her understanding to include counting the rest as a beat.

C – So there's eight of them.
T – So there's eight, but one of them is what?
C – You can't hear it.
C – You, it's still a beat, but you….
T – I did a clap, a clap….
C – A rest……

Ciara then demonstrates understanding of pulse.

The teacher builds a one-beat box as a metronome and plays back the two parts.

T- Now what's that guy doing (points to metronome ball)
C - Just going back and forward..
T – And in music what's it doing.
C – It's clicking.
T – It's clicking…and what is it clicking…..
C – The beat.

Here Conor demonstrates some understanding of meter as a function of the interaction between parts.

T – Ok so, what if I have one drum doing a five beat, could I make another drum do something that would tell me it was a five. C – Every five beats, the other drum could do one loud beat. T – So you mean (claps two part example as described) T – So if were listening to music and were trying to find out what the beat is, sometimes one drum doesn't tell us so we need..? C – Two.

Ciara begins to make the distinction between beat and rhythm.

She makes a row of steps using basic steps and ladders. The total length is six beat-units. T – Now, how many beats is in that? C – Eh…..(silence, may be counting)…eight This is the total number of note events rather than beats. When asked, she points and counts, clearly including each rung of the ladder as a beat. After a series of clapping exercises, Ciara begins to make the distinction. T – And if you put in a ladder like that one….? C – That's four beats. T – Four claps. C – Four claps. T – But it would still be only… C – One beat.

Finally, Ciara demonstrates concerned with the overall form of her piece. She makes decisions about the content of consecutive sections in relationship to each other.

She understands the importance of having some aspect of her piece change over time. C – No, I already did four beats….I've four, five and eight. C – Ok so, what number will I pick? C – Ill try three 'cos I've done eight, four, five.

She is clearly thinking of change from section to section in terms of unit length, which in fact equates to meter.

Other areas with which students engaged included accent, timbre, tempo and tempo change and rhythmic hierarchies. Their rhythmic perception improved developed new ways to perceive and think about musical objects and ideas. Much of the learning occurred through interactions instigated by the teacher, with the concepts or ideas raised subsequently explored and validated in the student's own work through interface-afforded activity. In some instances, there may be a question of student's intent – whether the expression of ideas was at the level of the interface, or the underlying musical ideas. Becky's case is clearly an example of the former. It is clear however, that the act of creating a piece of music using the software provided a context and vehicle for student-music and student-teacher reflection and interaction.

6.3.4 Teaching Intervention and Strategy

As the workshops proceeded, a variety of teaching strategies and interventions emerged, similar to those evidenced in the Hyperscore workshops. Some examples of these are again presented, and initial connections are made to both the affordances of the interface and the teacher's underlying reflection-in-action process. More formal analysis of the teaching process will be presented in chapter seven.

6.3.4.1 Teaching as Investigation

Again, many teaching interventions made were framed as questions. In some instances, these questions were designed to focus the students on some particular aspect of the work, while in others they were attempts by the teacher to become more familiar with his 'working materials', which included both the students work, and the student themselves.

T - Ok, what's your working number here? C - That one, that one and that one are eight, that one is four. T – (points to first pair of steps) So I think you're counting that as a beat, am I right, and that would be two beats (second pair of steps). C - (quietly) Yeah.

Having aligned his understanding of the materials with that of the student, the teacher frequently engages in longer series of questions designed to produce a specific outcome or understanding.

T - That one is......(waits for answer) this one is how many beats...(counts one, two, three, four, five, six, seven, eight). C – Eight. T - This one is (Pointing to a four-beat unit)? C – Four. T - This one is?

C – Four.

T - And this one is one, two...?

C – Four.

T - So in the time that this one goes once (the eight-beat group), all of these will go ...

C – Twice.

Much questioning is associated with task-framing – attempting to have the students more clearly define there next course of action.

T - What happens next - Is it going to do the same thing, or is it going to go on more and do some more - If it's going to do some more, would it be the same or different?

C – Different.

T - Different, so.....?

Similarly, the teacher questions Ciara as she works.

T – Now you had something that was eight beats, and they were all eight beats and this was two fours right?

C – Yeah they were two fours.

T – Now, this one then is a five.

C – Yeah and I'm going to do another five there (pointing to the end of the lower set).

T – And what are you going to do here (pointing to the end of the rightmost set).

C – A five.

T – But they'll be different fives from that – they won't be exactly the same?

C – Yeah….different ladders.

6.3.4.2 Task Framing

The notion of task framing is again important. In cases such as those demonstrated above, the teacher works with the student to define a mutually agreed task. However, in some instances, typically at the beginnings of sessions, he is more proactive in suggesting tasks that might help to define the work of the session. Furthermore, the suggested tasks frequently arise out of the teachers concern that these tasks should have some embodied learning, and that students should develop some internal musical representation of their constructions.

T – So what I want you to do is…I want you to try to make a piece for four different drums, with four different kinds of sounds, and each drum is going to do something that's eight beats…that's rule one.

C – Ok.
T – And rule two is, whatever they do has to go together…whatever you think goes together – so some drummer does something, some drummer does something else that goes with it…it's not really a rule, its just a…
T – But the most important rule is….you're only allowed do something if you can clap it for me or tap it for me.
C – Ok.

The suggestion that there be four drummers has arisen out of a conversation with Ciara. The teacher adds to this by suggesting the idea that different parts should go together and adds the constraint that Ciara should be able to clap anything she makes. This constraint is a reflection of the teachers concern that the interface may facilitate superficial work motivated by graphical rather than musical concerns. It attempts to test the notion that if Ciara is forced to clap anything she makes, she will have to construct an internal representation of the musical material, and so interact with music rather than just the interface.

6.3.4.3 Teacher Modeling

Again, modeling of behaviours and strategies was observed to be an integral part of the teaching approach. In many cases, this modeling was done on screen and was designed to indicate how to solve a particular problem or achieve a particular result.

Working with Ciara, he models various effects and techniques, pointing up why they work. In this instance he has made two short rhythmic sections with ladders, but has placed the ladders on different beats so that they may be clearly heard. He points to the ladder in each part as it happens.
T – So you can hear the sounds more clearly if they're different?
C – Yeah.

Later he does a similar exercise, assigning different instruments to various balls to demonstrate the effect of different timbres in each part.

T – So that's one important thing that if you're going to make music for lots of drums to play, probably you want them to have different sounds…
C – Yeah.

In other instances, the point of the demonstration was to surface or clarify a musical concept or idea. In this case the teacher builds a 'box' to illustrate ideas of pulse and rhythmic hierarchy.

The teacher then introduces a new technique. He demonstrates the use of 'boxes' to trap a ball and so create a pulse. He further illustrates ideas relating to rhythmic hierarchies by making different sized boxes and asking Conor about the possible results.

T - Do you notice anything about those two balls....are they together or not?
C - That one, the black one is a bit faster.
T – Why?
C - Because it's in a smaller….
T – 'Cos it's in a smaller space, do you see that?
T – That's a very interesting observation, well spotted - so why is that? It's like two people walking isn't it? If one person has a shorter step and one person has a bit longer step.....so they're out of step and every so often they go together.
C- Yeah.
Again the teacher makes reference to kinaesthetic ideas in support of the concept in question. He then introduces the functional musical meaning of the 'box' technique.

T - Ok so what's good about that is...once I put that in there, that has a very distinctive sound, once I put that in, what does that do for you in the music when you hear it?....what's its job? Can you hear that it's very steady?
C – Yeah.
T - Ok, so no matter what else is happening, what's this doing?
C - It keeps on beating.

Modeling activities were not confined to the interface, but sometimes spilled over into kinaesthetic modeling of musical ideas.

The teacher asks Conor to think about how to let the listener know what his repeating unit is.

T - So if someone was listening to me clapping, how could I tell them what kind of a beat it was, whether it was a four- beat or a seven-beat or a three-beat.

Conor suggests introducing variety within the repeating unit.

C - You could do a rest, or you could do a 'ti-ti.'
T - You could do a rest or a ti-ti, or what's the simplest one you could do is just do this……

He claps with accents every four.

C – Make one louder.

The teacher then claps a beat and taps a pulse every four with his foot.

T - What kind of a beat is that?

C – It's a steady beat.

T – It's a steady beat but how many every, repeats is it doing?

C - One.....every four.

The teacher has introduced the idea of meter and modeled a number of techniques to create a sense of meter in a piece, including placing rests or subdivisions in a repeating unit, use of accents and interaction between parts. In doing so he moves fluidly from use of the software to kinaesthetic demonstration and back.

6.3.4.4 Kinaesthetic Teaching, Fluidity and the Interface

In fact, use of more traditional kinaesthetic techniques was common. This may have arisen out of teaching needs which did not seem to be met by the interface, but also may have been a function of the teachers concern that purely virtual or screen-based activities may not give a full, holistic musical experience. The following example is typical.

After some discussion relating to accented steps and wormholes, the teacher asks Conor to count the number of beats in his piece (figure 6.3.4.1) as it loops three times.

T - Any idea

C – Seventy-two.

T - How many?

C - Seventy-two I counted.

T - Seventy-two!! Thats a big lot of beats, isn't it? Ok, play it again, and count it out loud for me.

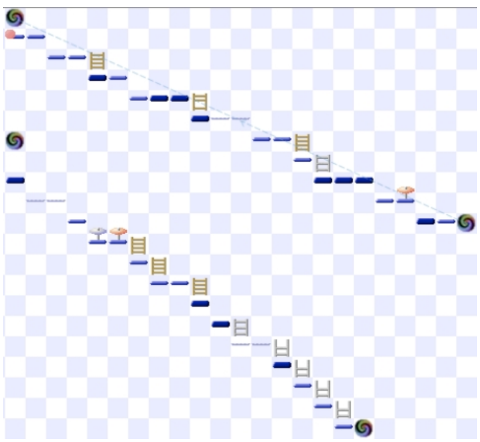


Figure 6.3.4.1 Seventy-two Beats

The section (figure 6.3.4.1) consists of twenty-six beat units, but has thirty-four actual sound events. It is not clear which (if either) Conor is attempting to count. The teacher asks Conor to play the piece again and count out loud. He clearly counts sound events (rhythm) rather than beats (pulse). In counting the ladder units he counts multiple times, once for each rung of the ladder. The teacher addresses this issue by using a clapping exercise. He has Conor clap a steady beat, and then claps subdivisions, initially doing two claps for each one of Conor's.

T - Now what am I doing?
C- You're going faster'
T - Faster - how much faster?
C – A beat faster.

The teacher engages Conor in further clapping exercises, until such time as he is satisfied that Conor can make a distinction between pulse and rhythm.

T - Ok, so when I ask you to count beats, what am I asking you to count- am I asking you to count all these little notes in between, or am I asking you to count the steady beat.
C - The steady beat.

In this instance, the teacher moves back and forward between the interface and the clapping exercises. In some instances, the nature of the representation itself seemed to suggest the focus of the exercise.

Working with Conor, the teacher moves to investigate the extent to which he has internalised the musical ideas he has constructed, specifically with respect to the ladders as beat sub divisions (figure 6.3.4.2). He claps the rhythm of one of Conor's rhythmic units and asks Conor to clap it back. Conor claps but does five beats instead of four for the ladder, plus a sixth for the following step.

Figure 6.3.4.2 Ladder/Step combination

After a couple of attempts, Conor claps the ladder step combination correctly. The teacher then refers to the representation on the screen to make the distinction between the four claps which comprise the ladder and the step which follows it.

T – So when you do 'babababa –bom', you're doing like the four beats of the ladder (pointing to ladder on screen he says slowly..) 'ba ba ba ba'….and then a 'Bom', is when it hits the step underneath, so 'babababa Bom' (clapping along)…do that…

Conor now claps correctly up to speed. The teacher has him now try to clap the entire figure again. He succeeds on the second attempt this time.

In this interaction, the teacher is concerned that Conor should have a clear internal representation of the music he is creating. He wishes to satisfy himself that Conor is not just moving elements around on the screen, but actually understands and can construct their musical meaning. He does this by a series of clapping exercises, in each case tying the particular rhythmic unit to its equivalent DrumSteps manifestation. This integration of use of the interface and more traditional methods becomes more pronounced as the workshops progress.

In a later clapping exercise, the teacher then asks Conor to clap a rhythm (consisting of a triplet and some single beats) repeatedly a number of times. Conor claps an incorrect number of events, and seems to be confused at the boundary between the triplet ladder and the following steps. After a number of attempts, the teacher says;

T – I'll make my finger be the ball and you clap.

The teacher traces the path the ball would take over the screen elements. Conor claps along. There is a definite improvement as he progresses. Initially he misses just one beat (the first on each repeat) but after a number of repetitions he begins to get this right. The teacher asks him to just clap the triplet ladder, which he does confidently and accurately. It seems that the act of tracing over the steps as he claps have helped Conor to create a boundary between it and the following step.

This use of the particular animated aspect of the interface is common. For example, by having Ciara follow the ball as it plays, he tries to have her shift her perspective, so that she perceives the section in question from a procedural standpoint rather than as a static object, enabling her to abstract structural information.

T – The ball is going to go down here, it's going to go bom bom bom bom tatatata bom (pointing and saying rhythm)…it's going to start again…
C – Yeah.
T – And you're clapping along the beat….how many claps are you doing in the time it takes the ball to get from there (points to first step) until it falls in there (points to bottom wormhole)…do you understand the question now
C – Yeah.
T – Ok good.

6.3.4.5 Other Strategies

Many of the other strategies and intervention types identified in the Hyperscore workshops reappear in the Drumsteps sessions. The teacher tries to engender a real-world perspective.

T – If you have all this noise going on and everybody's playing like mad – what's the most surprising thing you could do… C – It all stops?

Again, the teacher couches the discussion in a real-world context – what would 'catch people by surprise', what would happen 'if everybody was playing like mad'.

He alternates in a fluid way between setting local tasks that access particular musical ideas and maintaining a view of the overall goal.

T – Will your piece of music just start like that, straight in? It might….or will there be some start that you can imagine….and the next thing is, how long will it do that for and what will it do next?

Throughout the composition process, the teacher takes opportunities to explore basic rhythmic and musical concepts at a variety of levels. He uses the interface to model various musical ideas, for example constructing a single beat box as a metronome to point up the idea of beat.

T –….now what's that guy doing (points to metronome ball) C - Just going back and forward. T – And in music what's it doing? C – It's clicking. T – It's clicking…and what is it clicking….. C – The beat. T – The beat, the back, the steady beat, or another word is pulse.

The teacher tries to help students to develop criteria by which they might judge their work.

T – I said to you this one to go with that one – so what does that mean – I don't know, there's lots of ways it could go with it…I'm asking you what you… C – They have to sort of be the same… T – The same? C – Yeah. T – How the same, the same in what way? C – The same…….how many beats are in it.

T – You think there should be the same number of beats in it?
C – Yeah.

He engages with student's materials and makes suggestions based on his perceptions of them.

T – Ok, now, so is there any reason why they couldn't do…a third thing…?
C – A third thing.
T – In other words, they've all done eight beats, then they've all done five beats
C – And four beats.
T – Now they could do four beats, could they?

Finally, he continually tries to balance the need for intervention with his desire to empower students and where possible encourag them to make decisions themselves regarding their work.

T – Ok so are you sure you want that much or do you maybe….listen to it again?
T – Was that too short, too long, the right amount?

He allows the problem to remain complex so that students may choose what she will attend to in their work. He also encourages them to view the task as if they were composing a piece for real musicians to play.

T – Now what do I want to happen overall here – what do I want to be the same and what do I want to be different….for each drummer…you know what I mean…this drummer is doing something, maybe he wants to do something different (pointing to individual voices on screen).

The teacher's work is characterized throughout by fluid movement between a variety of strategies and the balancing of conflicting demands. His decisions are made on the fly and in response to his perception of student's needs at any given time. Where appropriate, he makes use of the various functionalities afforded by the interface to achieve his goals, but balances these with use of traditional methodologies and techniques as required.

6.3.4 Summary

The above sections describe in a similar manner to the Hyperscore workshops those behaviours that emerged in the course of the DrumSteps sessions. Students were exposed to the software over six sessions and again asked to compose a single piece of percussion music, again mentored by the author. The teacher again attempted to adopt an unplanned approach to the workshops although inevitably the teaching approach will have been coloured by his experiences in the earlier Hyperscore sessions.

There was less evidence of convergent compositional process, perhaps as a result of the undifferentiated nature of the DrumSteps interface. There was evidence of musical intent with respect to manipulation of various rhythmic parameters, and clear links were observed between the nature of musical interaction and interface affordances. Visually motivated gestures were observed, as were aspects of procedural motivation. Kinaesthetic interface interactions were not observed, as interactions of this type were not easily afforded. Again the role of the interface in shaping both teacher and student interactions was noted.

Evidence of an underlying reflection-in-action dynamic was noted. Both students and teachers were again observed to engage in key elements of reflection in action, including move-testing, reflective conversation with materials, task framing and reflection-on-action.

From the foregoing, it is clear that there are definable behaviours exhibited by students engaging in composition with these software applications. What is less clear is whether there are other behaviours that might manifest themselves in a larger sample and also what the relative prevalence of each behaviour might be. The following short section describes a block of supplementary data, collected via the internet, which gives some initial insight into these issues.

6.4 Online Compositions

6.4.1 Introduction

Both pieces of software under examination were made generally available via the internet and received publicity in the media. As a result of this exposure, many thousands of users downloaded and used each software application and submitted the results of their work to websites associated with each. From the resulting set, pieces were randomly selected for close analysis. This section will briefly present the results of this analysis. All online pieces are contained on the accompanying CDROM along with installers for the relevant software applications (see appendix A). Examples of the categorization of pieces are given in appendix D.

6.4.2 Analysis of Pieces.

In analyzing the submitted pieces a number of factors need to be borne in mind. The analysis presented represents an attempt to classify the ways in which users engaged with each piece of software. It first seeks to identify those pieces that seemed to employ primarily musical structures and manipulations. For those pieces that do not seem to be primarily musical in structure it then seeks to identify other types of unifying or organizing features. The analysis is not intended to have absolute statistical validity, rather to identify trends or to validate those trends observed in the face-to-face workshops.

It is clear from the workshops that there are dangers inherent in trying to draw conclusions based on product analysis alone. In the case of the pieces in question, there is no data available regarding the age or level of prior musical training of the composers, nor is there any data regarding whether or not composers were aided by a competent musical mentor. It is not possible to say with certainty what were the composers' motivations for particular actions. However, having closely observed a number of students and elicited information regarding their processes, it may be possible to make guarded assumptions about the online pieces based on observations of similar kinds of gestures in both data sets, and hence to make informed judgments about the level of musical engagement exhibited by the composers.

Analysis of the pieces looked for objective organising factors at various levels of granularity. To this end a set of criteria were devised by which to generate broad categories of pieces, based on the literature identifying objective aspects of the domain. While the criteria used were as objective as possible, there is always the possibility of observer bias. Validation of both the criteria themselves and of their application by the author would require an extensive study involving a number of suitably qualified judges. As the particular analysis is question is presented as supporting data only, it was felt that this validation study was beyond the scope of this thesis. Conclusions based solely on this data might therefore be tentative in nature but when taken in tandem with the case-based observations, more concrete conclusions may be drawn.

Value judgments on the musical quality of the compositions were not made, rather the level of apparent engagement with the objective musical factors was noted. As both pieces of software automatically generate a base level of organization, only organization above that generated by the software was considered.

There was some spillover between categorizations. There were pieces that existed at the margins of categories or displayed characteristics of several categories, so exact categorisation of particular pieces may have been to an extent a function of the observer. However notwithstanding this, clear categories or trends were noted.

6.4.3 Criteria for categorization of online pieces.

The first stage in the analysis was to try to distinguish those pieces that demonstrated a significant level of musical engagement from those that did not. To this end, a set of criteria was drawn up based on objective aspects of the music domain (see Appendix D). These criteria were subdivided into two broad areas:

- lower level parameters, which in general correlated to small scale or local structural units;

- higher level parameters, which in general correlated to larger scale structural features or relationships between different sections of the piece.

The analysis attempted to distinguish between those organizing features that were a function of the software defaults and those which were more likely the result of some deliberate action on the part of the user. The musical parameters which were used to define criteria were aligned with the functionality of the interface, yielding a set of criteria optimized for each interface.

In considering pieces with respect to the various parameters described, it is important to bear in mind that while the parameters themselves are described discreetly, in practice these clear distinctions may not manifest themselves in the pieces. Manipulation of a single parameter may appear to imply concurrent interaction with others. For example, in DrumSteps, the use of wormholes by definition involves repetition, which in turn implies a repeating pattern. This cannot be taken to mean that the user has deliberately created a structured pattern. Therefore, while the analysis looked at discreet parameters, these were considered in a holistic context within the piece. The presence or absence of a particular organizing feature was not considered to be valid unless supported by the simultaneous presence of one or more related features.

6.4.4 Results

Based on the analysis of the data set, clear categories of pieces emerged. These categories were broadly in line with the types of interaction observed in the case study workshops. DrumSteps pieces were divided into those which appeared to be primarily musically motivated, and those that were organized along either visual or procedural lines. Hyperscore pieces were divided into those which appeared primarily musically organized and those which seemed to have elements of visual or gestural organization. Other organizing principles were not observed in respect of either software (although there is clearly the possibility that those pieces consigned to the 'no organisisng principle' category were organized along axes which were not apparent to the author).

All percentage figures are quoted in relation to the total number of pieces examined.

DrumSteps Results

Of 156 pieces:

18% pieces were primarily organized by musical means.

36% were organised by non-musical means, of which:

> **25%** were primarily constructions or displayed some degree of visual organisation,
>
> **11%** were primarily procedural - i.e. motivated by aspects of animation.

46% had no discernable organising factors.

Hyperscore Results

Of 105 pieces:

15 were either blank, too trivial to analyse or resubmissions of downloaded examples or other people's pieces.

Of the remaining 90:

57% exhibited some musical organisation, of which:

> **21%** were organised at both motive (Small unit) and sketch (large scale) level.
>
> **36%** were organised at motive level only.
>
> **Of the latter;**
>
> **18%** were primarily organised visually in the sketch window,
>
> **15%** were primarily gestural in the sketch window
>
> **3%** had no discernable organising factors in the sketch window.

43% exhibited little evidence of significant musical organisation, of which:

> **17%** were primarily visual
>
> **15%** were primarily gestural
>
> **11%** had no organising factors.

Of the total number, while **48%** engaged at some musical level, only **21%** engaged with larger scale structures and principles, while **79%** did not.

Of this **79%** - i.e. of those who did not engage in a musical way with higher level structure (in the sketch window), out of the total:

> **34%** were primarily visual
>
> **30%** were primarily gestural
>
> **15%** had no discernable organising factor.

Chapter seven will present some discussion of these results in the context of observations made during the course of the case study workshops.

CHAPTER 7. DISCUSSION.

7.1 Introduction

This section will draw together the various strands that emerged from consideration of both the case-based data and the pieces submitted online. The discussion will proceed by first analysing the kinds of musical learning observed. It will point to a variety of factors that impinge on this learning, considering in detail the affordances of the particular interfaces examined and their affect on childrens learning, and also on the role of the teacher, including consideration of the methodological and strategic approaches adopted. It will then demonstrate that children working in graphical music environments exhibit a variety of clearly defined behaviours and that there are definite categories of teacher interventions and strategies which are effective in this context. Further, it will argue that these observed behaviours on the part of both teacher and learner are to an extent a function of interface affordances.

Finally, the various issues arising will be considered from the standpoint of Donald Schon's theory of reflection-in-action. The argument will be advanced that this theoretical approach adequately describes the underlying dynamic of both learner and teacher actions and interactions as observed in the workshops, and that fundamental to this position is the presence of a mutually well understood medium through which these actions and interactions may take place, which medium is provided by the computer-graphical music interfaces under examination.

7.2 Musical Interaction and learning

Throughout the workshops with both pieces of software, there is clear student engagement with musical materials, ideas and concepts on a variety of levels. Initially all students seemed to undergo a period of superficial exploration of each interface, manipulating visual elements in a variety of ways. However, there did also seem to be an initial awareness of a restricted range of musical parameters. Those parameters seemed to be to an extent a function of those made most immediately accessible by the particular interface.

Questioning by the teacher elicited references to these musical elements, which differed in each interface. In Hyperscore, they include note duration, motive length, number of notes and pitch range (high/low) and contour. In DrumSteps, they included timbre, pulse, number of note events, accent and unit subdivisions. However, in five out of the six cases, by the second session students had begun to attend to a wider range of musical parameters and exhibit evidence of engagement with a variety of concepts and processes.

Some examples of these different levels and modes of engagement are discussed below. In approaching the discussion of these events, it is important to bear in mind that each event exists as a 'snapshot' taken from a continuum of events. In this respect, the context within which each event occurred is clearly of importance in interpreting its meaning. Also, an event which is used to illustrate a particular point or idea will often have embedded within it implicit reference to other ideas or levels of engagement. This musical engagement may broadly be described in terms of musical rudiments, musical concepts, musical manipulations and compositional process.

7.2.1 Musical Rudiments

Students working in each interface demonstrated clear interactions with many of the musical rudiments as outlined in section 2.3**.** While initial engagement may have been a function of each child's intuitive understanding in tandem with those musical elements most immediately accessible in the interface, as sessions progressed, almost all children moved beyond their initial 'interaction set' to discover and engage with rudimentary musical concepts of which they did not demonstrate an awareness at the outset.

As might be expected, children working in DrumSteps were more immediately engaged by ideas of beat and rhythm. Conor (appendix C, p.iv) initially made a pair of step-sets that he played together. On playback, he noticed that one ball finished before the other, leading him to the realization that in order to finish together the two voices should have the same number of 'something'. In conversation with the teacher, this something became formalized as the concept of beat. Furthermore, he also began to demonstrate an awareness of the notion of relationships between things that informed his subsequent work.

In common with many of the students observed in both interfaces, Ciara initially demonstrated a disjunction between beat and rhythm (appendix C, p. xxviii). When asked to count beats, she counted note-events. In conversation with the teacher she engaged in a variety of interface-afforded manipulations and clapping exercises which enabled her to eventually separate the notion of beat from the number of discreet note events, so that for example, a four-rung ladder initially was considered to have four beats, but later was counted as a single beat.

Working in the Hyperscore sketch window, Emer (appendix B, p.xxix) initially made a series of overlapping curved strokes, indicating a lack of awareness of issues relating to texture, register and functional part writing. In her later work, parts (strokes) were separated out by pitch range with much less use of overlap, indicating a greater sense of part writing. She also showed a growing sense of musical structure. Her initial efforts were not bounded by any sense of narrative or sectional function. Her final piece however, is clearly in sections. This sectional view of her piece seemed to arise out of the fact that she worked in multiple sketch windows and then copied and pasted material from one to another to complete her final piece. She made many comments as her work progressed indicating her intent with respect to the function of each section or unit in the final musical form, such as:

It’s the end of the piece.

This is the start of the end of a piece.

Both Stacy (appendix B, p.lvi) and Kevin (appendix B, p.vii) similarly discovered the concept of rest. In Kevin’s case, the concept arose out of a consideration of two motives and an attempt to make them ‘go together’. The discovery that two motives were not the same length emerged from use of the drawing functionality in the sketch window, and led to the functional idea of a rest; an entity that takes time but makes no sound. In the course of the exploration leading to this discovery, the teacher engaged Kevin in a series of clapping exercises during which he began to decouple the notions of pulse and rhythm. Stacy discovered the rest idea more directly but in a similar manner. When asked to clap the rhythm of a motive she made, she initially clapped note events only (rhythm), but later clapped in the gaps as well, leading to the realization that these gaps (rests) take time and therefore are counted as part of the underlying beat (pulse). Later Kevin transferred this notion of rest from the small scale to the larger canvas. He noticed an unintended ‘gap’, or rest, between the end of one stroke and the beginning of the next, and moved the strokes to remove it.

While all students did not discover the same rudimentary concepts, there was certainly some congruence. Fundamental notions surrounding beat, time, length and sub-division arose in both interfaces, while pitch, interval, melodic movement and contour were accessed through Hyperscore. In almost all cases, some aspect of the interface was fundamental to the learning, either in terms of the manner in which musical information was represented, or the extent to which each interface afforded manipulation of musical objects, serving to surface key concepts. The intuitive nature of the note-level representation in Hyperscore afforded a consideration of the concept of a musical ‘gap’, or rest. Procedural aspects of the Drumsteps representation surfaced the notion of unit length. While discoveries of this nature were clearly embedded in a wider context which included teacher intervention (discussed later), it is clear that specific affordances of the interface had a fundamental role to play in enabling children to access these musical fundamentals.

7.2.2 Musical Concepts

As well as engaging with rudimentary musical entities and ideas, all children to varying degrees (with the notable exception of Becky) interacted with higher-level musical concepts such as change, variation, relationships between musical entities, structure and form.

Ciara engaged with the concept of change (appendix C, p.xxxi). She was clearly aware in each new section of the need to create interest by changing some aspect of the music. Initially she relied on the unit length (meter). Later she began to attend to the inner detail, so that while two units may have had the same length, they were defined as ‘different’ based on their content. There was also an element of perceptual ‘zooming-in’ in action here - moving from the perception of an aggregated unit to a perception of inner detail.

Both Ciara and Conor engaged with relationships between things**.** In the second session Conor (appendix C, p.ix) made three step-sets of twenty beats. He then made a fourth set which consisted of four repeats of the same five-beat unit. This demonstrated a clear awareness of length relationships between parts and also of the notion of grouping and subdivision within a part, with the associated implication, not yet fully realized, of meter. Later he reconfigured this voice so as to make use of the wormhole function to repeat the five-beat unit four times. At this point he has clearly formalized the notion of repeating units and has reconfigured the representation to express his more sophisticated understanding.

Ciara demonstrated a similar engagement (appendix C, p.xxix). In creating a three-voice piece, she said:

> That’s doing eight times at a time, that’s doing four and that’s doing four.

In other words, eight-beat units are repeating four times and four-beat units are repeating eight times, indicating awareness of hierarchy. Use of the word ‘doing’ may indicate a procedural component – the procedural nature of the interface seems to have facilitated the comparison between voices leading to the musical insight.

Conor showed evidence of his ability to maintain a sense of rhythmic position relationships between different voices (appendix C, p.xvi). He indicated that cymbal events in each of three voices occurred simultaneously.

> They’re all playing at number three, I did that on purpose.

Working in the Hyperscore interface, Stacy became aware of relationships between motives in terms of both their length and their internal structure. Pointing to two different motives, she indicated similarities in melodic contour.

> That goes up and down and that goes up and down.

She also realized the importance of change in her music.

> S – It’s playing the same thing over and over again…
> T - …do you think people might not like that?
> S – Yeah.

In making his motives, Kevin (appendix B, p.ix) repeatedly engaged with notions of pattern and sub-pattern. After a demonstration by the teacher of subdividing a motive into meaningful sub-units, Kevin applied this to several other motives. His first two motives were essentially single, coherent musical gestures. Later motives became multi-part, constructed from two or more discreet sections, each with its own distinct character yet each contributing to the greater whole.

Again students were observed to engage with similar high-level musical concepts across both interfaces. While each interface is fundamentally different, students managed to use aspects each interface to access these concepts despite the different representational forms and compositional processes implied in each software application. Much of this conceptual work involved examining and operating on discreet musical objects and seeking, similarities, differences and relationships between musical objects. In this respect, both the representational forms themselves and the manner in which the interface afforded manipulation of objects were observed to be important factors.

7.2.3 Musical Manipulations

A key element in evaluating the success of these interfaces in engendering musical engagement is the degree to which they act as vehicles for the manipulation of musical objects. While the interfaces clearly do act as notation systems, reflecting back to the user attributes of the musical material in question, they not only afford exploration of these attributes but also a variety of related musical concepts and ideas. The manner of this exploration is active. Students may explore their perceptions by easily manipulating and making changes to the material.

During the course of the workshop sessions, children engaged in a wide range of musical manipulations. Very often, these manipulations began with the notion of the interface as a descriptor of musical entities. Students referred to the notation in a way that indicates how they were using it to describe various musical events. Ciara accurately clapped a beat she has made.

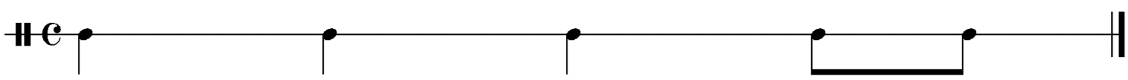


Figure 9.1 Ciara's clapped rhythm

This equates to three steps and a two-rung ladder. Ciara says:

C - I did a ladder.

The ladder symbol is clearly used to represent a subdivision of the main beat. Ciara's clapping indicates that she understands the meaning of the symbolic representation. However, Ciara goes beyond this simple reading of the notation. On several occasions, she examines a particular note grouping, claps or counts beats before adding or changing her material. In these instances, she is using the representation as a vehicle for both analysis and active engagement with the material.

Conor similarly makes musical manipulations that enable him to explore or express his growing musical understanding. On realizing that a twenty-beat unit consisting of four equal subgroups could be represented as a single unit repeated four times, he rebuilds the step-set to reflect this new understanding. In exploring meter (appendix C, p.xiv), he discovers that a sense of meter may be created by use of accents on strong beats. He then edits the attributes of the steps in these positions to reflect this. On several occasions he acts directly on repeating groups by editing the number of repeats associated with the wormhole icons. In each case, his re-ordering of the screen icons enables him to externally express his re-ordered understanding.

In building one of her motives, Stacy makes use of inversion and repetition, both standard techniques for developing and altering musical material. She constructs a three-note descending motive (appendix B, p.lvi) and immediately follows it with its inversion, followed by a repeat of the entire six-note figure. In the second figure, she then moves two notes up a half-step to create a variation of the first figure. This sequence demonstrates two types of manipulation. The first is that of creating a figure that bears some motivic relationship to a previous figure. In this case, she builds an inversion. The manipulation here is virtual – she is manipulating the idea of a three-note figure, although she is not acting directly on the figure itself. In the second case, she alters the figure directly by actually moving the note-icons.

Kevin also exhibits both of these types of manipulation in building his red motive. He makes an initial descending five-note figure and then manipulates the material to create a repeat (by copy-and-paste). He then acts directly on the new note group by shifting it around the window to change its pitch and rhythmic position with respect to the first group, creating new musical meaning through variation and change of context.

Musical manipulations across both software applications included those that occurred at the level of the individual note-unit, and those where operations were carried out on aggregations of note units. Implicit in the latter is the initial grouping operation, followed by the actual manipulation. Manipulations included pitch and rhythm shifts, group copy-and-pasting operations, extension of motivic material, variation, inversion and the physical movement of material on the screen for comparison purposes. Each of these interface-afforded operations carried with it at least the possibility of engagement with the underlying musical meaning, thereby acting as a catalyst for both student and teacher reflection.

7.2.4 Compositional Process

Students' compositional processes might be viewed as the aggregation of the various musical manipulations that they made in the course of their work. As none of the students had ever been involved in formal composition either in school or in other settings, they carried with them no baggage with regard to how to engage in the business of composition. They were required to discover all aspects of the process as they worked. In this respect, one measure of the success of the project and the applications deployed might be the degree to which children managed to generate a compositional process at all. The degree to which these processes chime with the observations of professional composers regarding their own processes may also be relevant in this regard.

Observation of the cases considered clearly demonstrated that all students developed some form of working process. In most cases, elements such as problem finding and solving, the generation of criteria, trial-and-error, kinaesthetic activity and movement from divergent to convergent activity were elements of the process.

In his first session, Kevin makes the discovery that "you need to test it first, so as you know what it sounds like". This indicates that he has extended his process to include trial and error. It also indicates a growing ability to generate and apply criteria to his work. His subsequent work indicates strongly that he incorporates this principal in everything else he does. Furthermore, it is clear that the ease of manipulation provided by the interface facilitates him in developing and exploring these processes.

Ciara, (appendix C, p.xxv) working in Drumsteps, also demonstrates a growing ability to reflect on her work and apply criteria. In making parts which are designed to go together, she variously claps her rhythms, points to the screen while counting elements and tests her work by playing at regular intervals, varying the number of elements in one set until it matches the other. In later sessions she develops a more problem-solving approach, manipulating discreet parameters in order to achieve a particular result. This contrasts with her earlier work, during which, when confronted with an unexpected outcome, she simply deleted everything and started again.

Emer and Kevin both undergo an almost parallel development of their working process. They move from initial random exploration of the interface to a more focused effort to produce a musical outcome. In both cases, motives evolve from an initial note placement through a series of moves, each dependent on the previous until the motive achieves its final form. Furthermore, both students motive-making process itself evolved over a number of attempts. In early efforts, both spent considerable time in less directed work, randomly placing and deleting notes. In later work, initial ideas, rather than being discarded, evolved in a fluid way to their conclusion.

Becky (appendix C, p.xxxix) also displays evidence of a developing process in her work. However in her case, the process is not primarily concerned with musical issues. She initially engages with notions of beat and timbre. However she then seems to become more engaged with the visual and animated aspects of the interface. She frames the problem in terms of the screen icons themselves rather than the musical sounds they represent, specifically relative synchronisation of ball movement on the screen. She then sets about building her 'piece' on this basis. While the engagement may not be primarily musical, there is clearly a process of problem finding, problem framing, choosing from a range of relevant parameters and problem solving which develops over the period of her use of the software.

Of the six students whose work is considered, five exhibited elements of compositional processes that are similar to those described by many composers. The way in which musical entities were observed to grow organically from in initial fragments or ideas mirrors comments made by Sessions (1970), Copeland (1957) and Berio (1985). This movement, from initial search for ideas through a refining of those ideas until a finished form is achieved, is also in agreement with the compositional process reported by Bennet (1976), although the notion of a 'final draft' is clearly not relevant in the current context. The linear process described by Bennet also broadly describes the work of the children here. However, both Smith Brindle and Bennet refer to a final review or editing process in which composers typically engage. This sort of overview of the work did not seem to be available to the children observed. In their work, children seemed to be reluctant to revisit earlier parts of their pieces, either to make edits or to find material for re-use. There seemed to be a sense in which, once a section was completed, it was then in its final form and the focus moved to the next section. The one partial exception to this was Kevin, who revisited material from the start of his piece and re-used it again at the end.

7.2.5 Discussion

One of the broader questions underpinning the current study concerns the nature of music learning when working in graphical music environments. While an exhaustive examination of the nature of learning would be beyond the scope of the current study, it is at the same time necessary to offer some brief characterization of what is meant by learning in order to examine whether it has in fact occurred. The notion of learning is clearly bound up with the idea of 'knowing'. At its simplest, learning might be said to have occurred if, after the learning experience or event, the learner knows more than he or she did beforehand.

Gilbert Ryle characterized knowing in terms of '"knowing that' and '"knowing how'. 'Knowing that' is concerned with propositional knowledge and as such is relatively easy to assess. 'Knowing how' is a much more subtle entity and consequently more difficult to pin down. As Ryle puts it, "It makes sense to ask at what moment someone became apprised of a truth, but not to ask at what moment someone acquired a skill" (Ryle, 1949).

By Ryle's definition, one might argue that the students in the current study have engaged in learning if they can be demonstrated to have acquired some body of knowledge or to have acquired an aptitude or ability to do something that they might not have been able to do previously, the latter being that learning which is situated in action and is to an extent itself the object of that action.

Inherent in this view of both propositional and action-focused learning is the notion of change. Observation of change in students, either through their actions or verbal expression may serve as evidence of the sort of internal cognitive change that might be characterized as learning. To this end, each case study was considered not as simply a chronological sequence of events, but rather in a manner that attempted to document the various ways in which changes occurred in the students' apparent body of propositional knowledge or modes of action.

It is very clear from the foregoing sections and the case studies themselves that both propositional learning and learning situated in action did indeed occur. Students learned about fundamental musical rudiments such as pitch, note value, rhythm, meter and accent. They learned to label these musical entities and ideas and to make use of them in their work. But as well as learning 'about', students also learned 'how to'. They learned the meaning of higher-level musical concepts and a variety of ways to manipulate musical materials in order to give expression to these concepts. Students demonstrated clear changes in their working process over the course of the workshops. New ways of manipulating material, strategies for generating new material and the generation and application of personal criteria were evidenced at various levels by all participants.

It could not be said of any student at any point that the workshop process that the acquisition of a particular musical skill or competence was finished. The skills involved in music composition are acquired over many years through continuous practice and are inextricable linked to a growing and deepening understanding of musical materials in terms of their attributes and the possibilities they present. While students demonstrated the beginnings of acquisition of these skills during the course of the workshops, there was no point in the process where one might apply a test and declare a particular competence 'learnt'. This in no way devalues the learning journey engaged in by the students, nor does it make any qualification necessary to the statement that music learning did in fact occur.

Having demonstrated that learning did occur, one might then consider the various factors affecting the manner and nature of this learning and seek to find an underlying dynamic, which this dissertation argues may be described in terms of reflection-in-action. While this is dealt with in more detail later in this chapter, it is worth noting here simply that for all participating children there were elements of task-framing and re-framing, move-testing and experiment, fluid movement between reflection and action, reflection-on-action informing later action, and reflective conversation with the working materials. Both the childrens learning, and their underlying reflective process were facilitated by interface affordances, but also depended to an extent on aspects of the teaching approach adopted, which factors will be considered in more detail in the following sections.

7.3. The role of the Interface

7.3.1 Introduction.

This section will examine the role of the interfaces used by children to compose during the workshops. It will briefly review those features of the interfaces that seemed important in facilitating the children's learning in terms of both the representation of musical objects and the manipulations of these objects afforded by the interfaces. It will primarily seek to identify and categorise a range of behaviours afforded by each interface based on both observations made in the case studies and analysis of a large number of pieces submitted anonymously via the internet. It will argue that such learning as was in evidence during the case studies was to an extent a function of interface affordances. Finally, it will argue that any graphical music interface will afford both musical and non-musical behaviours, and that in the absence of a competent musical mentor or teacher, it cannot be assumed that naïve or novice composers will necessarily gravitate towards musically motivated interactions.

7.3.2 Interface Affordances and Musical Learning

Chapter five has outlined the various musical affordances specific to each interface. Both the case study descriptions themselves, and the foregoing section indicate clearly that musical learning occurred, and that this learning was to an extent a function of the interface, both in the way in which each interface made musical descriptors and parameters explicitly available for consideration and in the manner in which each provided a set of manipulations through which a variety of musical ideas might be actively explored. Analysis of these aspects has to an extent been subsumed into the foregoing section, so elaboration is not required here, beyond briefly summarising specific and general features of the applications that seemed especially important.

At the motive window level, the Hyperscore software provided clarity of note-level representation along with free movement of notes within the working space. Pitch, note-length and rhythmic position were immediately accessible, engendering free and fluid musical interaction. Grouping of note objects and manipulation of these groups were afforded. The literal nature of the representation made it possible for workshop participants to make predictions about the sound of musical objects and the potential effects of manipulations. Moving from the motive window to the sketch window, the 'modular composition' aspect of the software clearly acted to engender an organized compositional process. As individual musical ideas were clearly framed and bounded, students were able to focus on more global aspects of their music. The ease of manipulation of these ideas provided by the drawing metaphor further facilitated a focus on aggregated and global features. Colour coding of strokes provided a means of navigating the score, so that while the learners could not necessarily predict note level content of strokes, they could use this feature as a means of reviewing content.

The clarity and intuitive nature of the representational system was also a key factor in learning during the DrumSteps workshops. Students quickly understood the basic premise of operation of the software and moved to making links between interface objects and the sounds they represented. In fact, constructing these relationships was fundamental to much of the learning. For example, it was not uncommon for students to mis-hear the number of beats in a musical unit. Counting step units or ladder rungs served to focus attention on this parameter, leading to enhanced perception. The causal nature of the interface was also a factor here. The notion of 'following the ball' while listening was seen to enhance musical perception, and also led to an enhanced ability to predict musical outcomes. Observation of how balls moved over different step sets afforded the opportunity to make comparisons with respect to both unit length and internal rhythmic detail.

In general, the combination of intuitive representations and fluid manipulation of objects and parameters allied to instant feedback provided by each interface were seen to enhance musical engagement and learning. Children navigated the interfaces at various levels of engagement, and moved fluidly between focused musical interaction, and more interface-driven action. While the initial intent in making a manipulation may not have been musical, there were inevitably musical consequences, often leading to an investigation of some musical concept. In other instances, a musical function or operation was required, and when sought, was provided by the interface. As students worked, they seemed to move freely between experimenting with the interfaces themselves and interacting with the musical sounds and structures they represented. As the workshops proceeded, the focus moved more towards creating a finished piece of music and so exploratory interface-motivated behaviors became less common (although this was undoubtedly to some extent a function of both the teaching approach and students increasing familiarity with the interfaces). The particular paths navigated by participants in each workshop varied considerably, so that the musical outcomes might be viewed as collaborations between the children's musical intent and the manipulations afforded by the software. In this respect, it is clear that the interfaces themselves were not neutral. In some instances the interface provided, or one might even say 'suggested' a possible manipulation leading to a particular outcome. These interface affordances were seen to guide childrens work in both musical and non-musical ways. These non-musical affordances and their affects on childrens working processes are discussed in more detail below.

7.3.3 Non-Musical Affordances

The case of Becky, working in DrumSteps was something of an exception by comparison to the other cases under examination. Despite the teacher's best efforts, Becky's musical engagement was sporadic. She clearly understood pulse and rhythm, was able to clap short musical rhythms accurately even when written in staff notation (calling into question her claim at the outset of the process to have had no prior musical training) and could also clap the short rhythmic units represented by ladders. When working in DrumSteps however, she made no effort to construct an organised piece of music and maintained her focus at the level of the interface itself. That is not to say that she working randomly, or without motivation. Her piece is clearly organized, but not from a musical perspective.

One might suggest that there are two kinds of organization in her work, procedural and visual. The first part of her piece is organized around an attempt to precisely control the manner in which the balls move over the steps, while the second (lower) section seems more concerned with producing a graphical effect, a diamond-shaped group of steps. Similarly, Stacy's work in the Hyperscore sketch window was clearly to an extent a function of the freedom provided by the interface with respect to physical drawing actions. Emer, while sometimes clearly focused on musical outcomes, at other times also makes gestures that seem to be motivated by a sense of visual or graphical pattern.

It is clear therefore, that while both interfaces supported a range of musical actions and manipulations, they equally afforded the user a range of actions that were not primarily musical in nature. In the case of Hyperscore, there seemed to be primarily two types of 'non-musical' interaction; those based on a physical or kinaesthetic sense and those based on a visual or graphical sensibility. In DrumSteps, the interface and mode of interaction is not such that one would expect to see free 'drawing' movements, and these were not observed in the workshops. There were instances of gestures and constructions that were visual in origin (such as Becky's diamond shape) and there were gestures and constructions that seemed to be based on a procedural sense (Becky's 'ball animation' section).

On reflection, this is exactly as one might predict. Each interface was designed to afford musical interaction, and musically motivated interactions were indeed observed. Each interface was graphical in nature, affording at least the possibility of visual or graphically motivated actions. Indeed, it is almost impossible to conceive of any computer graphical interface that would not lend itself to this mode of interaction to a greater or lesser extent. Finally, each interface afforded a mode of interaction that seemed unique or especially characteristic of the interface. In Hyperscore, this was a kinaesthetically motivated 'drawing' action, while in DrumSteps it was an emphasis on procedure and causation. At a higher level of description, these might simply be referred to as affordances particular to the interface. The suggestion here is that any computer music interface might well afford these or other modes of non-musical and non-visual interactions, intentional or otherwise on the part of the designers. Simply put, all computer graphical music interfaces will almost certainly support two modes of interaction, musical and visual, and may afford a third or more modes depending on the particular design, which modes may simply be described as *those interactions which are particular to the interface*.

7.3.4 Musical and Non-Musical Interactions in Unmentored Users

7.3.4.1 Introduction

Having identified the variety of possible modes of interaction afforded by each interface, one might then seek to ascertain the prevalence of each or any mode, as well as testing for other modes of engagement not observed in the case studies. In the case studies themselves, the teacher was obviously a factor in directing students towards those musical interactions afforded by the interface. This does not give any insight into the degree to which children might gravitate towards musical or other modes of interaction while working unsupervised or unaided. In order to investigate this question, both pieces of software were made available to a large number of users via the internet and a large number of pieces collected and analysed.

7.3.4.2 Analysis of Users Pieces

In the current study, a small number of learners were observed closely with a view to establishing behavioural patterns in their work. Certain gestural outcomes were noted in children's work, and theories generated about their procedural causes and motivations based on close observation of, and interaction with the children's work in progress. For those pieces submitted online, the children were not observed, so direct evidence of the procedures resulting in certain gestures was not available to the researcher. However, if gestures were observed in the submitted online pieces that seemed to substantially resemble gestures in the case study work (for which the underlying motivation could be established, to some degree at least), these gestures were assumed to have been formed by similar procedures or to have similar motivating factors

On the basis of the analysis, pieces were assigned to broad categories describing their primary organizational principle. A first-level distinction was made between those pieces that were organized primarily by musical means and those that were not according to the criteria outlined. Those that were not musically organized were further divided in to those that were organized by some other factor and those that had no discernable organisation. Pieces that displayed some non-musical organizing principle were divided into two broad categories; Construction/Visual and Procedural. In a small number of cases, pieces that appeared to be primarily procedural also exhibited significant evidence of musical engagement. These pieces were assigned to the musical category. A fuller description of these categories and examples of pieces assigned to each category are given in appendix D.

It is clear from of the two hundred and forty six pieces examined that users interactions with the graphical music composition software examined fell into clearly defined categories. A broad division may be made between those users who used the software to facilitate musical engagement, and those who engaged with the interface in what might be described as a more musically superficial manner. This is not to say that composers in this latter category were necessarily engaging in trivial activity. In fact, many of the pieces in this group displayed considerable sophistication. For example, in DrumSteps, many of the pieces in the process category demonstrated acute awareness of cause and effect, relationships between things, procedure, randomness, branching, looping and timing of events. In Hyperscore, many pieces exhibited a degree of sophistication in the use of visual patterns, colours and textures in the sketch window.

The distinction then, is that this group of users interacted at the level of whatever functionality was directly afforded by the interface. DrumSteps supported both visual and procedural thinking and acting, so both of these were evidenced in the pieces. Hyperscore supported both visual and intuitive physical forms of interaction so both were observed in the pieces. What is noteworthy in this respect is the number of users who engaged in this way.

In Drumsteps, of those pieces that showed some level of organization, **66%** of pieces were organized at this affordance level only.

In Hyperscore, of those pieces that showed some level of organization, **73%** were either wholly or partly organized at the affordance level.

This is a clear demonstration of the difficulties inherent in trying to use graphical interfaces to engender musical interactivity. A traditional musical interface, a piano for example, only affords a single type of interaction. The user presses the keys and the output is sound. A traditional interface for art, crayon and paper for example, facilitates graphical activity and output. In each case the function of the interface is clear, and the user is quickly led to the intended use. In the case of computer graphical interfaces, while the intended use may be for musical output and expression, there will inevitably be other possible modes of interaction. Furthermore, these modes of interaction will always be to some extent a function of the affordances of the particular interface (although it seems likely that as the interface is graphical, some form of visually motivated work is always likely to occur).

This highlights the problem with trying to make comparisons between the effectiveness of different graphical interfaces. There were clear difficulties in drawing comparisons between the two sets of results presented. The structure and intended range of each interface was different, so that the behaviours that each afforded the user were correspondingly different. The criteria used to assign pieces to categories were also to an extent a function of the functionality supported by the interface, making direct comparisons difficult.

It does appear that there was a clear division in each case between those users who interacted with music via the interface and those who interacted with the interface itself. In this respect, it seems on first inspection that the Hyperscore interface was more successful. (**57%** as opposed to **18%** for Drumsteps showed evidence of musical engagement). However, of all the functionality presented in both pieces of software, the pitch/time paradigm of the Hyperscore motive window afforded the most intuitive and direct access to musical information and manipulation. In this instance users were less likely to be led into other forms of interaction at the motive level. When we consider the numbers of students who seemed to engage musically at the sketch window level however, the number of Hyperscore pieces displaying significant musical engagement falls to **22%** which is in a comparable range to DrumSteps.

In other words, while users may have viewed the simple motive window as a 'music making' device, the non-musical affordances of the sketch window may have seduced them into acting in other, non-musically motivated ways. Drumsteps may have been viewed as a 'game' that produced sound and Hyperscore may have been viewed as a 'picture drawing device' that produced sound. In either case, the sound production aspect may not have been primary. An alternative explanation may simply be that users were more comfortable working in discreet small-scale units, but may not have been able to musically conceptualise the larger task. As Drumsteps did not facilitate this division between small and large-scale work, the same sort of division in modes of activity was not found.

There was one point of similarity between the two interfaces. In those pieces that were not musically organized**, 25%** DrumSteps pieces were primarily visual, compared to **17%** in Hyperscore (**35%** when those pieces with some motivic musical organization are included). It seems then, that children who produced pieces in this category did have broadly similar priorities with respect to manipulation of graphical objects.

In Drumsteps, **11%** of pieces seemed primarily procedural, while in Hyperscore **15%** of pieces were primarily gestural (**30%** when musical motives are included). This is the point at which the two interfaces diverge. All that can be said here is that children in these categories did not primarily engage at either the musical or visual level, but did engage with other functionality afforded by the interface.

Despite the fact that both interfaces were specifically designed for musical engagement, on aggregate as many as half of the users did not primarily engage on a musical level. In DrumSteps, only **18%** of pieces were primarily organized by musical means. In Hyperscore while **48%** engaged at some musical level, only **21%** engaged with larger scale structures and principles, while **79%** did not. While, there is no data available about the extent to which online users had access to a competent musical mentor in their work, it seems reasonable to infer that in most cases they did not. Evidence from the workshops would seem to indicate that while students may initially interact in a variety of non-musical ways, the presence of an appropriate mentor acts to guide them towards the musical aspects of the task. In many of the online pieces this clearly did not happen, leading to a greater prevalence of non-musically motivated modes of interaction.

There were some clear similarities between those behaviors evidenced in the online pieces and those observed in the workshops. In the case of DrumSteps, of the three cases described, two were primarily musical in nature, while the third (Becky) was clearly motivated by procedural factors with some attention to visual organisation. An example of work that was primarily motivated by graphical or constructional concerns was not observed. As the number of children in DrumSteps workshops was small (six students), it is likely that behaviour of this type might be observed in a larger sample. However, given the presence of a teacher/mentor, it is likely that children exhibiting this type of behaviour would be guided towards a more musically aware approach, so even if these behaviours were observed initially, it is possible that final pieces would not contain strong evidence of this. The most remarkable thing here is that despite proactive teaching, Becky failed to engage musically and persisted in her procedurally motivated approach.

In the case of Hyperscore, all three categories of pieces correlated with behaviours observed in the workshops. Kevin's piece was clearly musically motivated from the start, at both the sketch and motive window levels. Stacy, while motivated by musical concerns in the motive window, showed a marked tendency towards physical gesture in the sketch window. Emer, while producing musically coherent motives, relied heavily on graphically motivated gestures in the sketch window. Of the three cases described, two children had considerably more difficulty developing musical structure on the larger scale than they did in the small-scale motive window. This compares with the fact that in the online pieces, even of those that exhibited levels of musical engagement, little more than one-third showed evidence of musical structure on the larger scale.

The main difference was that in the workshop situation, students were not left to find their own mode of interaction, but rather were guided from the outset towards the musical aspect of the task. It would seem from the analysis presented, that this is an essential component for successful musical engagement. In the six cases described, five of the students engaged with musical materials, manipulations and processes at a variety of levels, while the online pieces studied, a large number of users did not engage with music in a significant way. It is clear that access to the software alone is no guarantee of a successful musical engagement or reflection. While the software affords the possibility of musical engagement, access to the software is not a sufficient condition to guarantee musical reflection. Support from a competent musical mentor clearly adds considerably to the likelihood of a musical outcome. While this might seem patently self-evident, it certainly questions a technology driven approach to the design of learning tools that assumes that well designed software will necessarily produce good learning outcomes.

7.3.4.3 Discussion

It is clear from the foregoing that however carefully an interface is designed so as to facilitate musical interactions, it will inevitably also facilitate other modes of action. These modes of action will be a function of those affordances offered by the interface, and will to an extent direct or influence the behaviour of users. It is likely that for any piece of graphical software, there will be some visual or graphical affordance leading to visually motivated work, along with other affordances specific to the interface.

One might argue that the interfaces examined here were in fact badly designed, in so far as they enabled users to engage in non-musical interactions. A well-designed interface might even be defined as one that only enabled musical action and interaction. However, such an interface could not have a graphical component. All computer graphical interfaces will carry with them the possibility of non-musically motivated actions. Even interfaces using standard musical notation are open to the possibility of non-musical interaction. Interfaces free of a graphical component would most likely have some mode of physical input, and so would clearly be open to kinaesthetically rather than musically motivated actions.

Furthermore, the interfaces under examination seek to address a very specific user group, those students who do not read musical notation or play a musical instrument, and so for whom these traditional interfaces do not engender access to higher-level compositional thought. In order to do this they each use a non-standard representational metaphor. There is a clear trade off then between, on the one hand, facilitating reflection on and manipulation of musical materials and on the other, enabling other modes of behaviour. Any interface that attempted to exclude all non-musical interactions would inevitably also exclude most, if not all, of the user group observed here.

While many of the pieces collected did not seem to be primarily organised by musical means, that is not to say that those pieces do not represent a sophisticated process of construction and organization of material on the part of the user. In many cases, quite the opposite is true. It would appear that interfaces such as those examined here exist in a grey area between a number of modalities. Users may choose to navigate the interface along any of several axes. They may at any moment be engaging in musical, visual, physical or other modes of interaction although they may gravitate predominantly towards one modality rather than another. The final outcome will therefore be a product of a number of different modes of action and reflection, each amenable to a wide spectrum of complexity and subtlety of engagement, both intramodal and intermodal. It seems from the initial observations made here, that this 'modal attention shifting' is quite simply not an issue for many children. While a music teacher may have concerns that a child is attending to graphical or procedural rather than purely musical issues, the children themselves seem entirely happy to exist and work at the margins between modes of engagement and shift freely from one to another. The question as to whether the outcome is a piece of music, a drawing with sound, an animation which generates sound or any one of the many other possible multi-modal descriptions rarely if ever arises for them. It would appear then, that one common affordance shared by both interfaces is their ability to break down barriers between traditionally separate domains and enable users to operate in multiple modes concurrently.

Most relevant to the current study is the fact that many students, when confronted with a graphical interface designed for musical construction, will not necessarily engage in musical interactions. What is especially striking is the degree to which users who - one might surmise - were not aided by a competent musical mentor, gravitated towards interface-driven rather than musically-driven interactions. In fact, when compared to the behaviours of the case study group, one might even make the argument that this apparent lack of musical motivation itself is indicative of the absence of such a mentor. While the data set examined is not large enough to make formal statistical comparison of mentored and un-mentored learning using the software, it certainly leads one towards the conclusion that no matter what interface is used, the presence of a teacher or mentor is crucial for many students so as to ensure some measure of meaningful musical engagement and reflection. This raises the question as to what the role of the teacher should be in working in environments mediated by interfaces of this type. The next section will address this question and outline a variety of teaching strategies and interventions that were observed to have positive effects on students' levels of musical engagement.

7.4 Teaching with non-standard graphical Interfaces.

7.4.1 Introduction

One of the primary aims of the study is to make a thorough examination of graphical interface-mediated teaching of music composition. It seeks to identify a variety of teaching interventions, strategies and techniques that are effective in a technology-mediated context, to identify the degree to which these are facilitated by interface affordances, and to demonstrate that, in a similar manner to that of the children themselves, the teachers process lends itself to consideration from a reflection-in-action perspective.

Examination of these questions in the workshops was facilitated by the use of digital video to record all student actions and student teacher interactions. In this way, the author could act as teacher and mentor in the field while later subjecting these interactions to analysis. At the outset of the workshops it was decided in so far as was possible, to adopt a non-directive approach. There was no body of material to be covered, and a very limited set of prescribed activities. In most instances, the teacher confined himself to suggesting an initial activity, idea or theme for each workshop session. Thereafter he adopted a reactive approach, making interventions in response to the child's needs as he perceived them.

7.4.2 Teacher Interventions

In the course of the workshops there were many situations where the teacher felt motivated to intervene. An examination of these teacher interventions yielded a categorization of intervention types, described below. Each broad category or type defines an area of teacher 'concern', an issue or set of related issues that the teacher felt worthy of intervention.

Where interventions were observed made, the strategy adopted by the teacher was noted. These teacher strategies or modes of intervention represent the particular manner in which the teacher attempted to tackle the perceived need in the moment. They are separate and distinct from the intervention types and were categorised independently of these. So, for example, the teacher may at various times have felt the need to intervene in order to try to help a student to develop some analytical criteria. Separate interventions in this area may have proceeded by a variety of strategic approaches or modes, such as specific questioning, modeling or use of kinaesthetic exercises.

7.4.2.1 Intervention Types

The intervention types observed were seen to break down into six categories.

1. Task framing

These were interventions where the teacher attempted to help the student to define, frame or bound the task at hand. These interventions generally arose out of a sense on the part of the teacher that the student was not working effectively or in a clearly focused manner. They ranged in scope from specific interventions designed to help the student overcome local problems, to higher-level interventions concerning the nature of the compositional task and composition in general. In working with Emer in the Hyperscore workshops, it becomes clear that while she has made some motivic material she is at something of a loss as to how to proceed. The teacher helps her frame the task by breaking it down into a series of subtasks. He does this by posing a series of questions.

> T - How many times do you think that will repeat?
> E – Four.
> T - Do you want to hear that on it's own at the start?
> E - Emm, no.
> T - What do you want to go with it?
> E - Em.....the yellow one.
> T - So where's the yellow one going to go?
> E - A bit lower. (appendix B, p.xlv)

Each question is designed to have Emer focus on a specific aspect of the task. A similar approach is adopted with Ciara in the Drumsteps interface.

> T – So how many drummers do you think might reasonably play together?
> C – Three.
> T – Well three, four, five, I don't know….it's not twelve, anyway.
> C – Yeah.
> T – And are they all going to play the same thing?
> C – Nope. (Very definite)
> T – So they're probably going to play different stuff?
> C – Yeah (appendix C, p.xxiv)

These task-framing questions are intended to have the student focus on local issues. However, in most cases they are balanced by an attempt to generate an awareness of the nature of the overall composing task.

> T - So what I want you to think about, is.....a piece of music usually has a beginning...
> S - And an end...
> T - And some stuff in the middle, so what I want you to think about is....really look at these motives...and think about instruments playing them.....and how would this piece start?... (appendix B, p. lxii)

The teacher's role involves a constant balancing of both local and global goals, trying to help students to frame both the immediate task and its place in the overall scheme (a key element of the students reflection-in-action process). He continually redefines the student's task until he feels that it is now within the students reach. In doing so he is himself engaging in his own reflection-in-action process, attempting to define the students needs in the moment, and continually reframing his own task and the nature of his interventions in response to these.

2. Compositional process and strategy

Even though they had begun to develop a sense of what was meant by composing, students frequently had no idea how to begin. At various points in the process, students frequently found themselves 'stuck'. Interventions in this category were those that were designed to help students develop and refine their compositional process and strategies for its execution. This category is clearly related to but separate from the first. For example, a student may have a clear idea what is required (i.e. compose a short motive). However, they may not have a clear sense of how to go about doing so. In this case the teacher may intervene by helping him break down the task into a series of subtasks or by suggesting ways to generate ideas. These teacher strategies may lead to a reframing of the task by the student, but they are more concerned with working process then task description.

The interaction with Kevin on the subject of patterns in music (appendix B, p.ix-xiii) is illustrative. In this instance, the teacher suggests a strategy to Kevin involving taking sections of one motive, copying them into a new window and using them as a basis for a new melodic figure. Kevin then adopts this strategy to produce a motive that is markedly different in character from his previous two. In this instance, the strategy is designed to stimulate a divergent process of innovation of new material.

In some cases, the teacher intervened to help students develop strategies to solve local problems that were impeding their progress. Conor, while working in Drumsteps, has noticed that two voices do not seem to synchronise, but is unsure how to remedy the problem. The teacher suggests that Conor imagine himself as the ball falling down the steps.

T….imagine you're the ball…so you're falling out here, your going across here and you're going down there…try and imagine in your mind how many beats that's going to take….

Conor immediately identifies both the problem:

C – There's too big a gap.
T – There's too big a gap – so that means what, it's gonna take the ball……..?
C – Longer.
T – Longer to fall there, so is that going to put like an extra beat or something?
C – Yeah.

and suggests a solution;

C – To move it……up a bit. (appendix C, p.xvi)

While both of these interventions are considerably different, they are each designed to help the student to develop a strategy to deal with a clearly framed discreet task. From the teaching perspective, there is clearly a task framing element here, but also a simultaneous process of modeling, telling and listening, with specific use of the capacity of the interface to facilitate the conversation.

3. Musical Perception

A frequent occurrence in the workshops was that students would make a musical phrase or section of material and yet not have a clear or accurate internal representation of the thing that they had made. This most often occurred in the area of rhythm although issues of pitch perception did arise in the Hyperscore workshops, albeit less frequently. In the Hyperscore workshops, for example, students would make musical motives with irregular rhythms, but when asked to clap the rhythm of the motive, would clap a regular pattern. In DrumSteps, this kind of divergence between what students made and what they seemed to think they had made often manifested itself as a divergence between the number of beats they thought were in a group of steps and the actual number of beats present. In these cases there was a clear disjunction between the children's perception of their work and its objective reality. Teacher interventions in this category were those that were designed to tackle this disjunction (for example, Conor miscounting of the number of beats in his step sets, appendix C, p.iv, Emer, appendix B, p.xli). In these instances, the teacher is moving fluidly between concerns, shifting from a position which is designed to help the students produce a musical output, to one which is concerned with childrens internal representations and perceptions.

4. Establishing criteria

All music composition, if honestly done, represents an attempt on the part of the composer to make 'good' music. The question as to what exactly this might mean is a vexatious one, and not one which will be answered here. As stated elsewhere in this document, this study is not primarily concerned with assessment or evaluation of the quality of children's compositional outputs. However, if children are to grow as composers, they themselves clearly need to develop analytic and critical skills with respect to their own work. Interventions in this category were those where the teacher attempted to help the children to do this.

At the first level, many of these interventions were simply designed to have the children justify their decisions on musical grounds;

> T - Which one do you like the best?
>
> T - Does that have a steady beat? (appendix B, p.xli)

Others represented an attempt to have the children begin to develop their own criteria for making judgements.

> T – You don't like it?
> S – No.
> T – What don't you like about it? (appendix B, p.lix)
>
> T - When you were putting those notes in, did you put them in because you thought they looked good or because you thought they sounded right? (appendix B, p.xxvii)

In other instances, they seemed to be more focused on reinforcing the point of a prior interaction.

> T - Ok - So if you were to start now in a new space...what things have you learned now, that you would have to think about if you were starting again? (appendix B, p.xxxi)

These interactions occurred at a variety of musical levels, in some cases designed to have the children develop their critical faculties with respect to some local musical issue, but in other cases they seemed to have a more global compositional focus.

> T - So the question is, how are you going to make this piece longer in an interesting way, and in a way that different from what you've done? (appendix C, p.xiv)

Inevitably there will be teacher bias here. While the teacher may avoid saying whether something is good or bad, and may even manage to avoid defining what the criteria for evaluation should be applied in a given circumstance to figure out what is good or bad, even indicating a preference as to what should be analysed will contain elements of the teachers own compositional values. The best that can be said is that the teacher here is attempting in so far as possible to enable the children to be the final arbiter of the work. He is seeking to find a balance between telling and listening. Suggestions are made, questions asked and examples given, but the emphasis is on leaving the final decision in the hands of the child.

5. Rudiments/concepts/techniques

Traditional teaching methodology frequently proceeds by defining and attempting to inculcate in students a body of knowledge about music and musical skills which might be defined under such headings as musical rudiments, concepts or ideas. A variety of standard ways of manipulating musical material are frequently included in music composition courses. In many cases, the order in which this is done is that rudiments are presented, examples given and finally composition 'exercises' completed so as to demonstrate mastery of particular ideas or techniques.

The approach taken in the workshops described here was somewhat different. Children were presented with the means to engage in musical manipulation and asked to complete a large, complex, multi-faceted task, without first having completed any formal musical training. In the course of their work, situations arose which either required clarification of some musical concept or leant themselves to the surfacing, illustration or discussion of a musical rudiment or idea. Interventions in this category were those where the teacher perceived an opportunity to engage in what might be perceived as 'traditional' teaching, but in the context of the students own work.

Issues relating to pulse, rhythm and rhythmic hierarchies arose frequently;

T – Is that right….now what's that guy doing (points to metronome ball).
C - Just going back and forward.
T – And in music what's it doing?
C – It's clicking.
T – It's clicking…and what is it clicking…..
C – It's like a clock….
T – It's like a clock….and what do we call that?
C – The beat. (appendix C, p.xxxi)

T – Think about this – this is an eight and this is an eight. If you made something that was a four…that was just a four…

C – Yeah.

T – How many times would it have to loop to match up? (appendix C, p.xxix)

Issues of pitch did arise but less frequently. This may have been due to the nature of the interfaces. Clearly DrumSteps did not support a dialogue around pitch, but even in Hyperscore there was a greater focus on rhythmic issues, most likely owing to the manner in which rhythmic disorganization at the motive level very quickly produced markedly disjointed musical outcomes, while the effect of unusual or dissonant pitching in motives was frequently ameliorated by the automated harmonization function in the sketch window. Thus, the interface itself seemed to exert a subtle influence over the nature of teacher interventions. In dealing with harmony, this influence on the teacher was markedly more obvious. In the cases of both Stacy and Emer, who made use of the harmony algorithm and harmony line functions, the teacher attempted to initiate a dialogue about chords, key and harmonic progressions, but in both cases success was limited and teacher focus shifted back to more productive areas. Clearly, while the interface mediates a reflective conversation, it does not do so equally with respect to all parameters.

6. Teacher investigations

What all the previous intervention types described have in common is the fact that they represent an effort on the part of the teacher to help the student to learn. Interventions of this type were those where the teacher was concerned, in a sense, with his own learning. He was trying to 'find something out'. The object of these investigations was sometimes the child's musical materials. Before engaging with the child the teacher would usually listen to and consider the child's material, so as to be in a position to identify issues and opportunities for progress. In some cases the teacher would experiment with the child's material so as to identify the possibilities it offered.

More often, the focus of the teachers' investigations was the children themselves, trying to understand something about the child's perception of their own materials, their thought processes and motivations. Questions such as those below were asked with a view to finding out to what extent were the children familiar with the attributes of their materials or to elicit something about their working progress. This information would them form the basis for the teachers next steps.

T – So you've made this thing……how many beats long is it? (appendix C, p.xxxiv)

T -Ok, so I said to you to make motives that are different from each other…….so how are they different from each other? (appendix B,, p.iii)

T - You took those three notes, and you put them in high and you put them in low......but....

E - I took out the last one.

T - You took out the last one...did you do that deliberately or by accident?

E – Deliberately. (appendix B, P.xlvi)

A smaller number of interventions seemed designed to test the effectiveness of his own teaching (attempting to investigate the success or otherwise of previous interventions or gather information to inform a subsequent intervention), while in other instances, the teacher, aware of his dual role as teacher and researcher, also made interventions designed to more directly address aspects of the broader research questions under consideration.

These interventions demonstrate clearly the multi-layered nature of the teachers reflective process. Many interventions that were either a hybrid of two or more types, or more often, moved in a fluid manner from one type to another. Conversations designed to enable the children to become familiar with attributes of their working materials often served the additional purpose of enabling the teacher to become more familiar with the child themselves, to evaluate the success of his own teaching or to shed light on some underlying research issue.

7.4.2.2 Teaching Strategies

The above characterization indicates the types of intervention that made up the teaching approach during the workshops. However, it sheds little light on the manner in which these interventions were made. A second analysis of teacher interventions was therefore made, in this case seeking to identify specific methodological strategies that were employed.

The observed teacher interaction strategies were:

1. Imposing constraint

This approach consisted of having children engage in a bounded task, so as to attempt to have them make progress in a single area or direction. In some cases, it was apparent that the children had difficulty managing both the complexity of the task and the sheer amount of musical information with which they were required to engage. In these instances, it was found useful to impose constraints with respect to the size or scale of the task, with respect to the complexity, number of layers or axes that should be considered and even in some cases with respect to specific manipulations of the interface.

This is clearly related in some ways to the notion of problem framing. However, the constraint strategy has application outside this focused area. For example, a child working in Hyperscore may have difficulty with rhythmic perception, making it difficult to produce a rhythmically coherent motive. In this instance, the task and the factors to be attended to may be clear but the means of execution is lacking. The teacher might suggest the constraint that notes should only be placed in rhythmic ‘slots’ corresponding to the note length in such a way that the beginning of the note aligns with the beginning of the ‘slot’. The intention is to impose a constraint on the way in which the child manipulates the note objects so as to create a link between note position and rhythmic coherence, while the mechanism by which the intervention is made finds expression in the particular affordances of the interface.

2. Using the Representation

In both DrumSteps and Hyperscore workshops, the teacher made frequent reference to the representational system in the course of conversation with students. Implicit in this use of the representational system in teaching was one of two assumptions; that with regard to the topic under discussion, the student was able to understand the meaning of the representation; or, that understanding the representation implied a concomitant musical understanding, so that if an issue could be clearly understood in terms of the symbols, musical understanding would follow. In any event, the teacher made frequent reference to screen objects in the course of attempting to clarify particular musical issues, often saying “look at this”, “follow this as it plays”, “look and listen” and so on. The implication here is that there is an attempt to have the student engage in the visual mode as well as the aural, and to make links between the two modes so as to construct understanding. In this respect, there was clearly an awareness on the part of the teacher of the manner in which the interface might afford musical understanding for the student, but also an implicit recognition of its importance in mediating the various conversations he wished to pursue.

3. Kinaesthetic Techniques

The most obvious difference between creating music at a computer and on a musical instrument is the lack of a kinaesthetic component to the former. However, in the course of the workshops, the teacher frequently tried to have students externalize their internal understanding of the music, either by singing, clapping, tapping or stamping, thereby bringing the music making back into the physical domain. This type of exercise had a variety of objectives. In some cases it was a way for the teacher to gain a sense of a child’s internal representation of a particular musical object or idea. In other cases, it was intended to help the child become more aware of their own understanding or to illustrate some musical rudiment, idea or relationship. It is striking that even a teacher with considerable experience of working with and through sophisticated technology would so frequently fall back on traditional music teaching methodology, suggesting that while technology enabled methods may be effective in certain circumstances, they may not address all teacher or student needs. It is also worth noting the fluency with which the teacher managed to interweave kinaesthetic techniques into the overall approach. While the teacher was clearly aware of the manner in which the interface afforded him the opportunity to engage in certain types of reflective conversation, he was also able to draw on his repertoire of standard techniques as appropriate to the needs of the situation.

4. Use of Examples (Modeling)

This strategy involved the teacher directly making and manipulating short musical fragments to illustrate particular points, or editing or otherwise manipulating the child's own musical material. In all cases, the teacher deleted exemplary material and/or returned the child's material to the state in which he found it once he was satisfied that the point at issue was understood. Examples were given to illustrate ways of manipulating musical material, to demonstrate strategies, to develop critical appraisal ('Do you think this is better or worse? Why?'), to fine-tune perception or to raise points relating to musical fundamentals.

Although the ways in which the modeling technique was employed were varied, what was in common was the manner in which each illustration was used as a starting point for a conversation with the child. Observing the children's actions in the time period immediately after the demonstration would seem to indicate that this technique may be particularly effective. For example, Kevin (appendix B, p.ix), having had a demonstration of copy-and-paste as a tool for generating variations, immediately employed the same technique but did so in a manner indicating that he was not simply following a prescribed set of steps, but rather had understood the principal and was employing it to his own purposes. It might be that these illustrations were of particular effectiveness due to the transparency of the medium, enabling the children to understand the musical meaning of the demonstration, but also because they could immediately begin to manipulate musical materials in the same way and so construct their own meaning for the model.

5. Specific Questioning

Frequently it seemed that when students failed to make progress, it related to a lack of clarity regarding either what they were trying to achieve (task framing) or how to make progress towards their goals (process and strategy). In these cases, a well-directed question from the teacher was often sufficient to enable them to 'kick-start' their process again. Sometimes these questions produced fundamental shifts in student's behaviour. For example, in the very first session, Kevin made four extremely random-sounding motives. A conversation with the teacher ensued during which the teacher tried to establish what was Kevin's motivation for particular gestures he had made. During the course of the conversation, the teacher asked '…why did you put that note there?'. This question started Kevin down a path of reflecting on the rationale for his own actions, leading to a point where he realized he was not, in fact, using the interface to make musically organized sounds. Thereafter, his approach to the composing process was completely different as was the quality of the work he produced.

6. Musical Imagination

Another strategy that was employed to some effect was to try to stimulate childrens musical imagination. At various points, where a student seemed to have problems completing a motive or section, the teacher would have the student close his eyes, listen to the musical fragment in question, and try to 'imagine' what might come next. This strategy represented an attempt to try to have the children connect with their own musical intuition, to 'think in sound' rather than simply move icons on the screen and observe the result. It might be viewed as an effort to have the children internally reflect-in-action on their material, before using the interface to give expression to the results of this action. Again, there is a reliance on traditional methodology as might be used in a non-technology mediated context.

7. Perspective Shifting

Finally, throughout the whole process with both software applications, the teacher adopted a position that the children were composing real music that, as such, might be the subject of public performance. He encouraged the children to take a similar perspective on their work. Frequently, where the child was attempting to balance musical forces and come to a resolution of an issue, the teacher would pose a question such as 'what would the audience think of that?' or 'if you were in the audience, how many times would you want to hear that before you wanted a change?'. The strategy here clearly was to try to have the children stand back from their work and evaluate it from a new perspective, so enhancing their ability to make critical judgments.

9.4.3 Discussion

There are many factors that will impinge on any technology-mediated learning situation. These may be broadly divided into: factors relating to the teacher (his beliefs, biases, prior experience etc); factors relating to the child (prior experience, attitude to learning etc); factors relating to the structure of the domain and factors relating to the structure of the interface. The types and strategies of intervention described above relate to a single teacher teaching a small group of children using particular interfaces. One could not say with any degree of certainty that another teacher would adopt the same or similar strategies. However, in general, most teachers will respond as best they can to what they perceive to be the needs of the moment, using the tools at their disposal.

It is clear from the transcripts that in many of the events in the case studies that might be termed 'learning events' the input of the teacher was hugely influential. One might argue that given another teacher, the results might be entirely different. In fact, in some respects, it could not be otherwise. The teaching approach itself is not just a function of the teacher, but also of the interaction between the teacher and the student. The approach would undoubtedly change not only from teacher to teacher, but from student to student depending on the perceived needs of the particular case. If the study was carried out with a different teacher, there could not but be different outcomes, which would reflect the particular teacher's priorities and also his or her interpersonal interaction with the participating students. Some students might respond better to a different teacher or teaching style, some may respond less well. This is not to say that learning would not occur, merely that the things learned, the timing and the manner of their learning might well be different.

However, teacher interventions are also a function of the interaction between the child and the musical domain. A child will approach the domain with a specific set of understandings, attitudes and bodies of knowledge. In carrying out a given task, problems, points of confusion or misunderstandings will arise. These will be a function of the child's interaction with the objective aspects of the musical domain, so it is likely that the same child will exhibit many of the same problems, regardless of context, tool or teacher. It is these problems that provide the opportunity for teacher intervention. One might speculate that, in dealing with the same child, any competent teacher might well find themselves making a similar assessment of the child's needs with respect to these objective musical aspects and acting accordingly, so in fact it is likely that even if the teacher were different, there might be some similarity in the outcomes, or at the very least, in the nature of the interventions.

Finally, the manner in which a teacher might intervene in any given situation will to a degree be a function of the available tools. If musical instruments are available, they will be used. If the teacher has access to a library of recordings, these will be employed to illustrate specific points. In the current study, the available tools consist of computer interfaces, which, as has been clearly demonstrated, lend themselves to particular types of musical engagement, surfacing some musical attributes to a greater degree than others. This will inevitably affect the nature of the childrens' musical engagement, focusing their attention, and hence that of the teacher, on particular musical issues. The specific strategies by which interventions are made will be the result of a combination of the teacher's repertoire of technique, based on prior experience, filtered through the affordances of the interface.

A clear example of this is the dialogue with Kevin regarding the concept of pattern (appendix B, p.ix). The teacher uses very specific facets of the interface functionality to both illustrate the concept and model how this idea might be put to practical use in composing a new musical motif. The strategy adopted here is almost entirely a function of what the interface will easily afford.

Limitations in an interface act just as markedly on the teaching approach as they do on learner processes. It is of interest that in the Hyperscore workshops, so little of the recorded interaction related to the area of harmony, notwithstanding its fundamental importance in the musical domain. Despite the best efforts of the teacher, it was found difficult to engage in a meaningful dialogue in this area simply because the interface itself did not support such dialogue. There were no absolute pitch names attached to notes, no representation of triad or chord structures and no visual indications of chord changes, so that the tool was singularly unsuited to discussion in this area. It is unlikely that any teacher would manage to overcome these shortcomings to any significant degree.

So, clearly the teaching approach will be to an extent a function of the interface, as well as the musical structures in question, the needs of the child and the teachers personal concerns. While in any given situation there will be any number of issues to which the teacher will choose to attend, three of the four main factors governing teacher interventions will likely be common to most situations. It is likely that many teachers will share concerns, have had standard methodological training and share a body of similar prior teaching experience. Therefore, while one could not say with any degree of certainty that in a specific circumstance a given teacher would adopt a similar strategy to those outlined above, in the aggregate, it is likely that there will be a large degree of commonality. The strategies outlined here will not be adopted spontaneously by all teachers, nor is the list necessarily comprehensive. However, it is likely that many teachers in similar circumstances would make use of some or all of these strategies at some point. It is also equally likely that there will be variance. This does not invalidate the strategies outlined, but rather simply recognises the unique and individual priorities that all teachers bring to their work.

7.5 Musical Reflection-in-action: The Computer as Mediator.

7.5.1 Introduction

The sections above deal separately with issues surrounding musical learning and engagement, and the roles of both the interface and the teaching approach in facilitating these. However it is clear that despite their separate treatment, these areas are intrinsically related so that consideration of any one in isolation is of limited value. What is required then, is a standpoint that simultaneously encompasses and unites these areas of student learning, teaching methodology and interface affordance.

This section will propose that such a standpoint is provided by a consideration based on the notion of reflection. Furthermore, while learning and reflection are clearly linked, it will be suggested that the nature of the interactions described throughout the study is more accurately described by the theory of reflection-in-action as outlined by Donald Schon (1983, 1987). This section will briefly revisit Schon's theory of reflection-in-action and demonstrate how this theoretical position may be used to describe and explain most, if not all, of the interactions observed in the case studies. Further, it will seek to argue that without a common 'medium of reflection', many of these interactions and the associated learning would not be possible, and that non-standard computer graphical music interfaces can offer just such a medium, thereby affording reflection in- and on- action for learner and teacher alike.

7.5.2 Reflection in action and music composition.

A key element of Schon's reflection-in-action model is its characterization of professional thought and action as a process of research. Each situation is approached in a spirit of enquiry with a view to illuminating its core elements and characteristics so as to inform action. Actions so informed, themselves become inquiries yielding further information, further actions and so on in a continuous spiral. Each action, while intended to achieve a result, also constitutes an opportunity to interrogate the situation. Schon describes this continuing spiral of action and outcome as a 'reflective conversation' between the practitioner and the working materials. The practitioner reflects on the materials, makes an action or 'move' and observes the resulting effect on the materials. The materials in a sense 'talk back' to the practitioner, making their attributes known and so informing future action.

The process is a fluid one. Action and reflection on the results of that action are intertwined and interdependent, and the practitioner moves seamlessly from one to another. The essence of reflection-in-action is embodied in the relationship between these two states. In Schon's description, this relationship is so symbiotic that action and reflection merge, so that ultimately reflection is embodied in action. The experienced professional acts in a fluid and intuitive manner, always aware of goals, actions and outcomes and the relationships between them. Schon makes a distinction between this spontaneous 'reflection-in-action' that occurs in the moment, and 'reflection-on-action', which occurs at points of repose in the process and where the professional takes stock of the work so far, examines the meaning of past 'reflection-in-action' episodes and reformulates overall goals and strategies accordingly.

Schon's general descriptions of reflection in and on action chime remarkably well with composers descriptions of the process of musical composition. Berio (1985) speaks of how a musical idea or object will 'seize the attention of a composer' setting in motion a series of actions. This musical talk-back stimulates in the composer a cyclical process of action and reflection where each choice "exerts an ever greater influence on what is to come" (Sessions, 1970). In making these choices, the composer operates "within a specific framework" (Sessions, 1970) implying a degree of task-framing. In the course of composing, the composer considers both the attributes of the musical materials at hand, and seeks to find the possibilities they offer for manipulation and development. The composer "First … tries to find its essential nature and then he tries to find what might be done with it – how that essential nature may momentarily be changed" (Copeland, 1957).

In describing architectural design, Schon says, "In the designers conversation with the materials of his design, he can never make a move which has only the effects intended for it" (Schon, 1983). The implied reference to problems of complexity and the interrelationship of the materials to each other parallels similar problems faced by composers. Moves made along one musical axis will invariably have effects - some unanticipated - along others, creating both problems and possibilities. Composers are forced to consider situations in their entirety, choose from a range of parameters and make manipulations of these parameters in the knowledge that these manipulations may well yield unexpected results. In this way, composers actions are somewhat akin to Schon's description of reflection in action as a series of "moves which are also experiments" (Schon, 1987). In framing the composing problem, the composer must choose from a variety of competing factors which one to attend to, but must also be open to the possibility of continually reframing the problem on the basis of the results of these experiments.

Schon's description of reflection-in-action may be considered to both subsume and extend the variety of viewpoints expressed by music educators and education researchers with respect to both children's music cognition and composing processes and the teaching of music composition. The models proposed for composing as creativity (Gorder, 1980; Calkins & Welkowitz 1984; Webster, 1994) offer 'staged' descriptions of a process, the various stages of which include such terms as preparation, incubation, reflection, and verification. Schon's description, while including many of these aspects, offers a more fluid account of what is a dynamic process. Furthermore, Schon's account extends not only to the child-composer but also to the teacher and the teaching approach in a manner that both accords with and extends those views expressed by Harris and Hawksley (1989), Glover (1990), Swanwick (1999), Paynter (2000) and others, while providing a view of teacher-as-researcher which is entirely appropriate to the current context.

7.5.3 The Case Studies – Children's Musical Reflection-in-Action

While it would be overly long to reconsider the cases in their entirety from the perspective of reflection-in-action, it is possible to demonstrate through a small number of examples, that the children in the case studies did in fact engage in processes both similar to those reported by professional composers and in keeping with Schon's reflective practice perspective. Evidence of an inquiry driven approach and associated move testing experiments, fluid movement between reflection and action, knowledge embedded in and expressed through action, problem framing and reframing and reflective conversation with the working materials may be found throughout the children's work.

Kevin's construction of his third motive (described in detail in appendix B, pp ix-xiii) is especially illustrative. In approaching the construction of this motive, Kevin was undoubtedly influenced by both his previous work and a prior conversation with the teacher that included a demonstration of the importance of pattern in music and a characterization of his previous motives as primarily rhythmic rather than melodic. It is likely that in framing his priorities for composing this motive, Kevin would have assigned a greater priority to melodic interest than he had previously done. It is also clear that he made deliberate use of both the copy-and-paste functionality and the notion of pitch shifting as the principal means of manipulating the material itself.

An examination of Kevin's compositional process does indeed suggest that he has clearly framed the problem in terms of melody, and has specified melody to mean a run of consecutive notes of different pitch. After playing with a variety of possible positions for the first note, his next moves consist of placing a series of five descending notes all of the same rhythmic value and spacing. His later moves seem primarily concerned with creating melodic rather than rhythmic interest, consisting of highlighting and pitch shifting notes rather than changing their length or rhythmic position. However, when he has completed the melodic shape of the motive he notices that it does not completely reflect his internal perception of how it should sound. He then reframes the problem to include an appreciation of the rhythmic component and changes the rhythm of the ending without altering the pitch contour.

The fluid manner of his interaction with the materials is also indicative of an underlying ‘reflection-in-action’ process. Every time he makes a significant move, he tests its effect by listening to the results. These hearings then inform future moves. Moves emerge naturally from previous listening events, each move forming a mini-experiment leading to further moves and further tests in a cycle of inquiry.

For example, having made a sequence of descending five-note melodic lines, he moves the last note up.

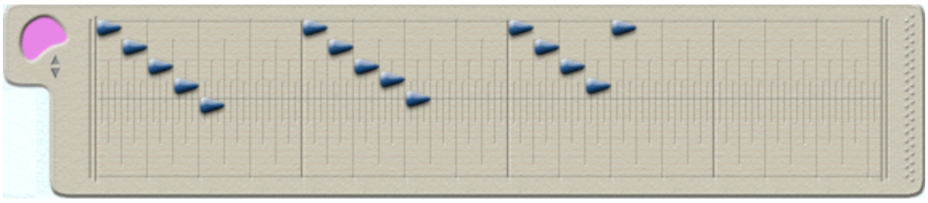


Figure 7.1 Kevin’s reflection-in-action 1

On considering the effect of this move, he then goes back and moves the second last note up.

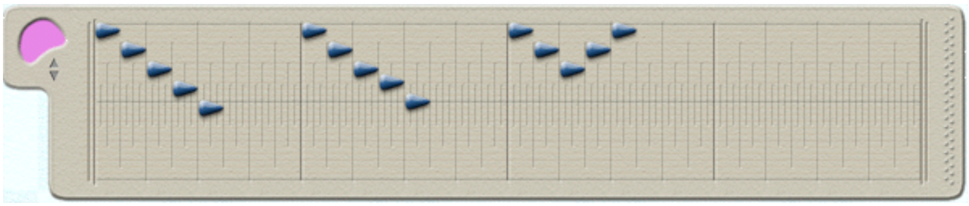


Figure 7.2 Kevin’s reflection-in-action 2

Moving the fifth note of the group has altered his perception of where the fourth note should be. This is a clear example of what Schon might refer to as ‘move-testing’. Kevin has engaged in a reflective conversation with the materials, listened to the situation’s talk-back and acted accordingly. This fluid cycle of move and appreciation characterises his process throughout the construction of this motive.

Schon also refers to the importance of surprise, and how an unexpected outcome may lead to a shift in perspective. Kevin undergoes these sorts of shifts regularly throughout the composing process.

> K - Well like no, well first it was a bit of a kind of an accident but after that I thought, well you may leave it cos I think it sounds good.

This indicates not only reflection-in-action but also Kevin’s ability to reflect-on-action, to review a situation after a spiral of activity is complete and evaluate in a more considered manner.

Working in DrumSteps, Conor shows evidence of a similar reflection-in-action approach. He frames a problem, makes some moves, tests the situation and makes further moves based on these tests. Having made a line of steps and identified it as consisting of twenty beat-units, Conor is asked to make a second line of steps to go with it. When asked afterwards about this new line of steps, he responds:

C -That has twenty as well.

He has clearly framed the problem in terms of overall number of beats. As he works, he stops periodically and considers his work, as if counting beats, so that when he makes his last two moves, he is confident that the total number of beats will be as expected. In making a third set of steps, Conor makes a series of five step units and has them repeat four times. In this instance, he has engaged in a reframing of the problem. He shifts his stance so as to consider a twenty-beat unit as a series of five-beat sub-units. As he works, he clearly moves the mouse under each step in turn as if counting and adds steps as required. He moves in a fluid manner between counting actions and step-placement until he is satisfied with the length of the unit.

Conor also demonstrates some capacity for reflection-on-action. Having discovered the principle of repetition as described above and noted the mathematical relationship between shorter units repeating more often and longer units repeating less often, in subsequent sessions he adopts this notion as the core organizing principle for much of his work. He reframes his approach in the light of his reflection on the results of previous action. In so doing, he still maintains a degree of flexibility and fluidity in his approach, so that when in building his final section he discovers a ball falls from one path into another, he is capable of changing tack and finding a new step configuration that will achieve the same result.

Emer also demonstrates this combination of reflection in- and on-action in the construction of her motives. Her initial motive making efforts consist of prolonged periods of experimentation, making, moving and discarding notes and listening to the results of her work. Eventually, these periods of reflective conversation with the working materials lead to a focused reframing of the problem in terms of a limited number of parameters, so that final motive ideas are executed relatively quickly. She shows the ability to revisit past material on the basis of new insights gained by reflection on current work. For example, she makes a motive (figure 7.3).

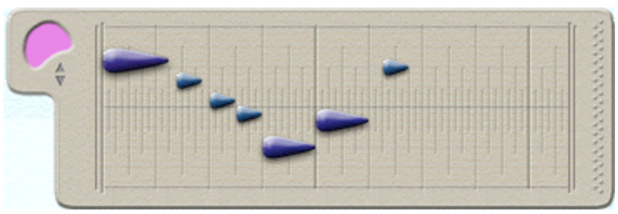


Figure 7.3 Emer’s reflection-in-action 1

She then makes a second motive (figure 7.4)

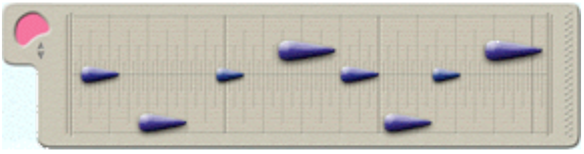


Figure 7.4 Emer's reflection-in-action 2

As she is making this new motive, she notices that its second part consists of a repetition of both pitches and note values from the first part. Reflecting on this structure, she revisits the first motive and extends it based on the same principle (figure 7.5).

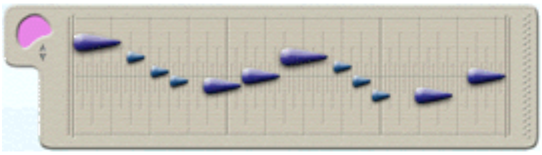


Figure 7.5 Emer's reflection-in-action 3

Her reflection on the structure of her second motive is not verbally articulated, but finds expression in the manner of her action in altering the first.

Both Emer and Stacy at various times demonstrate a fluid motive construction process similar to that evidenced by Kevin, consisting of note placement, experimentation, listening, moving adding deleting and altering notes. The development of their motivic compositional style over the course of the workshops indicates a more considered reflection-on-action, so that techniques and approaches discovered in one session become part of the store of experience which inform future efforts. Working in DrumSteps, Conor and Ciara demonstrate a similar approach, characterized by a combination of moves and 'move-testing', although the move testing in Drumsteps is frequently expressed outwardly by counting or clapping beats. Ideas explored and tested in one fluid sequence frequently become encoded in the overall approach and are employed in later work. Even Becky, who is clearly not primarily motivated by musical concerns, engages a similar fluid process, although she has framed the problem in terms of the relationship between ball animations rather than musical parameters.

Clearly, there are ongoing processes of reflection-in action and reflection-on-action in operation for the children during the workshops, and elements of these processes are analogous to those described by both Schon and many professional composers. However, it would be misleading to suggest that the children's processes were identical to those experienced by mature composers. There are obviously limits on both the breadth and depth of the children's reflective processes. These limits seem to operate primarily in the areas of what is reflected upon, and how this reflection finds expression.

Initially, children in the workshops had a very restricted set of musical parameters of which they were aware, although for most children, their repertoire of 'attendable-to objects' did increase over time. Children also were initially unaware of many of the ways in which these objects were amenable to musical manipulation. In most cases they did expand their repertoire of possible moves over the course of the study, although the degree and specific focus of this development was to an extent a function of the teaching approach and the particular manipulations supported by the interface.

What was clearly apparent was the difficulty children sometimes had in attending to and manipulating one parameter, while simultaneously holding in mind one or more other related parameters. This multi-layered reflection is characteristic of mature composition. In many cases, when children engaged in manipulation of musical material, they seemed to attend to a single salient feature, and other aspects of the material were pushed into the background. For example, in making a motive, Emer demonstrates some concern for matching pitches, so that pitches in the second part of the motive are the same as those in the first. When it is pointed out to her that there is a discrepancy in note lengths, she moves a note so as to compare its length to that of another, resets its length and then moves it back, but into the wrong pitch position. In this case, her attention to note length has obscured the pitch parameter, despite her clear ability to engage with this parameter earlier. Similarly, in making the motive described above, Kevin attends almost exclusively to pitch and melodic contour throughout the construction process, and then reframes the problem to include the rhythmic parameter only after issues of pitch have been resolved.

These caveats notwithstanding there is no doubt that children observed in the workshops did indeed engage in processes of musical reflection-in-action and reflection-on-action, and that the manner of this reflection was to some extent a function of the interface. In order to reflect-in-action, it is necessary to be able to examine musical objects and to be able easily to carry out operations such as making, changing, comparing, assembling and breaking apart such objects. This ease of manipulation is crucial, so as not to disrupt the natural flow between reflection and action. For the children in the current study, the interfaces under examination clearly served these functions and were crucial in affording them a reflection processes in a manner and to an extent that would not be possible using standard representational systems or physical instruments.

7.5.4 The Case Studies – Teacher Reflection-in-action

While the interfaces studies clearly had a role to play in facilitating students musical reflection-in-action, it is also clear from the foregoing that without the presence of a competent mentor or teacher, access to a graphical music interface may not itself be a sufficient condition for this reflection process to occur. The teaching that occurred during the workshops was clearly instrumental in enabling the children to engage in the various reflective processes described. This teaching is itself amenable to consideration from a reflection-in-action standpoint. Schon characterizes teaching as an inquiry designed to interrogate the situation. The object of this inquiry may be at various times the students working materials, the student themselves or the teacher's own working processes and methods. Schon describes a variety of teacher-learner interaction types which may have a positive role to play in enabling student reflection in action, broadly categorized under two headings which he calls telling and listening and demonstrating and imitating. In these descriptions, the teacher's action is inextricably bound up with the learner's response, each one dependent on the other. The teacher makes interventions, acting fluidly and with an awareness of both the learner's working materials and the demeanour and responses of the learner themselves.

These broad descriptors of teacher-learner interaction may be viewed as encompassing both the types and modes of teacher intervention outlined earlier. Any teacher action will be underpinned by a concern for what particular area requires intervention (intervention type) and what strategy should be employed to best help the student (mode of intervention). In selecting an intervention type, the teacher may first question the student so as to determine need and then proceed to act in a manner designed to address this need. In so doing, he may utilize a variety of strategies, reflecting on the efficacy of each and adapting his strategic approach as required. He may uncover other areas of need, again leading to a re-evaluation of the situation and subsequent changes in strategy or approach.

So, for example, a teacher may have concerns that a student does not have a clear internal representation of some aspect of their musical material. He may question the student to identify the exact nature of the misconception and proceed by a combination of telling and demonstrating. His telling may include outlining some aspect of the problem, suggesting a process or strategy to enable the learner clarify the relevant issues, describing relevant musical fundamentals or using the representation system to point to salient features of the materials. This telling will for the most part be grounded in the student's own work, or as Shon puts it, "Whatever the coach may choose to say, it is important that he say it, for the most part, in the context of the students doing" (Schon, 1987).

His demonstrating may include manipulating the learner's material, engaging in clapping or singing demonstrations or providing other examples to illustrate the point. Demonstrations may be intended to provide a sample outcome for learners to work towards or to model some aspect of the production process.

In practice, telling and demonstrating are intertwined and interdependent as are the students listening and observing/imitating. The manner in which the teacher varies his telling or shifts between telling and demonstrating will to an extent be a function of his perception of the student's ongoing responses. The student in turn, will reflect-in-action on the teachers telling or demonstration, leading to a variety of responses including questioning, volunteering new information or understandings or attempting to imitate whatever he perceives as the core elements in the teacher demonstration.

This mutually-informing cycle of reflection-in-action on the part of both student and teacher is characterized by Schon as a 'ladder of reflection'. This provides a description of the various intertwined layers of reflection and action that underpin learner teacher interactions. Each actor moves fluidly through a reflection/action cycle which includes reflecting on the materials, acting on the basis of these reflections, making statements, expressing understandings or asking questions, reflecting on the responses to these utterances and reflecting on the nature of the dialogue itself.

Examination of learner-teacher interactions throughout the workshops provides clear evidence of just such a process. There were many such interactions, however a single example will be considered here in order to illustrate in a holistic way this reflection-in-action process. While the following dialogue has been reported previously, it will now be considered from the standpoint of reflection-in-action to illustrate its underlying dynamic.

Kevin has made a new motivic figure. The teacher first makes an intervention designed to inquire into the nature of Kevin's perception of his motive.

T – 'Ok, now tell me something about this motive. What was the plan behind this?'
K – I'm not sure really....it wasn't really a plan, it was just trying to create one that...that might sound a bit better, cos, like y'know, it's just three motives...I wanted something that sounded a bit different.
T - Ok, you might want some variety, so you wanted to make a different sounding motive....ok, so how is this different...
K - I think it has a lot more of....it's a bit constant, you know...it has a bit kind of a pattern but not a real pattern, not a real like dah dah dah dah (sings alternating on two pitches, regular rhythm).

Reflecting on Kevin's motivic material, the teacher observes a rhythmic irregularity. He pursues a variety of strategies in order to try to have Kevin notice this, including clapping exercises, pointing to the rhythmic markers in the application and manipulating the material itself, moving motives so as to visually compare their rhythmic content. The teacher then makes another 'move testing' experiment, asking Kevin a probing question to elicit whether he has in fact understood the point of the demonstration. At this point, the teacher has expanded his focus from Kevin's musical working materials to include a view of his own working materials which includes Kevin himself.

T - Now if you look at that motive (lines up purple with orange)....if you were to play those two motives together, can you figure out what would happen?

Kevin reflects on the meaning of the demonstration but initially does not understand.

K - Not really.

The teacher engages in further pointing and demonstrating in the interface.

T - Well, those two notes would sound at the same time, then this one would play, but nothing would play in this motive (orange motive).
K - Oh yes.
T - Then, these two notes would play together, then this one would play, and nothing would play here, and then these two would start at the same time. (etc)

Kevin is clearly reflecting-in-action on the meaning of the demonstration and interjects, indicating understanding.

K - But that one would be longer.
The teacher reflects on Kevin's apparent understanding and makes another probing move designed to satisfy himself that Kevin indeed understands. He does this by asking Kevin to use a similar technique to the one he has just demonstrated to describe a different motive pair. Kevin then imitates the teachers approach, while the teacher reflects on and responds to each of Kevin's' actions in turn.

T -...can you figure out what might happen with these two motives?
K - Those two would start at the same time.
T - The two would start at the same time....
K - But they wouldn't be the same pitch. (etc)

Once he is satisfied that Kevin has understood the point of the demonstration, the teacher returns to the original issue of note alignment within a particular motive and demonstrates a possible approach to solving it. By taking a section of Kevin's material and moving it left and right, he demonstrates several different options for alignments that might work. As he does so, he questions Kevin.

T - Now do you notice what I did there....now that would align up with that.
K – Yep.
T - And they'd all align up all the way along, and that one would align up perfectly with the start of that one....or you could go the other way (moves figure to position a sixteenth note left of its original position)...I could have done that....and now this one lines up perfectly with the end of that one, and this one lines up with the start of that one, and so on.
K – Yep.
T - You see what I mean?
K – Yep.

Having made his point he returns Kevin's motive to its original state and leaves Kevin to work on figuring out the alignment issue. Kevin immediately begins to manipulate the materials in a manner that imitates that demonstrated by the teacher, combining note moves and listening in a series of move-testing experiments until he resolves the alignment issues.

He then moves to the sketch window and uses the technique learned in the last session of drawing two motives together in the sketch window and listening to them together. He notices a synchronisation problem, and moves to fix it by extending the length of one of the motives. In doing so, he is demonstrating the ability to reflect on past action and draw elements of his newly expanded repertoire of manipulations into his current reflection cycle.

Reflecting on his attempt to resolve this new issue Kevin immediately states the problem.

K - (Points at screen) I tried to put a rest....I tried to put a rest in it 'cos it didn't sound good.

This statement then stimulates a further series of interactions involving teacher telling, questioning and demonstrating and Kevin listening, answering and imitating. At the very end of the session the teacher asks Kevin to externalise some of his new found understandings.

T - Ok, so what, so what do you notice then about motives, about the lengths of them in order for them to match?

K - That, em, it needs to be a certain length if you want to get a certain sound.

T- It needs to be a certain length if you want to get a certain sound….and does there have to be a relationship between the two motives?....their lengths?....what kind of a relationship?

K - That one fits-into the other

T - One fits into the other...a certain number of times?

K – yeah

T – Evenly?

K – Yeah

So, at various times we see the teacher interrogating the situation at various levels, investigating Kevin's understanding, examining his musical working materials, telling, illustrating, modeling and demonstrating both process and desired outcome and reflecting on and examining the efficacy of his own intervention strategies. Kevin in turn reflects on both his own materials and the teacher demonstrations that manipulate these materials, imitates these teacher demonstrations, reflects on his new understandings and expresses these understandings. These expressions, both verbal and embodied in his actions, form the basis for further teacher reflection, leading to further teacher action, and so the spiral of action and appreciation continues.

While the foregoing is a single example of learner-teacher interaction, it is very typical of the range of interactions that occurred in workshops with both interfaces. In fact, almost any section of the workshop transcripts would be amenable to consideration from a similar standpoint and would yield a similar range of reflective processes. Throughout the workshops, learner-teacher interactions were characterized by the same seamless movement between reflection and action, with reflection embodied in both verbal, physical and on-screen actions. Teacher and learner reflections throughout were seen to be intertwined and mutually informing.

This analysis of teacher interventions and actions considers the teaching approach as situated in the context and the moment. The teacher is reflecting-in-action. However, there were also many examples of teacher reflection-on-action, evidenced by actions that seemed to be informed by a conjunction of a more considered reflection on past actions applied to the needs of the current situation. A clear instance of this relates to the interaction between the teacher and Kevin concerning patterns in music (appendix B, p.ix). In this case, the teacher is seeking a strategy to enable Kevin to expand his compositional repertoire. He spontaneously attempts the copy-and-paste strategy described, with no real idea as to what the outcome might be. However, having observed the success of the strategy, he then proceeds deliberately to make similar interventions with every other child in the workshop series. Similarly, in attempting to have Conor figure out a part synchronization issue in DrumSteps, the teacher suggests that Conor should '…imagine you're the ball…'. This shift in perspective helps Conor to reframe the problem and hence discover a solution. Reflecting on this outcome, the teacher subsequently employs this technique several times with other students. In each case, the teacher's reflection-on-action has expanded his teaching repertoire, yielding methodological tools or techniques which are added to his store of teaching experience and deployed as required thereafter.

Fundamental to the teacher's reflection-in-action and reflection-on-action was the presence and nature of the facilitating computer graphical interface. In giving verbal instructions, asking questions and making demonstrations, the teacher made considerable use of the graphical medium. He did so on the understanding that the musical meaning of these interventions would be explicit and accessible to the students within the limits of their overall musical understanding. Musical objects could be created, altered, moved and discarded at will and in a manner such that the student could participate fully in the reflective conversation and then explore the meanings obtained in their own reflection-in-action cycles.

7.5.5. Interface Affordances and Reflection-in-Action

It is now possible to draw together the various themes explored in the study. Children used two graphical interfaces to engage in music composition activities. As they worked, they were mentored by an experienced music teacher. The study then sought to explore in a holistic way, the nature of both the childrens learning and the teaching approach adopted, and to surface connections between these and the graphical interfaces used.

It is clear from the study that learning did occur on multiple levels. It is also clear that this learning was a function of many factors, but that the teaching approach and the affordances of the interfaces used were fundamentally important. Both the childrens working process and the teaching approach were shown to be intertwined and mutually-informing, and may be viewed as expressions of an underlying a reflection-in-action process.

Throughout this reflective process, each interface acted as a mutually well-understood medium, affording reflection and exploration for both learner and teacher. They both made attributes of the material available for inspection and consideration and enabled reflective manipulation of the material. They made both processes and outcomes of teacher and student manipulations accessible, each to the other, so that both might fully participate in the multi-layered reflective cycle that underpins both teaching and learning.

So, while the two interfaces are fundamentally different in design, function and intent, they do ultimately seem to share a global affordance – they afford reflection-in-action.

7.5.6 Reflection-in-action and the research approach

The act of teaching and the act of research are in some ways synonymous. The teacher proceeds in a spirit of inquiry to interrogate the situation, devise a teaching strategy, deploy this strategy and examine the resulting outcomes. In so doing, he is acting as a researcher of the particular case. The author in the current study adopted a dual role, that of researcher and teacher. In acting as a teacher, his inquiries were concerned with finding the best way in any given moment to help the particular student to learn. In acting as a researcher, he was at the same time attempting to examine each situation through the lens provided by the research questions. In so doing, he was concerned with a multiplicity of issues including childrens musical cognition and process, elements of interface structure and design and his own teaching methodology and strategy, and was concerned not just with the case in hand but also with the aggregation of a number of such cases.

This awareness of his researcher role necessitated an added layer of reflection, both in- and on-action on the part of the teacher/researcher. While some teacher interventions during the workshops were in fact researcher interventions designed to shed light on the research questions underpinning the study (although as outlined above, many teaching focused questions had a research element and vice versa), this research reflection-in-action required refinement through a post case-study period of reflection-on-action, especially in the consideration of his own teaching approach. This second layer of reflection was facilitated in particular by the nature of the technology under examination.

Any study concerned with either teacher or student reflective processes, is attempting to examine events the motivations for which, by their very nature, are hidden from view. A researcher can only attempt to examine the outward manifestations of these processes and ascribe motivations that seem most consistent with observation. In the current study, the medium through which both student and teacher engaged in their respective processes was the graphical interface. Students explored musical materials and manipulations by interaction with graphical objects. The teacher similarly employed these graphical objects and manipulations in pursuit of his objectives. In this manner, the interfaces served, not just as a vehicle for musical thought processes, but also as a window into those thought processes.

Students and teachers understandings, concerns and apprehensions were made available for scrutiny through the graphical medium, in some instances in a manner more direct even than their verbal utterances (indeed, in some cases, students comments on their motivations were clearly contradicted by their actions in the working medium). In this way, the interfaced served not just as a teaching tool, but also as a research tool, enabling the researcher to engage in examination of both the children's musical cognition and processes and his own teaching. Furthermore, combining these interfaces with digital video capture enabled the required layer of teacher/researcher reflection-on-action. As children were working in an easily captured visual medium, the videotape contained a record of not only their verbal utterances and those of the teacher, but also a blow-by-blow, move-by-move account of their entire working process. This complete record was then available for scrutiny, enabling the researcher to consider at length and in a more detached way, both the children's actions and his teaching strategies and approaches. The interfaces examined facilitated not only the in-context teacher and learner reflection in- and on- action, but in tandem with video capture, also supported the further layer of 'reflection on reflection' necessary to fully understand the meanings inherent in the complex and multi-layered situations that were the focus of the study.

7.6 Summary

The current chapter seeks to examine the data gathered from the case study workshops and online submissions with a view to addressing the research questions underpinning the study. Analysis is made of transcripts of the case study workshops, along with consideration of those pieces collected online. In the first instance, issues surrounding childrens music learning are examined, considered at a variety of levels. It is clearly demonstrated that most children in the workshops interacted and engaged with musical material in a meaningful way in terms of musical rudiments, concepts and manipulations, and that this engagement was facilitated by the graphical interfaces in question.

The interfaces themselves were examined in detail. Similarities and differences to both standard music staff notation and computer-based piano-roll notation were noted, and the particular affordences of the interfaces which seemed instrumental in facilitating childrens musical engagement were outlined, as were those aspects of the interface which seemed to afford other non-musically motivated actions. A categorisation of modes of interaction was proposed, encompassing both musically and non-musically motivated actions, and links were made between these categories and the structure of the interfaces employed.

Examination of a large number of pieces submitted via online fora indicated that while musical engagement and reflection were facilitated by the interfaces, access to a suitable interface was in itself not a sufficient condition to ensure such engagement. The argument was advanced that in many cases, the presence of a suitable teacher or mentor may be necessary to ensure such engagement. A detailed analysis of the teaching strategies employed by the teacher in the case study workshops yielded a classification of both types and modes of teacher intervention which were observed to be effective in facilitating student's musical engagement. These strategies were demonstrated to be appropriate to, and in some cases a function of, the computer graphical software employed.

Finally, both student and teacher actions and interactions were considered through the lens of Schons theory of reflection-in-action. Examples given both of students individual work and of teacher interventions were seen to embody the key aspects of Schons theory. The role of the graphical interfaces employed was considered, leading to the assertion that these interfaces may play a key role in the reflective process by providing a mutually well understood medium affording both learner and teacher reflection-in-action. The issue of the teacher-as-researcher was examined, suggesting that the combination of computer graphical musical interfaces and digital video capture may have a key role to play in enabling the kind of multi-layered holistic examination of music teaching and learning attempted in the current study.

CHAPTER 8. CONCLUSIONS AND FUTURE WORK.

8.1 Introduction

The current study set out to examine aspects of the use of graphical music software tools for the teaching and learning of music composition. The study was holistic in nature, considering aspects of both learner and teacher behaviours and interactions in working with these tools and was informed and bounded by Schon's theory of reflection-in-action.

The work of this dissertation has been framed so as to address a number of inter-related research questions posed at the outset. These questions were structured as a set of subsidiary questions, subsumed within an overarching question related to the suitability of the reflection-in-action model.

8.2 Conclusions

8.2.1 Subsidiary Conclusions

The results of this study are here framed as answers to the initial research sub-questions.

Are there definable categories of behaviours apparent in children while engaged in the learning of music composition facilitated by graphical interfaces?

The current study clearly demonstrates that children engaged in music composition with computer graphical software will exhibit a variety of distinct, definable behaviors, and that these behaviours will be to an extent a function of the affordances of the software. Behaviours observed in the current study included those motivated by musical, visual/graphical, kinaesthetic and procedural concerns, although clearly other software may engender other behavioural types.

Are there definable teacher interventions and strategies that are effective in this context?

The teacher in the current study was observed to engage in a range of intervention types, motivated by a variety of concerns, and these interventions were instantiated by a number of distinct strategic approaches. Intervention types were those motivated by concerns in the area of task framing, compositional process and strategy, musical perception, establishing criteria, musical rudiments, concepts and techniques and teacher investigations. These teaching interventions were operationalised by a variety of strategies including imposing constraint, using the representational system, kinaesthetic techniques, modeling, specific questioning, stimulating musical imagination and perspective shifting.

Teaching techniques employed were observed in many cases to be directly related to interface affordances and functionality.

Can the combined-technology research approach yield particular insight into children's compositional processes and strategies and aspects of their musical perception and cognition?

While childrens music cognition was not the primary focus of the study, it is clear from the outcomes that computer graphical interfaces can act as a window on childrens music cognition. Children in the study were seen to engage in a variety of processes and behaviours that would be difficult to capture or analyse through other media. Furthermore, the pairing of graphical interface and digital video capture was seen to be particularly effective for holistic studies of this nature, freeing the researcher to act in the field while preserving all learner interactions for later analysis and reflection.

8.2.2 Primary Conclusion

The over-arching research question informing the current study was:

Do graphical music software tools support learner and teacher reflection-in-action and reflection-on-action while engaged in the process of learning and teaching music composition?

Concomitant with this was the question:

To what extent is the Schon reflection-in-action theoretical model appropriate to describe the behaviours of learners (specifically children) and teachers engaged in computer-graphical technology-mediated music composition.

The current study clearly demonstrates that learners and teachers both can and will engage in reflection-in-action and reflection-on action when working with computer graphical music software. While a wide variety of behaviours and interactions were observed in the course of the study, these behaviours were amenable to interpretation from a reflection-in-action standpoint. Therefore, the study concludes that the Schon reflection-inaction model is both appropriate and adequate to describe behaviours of learners and teachers engaged in music composition mediated by computer graphical interfaces.

These reflective processes are supported, and to an extent engendered, by the mediating effect of the computer graphical environment. Consideration of the nature of the interfaces from the affordance standpoint indicates that graphical music interfaces afford activity at multiple levels, but that the key affordance is that they both afford and mediate a reflection-in-action process. Ultimately, it might be argued that the value of any graphical interface for music learning rests in part in the extent to which it affords just such a process for both learner and teacher.

8.3 Future Work

While the current study was expansive the range of issues explored, it was necessarily limited in context. There is a variety of further work that might be undertaken to both further validate and extend the conclusions drawn here.

As this study consisted of observations of a single teacher, who is also the author, there is certainly room to extend the work in this regard. Observations of a number of teachers from a variety of different backgrounds might confirm observations made of the teaching approach, extend the range of observed behaviours and provide a degree of generalisability. Furthermore, the context in which this work was carried out could not be said to be representative of the type of environment in which most formal learning takes place. Examination of the software and associated teaching issues in a variety of teaching and learning contexts would provide added insight as to the value of these software tools in formal learning situations.

The software interfaces examined in the current study are quite different both from each other and from mainstream interfaces in common usage. There are a variety of questions that might be examined concerning the affordances of more standard notation and sequencing software, and the degree to which the reflection-in-action model demonstrated here might apply to these applications. Specific conclusions with regard to the relationship between interface affordances and teacher and learner interactions could be extended by similar holistic examination of other software types.

While the specific focus of this study did not permit examination of more general issues surrounding children's music cognition and perception, it is clear that the software tools examined may have application in this regard. A variety of more closely specified studies could be envisaged, examining children's cognition with respect to construction of melody, rhythm and harmony and related issues, capitalizing on the demonstrated value of these graphical interfaces as facilitators of reflective research.

As stated at the outset, there is a lack of clarity about the role of technology in the teaching and learning of music, and specifically about its function in enabling music composition activities. There is a need to better understand not only how children behave when working with and through various computer-based systems, but also to understand, in a more holistic way, how these systems affect the teaching and learning process. The current study set out to address this need. Notwithstanding the limitations inherent in any study of this nature, it represents a contribution to our knowledge of how children learn and how teachers teach in computer-mediated contexts, and provides a clear theoretical basis on which to build a growing understanding of the subtle, complex and multi-layered nature of computer-mediate music teaching and learning.

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APPENDIX A Contents of the Accompanying CDROM

Appendix A. Contents of the Accompanying CDROM

The accompanying CDROM contains the full data set associated with this thesis including material from case studies not directly referred to, installers for the software and and some digital video clips taken from a single Hyperscore case study. This latter material is presented for illustrative purposes only and is not directly referred to in the document.

DrumSteps Data

Thesis Case Studies

- Conor
- Ciara
- Becky

Each folder contains students work saved from each session as well as a full transcript of the entire video record.

Online Pieces

This folder contains the complete set of submitted pieces in categories (as per Appendix A), and a separate folder duplicating only those examples directly referred to in the thesis.

Supplementary Case Studies

This folder contains student's work from those studies not referred to in the thesis.

Hyperscore Data

Thesis Case Studies

- Kevin
- Emer
- Stacy

Each folder contains students work saved from each session as well as a full transcript of the entire video record.

Online Pieces

This folder contains the complete set of submitted pieces in categories (as per Appendix A), and a separate folder duplicating only those examples directly referred to in the thesis.

Supplementary Case Studies

This folder contains student's work from those studies not referred to in the thesis.

Installers

This folder contains installers for DrumSteps and Hyperscore, as well as installers for DirectX necessary to run the Hyperscore application.

Video Examples

THs folder contains a series of video clips taken from a single Hyperscore case study. These are presented for illustraton purposes only, so as to give the reader a clearer sense of the nature and scope of the workshops, and are not directly referred to in the thesis.

APPENDIX B Hyperscore Case Studies

APPENDIX B. HYPERSCORE CASE STUDIES

Hyperscore Case Study 1 – Kevin.

Introduction

Kevin is a bright and articulate child who, despite having little former musical tuition, made considerable progress working through the Hyperscore interface. His case was chosen to exemplify instances of musical learning and to provide a clear contrast to the less musically oriented behaviours exhibited by children in the other cases.

Session 1

In the first session Kevin is introduced to the software. He is told that he will be using the software to compose a piece of music, and is introduced to the idea of 'motivic' composition as embodied in the software. He is shown how to make motives by dropping notes into the motive window, how to change their pitch and note length, how to playback and edit. The sketch window is not introduced at this stage. He is given an introductory task:

> "Make four musical motives that you like and that are different from each other."

Kevin works at this task unaided for approximately twenty-five minutes. During this time he produces four musical motives, two of which are shown in figure 6.2.1.

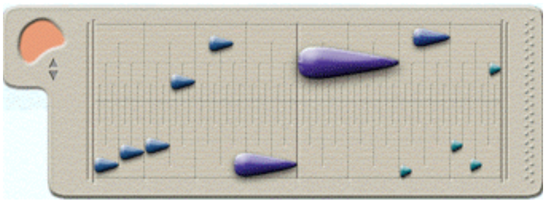


Figure K1(b)a

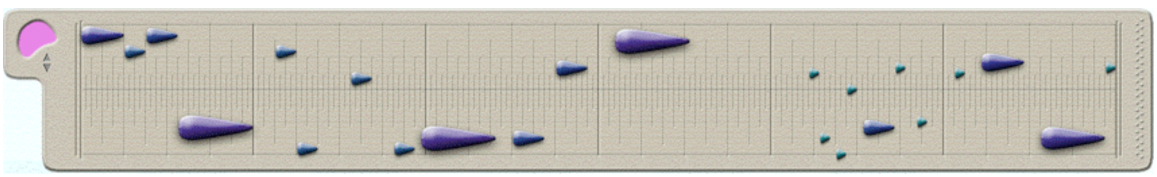


Fig K1(b) Purple Motive

Kevin's working process seems almost completely arbitrary. He quickly makes four one-measure motives by dotting notes randomly around the motive windows, and then almost in a desultory fashion, goes back and extends the two shown. The motives themselves seem to have no clear melodic or rhythmic structure. While he is making these, Kevin listens to two of the motives once each but does not revise or edit. The other two motives are not listened to at all.

Towards the end of the session, the teacher returns and engages Kevin in conversation about his work. He asks Kevin to describe his motives. Kevin responds by describing the motives in terms of the number of notes, the kind of notes (long or short) and the overall length of the motive. He says nothing about pitch, melodic contour, pulse or rhythmic structure. In talking about the purple motive, Kevin says;

> K - (laughs)…… I made a really long one.
> T – That's good…
> K - I haven't played it yet.
> T - You haven't played it yet? So you made it all before you played it?
> K - Yes…..(plays back purple motive)
> T – So you made it all but you haven't listened to it yet?
> K – Yes.

The teacher clearly perceives that there is an issue of musical intent with respect to Kevin's work. He first asks Kevin to sing the motive, in order to ascertain if Kevin has a clear internal representation of its content and structure. Kevin tries this. He pitches the first note correctly and last note approximately, but sings some fast notes randomly in between. Neither the number of notes nor their rhythmic or pitch content are sung correctly. The teacher then questions Kevin as to his motivation for particular note placement.

> T – OK. (points to a note) so why did you put that note there? Because it looked good or because you thought it looked right, or because you thought it might sound right, or….or for some other reason?

> K - No, I was just messing around with them like, 'cos like I was just putting them to see what it sounded like.

Although Kevin says he was 'messing around' with the notes to 'see what they sounded like', he has not listened to them to find out. After further conversation however, Kevin comes to the following realisation;

> K - Because if you don't know what it sounds like, then you don't know whether it'd be good or not, so……so, you need to test it first, so as you know what it sounds like, build it up, you know…..

Kevin has made two fundamental discoveries, one about the nature of the task and the other about strategy. Firstly, he has understood that the point is to make something that sounds 'good', and secondly he has realised that in order to do this he needs to listen, to 'test it first'. His use of the word "test' is revealing in that it implies some sort of criteria to decide if something sounds good and also indicates the possibility of action based on the test.

Kevin is asked to describe his motives and say in what way they are different from each other. During the conversation, the teacher attempts to have Kevin begin to think analytically about the pieces he has made, while at the same time trying to understand what parameters Kevin is attending to.

> T - Ok, so I said to you to make motives that are different from each other…….so how are they different from each other?
> K - (points to blue) This one has less notes in it.
> T – Anything else about it?
> K – The other one has…..slightly bigger notes than the other one (indicating the yellow motif).

Kevin seems to be attending to both number of notes and note value (duration). Later he refers to both pitch and melodic contour as salient factors.

> T – What ways do they sound kinda the same and what ways do they sound kinda different?
> K – Well, they sound kinda the same..y'know 'cos they both have kinda deep notes and…y'know they both have kinda high notes.
> T – Does it start high or low?
> K – Yeah, probably, it starts high.
> T – And it goes…?
> K – It goes lower…..

During the course of the conversation the teacher has Kevin sing pitches at various points. Kevin's sense of pitch is excellent and he succeeds in the task of listening to the yellow motive and finding two notes of the same pitch. Having satisfied himself as to Kevin's pitch perception, the teacher then turns the conversation to issues around rhythm and rhythmic regularity. He points to the orange motive and plays it.

T – Even rhythm, or uneven rhythm?
K – Em, probably, em uneven rhythm….
T – Uneven rhythm…what makes the rhythm uneven…….? (zooms in on motive)
K – Yeah, the notes are in different places…..

The comment 'the notes are in different places' seems to indicate that Kevin has made the link between note placement in the representational system and the rhythmic effect produced. The teacher then points out to him the 'grid' system in the motive window and ascertains that he understands how this may be used to help with rhythmic placement. He sets Kevin a task to re-examine the 'orange' motive and explore the idea of rhythmic alignment to see if he can make it more rhythmically consistent. The teacher leaves and Kevin resumes work. He moves very quickly to identify those notes that don't seem to align well with the underlying grid and shifts them so as to place them more regularly. He then listens four times. Kevin has begun to engage with the notion of pulse and to use the interface to explore this.

Session 2

The second session opens with a brief discussion about instruments of the orchestra. Kevin is asked to think of examples a high and low instrument in the orchestra. He suggests violin as a high instrument and double-bass as a low instrument. He is asked whether these instruments would play the same kinds of music, and responds that the basses would play 'lower notes' and also might play 'slower' than violins. The task for today is explained, which is to make just two musical motives that might be played by the violins and the basses, and which would 'go together'. The 'go together' concept is not explicitly defined.

Kevin's working strategy in the second session is markedly different from that in the first. As he places notes in the motive windows, he continually plays back and listens to his work. The motives he produces are fundamentally different in character from those he made in the first session (figureK2).

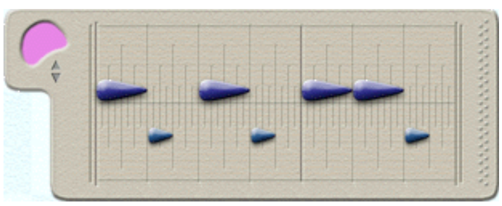


Figure K2(a) Purple motive

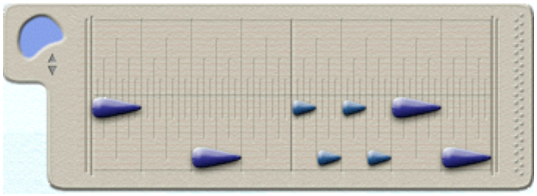


Figure K2(b) Blue Motive

Both motives are intervallic (perfect 5th and minor 6th respectively), and both have a clear pulse and strong internal rhythmic structure. In conversation with the teacher, Kevin indicates a clear internal representation of each motive by singing both of them correctly in terms of pitch and rhythm. He also verbally describes the shape of one of the motives.

> K – Its just…kindof….high note, low note, high note, low note, high note, high note, low note.

Having completed only the first four notes of the purple motive, he is able to sing his last three intended notes before placing them on the screen. While he is working on this motive, the teacher questions him on the range of possible note pitches available to him.

> T - So how many different places…that's the same thing twice…. (Kevin sings the motif so far, correct pitch and rhythm), then there's one way up there….ok….how many different places could that not go?
>
> K - Em…..that could go……it could go anywhere (points with mouse to a range of pitches in the same rhythmic space).

Kevin is clearly aware of the wide range of pitch possibilities. Despite this, however, he gravitates towards motives based on a single interval. Both motives also have a defined rhythmic structure.

In making these motives, Kevin demonstrates that he has reframed the task in a fundamental way. There is no longer any question about his intent regarding pitch or rhythmic placement and he demonstrates a strong internal representation of the motives.. His reframing of the task has had a clear impact on his working process, particularly in respect of his use of the playback feature.

The blue motive seems to be constructed in the lower part of the working space and the purple in the upper part. The teacher asks Kevin what his intention is regarding instrumentation. Kevin indicates that the blue motive is indeed intended as a bass part. The teacher then moves on to the question of how these motives might 'go together'.

> T – Ok, so would you imagine that these two motives would sound good if they were played together?
>
> K – Well, I'm not really sure…
>
> T – Well how are you going to find out?
>
> K – Play them both at the same time.

At this point the teacher introduces the sketch window and asks Kevin to 'draw' each motive where he thinks it should go (figure K3). They then playback the two motives and listen together.

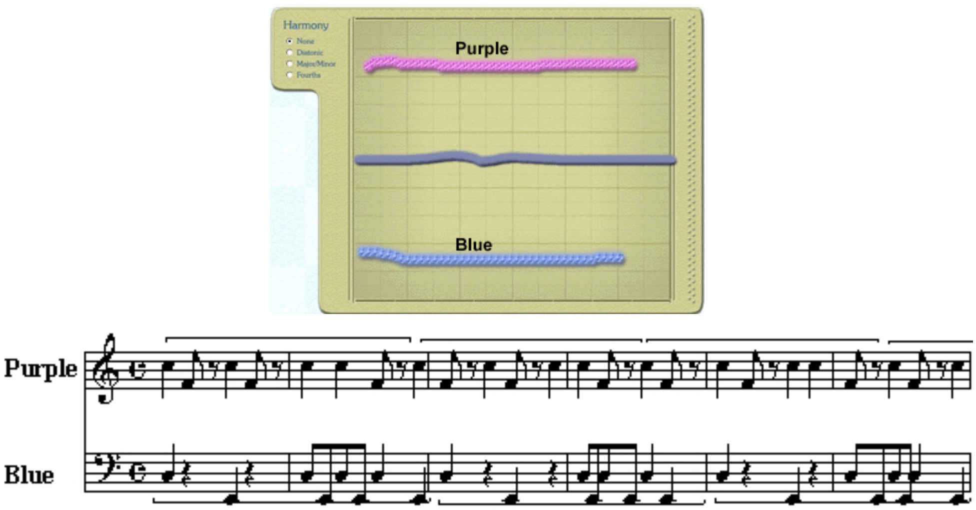
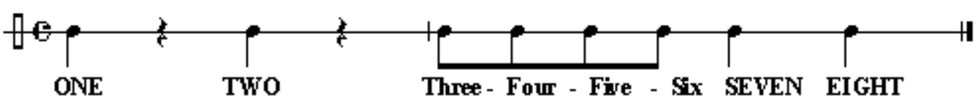


Figure K3 Motive Synchronisation

As the motives play back together, they get progressively out of sync with each other, owing to the fact that one is seven beats long (Figure K.2(a) Purple) while the other is eight (Figure K.2(b) Blue). Kevin looks quizzical, as if the result was not quite what he expected, but doesn't say anything. The teacher tries to focus his attention on the problem. His initial strategy is to have Kevin count the number of beats in each motif. For the purple motive, Kevin counts seven beats accurately on the second attempt. In the second motive however, Kevin counts notes rather than beats, e.g. he counts:



He fails to count anything on the rests, placing a count on each note rather than on each beat. He has confused pulse and rhythm and does not have the concept of a rest as a beat unit. The teacher indicates the 'gap' in the motive window representing the first crochet rest in the blue motive.

T - See that….count it or don't count it?

K – Ehhh…..don't count it…

T – Why not?

K – Because there's no…there's no notes there…..

The teacher suggests that he think of the rest as an 'imaginary' or 'invisible' note and count again. After two attempts, Kevin laughs and says;

K- It was eight….

Kevin has begun to internalise the rest concept and has established the relative lengths of each motive. The teacher then returns to the problem of synchronisation between the two motives, suggesting the addition of a 'rest' at the end to extend its length to eight beats.

T- But, we said, that that's a silent note (pointing to rest in the blue motive), why couldn't there be just a silent note at the end? (pointing to the end of the purple motive).

K – Yeahhh?

T - But it would still count?

K – Yeah.

The purple motive is window is extended so as to have a quarter note rest at the end and then played back.

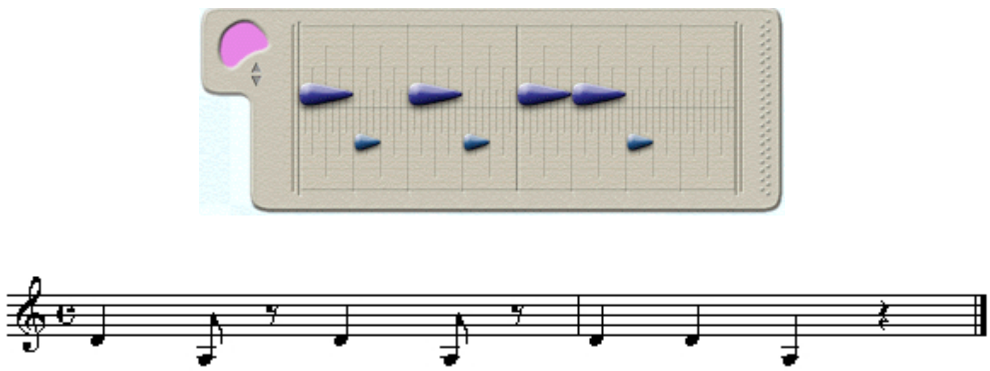


Fig K4 – Purple Final

T - Well let's hear what it does (he plays the purple motive in the sketch window).

K – (spontaneously counts along evenly)…one, two, three four five six seven eight (and laughs on eight).

Kevin has understood the concept of 'rest'. He has also understood something about the rhythmic factors involved in having multiple parts play together. Furthermore, he has acquired a process for testing motives to check their respective lengths, which he uses spontaneously in later sessions. Kevin's learning in this session has 'fallen out' of the real musical task in which he was engaged, that of making two musical ideas which 'go together'. The interface has given him a vehicle to explore his ideas, while the teacher has helped him by helping him to frame potential problems and find strategies for their solution.

Session 3.

In this session Kevin begins to work on his composition proper. The teacher tries to help Kevin get a sense of the scale of the overall task. He does this by stretching the sketch window to its fullest extent.

> K – Wooohohoah!
> T - Do you think you could make a piece of music that would fill that?
> K –No.

At this point Kevin cannot imagine the possibility of making an extended piece that might 'fill' all this space.

Kevin decides to keep the two motives he has but thinks he may need to add another one or two to have enough to make a piece. The teacher suggests that in making his new motives, he think about the idea of pattern.

> T – What would you mean....what would you understand by patterns?
> K – Kinda like....the same thing....
> T – Something that you'd recognise......?

Without formally defining the idea of pattern in music, there is agreement that there is some element of repetition involved. The teacher decides to use the interface to illustrate how this notion might be used in composing. He makes a semi-random motive and then asks Kevin to listen to it and see if he can pick out any bits of the motive that sound interesting and might form the basis for a pattern.

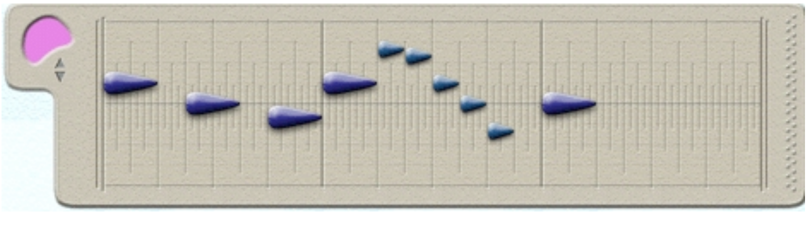


Figure K5 Pattern Example

The teacher is trying to get Kevin to listen to the motif in a different way - to try to 'zoom in' to the motive, break it into sub-units and consider each unit in isolation. The skill or strategy which the teacher is getting at here is the ability to change the perceived level of detail. Kevin doesn't really understand the task, so the teacher demonstrates using the interface. First he uses the playback feature to repeatedly play back the opening syncopated three note figure. Kevin understands immediately. The teacher then uses the copy-and-paste function to make a new motive consisting of three repeats of this figure. He then makes small variations to the figure.

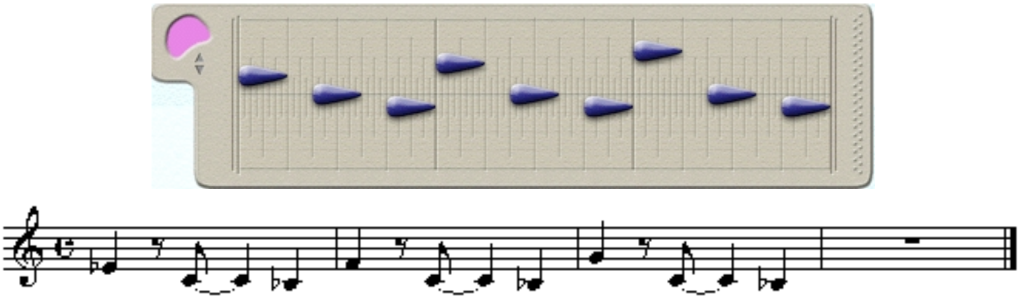


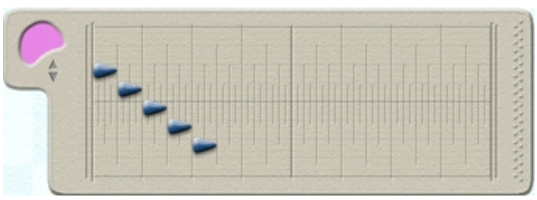
Figure K6 Variation Example

The teacher then repeats this illustration twice more, taking different sub-units of the original, 'copy-and-pasting' to make a new repeating motif and making variations.

Kevin then begins to make his new motive. His work is especially interesting in the way in which he applies the strategy he has just been shown and also in terms of his overall process. Again, his working style is characterised by listening almost every time he adds or changes a note. While his working process is fluid, there seem to be stages through which he moves characterised by shifts in his perspective and the application of particular strategies. These stages are illustrated below with brief comments.

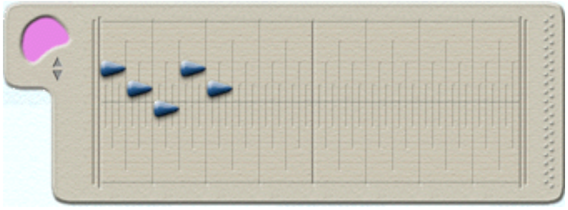
Kevin experiments for a time eventually settling on a descending five-note figure.

(a)



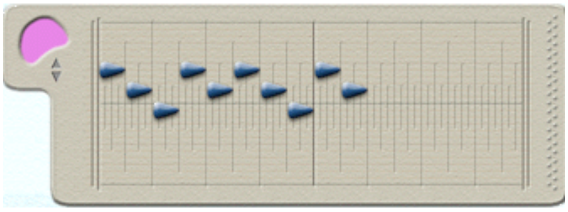
He then highlights the last two notes as a unit and moves them both up in pitch.

(b)



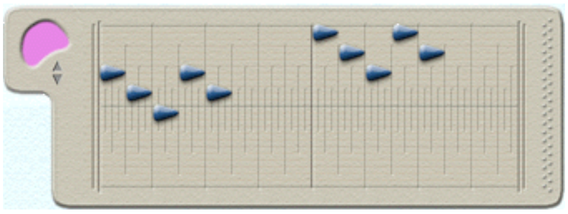
He copies the entire figure and pastes it in a second time, applying the strategy he was shown at the start of the session, but in the context of his own musical idea.

(c)



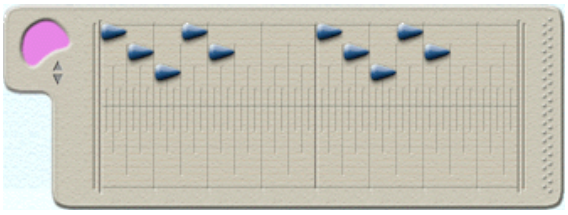
He then highlights the second figure as a group and shifts it right and upwards.

(d)



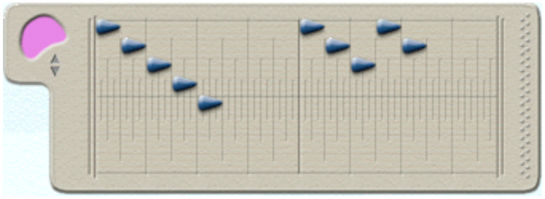
He shifts the initial figure up to match.

(e)



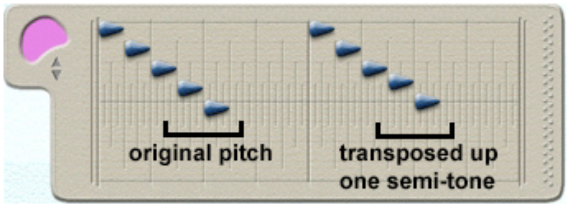
For these last three moves, his working unit, what Jeanne Bamberger might term his 'unit of perception' (Bamberger, 1991) is a five note group. He then focuses on a two note group at the end of the first figure and moves these two notes down as a unit to revert to his initial melodic idea, although transposed in pitch.

(f)



He then does the same for the second group. However, he shifts the last two note figure up a step so as to make a variation on the first group. He tests this by listening, moves them back down, listens again and then shifts them back up again.

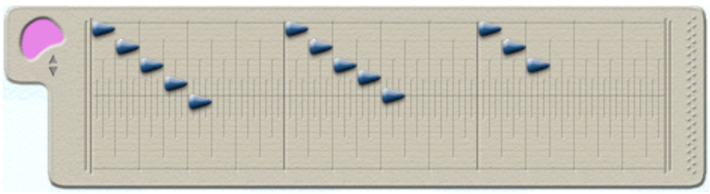
(g)



He has clearly understood the concept of variation and deliberately applied it.

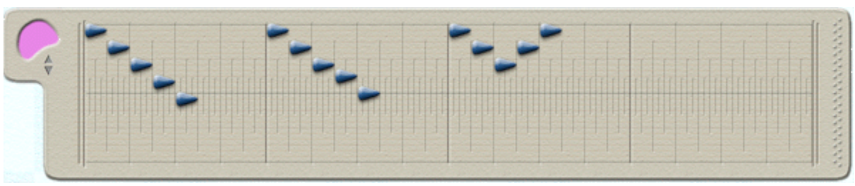
He then carefully places three notes to match the pitches of the first three notes in each of the preceding figures.

(h)



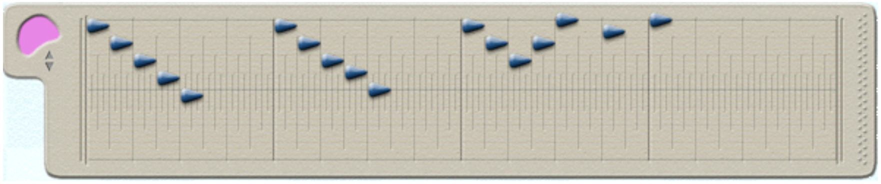
He places two more notes and experiments with several pitch positions before settling on the symmetric figure shown.

(i)



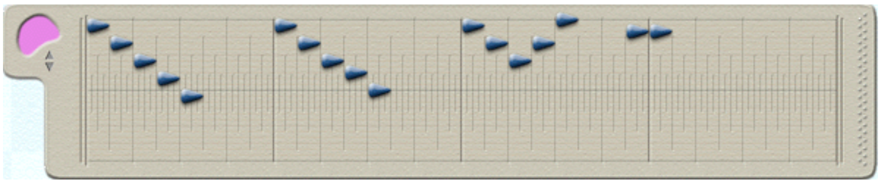
He places two more notes, but seems unhappy with the pitches. At this point the teacher arrives. He asks Kevin what he is doing. Kevin responds by describing the ending and then singing exactly what he wants. In doing so, Kevin demonstrates that he has gradually moved from a divergent process (Webster, 1994) to a point where he is converging on a definite idea. The teacher suggests that he methodically move the penultimate note up by step until it matches the pitch he is imagining. Kevin does this, listening each time. He passes the pitch he had sung. He says ‘just down one there’ and moves the note back down a step.

(j)



Having got both pitches as he wants them, he then moves them as a unit right by step until he has the required rhythm.

(k)



Kevin has clearly undergone some sort of process analogous to that described by Sessions (1970).

> “His choices are made within a specific framework, which, as it grows, exerts an ever greater influence on what is to come”

Each step has suggested something about what might come next, gradually moving towards what can ultimately be the only resolution.

The teacher has Kevin sing his entire motive, which he does accurately for pitch and rhythm. However, Kevin sings longer notes at the end of each unit than those represented on the screen. The teacher notices this and asks;

> T – ‘Should any of those be longer?’

Kevin indicates two notes, the last and third last of the motive.

> K – ‘That one and that one’

He alters these, then sings again. He realises that some other notes are not as long as he wants them and alters them, leading to the final version of the motive.

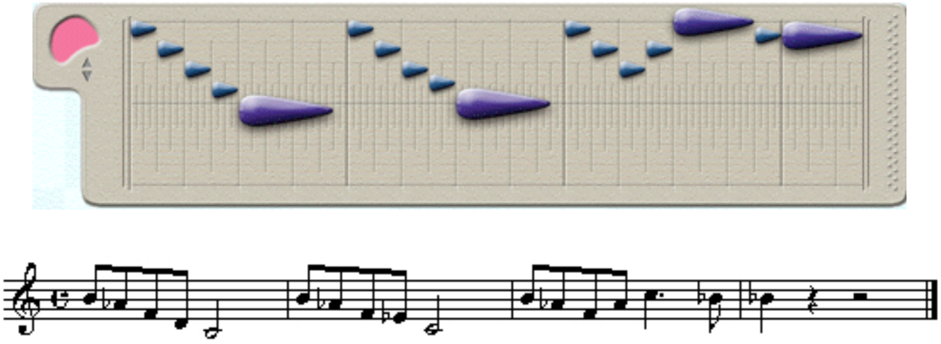
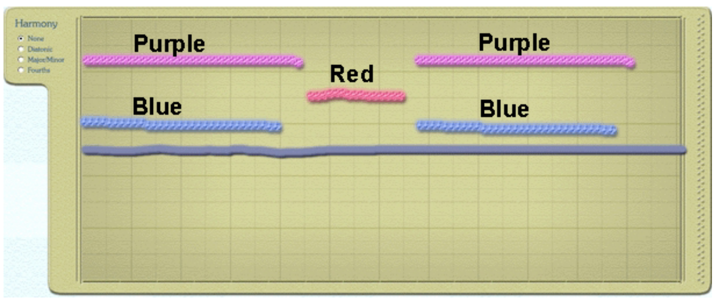


Fig K7 Red Motive Final

In this instance, there is an issue of perception. Kevin has a clearly formed idea of what the motive should sound like. He does not notice that there are small differences in his singing and what the computer is playing back. The teachers function here is simply to direct his attention to the disjunction. Kevin then perceives the difference and rectifies the situation.

While this is a long description of something small that happened in one session, it is revealing both as an illustration of Kevin's working process and of the nature and level of observation throughout the study. John Sloboda (1985) suggests that the best way to understand the way composers work is to observe them all through the process. Kevin starts with a blank screen. He begins with initial experimentation until he settles on an idea. He then plays with different variations on this idea, gradually working towards the final form of the motive. His movement from an initial experimental phase, through the development of his idea to final certainty is indicative of a process similar to that described by both Sessions and Webster.

Kevin now has three complete motives, so the teacher suggests that he might like to move his attention to the sketch window and think about how he might use these motives to begin to make a piece of music. After a short period, Kevin has completed an opening for his piece.



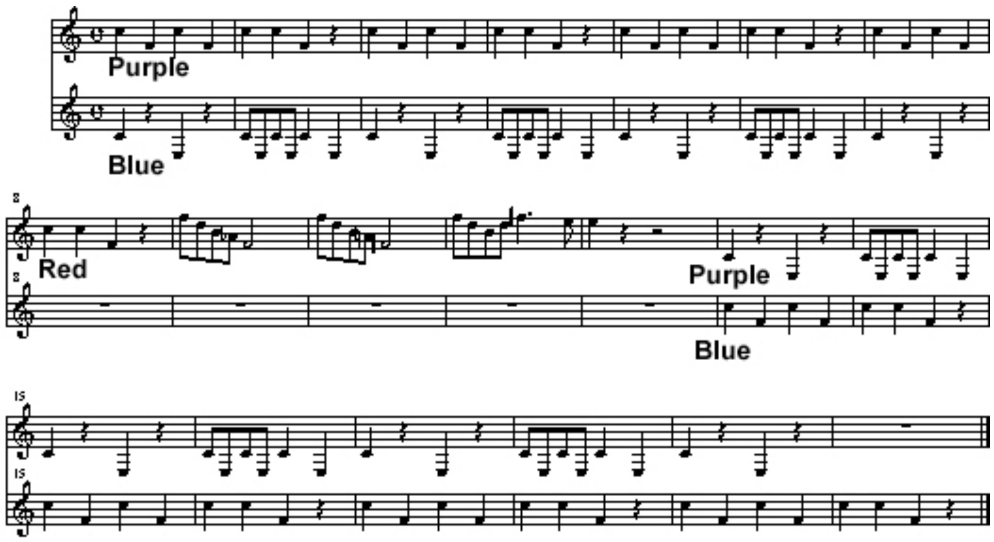


Fig K8 Kevin's Opening Section

As he works, he pays very careful attention to rhythmic alignment. He meticulously ensures that parallel voices begin at exactly the same time and that there is no gap between the end of one unit and the beginning of the next. He spends a great deal of time redrawing the both the purple and red lines so each contains and exact number of motivic units. He seems less concerned that the blue stroke ends with an uneven motive. The teacher questions him on this point.

> T - Now, two questions before we finish...that one stops before that one...did you do that deliberately or accidentally?
>
> K – Deliberately.
>
> T - You definitely wanted to start.....?
>
> K - Well like no, well first it was a bit of a kind of an accident but after that I thought, well you may leave it 'cos I think it sounds good…

This again is an instance of the teacher noticing an apparent inconsistency in Kevin's work and drawing his attention to it. The intervention is designed to ensure that Kevin is aware of the feature in question and that is the result of a deliberate choice. It also serves to inform the teacher of Kevin's intent before making further comment. Kevin shows a degree of flexibility in his approach. Despite having demonstrated a concern with rhythmic alignment, he is both willing and able to reflect and rethink on the basis of feedback from the work itself.

Kevin creates the second two stroke unit using the copy and paste function. He does not experiment with pitch placement. He seems happy that the purple stroke will be in the upper register and the blue in the lower and does not experiment with the interval between the strokes. He opts not to make use of contoured strokes despite having been explicitly shown how to do so. Here again, he is demonstrating the ability to selectively attend to specific musical parameters from the wide variety available to him.

Session 4.

At the start of this session, the teacher introduces the harmony line functionality, explains its operation and suggests that Kevin might experiment with this and see if he likes any particular kind of harmonization for his piece. He also raises the idea of texture, using the interface to demonstrate multi-part textures, and satisfies himself that Kevin has some understanding of what the concept means. When he begins to work however, Kevin immediately begins work on some new motivic figures – he is clearly setting his own agenda here. His two motives are both different from each other and a departure from his previous work. The orange motive is a simple repeating accompaniment figure. From the placement of notes in the motive window, and its subsequent use in the sketch window, it is clear that Kevin intends this as a bass line. He is not attending to the material in isolation, but rather is aware of its function in the context of the overall piece.

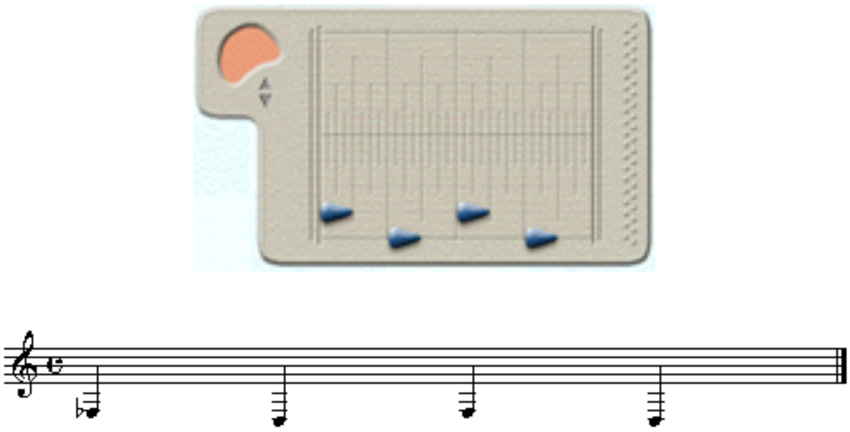


Fig K9 Orange Motive

The green motive is somewhat more complex.

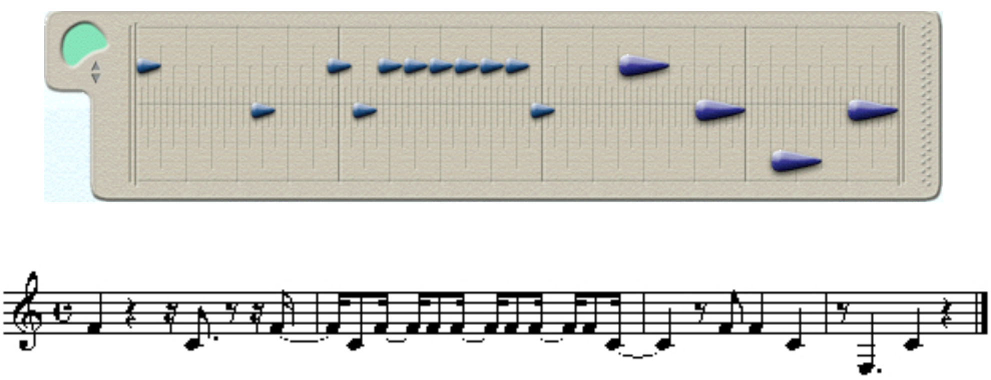


Fig K10 Green Motive (Incomplete)

This motive seems to have three distinct sections; the initial two note opening, the repeated note grouping in the middle, and the four longer notes at the end. While each unit seems to have an internal rhythmic coherence, in combination the effect is somewhat arrhythmic. Kevin has not considered the motive in the context of how it would sound against a pulse or another motive.

The teacher first has Kevin clap a steady beat and points out the function of the rhythmic divisions in the motive window, explaining how they break up the beat. Next he adopts the strategy of having Kevin ‘line up’ two motives in parallel on the screen and trying to figure out what would happen if they were played together. Initially Kevin doesn’t understand the point of the comparison. The teacher explains further by pointing to notes in each motive and indicating which ones would sound at the same time.

> T – Well, those two notes would sound at the same time, then this one would play… (pointing to relevant note in green motive), but nothing would play in this motive.. (the orange motive).
> K – Oh yes.
> T – Then, these two notes would play together, then this one would play, and nothing would play here, and then these two would start at the same time…
> K – But that one would be longer...

Now that Kevin understands the point of the process, the teacher lines up his new green motive with the purple one composed previously and asks Kevin to explain what might happen if they were played together. Kevin accurately describes this new case.

Now that Kevin has clearly understood that there is an issue to resolve, the teacher demonstrates a possible approach to solving it. Without substantially altering the pitch or rhythm content of the green motive, he highlights the centre short-note grouping and moves it both left and right, demonstrating how it can be made to fall into alignment with the beat division as a section rather than note by note. He demonstrates several different options for alignments that might work. Having made his point he returns Kevin’s motive to its original state and leaves Kevin to work on figuring out the alignment issue. When he returns Kevin has substantially reworked the rhythmic aspects of the motive and added a note at the end.

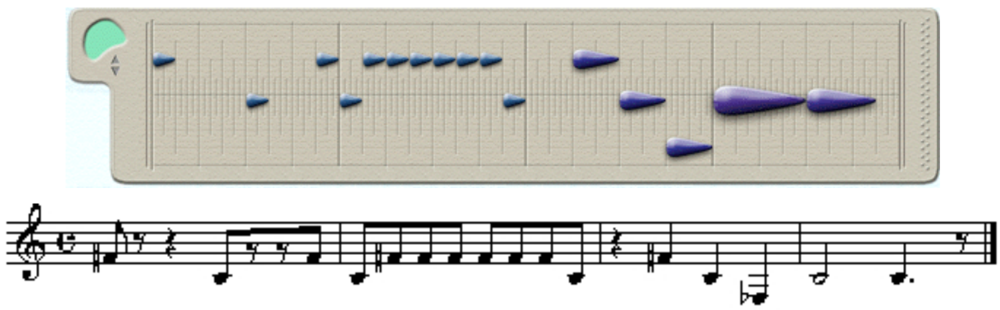


Figure K11 Green Motive Final

Kevin has finally produced a motive with considerable rhythmic coherence and yet has not substantially altered the constituent musical ideas.

In the case of both motives, Kevin has again expanded his horizon. He has made one motive which is more complex and less repetitive than his previous work, while still retaining an element of pattern, and a second which is much simpler yet pointed in its function. Again we see teacher intervene to help Kevin to sharpen his rhythmic perception. In making the green motive, he has attended to aspects of melodic shape and overall form, but needs help in fine tuning rhythmic details. The teacher has not suggested solution, but rather pointed to the problem and suggested strategies.

Kevin explores various combinations of motivic material in the sketch window, eventually settling on the combination of red and orange. He nods his head in time as they play, but then seems to stop as if something has disturbed him. The motives are getting out of time with each other, owing to a slight irregularity in the length of the red motif. He adjusts the length of the red motive, but the problem is not solved. The teacher arrives back and Kevin immediately states the problem.

K - (Points at screen) I tried to put a rest....I tried to put a rest in it ‘cos it didn’t sound good.

Kevin has tried to apply the strategy learned earlier in the context of the blue/red motive alignment problem. In this instance the orange motive is one measure long while the red is three whole measures plus an uneven fraction. The teacher draws Kevin’s attention to this by moving the orange motive to line up with the first, second and third measures of red in turn. When he lines it up with the last partial measure of the red motive, it becomes clear what the issue is – that in playback the two motives will get out of synchronisation. Kevin perceives the problem, and after some discussion, settles on a solution, extending the red motive so as to be a whole number of rhythmic units long.

Kevin now returns to his opening in the sketch window, and extends his piece. He adds just two strokes, using the red motive as a melodic feature, accompanied in the bass by the orange motive. Again he is careful about rhythmic alignment and complete numbers of motivic repeats within each stroke. He places each stroke in a specific pitch range, but does not experiment with the interval between them.

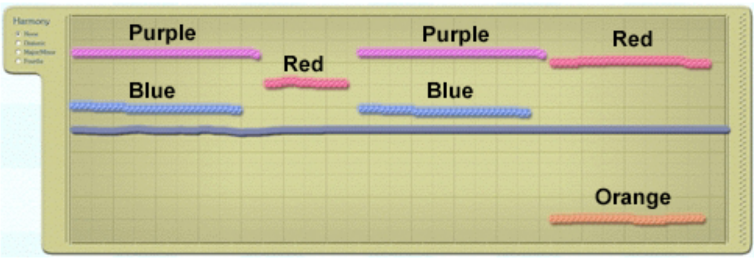


Figure K12 Beginning Extended

Session 5

At the start of this session, the teacher looks at what Kevin has done so far, sings through each of his motives in turn and suggests a strategy for Kevin to try.

> T - Ok, so what I want you to do now is to....play that back....not yet!!...play it back, and listen really hard...and try, before you do anything....try and imagine in your mind....what's gonna happen next……

In suggesting the 'imagine' strategy, the teacher encourages Kevin to begin to think more globally about his piece, to try to have a sense of overall structure and direction. Kevin listens to his piece a couple of times and begins work.

Kevin's progress through the piece thus far is marked by a series of explorations. He seems to be able to analyse what he has done so far, pick out some of its attributes or salient features, and then find ways to change his approach. He is continually 'breaking-out' of his self imposed discipline. Thus far he has used thin textures but in his next 'move' he experiments with thicker texture. He first places a single green line in the bass register. He then places five parallel lines, one for each motive evenly spaced in the pitch range. Initially all lines are in pizzicato voice and of equal length and volume.

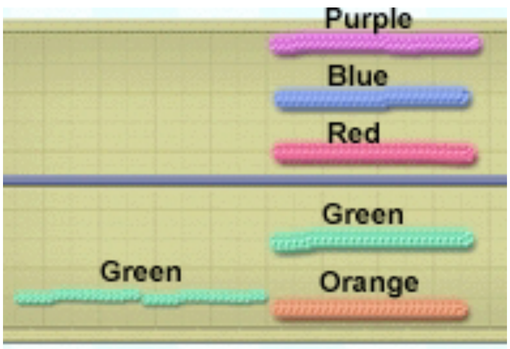


Figure K13 Texture

In the course of listening to the new section, as playback gets near to the sudden thickening of texture, Kevin says;

> K – I don't think that people will be expecting it in the audience.

He clearly perceives the sudden thickening in texture as an expressive gesture which is designed to catch the audience off guard. The teacher suggests that Kevin might think of various ways that the effect of this surprise might be heightened.

> T – What could you do?
> K – Highlight it...
> T – Highlight it and do what?
> K – Pump it up louder.

The teacher then asks Kevin if he wants any one voice to stand out, and if so how might he achieve this. After a little discussion Kevin suggests,

> K – You could make it sound a bit different.

Further discussion leads to the idea of changing the timbre of a given voice as a way of making it 'stand out'. Kevin plays with various combinations of pizzicato and arco voicings and dynamics and settles on the green voice as the main focus. He sets its volume as loud as possible and its timbre to arco, while all other voices are left pizzicato and quieter. He also extends the green line so as to continue beyond the accompaniment parts. Kevin has made a definite compositional 'trial' here – let's put everything together and see what happens. He has a clear idea of the effect he wants and experiments with combinations of sounds until he achieves it.

Session 6

Kevin's next move is to add a contoured purple line in the treble, with orange in the bass. This is the first time he has used a contoured stroke. Kevin is again extending his range by exploring melodic contour. He is clearly using the orange motive as a bass line.

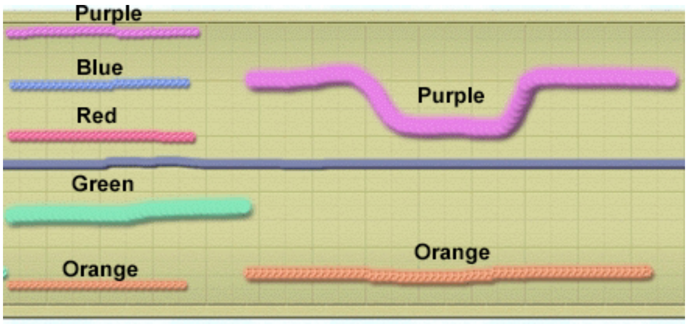


Figure K14 Contour

One characteristic of Kevin's work in the sketch window so far is that all of his strokes contain a complete number of repetitions of their respective motives. In this instance the green line initially contains an uneven number of motives and there is a gap between it and the next purple stroke. The teacher questions Kevin about this.

> T – What about that green one?
> K – Its too long.
> T – How much too long is it?
> K – One note.

The teacher reminds Kevin that he can use the right click function to stretch or contract each line. Kevin quickly resets the length so as to have a complete number of repetitions. However, there is still the problem of the gap between green and purple. The teacher has him play back the section and simply taps the pulse, accenting the beats in the gap. Kevin immediately says "

> K – Oh yeahh, yeahh.
> T – What do you notice?
> K – That, that there's a gap….

Kevin moves the purple and orange left so as to start immediately after green as shown

In this case, the teacher feels that he has a sense of Kevin's priorities based on his work so far. He draws Kevin's attention to the extra note on green and the gap before purple without suggesting a solution in either case. Kevin himself then fixes the problem. In the second case, the teacher does not say anything, he simply taps the beat, but Kevin immediately gets the point – the conversation here is not about music, it takes place through the medium of music.

At this point the teacher reviews Kevin's work. He discusses Kevin's use of texture as a means of creating interest/variety. He then suggests that Kevin should think in an overall sense about his piece. In particular, he introduces the ideas of climax and surprise. He suggests that one thing Kevin might consider is a gradual build-up of texture to create a climax or high point, before thinking about how to end the piece.

Kevin then spends a considerable amount of time experimenting with the addition of an upward diagonal to the purple line.

> T -...so you've some different idea about trying to make a climax in here?
> K - Yeah ....see I kind of… (plays back the stoke, then continues to sing next three notes as he would imagine them followed by a glissando downwards....)
> T - You want it to go up....Ok, well we can work that out........you might have to experiment to get exactly the right length you want.....but you definitely have a plan in your mind...

Kevin seems to have a clear idea of what he is trying to achieve. It seems that he has understood the idea of climax, but is trying to implement a climax in a completely different way from that suggested by the teacher. Rather than use textural devices, he seems to link climax with rising pitch. This session finishes before he manages to achieve the desired result, so he returns to this at the start of the next session.

Session 7.

At the start of the session, Kevin is considering another students piece on the computer he uses. The particular piece is characterised by florid drawing, thick texture and rapidly running note groups. While the piece is visually more interesting than Kevin's, it is considerably less musically organised. Kevin seems to be feel that his piece is boring in comparison. This is the first time that Kevin has shown any tendency towards being significantly influenced by the visual aspect of the interface.

> T - You think your piece is boring, do you?
> K - Well there's not a lot of spice in it.
> T- Simple doesn't mean boring....often simple is the best thing......ok, so, but I want you to hold that thought, I want you to think about what you've just said - You said that your piece is very simple and you think its boring, and you said it has no spice.
> K - Well it's the same thing, it doesn't have a lot of (vocalisation indicating lots of notes running up and down).
> T - It doesn't have to have, does it?
> K – No.

Kevin is able to think analytically and make insightful comments about what it is that makes the other student's piece different from his. The teacher tries to make Kevin aware that there are many ways to compose and to support his sense of his own judgement being as valid as anyone elses. He also introduces the idea of minimalism, trying to give Kevin a sense that his compositional style is not only valid, but also current among other composers. The teacher then reviews Kevin's work from the last session.

> T – And then you have this...now, is this gonna be the big....the highest point in the piece?
>
> K – Mmm, probably, I'd kinda like it to go.. (sings up from end of purple where diagonal stroke is) and then all things, you know, different things start around here.

Again Kevin demonstrates his ability to imagine the sounds that he wants and externalise them by singing and verbal description. He sings the effect he wants from the rising purple stroke and then indicates that he wants something 'different' to happen thereafter. After a period of experimentation he creates an upward diagonal that seems to satisfy him (see figure 6.2.16 below). He then completes the next section consisting of four strokes overlapping spread throughout the pitch range. The organisation here is another departure from his usual style. The entry of the strokes is staggered, although three of the strokes end together. He is concerned with complete numbers of repetitions in the green stroke only, allowing incomplete repetitions in the others. He seems to be attending to the melodic aspect of the green motive again and using the others as accompaniment. This section is also the first that doesn't begin immediately after the preceding one, nor does it begin on a strong downbeat.

The teacher questions him about the unusual gap between this and the preceding section.

> T- Can I ask you about the gap.....this works its way up?
>
> K – Yeah, I know, I'm gonna figure that out now.
>
> T – So you think you're gonna have to figure something out about that….?
>
> K – No actually that's all right....the gap....it kindof, it kindof stops you from expecting anything, you know.

Later, speaking about this gap he says;

> K – Yeah, Its kindof...it kindof says to the audience that something's gonna happen and then…...it's normal.

Kevin is using this unexpected silence as the 'surprise' feature. Again he is deliberately deviating from his previous working strategy so as to make a deliberate musical gesture. The teacher then questions him about the overlapping section.

> T – That's interesting.....they don't all stop together.
>
> K – No.
>
> T – Did you want them to?
>
> K – No.

Again, the gesture is clearly the result of a deliberate choice on Kevin's part.

He then continues with his piece. He goes back to the start of the piece and copies the 'red' stroke then pastes onto the end. He is reusing material from the start although this has not been suggested to him. He is probably aware that this stroke already contains an even number of repeats, so saving work of redrawing. He positions this stroke so that it seems to begin as green ends, then listens and finds it does. He edits timbre to arco and adjusts the volume. He now copies the green stroke he made above and pastes it again onto end. It appears to be overlapping red motive so he shifts right to begin as red ends.

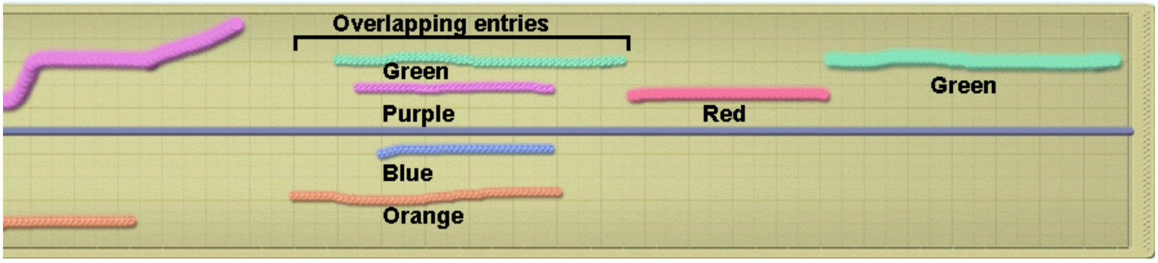


Figure K15 Ending

Kevin listens to the last two strokes, then stops after the red and adjusts volume. He clearly has intent here regarding not only what should happen, but also how it should happen. He changes the final green stroke to arco and raises the volume then listens again.....

K – There we go, that's it!!

Kevin's focus shifts continually during this session, from consideration of individual strokes, to sections to an overview of the piece. He considers the piece as a whole and decides to re-use material from the beginning at the end without being prompted to do so. He seems to have clear intent for everything he does. As with the green motive earlier, his compositional process seems to be converging on what the 'right' answer is. He is no longer reaching blindly, but rather as he approaches the end, his perception of the internal logic of the piece is suggesting what should happen. His use of silence to frustrate the expectation of the rising purple motive displays a sophistication of musical thought. He continues to expand his style, experimenting with overlapping entries for the first time, and again engages with issues around expressive gesture. During the session, it is clear that he is using the software intuitively and almost without thought and that his focus is on musical issues throughout.

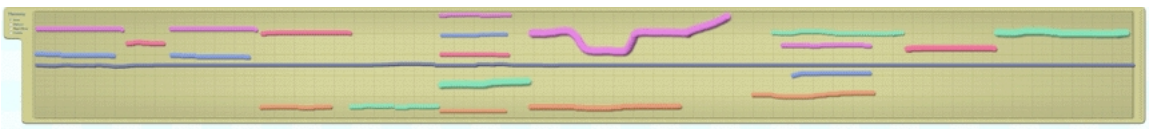


Figure K16 "Outbursts"

Case Study 2 – Emer

Introduction

Emer's case is the first of two subsidiary cases chosen from the Hyperscore workshops. It was chosen so as to both reinforce observations made in the foregoing case and to provide a specific example of work motivated by visual/graphical concerns. The case will not be described chronologically as it is felt that the chronological description of Kevin's case is sufficient to give a clear indication of the nature and scope of the work. Rather, excerpts from the case transcript of particular interest will be presented, along with initial analysis and discussion. This discussion will be presented under three broad headings, Composing Process, Musical Interaction and Learning and Teaching Interventions and Strategies.

Emer's Composing Process

Emer's initial process in the motive window is quite similar to that exhibited by Stacy (section 6.4), insofar as she proceeds by random experiment (bricolage), then hits on a single idea or theme and rapidly carries it to conclusion. However it appears that she does so based on both musical and visual criteria. Many of her moves and operations seem to be a function of both visual factors, and operations suggested by the interface itself.

In her first session Emer makes four motives. As she works she listens regularly.

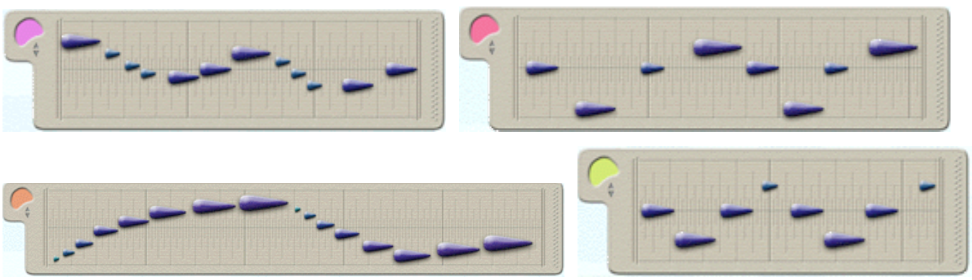


Figure E1 Emer's First Motives

In working on her purple motive, Emer initially makes a three note descending figure. She experiments with a couple of pitches for the last note, then asks how to make notes 'smaller'. She then makes the middle note shorter and 'fills in the gap' with one smaller note, then another. This sort of 'gap-fill' move occurs many times throughout her work. In working on the ending, she experiments with various pitches, eventually settling on what is a tonal Do-Mi-Do' ending - as soon as she hits on this note she moves on.

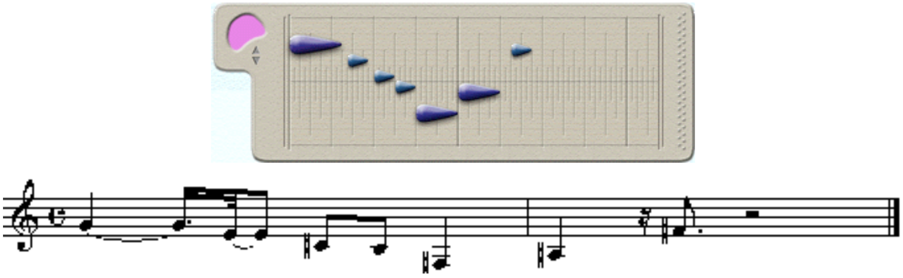


Figure E2 Purple Motive

The next motive is Red. Emer quickly dots in five of notes, low-hi-low-hi-low. The exact pitches are random. She then throws away all these notes and places four notes at the same pitch spaced more or less evenly across the window. She seems to have a definite idea. She quickly fills in the rest of the motive by placing alternating high notes above and below the central pedal. In doing so, she is very careful to ensure that pitches are consistent. She does not seem concerned with rhythmic placement of the notes. However, she does carefully place the notes in the latter part of the motive to exactly match the pitch of those in the first part. As Emer works, her perspective seems to have shifted so that she begins to conceive of the motive as composed of two four-note groups.

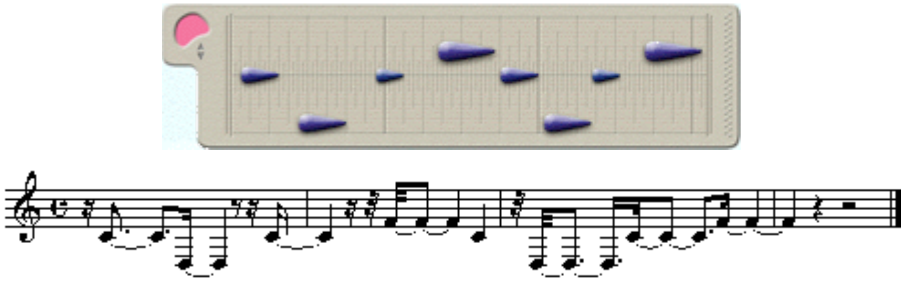


Figure E3 Red Motive

Having completed this motive, she now goes back to her first motive and applies this new idea of repeating sub-units. She extends the motive so as to create a repeating figure. While note values and contour are replicated, absolute pitches, rhythm and internal pitch relationships are not. She does not listen to the motive to check her work and seems to be working on the basis of visual attributes.

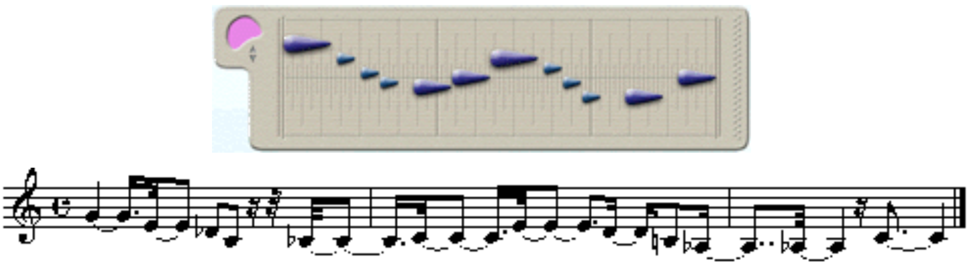


Figure E4 Purple Motive Second Version

In making her third (yellow) motive, Emer follows exactly the same strategy and procedure as for her second, producing a very similar motive. Her fourth (orange) motive seems to emerge in two distinct moves or sections, with little experimentation. She quickly completes both figures, doing the opposite in the second part to what she did in the first. She listens once and moves on.

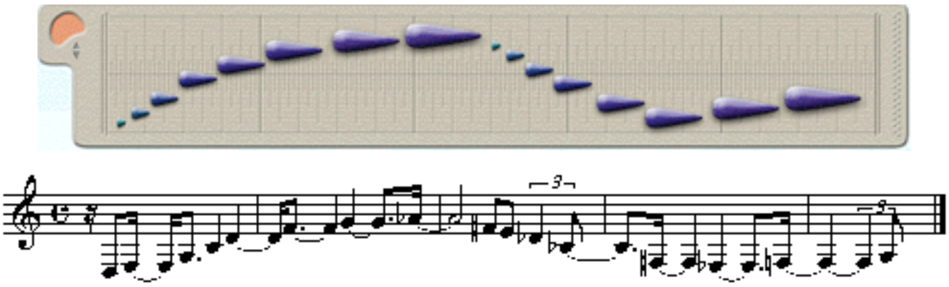


Figure E5 Orange Motive

This final motive has a sense of pitch contour and a symmetric rhythmic structure in terms of note value, but placement and the exact relationship between the note lengths is approximate. It is clearly visually motivated, and while it does appear organised at the level of visual contour, it lacks a coherent musical structure.

Despite evidence to the contrary, Emer asserts that she is focussing on the sound of her motives.

> T - When you were putting those notes in, did you put them in because you thought they looked good or because you thought they sounded right?
> E - Sounded right.

Later, Emer appears to adopt a more convergent style similar to that shown by Kevin. She makes a series of moves which seem to evolve in a more natural and fluid manner.

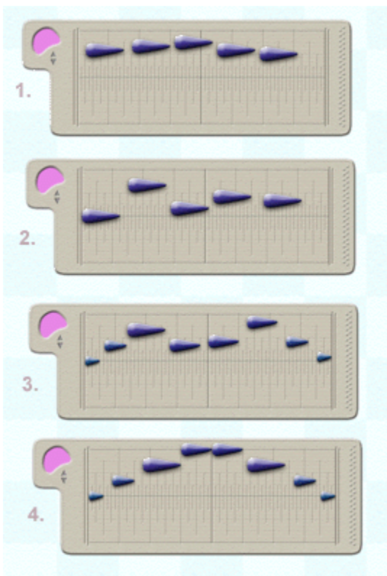


Figure E6 Convergent Process

In a later session the teacher introduces the idea of pattern. As with Kevin, he and demonstrates how to copy and paste melodic fragments from one window to another and make variations on them. Emer tries to employ the same technique but with considerably less success. She attempts to copy a three-note unit from the motive above and paste it into a new window. However, she clearly makes an error at the copy stage, as the material pasted is that remaining on the clipboard from the teacher's demonstration. She doesn't appear to notice, and pastes it in a second time, then attempts to create variation by moving the last note of the figure up a step. In doing so, she is following literally the procedure demonstrated by the teacher – her interpretation appears to be 'variation means move a note up'. In this instance, she seems to have understood the teacher's demonstration at the level of the interface, but not it's musical meaning.

She then makes multiple moves, shifting single notes around the window, re-pasting the initial three-note figure a number of times and making several accidental erasures.

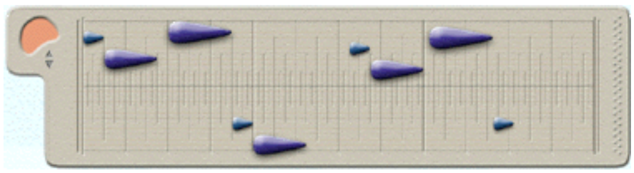


Figure E7 An 'Accidental' Motive

The final structure of the motive is almost entirely without musical intent, despite its tonal and rhythmic coherent. This clearly points to the difficulty of trying to ascribe motivation or intent to children's compositional work based entirely on analysis of outcomes. It also clearly demonstrates the value of combined graphical interface and continuous digital video capture in analysis of children's working processes.

In making her yellow motive, Emer again uses the copy and paste function to take segments of material from previous motives and deploy them in a new window.

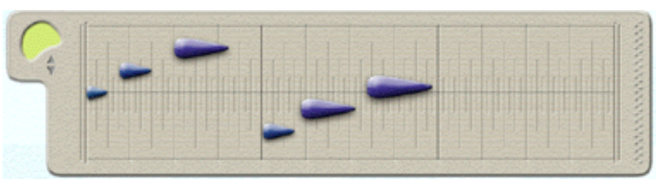


Figure E8 Copy and Paste

The motive appears to be sequential, based on the first three notes of her purple motive. However, Emer makes a variety of accidental deletes, and is forced to try to approximately recreate the figure. So, while the figure looks like a sequence, the note values and intervals between consecutive notes in each sub-unit are different. She has understood the principle of sequence, but has not executed it precisely. Her implementation is based on gross visual descriptors rather than precise pitch or rhythmic relationships.

Emer's initial attempts in the sketch window consist of several wavy lines. These are clearly the result of an intuitive physical gesture rather than any musical, or even visual intent.

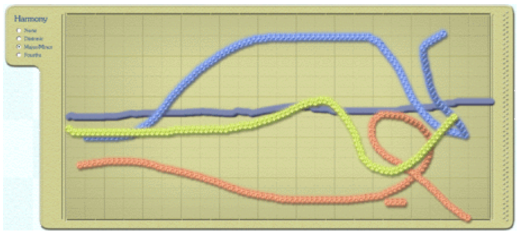


Figure E9 Physical Gesture

Later, Emer makes extensive use of dots.

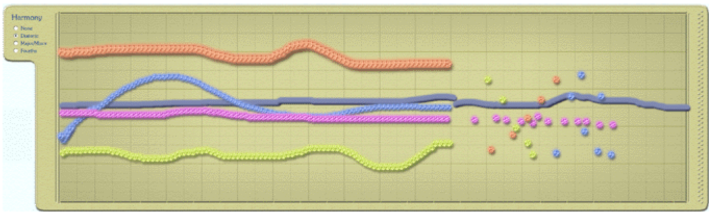


Figure E10 Visual Gesture (Dots)

These are arranged in sets of crossing lines but do not produce rhythmically or melodically coherent result despite their visual organisation.

At one point Emer places a set of dots vertically one over the other. The teacher points out that these will play simultaneously rather than one after the other. Emer seems surprised at this. In this instance, it may be that Emer's perception is that because she ‘drew’ the dots one after the other they should sound one after the other. There may be a conflict between Emer's kinaesthetic perception, her ‘felt-path over the notes (Bamberger, 1980), and the left-to-right nature of the representation. In this respect, the interface may act to facilitate her movement from the ‘felt-path’ to the absolute realisation of time and temporal placing of events.

As she continues to work in the sketch window, Emer becomes more generally aware of the relationship between her drawings and their musical output. She makes shorter, flatter lines and becomes more aware of voice entries and exits.

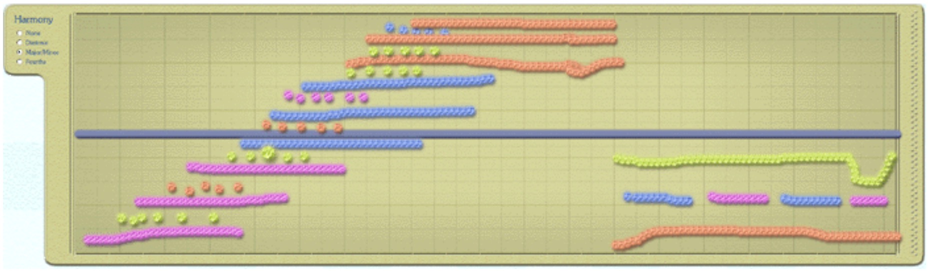


Figure E11 Shorter Lines

However it is still not clear that she is precisely aware of events at the note level. While she is aware of large scale parameters such as general pitch ranges and the relationships between strokes in terms of entries and exits, her primary motivation here seems to be the production of visual patterns. This is particularly apparent in her use of dots, which are neither melodically nor rhythmically coherent.

In her final section, Emer reverts to a clearly visual style. Her long, crossing strokes (top and bottom) are symmetrical. The blue (middle) stroke is a ‘zig-zag’ pattern, with the surrounding dots placed so as to partly mimic the shape. The four short strokes at the end are symmetric around the central axis (outer are purple, inner are both blue) while the final lines of dots are initially also symmetrical, although the lower is later extended.

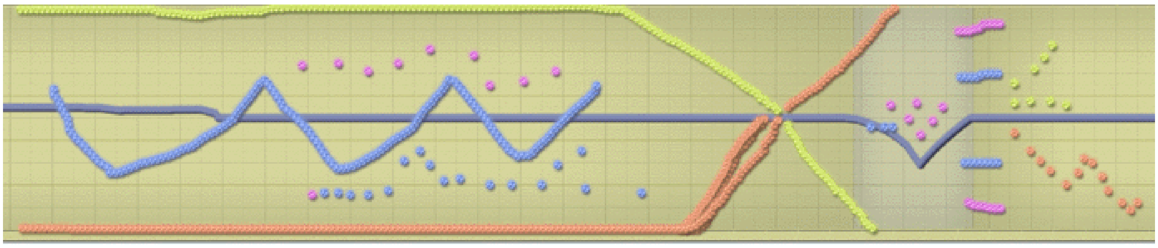


Figure E12 Symmetrical Gesture

While Emer’s work has a strong visual aspect, she is aware of the musical implications of her actions on various levels. Her early work involved multiple crossing lines. Later she learns to separate out parts by pitch range. Her style changes and she begins to use shorter strokes, indicating a growing awareness of the importance of change over the course of the piece.

> T - Ok - So if you were to start now in a new space...what things have you learned now, that you would have to think about if you were starting again?
>
> E - Try not to make them all like, the same...

She also demonstrates a growing awareness of the overall shape of her piece. She begins to work in multiple sketch windows each of which represents a separate section, and pastes these together later. She has a sense of the structural function of the material in each window.

T - So is this the start of a piece or the middle of a piece or the end of a piece....is there some bit you can use somewhere?

E - It's the end of a piece...that's the....it kinda goes… (indicates with hand that the rising stairs might be preceded by a descending section).

E - And then that's the end...(pointing to second section).

T - And is this the start or would you put this in the middle of another piece?

E - This is the start of the end of a piece.... (Very clearly pointing to beginning of window).

T - So you'd have some other music that would happen before this?

E – Yeah.

Musical Interaction and Learning

Despite her visual focus, it is clear that Emer engages to some extent with music at multiple levels in terms of both rudiments, manipulation of materials, structures and concepts. It is also clear that the manner in which this engagement takes place changes over time.

In making her initial motives, Emer seems to attend to the same type of top-level features as Kevin and Stacy. In describing her motives, she refers to note length (big/small notes), pitch (high/low notes) and contour but she does not refer to her motives in terms of any underlying scale template or key. She seems to have a limited awareness of the musical parameters available to her or how these might be manipulated.

T - What is different about all of these from each other?

E - Different sizes.

E - Some have big notes and some have small notes.

T - What kindof notes does that use? (points to first note) It starts with a ......?

E - A low note....

When asked to describe how two motives differ from each other, Emer again describes the differences in solely terms of contour and note value.

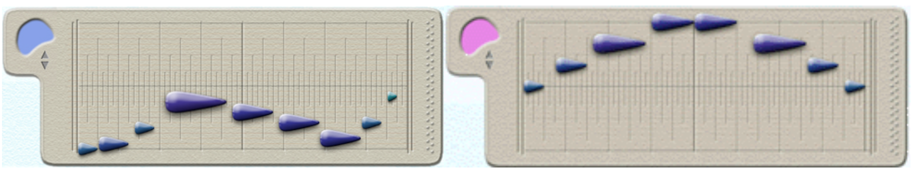


Figure E13 Motive Contour

E - They just sound the same.

T - The same how?

E – They're both going up and then back down.

T - So they both have the same shape, don't they?

E – Yeah.

T - And what about the kind of notes they have?

E- This one (second) has more smaller notes than this one....this has very small notes (second) and this hasn't (first).

In making the motives, her initial stock of ideas is limited. She does not have a wide variety of parameters which she can manipulate in order to distinguish the motives from each other. Furthermore, even though she could create a degree of variety just by manipulating pitch, for example, her pitch perception is not acute enough to perceive difference on this basis. While the pitch content of the motives above is radically different, with completely different tonal and melodic effect, Emer is attending to global attributes (shape, number of notes etc) and so perceives them as being 'kind of the same'.

As she makes further motives however, she begins to discover a variety of compositional manipulations and techniques including repetition and variation. Repetition becomes an important structural aspect in most of her motives, although this is generally with respect to gross descriptors such as contour, rather than pitch or rhythm at the note level. Emer later discovers pedal notes and alternating pairs of pitches. She also discovers variation, notably in the orange motive, and specifically inversion of the melodic contour and note duration.

There are clear examples of Emer's interaction with, and reflective processing of musical information. In some of her interactions, it is not clear whether Emer is primarily focussed on the visual aspects of the interface or the musical objects it represents, but at other times she is very clearly using the interface to access musical ideas.

E - 'Well I could make the small one but I just couldn't put it in the right place....'

T - Ok, so you could make the right note length....

E - But it just has to do a 'ding'...

T - But it was a ding at the wrong line, the wrong pitch?

E – Yeah.

Throughout her work, Emer makes moves which are characterised by definite intent and predicated on some internally realised priorities. In developing these priorities she attends to some things and not to others. She is able to focus on large scale descriptors such as contour, note value, textural aspects. When working in situations which require attention to multiple parameters simultaneously, she is less successful and responds by fixing on one aspect and ignoring others. She is initially less successful in dealing with the large scale structural aspects of the piece in a holistic way, although she does develop some sense of structure towards the end, and manages to deploy several parameters in order to create a successful ending, albeit with some help from the teacher.

T - How do you know when a piece is coming to an end?
E - It gets slower.......

T - So what are you thinking about there?
E - I'm thinking (unclear) so it'll sound real low at the end of it.
T - Oh you want to work it down till it sounds real low at the end of it?
E - Yeah.
T - With these little dots like bom bom bom...(going down) - that kind of thing?
E - Yeah.

In this instance she manipulates elements of texture, melodic contour and harmony to create her ending section.

She begins to show a definite intent with respect to her desired outcomes

T - Tell me what this is doing
E – It's going up in stairs, but they're supposed to finish at different ones here but I wanted them to finish at the same time.
T - And then just as they end...
E - That one starts.

She has discovered the importance of testing. She learns to listen to her work and make decisions based on her listening.

T - Did you say to me that there were some bits of this that you liked and some bits that you didn't like?
E – Yeah.
T - Which bit didn't you like?
E - The purple one.
T - (Plays back section with purple stroke muted).
T – It's definitely a lot better - will we take the purple one out?
E – Yeah.

Emer shows evidence of the sort of shifts in perception that are characteristic of learning. For example, while she has a clear sense of her motives as being made up of a series of subunits, her perception of the boundaries between these subunits is not fixed. In making her purple motive, she uses the copy and paste function to create a motive that is composed of two six-note units arranged in an approximate sequence. (see figure 6.3.14)

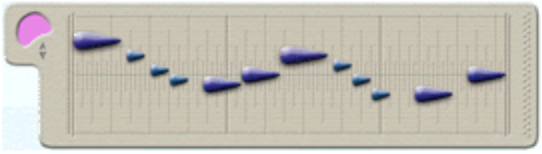


Figure E14 Sequence

The teacher asks her to describe the motive in terms of the note values.

E – Slow.

T - Then?

E – Fast.

T - How many?

E – Three.

T - Then how many of them (the group of longer notes in the middle)?

E - Two...or three.

She initially describes the first part of the motive as a slow note, three fast notes and two slow notes, reflecting the manner in which it was constructed. Then she rethinks and says again;

E – Three.

She built the motive clearly as two groups of six notes. However, considering it afresh while looking at the representation, her perspective has shifted and she perceives the three long notes in the center as a group or unit. She is now attending to different attributes and is mentally 'breaking-down' the motive differently

Emer makes progress in alignment and rhythmic perception. Initially she has difficulty perceiving whether notes are aligned with the underlying pulse or not, but as she works her perceptions begin to sharpen. In this example from one of the earlier workshops Emer's internal representation does not match the actual structure of her motives.

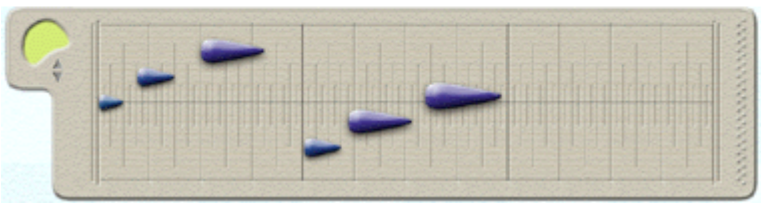


Figure E15 Motive Perception

The teacher has Emer clap the rhythm. She claps an approximation but which is much more regular.

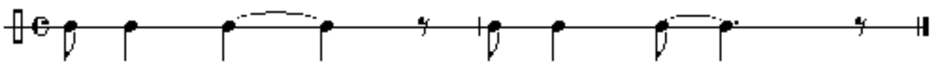


Figure E16 Emer's Clapped Rhythm

This is a very clear demonstration of the difference between what she thinks she has made and what she has actually made. She perceives the motive as being composed of two rhythmically identical sub-units. She completely fails to notice the subtle rhythmic inconsistencies between the two halves. Also, she claps a shorter note at the start. In fact, as there is a gap between the end of the first note and the beginning of the second, the two are functionally the same length. In this instance, she is clapping a shorter note, possibly based on the visual representation rather than the actual rhythmic content. Later, in working on one of her motives, there is one note mis-aligned with the underlying pulse. The teacher has Emer listen while clapping the pulse.

> T - Is there a little pause in there before any of these notes happen?
> E – (points to the gap between two notes).
> T - So how could you move them so they might start on a beat?
> E - Move them left.

Emer immediately points to the relevant note, and then moves the notes in question to address the problem. Up to this point Emer had failed to notice such rhythmic inconsistencies. Now she notices the problem and finds a solution herself.

As she works in the sketch window, Emer makes some important discoveries. Her initial strokes in the sketch window are contoured and overlap (figure 6.3.9 above). However, she realizes that in order to produce a more coherent outcome, she needs to use sparser textures and to separate voices in the pitch range, which she does for the remainder of her piece (figure 6.3.10 above).

While there is a definite visual aspect to her work, Emer is aware of the effect of the contoured strokes on the pitch content of her motives and later uses this to manipulate melodic contour.

> T - Well, what changed about it - was it still doing this? (pointing to motive window)
> E - It was still doing that, like, but a different kindof...tone....
> T - Different tone....like what, did it go...some direction?

E – Higher.

T - You think it went higher? Well let's listen to it again....

E - (Laughs).....Lower..

T - It goes lower...and the reason it does that is this...

E - Cos it's going down, the line, as well.

Emer is aware of the difference between the arco and pizzicato sounds available to her, and makes deliberate choices in this regard.

T - Your using a plucked sound - do you not like the other sound?

E – No.

T - Why?

E - It annoys me.

T - Why does it annoy you?

E - Its kindof...I don't....I don't like violins.

In working in the sketch window, there are a large number of parameters at play. Emer initially has difficulty in separating these out. Referring to a complex texture that Emer has made, the teacher asks;

T - What do you think of that?

E - I don't like it.

T - Why don't you like it?

E - Its too noisy!!

Emer is alluding to the internal 'disorganisation' which is a function of rhythmic and pitch factors and their interplay in a complex texture. She uses the word 'noisy' in the absence of a clear idea of what the problem is or an appropriate vocabulary to describe it. She doesn't have a clear perception of what is causing the 'noise' or of how to fix it.

Later as she works, she begins to develop the ability to attend to and manipulate these factors separately. She first realizes what might be causing the 'noise'.

T - Ok, so even if you might not like violin sounds...if everything has the same kind of sound....what do you think the effect that has when you've lots of things happening..

E - You can't hear them..

She then proceeds by placing strokes in discreet pitch ranges with no overlaps for maximum clarity and uses both volume and timbre to create a more sharply defined texture.

Finally, Emer begins to find a language to describe her music. Her initial descriptions of her work are vague and imprecise and she has not yet developed a set of explicit criteria for making judgements.

T - Which one do you like the best?

E - (points to orange) That one.

T - Why do you like that one? Play it for me.

E - Because......it makes a nice sound.....

T - What do you think of that?

E - I don't like it.

T - Why don't you like it?

E - Its too noisy!!

T - You don't like that?

E – (shakes her head)

T - Why don't you like that?

E - Its just.....weird.

While there are clearly has some sort of internal criteria in operation, these are not yet explicitly accessible to her. Later she begins to make more considered assessments and descriptions of her work, apply musical criteria to it and to use some of the language she has heard in this context.

E - It gets confused.

T - You'd get confused - why would you get confused?

E - Cos all of them playing at the same time and them two (blue and purple) don't really go together.

T - So what did you do when you went down here?

E - Just did a kindof a pattern....these…. I just did and I did that little droop at the end of it.

E - Yeah....and there's a pattern there.

T - Tell me what this is doing.

E - Its going up in stairs, but they're supposed to finish at different ones here but I wanted them to finish at the same time.

T - And then just as they end...

E - That one starts.

Emer seems to make little progress in the area of harmony. When first introduced to the harmony options tab, Emer doesn't seem to like the effect of these options on her motives.

T - Don’t like that - why don’t you like that?

E - Its, ‘cos it mixes it all up (all over the place).

T - It mixes it all up....you mean it changes your motives?

E – Yeah.

T - And you don’t like them changed?

E – No.

However, later she opts for major/minor harmony mode and persists in this mode for the duration of the sessions. The teacher demonstrates the Harmony Line function in major minor mode. He plays Emer’s piece in major/minor mode, singing the root note. Both Emer manages to sing this pitch accurately. He then makes an orange/green section (V-I) section and says;

T - I’ll sing exactly the same note all the way through, and I want you to hear what happens (demonstrates)

E - It doesn’t go with it......It changes.

T - The music changes so that the note I’m singing....

E - Doesn’t go with it...exactly.

The teacher then sings all the way through, and Emer notices when the tonic begins to ‘go with’ the music again;

E - It starts to level up.....

Emer has a clear sense of the tonic note. She can tell when the harmonic progression shifts away from and back to the keynote.

The teacher asks Emer to sing Doh-Soh-Doh - Emer sings back at correct pitches. The teacher sings;

T - Doh-Soh......Soh-Doh.

T - Which of those makes a better ending?

E - The second one.

Not only can Emer hear harmonic movement, but she is also aware of the functional implications of the harmonic progressions.

However, despite her intuitive understanding of harmony as a listener, Emer seems to have difficulty making use of this understanding in shaping her own piece. She experiments both with various harmony options and with the harmony line itself, at various times making as variety of seemingly random gestures including both local harmonic curves and modulation ‘spikes’. She later deletes most of these, so that her final piece contains almost no harmonic manipulations.

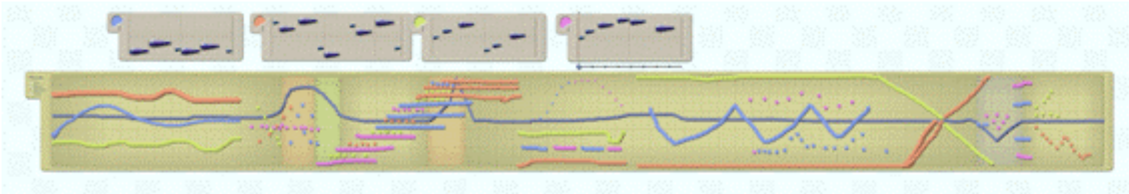


Figure E17 Emer's Final Piece

It might be that because she cannot quantify the exact effect of the harmony line clearly, she avoids using it and prefers making stroke gestures in the sketch window, the effect of which may be immediately and clearly perceived.

Emer's learning is more difficult to explicitly quantify than that of either Kevin or Stacy. She is generally less well able then either of them to express her ideas verbally. She is also less forthright in looking for help or in asking specific questions of the teacher. It is difficult to tell at times whether her motivation is primarily musical or is concerned mainly with the graphical aspects of the interface. There is no doubt that some of her actions are made for visual or gestural reasons. Having said this, it is also clear that she does engage with the musical aspects of the task on many levels and that the nature of her engagement changes and deepens over time.

Teaching Interventions and Strategies.

The initial case study with Kevin identified a number of types of teacher intervention and a variety of strategies employed. A similar analysis of Emer's case yielded a similar range of interventions of various types.

Initial teacher interventions follow similar patterns to those in the cases of Kevin and Stacy. The teacher moves to establish Emer's concerns and have her identify and perceive aspects of the structure of her motives. These interventions also have the simultaneous aim of allowing the teacher to interrogate Emer's perceptions of her motives. He does this by focused questioning, using the representation as a point of reference. As in many interactions, while the object of a given intervention may be fixed, the teacher may try a variety of strategies in pursuit of his objective.

> T - What kindof notes does that use? (points to first note). It starts with a ......?
> E - A low note....
> T - A low note, and what size of a note is it?
> E – A small one.
> T - So it starts with a low small note, and then it goes....? (traces curve of melody on screen)

The teacher makes use of kinaesthetic techniques, both by having Emer physically trace the shape of her motive and by similar clapping exercises to those used previously. Again, he combines the physical aspect of the exercise with use of the interface.

> T - What about this one? (red) What shape is that?
>
> E - Its like that (traces down-up-down-up with her hand)
>
> T - Which ones have a smoother shape and which ones have a less smooth shape?

Emer identifies two smooth and two 'rough'.

The teacher asks her to clap a steady beat - she does. He then asks her, pointing to a motive.....

> T - Does that have a steady beat?
>
> E - No it's not a steady beat.
>
> T - So its kind of uneven, the beat, is it?
>
> E – Yeah.

The teacher moves to try to bring Emer's internal representation of one of her motives into alignment with its objective aspects. He uses a 'ruler' metaphor to explain how the divisions in the motive window divide up time, and explores the placing of beats with respect to the pulse by using 'even' and uneven' to describe rhythmically aligned and unaligned notes, demonstrating how to place notes so that they will be aligned with the underlying rhythm template.

> T - If it has to have an even beat....how do the notes happen in time?'
>
> T - Would they be spaced out evenly or unevenly in time?
>
> E – Evenly.
>
> T - So...that guy there looks as if he's gonna be an even one....doesn't he?
>
> E – Yeah.
>
> T - What about that guy there?
>
> E – No.

Emer seems to understand and indicates this by her ability to pick out 'even' and 'uneven' notes. The teacher then sets her the task of trying to 'move notes around and see if you can come up with something that's a little more even'. The teacher's intent here is that Emer should work on the rhythmic alignment of her motive. However, as soon as she starts to work, Emer completely obliterates the motive pitch content and remakes the motive with most of the notes at a single pitch. Having made an 'even' rhythm, she then moves notes up and down so as to create a melodic contour approximating to the original. In doing so she now re-disturbs the rhythmic placement.

Emer has taken the teachers emphasis on rhythmic placement literally, and has focused on it to the exclusion of pitch. In focusing on rhythmic placement, she loses sight of the melodic aspects, while when she returns her focus to melodic contour, she loses sight of rhythmic placement. While she clearly understands both concepts, she doesn't seem to be able to hold onto the two things simultaneously. The teacher returns, observes that the motive is not aligned rhythmically, and so repeats the demonstration.

Later in working on her blue motive Emer again attempts to create a more rhythmically aligned structure at the teacher's suggestion. After several attempts, she figures out how to move notes so that they are all aligned regularly. In doing so however, she alters the pitch of some notes. She recognises this and tries to move the notes to their previous pitches. She can't seem to find the correct pitches and so uses the Ctrl-Z (step-back) function a number of times to try to reset the motive to its original, unaligned state. When the teacher returns it appears to him as if she has not made progress and therefore not understood the alignment issue.

> T - You didn't do this one yet (the motive in question).
>
> E - I did but it sounds very weird....(points to the notes where the pitch alteration is apparent)....them two...

The teacher again helps with the rhythmic realignment, but doesn't engage with the pitch issue.

Later analysis of the videotape shows that Emer clearly understands the alignment principle - she has successfully realigned both motives. The teacher has not perceived this and has repeated the intervention both times. A more fruitful approach might have been to spend some time interrogating Emer's understanding rather than assuming she needed a further demonstration. In this instance, the demonstration has failed, to the extent that it has contributed to Emer's focus on rhythmic aspects to the exclusion of pitch. The teacher's analysis of her 'product' here has indicated that she has not understood but analysis of the video shows that she has. This is a clear demonstration of the value of digital video as an aid to researcher reflection, as well as an illustration of one of the dangers of attempting to make an assessment of children's learning based on outcomes alone, especially in computer mediated creative work.

A good part of the teachers work with Emer is concerned with trying to grasp the various opportunities her actions throw up to surface basic musical rudiments, concepts and techniques. Over the course of a number of conversations, basic musical ideas relating to pitch, note value, rhythmic relationships, melodic contour, timbre and instrumental function are dealt with (see appendix B). These are not dealt with in isolation but often as part of a larger conversation relating to musical form and structure and higher order concepts such as change, relationships between things, structure, pattern, repetition and variation, along with various related techniques for manipulating the musical materials so as to give expression to these concepts.

A variety of techniques and strategies are employed to surface these issues including:

Specific questioning regarding the material;

> T - So why would this one be good for violins and this one be good for low instruments?
> E - Because this is very high.

Asking Emer to try and imagine outcomes;

> T - Can you imagine, are the double basses gonna be going (sings fast bom bom bom) playing really fast all the time, or are they more likely to be going (sings slowly, bom bom bom....)
> E - Yeah, they're more likely to go slower.

Making specific use of the representation;

> T - These lines are there to help you think about how to make the notes start on a beat….. so how could you move them so they might start on a beat
> E - Move them left. (Emer sees the solution herself)

Again using the representation to discuss ways of manipulating the material;

> T - How would I make the first part into the second part?
> E - Turn it over.
> T - So this is like this backwards, is that true?
> E – Yeah.

Asking Emer to shift her perspective and imagine what an audience might hear;

> T - Its too noisy - Ok So what could you do, if you were going to pick something for the violins and something for the basses, what could you do to make it easier for someone to listen to that?
> E - Emm, could you make them slower?

The teacher also models the various ways in which material might be manipulated. In doing so he engages Emer in a fluid conversation about the various options available, stimulating her to develop criteria for decision making.

> T - Ok so now were starting to think - where do we want it exactly.
> E - It starts a bit too soon (again, definite response in terms of ideas about structure).

T - (moves new figure to more rhythmically coherent place) If you were to put another note on the end, would it be the same or different?

E - It would be the same place like.

T - Well, which is better? To do the same or different?

E – Different.

This engagement with criteria and decision-making is fundamental to many teacher interventions. In this respect, the teacher is clearly concerned that Emer make decisions on the basis of aural rather than visual factors.

T - When you were putting those notes in, did you put them in because you thought they looked good or because you thought they sounded right?

E - Sounded right.

T - And did you listen to it every time you put a note in?

E – Yeah.

He tries to surface the functional implications of her material and have her consider these in ways which may not have occurred to her. She has made a motive which is notionally intended as a bass part – however it is not very idiomatically written with respect to the capabilities of that instrument. He uses the 'perspective shifting' technique again.

T - So its more likely that the double basses will do what kind of notes, long notes or short notes?

E - Emm, long notes.

T - Are the bass players gonna like that or not?

E – No.

T - You don't think they will?

E - No...it's too.......

T - Do you think it would be hard for them to play that?

E – Yeah.

Emer has realised something about function and also about the criteria which she might apply to her work.

In the opening sessions, the teacher defines small, constrained tasks as a way of enabling Emer to become familiar with the interface. During the second session he begins to introduce the overall task, that of composing an entire piece of music. Typically at the start of each subsequent session, the teacher describes the task for the day.

T - Using the same motives that you have already, or by changing them slightly, try and get two or three or four motives that are going to be what you're going to use to make your piece of music. Two motives that you like the sound of....that kind of have some pattern to them...maybe...but that the pattern isn't the same all the way through.

This is generally a broad set of things to think about for the days work. After a couple of sessions however, it becomes clear that while Emer has made some motivic material, she is not clear about how to proceed with deploying this material in the sketch window. The teacher intervenes and attempts to have Emer break the task down into a series of separate questions relating to specifics of her material (What pitch do you want it? Do you want it to go up like that? How many times? Do you want something else to happen while that's happening? What other motive do you want to go with that?). The intention here is clearly to have Emer focus on a range of simpler, narrower tasks as a way of achieving some progress. When Emer still appears to have difficulty, the teacher becomes even more proactive. He begins a 'guided' composition exercise during which he asks Emer a very specific set of questions relating to how she might want to use her material.

T - How many times do you think that will repeat?
E – Four.
T - Do you want to hear that on its own at the start?
E - Emm, no.
T - What do you want to go with it?
E - Em.....the yellow one.
T - So where's the yellow one going to go?
E - A bit lower.
T - A bit lower, so its going to match up with, its going to go along with the....now do you want it to happen after it or at the same time as it?
E - Ehhh....(unclear)..in the middle of it.
T - OK, so put it in there - Ok now lets hear what the effect of those two together is.

As her work proceeds, it becomes clear that Emer has difficulty breaking down the task at hand and separating out the various threads which comprise it. She can usually identify when she doesn't like something but has real difficulty in identifying exactly what it is she doesn't like and which parameter might be appropriate to manipulate in order to solve the problem. She also thinks locally and has difficulty in planning ahead. The teacher perceives this and continues to adopt a more proactive role than was necessary with Kevin or Stacy, breaking the overall task down into a series of simple decisions. At the same time he tries to encourage Emer to experiment and explore at this more local level. In this respect he is engaged in a delicate balancing act between helping Emer to complete the task and allowing her as much freedom as possible to express her own ideas. The process is one where he tries to have her identify and describe some aspect of the music, become aware of some of the ways in which it might be changed, notice the results of the change and make decisions on that basis.

T - Now, one thing you can do is you can decide to make one of these make the bowed sound (demonstrates with orange motive and plays)...what effect does that have?

T - Are you hearing any one thing more now?

E - The orange.

T - You just kindof hear the orange one, don't you?

T - So you're in the audience, what would you think?

E - It gets confused.

T - You'd get confused - why would you get confused?

E - Cos all of them playing at the same time and them two (blue and purple) don't really go together.

T - Ok so you think that maybe these two don't go together very well and there's too much happening...

E – There's too many dots.

The teacher gradually introduces successive levels of constraint until such time as Emer is able to act autonomously. He breaks down the problem for her into a series of sub-problems and helps her to make decisions at this level while attempting to help her build to a more complete overview of her work.

Throughout his work, the teacher tries to become familiar with his 'working materials', which include both Emer's musical materials and Emer herself. He tries to become aware of her perceptions, needs and priorities so as to be able to make informed interventions. He guesses how she made one of her motives;

.

T - You took those three notes, and you put them in high and you put them in low......but....

E - I took out the last one.

T - You took out the last one...did you do that deliberately or by accident?

E – Deliberately.

T - Points to last single note.....'and this time you.....

E - I.....(unclear - prefer?) to get rid of it...

T - You want to get rid of that note altogether?

T - Well let's listen....(plays motive).

E - No I like that actually.

T - You like the last note, do you?

E - Yeah.

Such interventions are primarily information gathering on the part of the teacher, before making a more pointed intervention. As he works, the teacher attempts to establish Emer's needs and concerns at any given moment and respond on that basis.

T - Are you happy with that ending?

E – It's just, like, there's something missing, but I cant, I can't get it like.....

T - There's something missing....like what missing...

E - Like another dot but em..better sounding.

T - There's some particular note that you're looking for at the end that you can't find?

E – Yeah.

T – Ok.

Hyperscore Case 3 – Stacy

Introduction

Stacy's case is the second of the two subsidiary cases chosen from the Hyperscore workshops. This case was chosen so as to illustrate kinaesthetically motivated behaviour, while reinforcing observations made in other cases with respect to student and teacher behaviours. It will be analysed under similar headings to those employed for the previous case.

Stacy's Composing Process

In the first session, Stacy is given the same task as Kevin – to make four motives which are different from each other. She listens to her work regularly, without having to be prompted. She makes three motives – blue, purple and orange. All are rhythmically and melodically coherent.

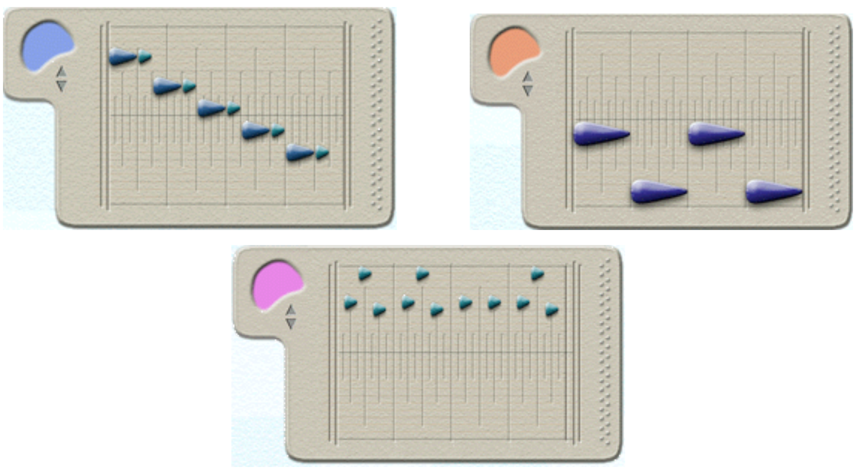


Figure S1 Stacy's First Motives

She seems to experiment randomly until an idea occurs. At this point she very quickly completes the motive as if it was fully formed in her mind. Each motive seems to be the working out of a single idea.

She does not yet exhibit the sort of convergent behaviour engaged in by Kevin. Her motives have a clear sense of organization with respect to pitch, rhythmic placement and tonal factors.

In the second session, Stacy again is asked to make two new motives that ‘go together’. She again seems to operate here on the basis of a single idea underpinning each motive. She has a simple idea then executes. She quickly makes two new motives. In making the first (blue) motive, she makes and discards four different motives before settling on the fifth.

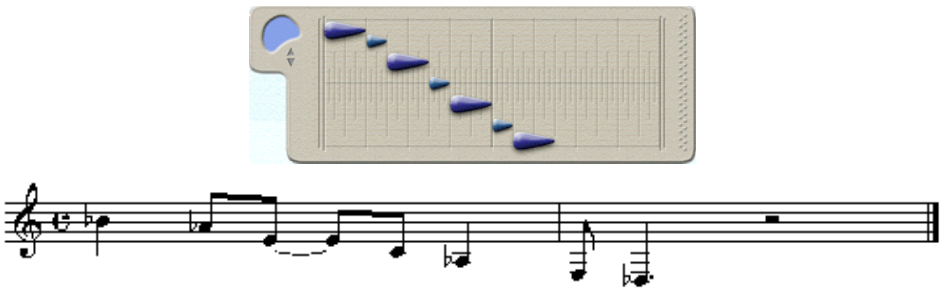


Figure S2 Stacy’s Second Attempt (blue)

In making her next motive (purple), she returns to random experiment. She spends some time dotting in notes, first quarters then 16ths. After a time, she stops and listens. The notes are distributed in alternating up/down pitches.

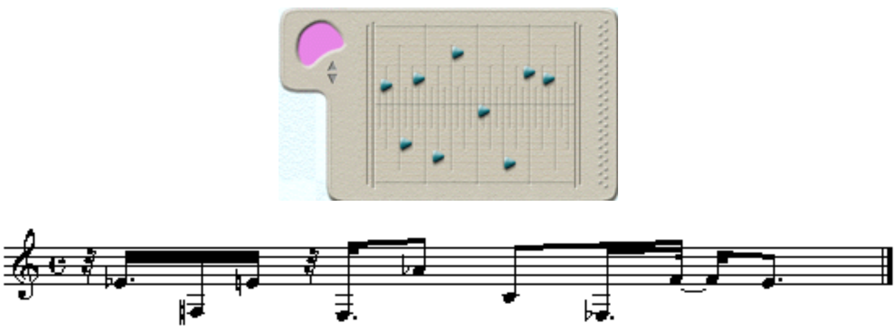


Figure S3 Stacy’s Initial Process 1

She then seems to hit on an idea. She clears the screen and begins to work in a structured way, placing five sixteenths alternating high and low, carefully ensuring that the pitches match in both the upper and lower register. She listens. The last note is a semitone too low so she moves it up. She makes some adjustment to the rhythmic position of two notes.

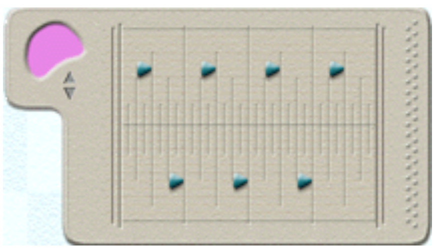


Figure S4 Stacy's Initial Process 2

In this case, there is some sense of early experiment, but then her reaction to what she has made leads to the formation of a plan which is then worked out.

In working on her next motive, Stacy seems to move towards a more convergent approach.

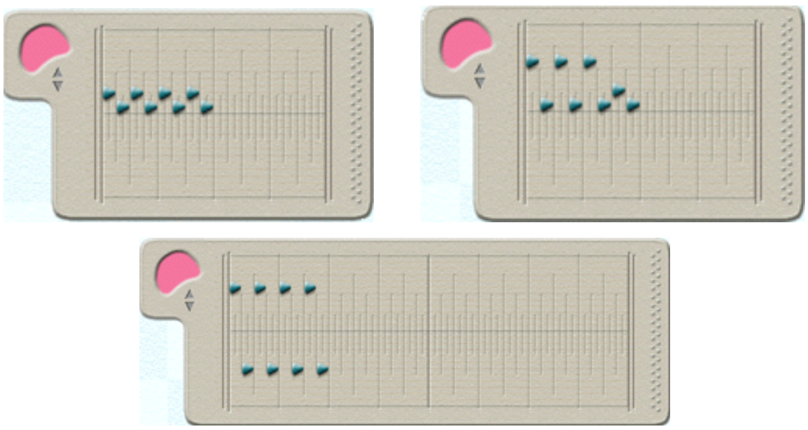


Figure S5 Convergence 1

This is quite similar to her earlier purple motive. At this point she randomly dots in some notes, disrupting the organisation the pattern. She clears the window and begins again, using small notes and maintaining something about the intervallic nature of the pattern.

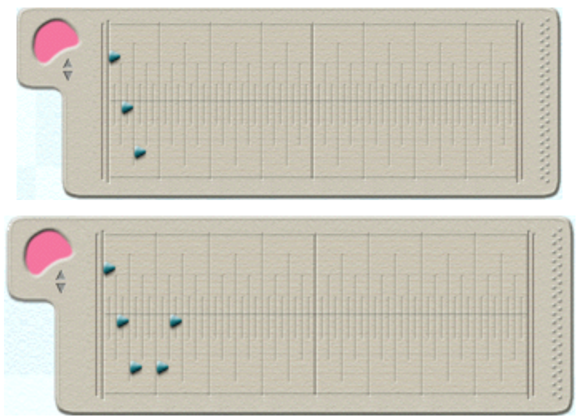


Figure S6 Convergence 2

She seems to have a definite idea that she is working out.

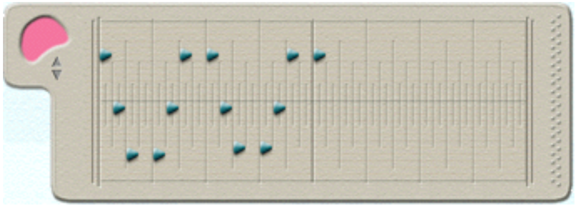


Figure S7 Convergence 3

At this point, she listens twice. She does not adjust the lower two notes in the second figure, despite the fact that they are a semitone higher than their equivalent notes in the first figure. She does however trace the shape of the motive on the screen with her finger and sings under her breath before very deliberately adding the last three notes. We might speculate that at this point she has a fully formed idea of the ending.

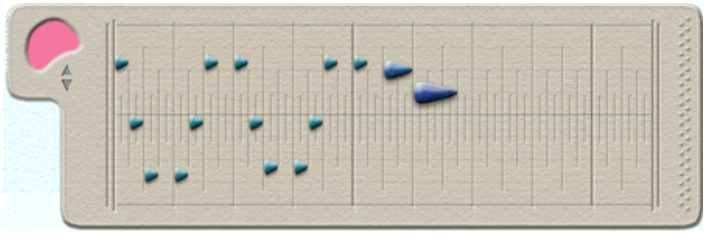
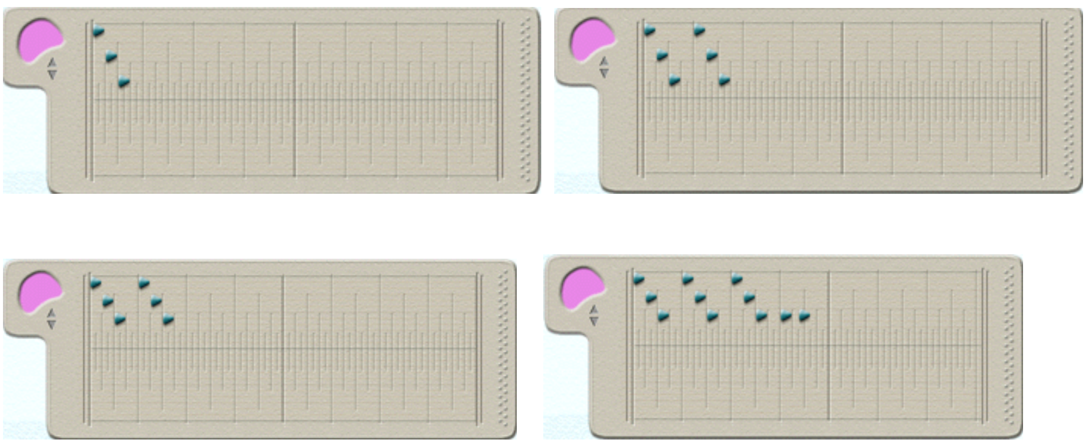


Figure S8 Convergence 4

Stacy has spent some considerable time in ‘bricolage’ before she settles on an idea with which she is happy. While she discards her earlier attempt, it is clear that some aspects of this have informed her final version. She maintains both note unit lengths and the intervallic up/down model as a basis for her final figure, converging on the eventual solution. This motive is based on a three note unit which is then repeated, inverted, and varied although Stacy may not yet be overtly aware of these structural relationships. The manner in which it has developed bears a striking resemblance to Kevin’s more developed motive-making, and represents a more fluid and coherent process than Stacy’s own initial efforts. Her later work continues in this vein.



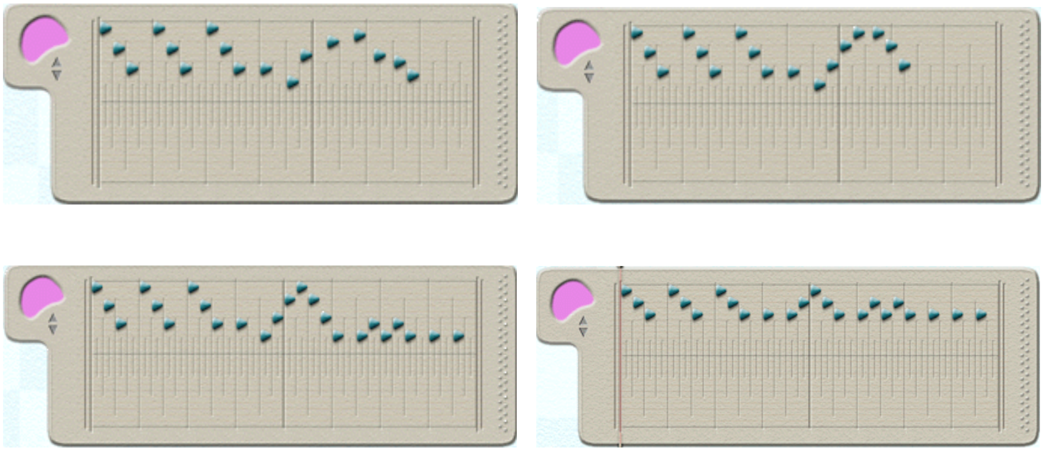


Figure S9 Fully Developed Convergent Process

Over the course of a number of sessions, Stacy's approach to making motives has undergone a shift, from realising simple, preconceived ideas to a gradual process of feeling her way towards a solution based on a fluid interaction with the materials as she works.

Stacy's initial work in the sketch window seems to be primarily gestural. She draws in three wavy lines, each representing a different motive. Each is drawn with a fluid gesture from left to right.

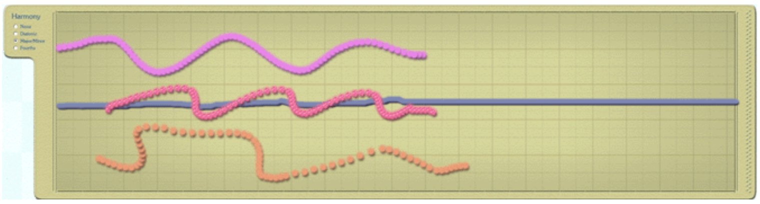


Figure S10 Kinaesthetic Drawing

In a later section of the piece we see evidence of a similar approach. She makes a series of u-shaped gestures, drawn first and positioned later. She fills in the middle of the pitch range with a series of diagonal lines, again drawn with a single fluid gesture.

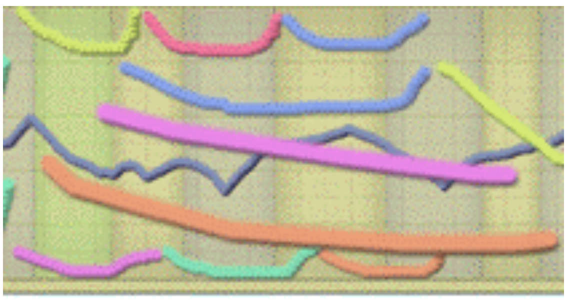


Figure S11 Further Kinaesthetic Drawing

The teacher asks her about her drawing;

T - Right, so you've got these kinds of shapes like this....why that shape?

S - (Laughs)...I just drew lines. (accompanied by 'shrugging' action with hand).

There is question of her musical intent here. She has made decisions regarding which motive to use. She has placed some strokes higher than others. She has deliberately placed some after others - so, she has engaged with sequential placing of the motivic content and pitch range. She seems to have a clear idea of differentiating parts, in so far as the lines do not generally overlap and inhabit particular regions in the pitch range. She is aware of rhythmic alignment between strokes, both their beginnings and the internal rhythmic alignment of notes. She demonstrates by singing at various times that she has a clear internal representation of the motive represented by each stroke. However, she clearly does not know what the exact pitches will be in any stroke, nor does she know about how this pitch content will interact vertically. She may intend something about melodic contour on a gross level of description. It seems more likely though, that the shape of the stroke is more a result of what is an intuitive drawing gesture, and does not embody any particular musical intent.

Having made her opening section she seems to be at something of a loss as to how to proceed. While relatively prolific in terms of motive production, she has difficulty in working on the larger scale represented by the sketch window. The teacher demonstrates the idea of short, flat strokes deployed in stepwise fashion. Stacy seems to latch on to this idea. She draws short green strokes making unit that repeats the motif figure four times and places them at various pitches using copy-and-paste.

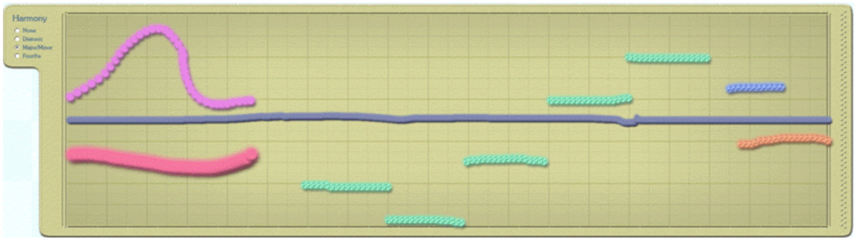


Figure S12 Flat Strokes

She then hits on the idea of pairing different coloured strokes as a working unit. She is soon clearly working to a plan and in a short time has created a figure that has parallel short yellow and green strokes in pairs moving down and then up, following the contour of the green strokes above.

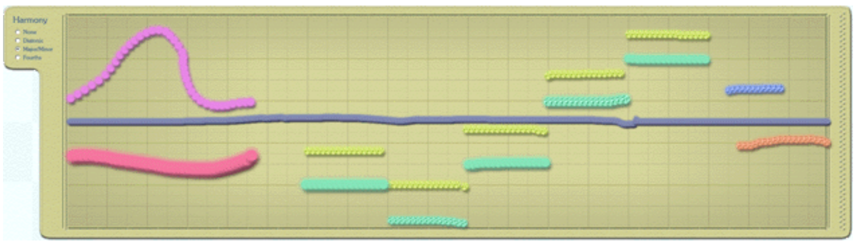


Figure S13 Paired Strokes

This is interesting in terms of Stacy's working practice. Until she sets the parameters within which she is working, she makes little progress. After the teacher's intervention however, she chooses some narrow range of parameters with which to work, effectively imposing a level of constraint on the task. She uses short flat strokes in pairs. Once she settles on this idea she then devises a plan of action and rapidly finds a solution. In this respect, the process seems somewhat akin to her earlier, more spontaneous motive-making.

Stacy begins to develop an overall sense of the shape of her piece. She makes a definite move, taking the orange over green section and moves it all the way to the right.

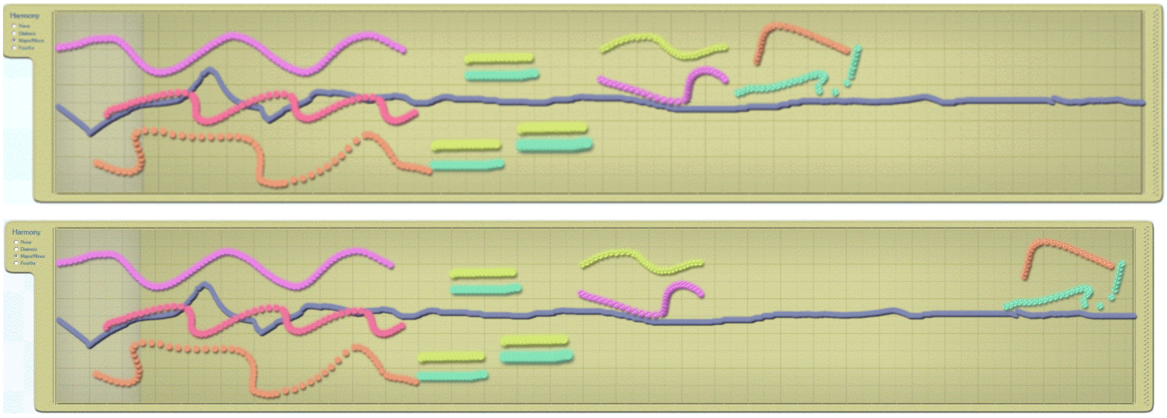


Figure S14 Awareness of Structure

There is clear intent regarding this subunit as a possible ending, confirmed in conversation with the teacher. She has moved from a linear, left-to-right approach to a consideration of overall structure, or at least shows an awareness that this is an issue. She is beginning to conceive of the piece as a whole and to converge on an ending.

Musical Interaction and Learning

In the first session, after Stacy has made two motives (blue and purple), the teacher engages her in conversation regarding what features of each she is attending to.

Figure S15 Attention to Structural Features

Stacy refers to both note-pitch and melodic direction, but not note length or rhythmic factors. When asked about the blue motive;

T - Ok, now, how many different kinds of notes are in this one (blue)
S – Five.

She is clearly attending to pitch rather than rhythm. The teacher draws her attention to the rhythmic aspects of the motive.

T - If I said don't think about pitch, think about length of notes, how many different kind of note lengths....
S – Two.
T - Two, there's kind of a smaller one and a bigger one?
S –Yeah.

She now perceives the motive as having two kinds of notes. She has shifted her perspective so as to view the same object from a different standpoint. A similar shift happens in considering a later motive.

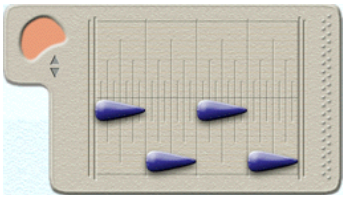


Figure S16 Perception of Sub-Units

T - So play it and show me what bit repeats and how many times
S - (Points to two higher notes) Them two repeat..
T - If you were to split it, and say, here's a bit and here's the same bit again, where would you split it?
S – (Makes diagonal gesture with her finger indicating a separation between the first two notes and the second two)

Initially, she is attending to pitch – she conceives of the motive as a higher not which repeats and a lower note which also repeats. She then refocuses her understanding to consider it as a two note unit repeating in time.

Later, considering a different motive, the teacher returns to the idea of repeating sub-units.

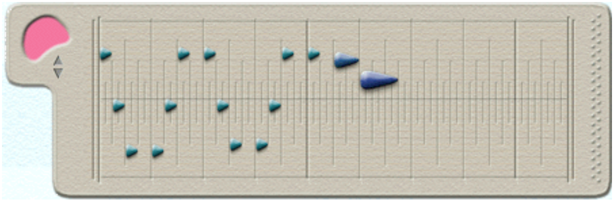


Figure S17 Perception of Pattern

T - But you obviously are thinking about patterns....

T – Aren't you? Are you?......what's a pattern?

S - Something that goes over and over again....

In a later conversation, Stacy indicates she knows that the two repeating sub-units in the red motive are not the same.

T - Now listen very carefully - are the two patters exactly the same?

S – (Interjects)'No'

In describing her pattern later she says…

S - It goes down and up (Contour/Inversion).

S - Its going backwards (Noticing the inversion in the first section).

In her conversation, Stacy demonstrates the ability to gradually break-apart her motive into its constituent units. She considers the six-note repeating unit, describes its contour ("down and up") and notices the pitch difference in the repeat. However, she then changes the size of her working unit of description and considers a three note unit ("it goes backwards"). This is very similar to the perceptual 'zooming' behaviour exhibited by Kevin. Stacy is considering the same material from multiple perspectives and at different levels of granularity. She is clearly using the representation as a vehicle for consideration of specific aspects of the musical material.

Stacy encounters the idea of pulse and manages to uncouple rhythm from underlying beat, in a manner similar to Kevin. The teacher has her clap along the pulse of a motive while it repeats. Initially she claps the notes and leaves a silence in the gaps, but then she begins to clap in the gaps. After some discussion, she claps a regular pulse and counts 'one, two, three, four, five'.
The teacher draws her attention to the silences.

T - So one of them was...?

S – Silent.

T - So what do you call a silent beat?

S - Skip?

T - Skip is one word....there's a word in music we call a 'rest' - have you heard that word before?

S – No.

T - So a rest is the opposite of a note - a rest is like a silent note....

In discussing how the motive sounds when played in the sketch window, Stacy uses this new information.

T - What happens between each repeat?

S – There's a rest.

Later, two motives don't seem to match up when sounded together.

S - (listens) There's no rest.

Stacy has further applied her new concept of 'rest' but in a completely different circumstance.

While working in the motive windows, there is a limited range of musical parameters at play. In the sketch window, things become more complicated. Now, rather than considering simple melodic and rhythmic aspects of the motives in isolation, the interplay between motives becomes important. Factors such as pitch range and interval between strokes, rhythmic alignment, contour (in the aggregate), overall structure and the manipulation of harmonic gesture add to the overall complexity of the task. In this context it becomes increasingly difficult for Stacy to maintain control over all parameters. When working with large-scale factors such as harmony, she sometimes loses the ability to perceive things on the smaller level. Similarly, when concerned with a specific musical parameter, she sometimes has difficulty in maintaining focus on others.

For example, at one point working in the sketch window, Stacy edits the timbre of a number of strokes. In doing this she accidentally moves one stroke of a pair so that the two strokes are no longer correctly aligned. On the first playback she doesn't notice this, but does stop to raise the volume of the four last strokes. Stacy has demonstrated she is capable this level of rhythmic discrimination and has explicitly expressed a preference earlier that these two strokes should start together, yet she doesn't notice now. In this case she is attending to timbre and so neglects the rhythmic aspects.

Later, Stacy begins to demonstrate the ability to engage with multiple issues in a more holistic way. She has created a new motive and deploys it in the sketch window.

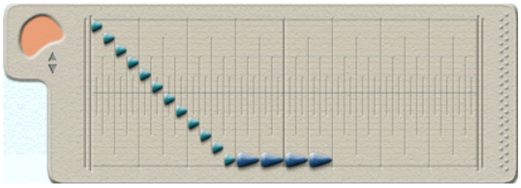


Figure S18 Alignment

This motive is characterised by a long rest at the end. When she draws it in the sketch window, she is careful to align its ending with the purple stroke with which it is paired. However, despite the fact that the strokes visually end together, the content of the purple motive continues to play after the orange has stopped because of the long rest. Stacy notices the problem

> T - What did you think of it?
> S - I think I'll put it where it's supposed to stop....that didn't really stop.
> T - Now it didn't...do you know why it didn't?
> S – 'Cos there's a gap in the motive.

She is relating the content of each motive to what is happening in the sketch window, making connections between both the smaller and larger scale, and between the note content of each stroke. This idea of inter-relationships between musical motives arises many times. In discussing two motives;

> T – Is there something about how one starts and ends and how the other starts and ends....and how they repeat that matches up or doesn't match up.
> S - They don't stop at the same time.

One motive is extended so as to match the length of the other.

> S - Oh, that's cool....I like that.
> T - So what's better about that?
> S - They start at the same time.
> S - They start together....and they finish together...

Again Stacy is demonstrating the ability to apply criteria to what she is hearing. Later she makes practical use of these interrelationships. As she works on a motive, she moves it to line up with one made previously and extends the length of her new figure to match indicating awareness of context and making practical use of the software to explore the notion of rhythmic alignment.

When she first deploys material in the sketch window, which is set to the default 'no-harmony' mode, Stacy dislikes the results.

> T – You don't like it?

S – No.

T – What don’t you like about it?

S – The music is sort of all over the place.

Stacy values organization, both rhythmic and melodic, as clearly seen in her motivic work. The teacher demonstrates the effect of each of the options on the piece he has made. Interestingly, despite the fact that the options are presented in the interface in order – no harmony, diatonic, major/minor and fourths, the teacher presents the major/minor option last, each time asking Stacy whether this sounds better then the previous. This seems to be a clear case of teacher bias, which may have affected Stacy’s response. Alternatively, it might be that the teacher’s intuition was to introduce the options in increasing order of perceived imposed order. Stacy expresses a clear preference for the major/minor option.

He explains the action of the harmony line in terms of its effect on the notes that comprise each stroke. He makes a red/green, I-V-I cadential section and sings a continual tonic note through the I-V-I change, asking Stacy to say when the note he is singing sounds ‘wrong’. Stacy notices where the change takes place.

S - Oh yeah.

T - What I was singing started being wrong.....

S - (Interjects, pointing at the screen) It goes up, and that’s how you’re getting further away from it.....its flat and it goes up and it goes down.

Stacy has an intuitive understanding of key, and now knows that the harmony line causes the music to move away from, and back to, the tonal centre. However, chord function has not been formally discussed, neither have the concepts of key or modulation. Stacy opts to work in major/minor mode. She expresses her reasons for this.

S - It changes the music sort of....the sound of it.

T - Even though it changes your bits of music?

S – Yeah.

T - But they still sound like your bits of music, don’t they?

S - They go better together.

Stacy seems to have a keen harmonic sense. It might be that this has a higher priority for her than any perceived small changes to the motives themselves. She is choosing to prioritise ‘go together’ harmonically rather than exact repetition of the motives. This is an interesting contrast to Kevin, who chooses not to use the harmony line at all so as to maintain as much control as possible over the output..

Later, working in the main window Stacy experiments with manipulation of the harmony line. She makes multiple adjustments without listening to the effect of each. Her adjustments to the harmony line do not seem to be specifically aligned with stroke gestures. While she does not seem to explicitly target harmonic gestures at particular strokes, she is to some extent aware of its interaction with her motivic material, certainly to the extent that she is aware that her material is changed by application of the harmony line. A later interaction in the area of harmony demonstrates this. She moves to close a gap between some strokes by shifting them laterally in the window. This has the effect of moving their note content with respect to the underlying harmony. Stacy notices this immediately.

> S - And the harmony is gone different.

So while she is not specifically aware of exactly what the harmony line is doing, she is generally aware of the change in effect. Later, in working on harmony manipulations in the yellow/green parallel section or her piece she seems to address this issue of harmonic alignment with stroke content. She works in a methodical way through the section from left to right. She makes five clear moves, apparently attempting to associate a single harmonic gesture with each stroke pair, although the beginnings and endings of each gesture are not precise.

In working on her ending, Stacy demonstrates a clear preference for a tonal ending and indicates a developing sense of key. She now understands the function of the green and red sections in terms of a tonic or ‘home-note’.

> T - And this orange, green and orange business...can you remember what effect they have on the music?
> S - The orange made it go from the.....farther away from the home note.
> T – Ok.
> S - The green goes back down to the…
> T - The green goes back down to the home note.
> T - You finished the piece in an orange section.
> S - Yeah, I was trying to get a green section.

She spends some time adjusting the harmony line to achieve the desired harmonic effect. She then tries to make a two-note soh-doh tonal ending. After repeated listening and experimenting with a range of pitches, she eventually creates a V-I tonal ending.

Teaching Interventions and Strategies

The teacher engages in a similar range of strategies in helping Stacy with her work as in previous cases. He consistently draws her attention to aspects of her material that she might not have considered.

T - I want you to listen to they way those two are going....there's something that's happening between the two of them....

S - I don't know.

T - Ok, I'll try and make they question clearer....is there something about how one starts and ends and how the other starts and ends....and how they repeat that matches up or doesn't match up.

S - They don't stop at the same time.

He tries to draw the discussion into the physical realm, to have Stacy engage with the music on a kinaesthetic level. In the discussion about 'gaps' or 'rests' referred to earlier, the teacher has Stacy clap along the pulse while her motive plays. Initially she claps four times and leaves a silence in the gap, but as it progresses, she begins to clap in the gap. The teacher asks her if she should count the gap. She's not sure, or at least doesn't answer, so the teacher has her repeat the exercise, but count out loud as she claps. Stacy counts 'one two three four …'counting notes but not the rest. The teacher tells her to:

T - 'Go back to one whenever it starts again'.

This time Stacy counts first 'one two three four (gap)' but on the second attempt, she clearly counts 'one, two three, four, five' repeatedly, counting 'five' on the rest. Her physical actions have helped her to reformulate her understanding.

At several points in the workshop process the teacher asks Stacy to try to listen and imagine what might come next.

T - Make something that sounds like a tune, with a combination of long and short notes....that you might sing...(later)...see if you can imagine the tune in your head and see if you can make it on there....

Whenever the opportunity presents itself, the teacher tries to introduce both rudiments and formal concepts suggested by Stacy's work.

T - But you obviously are thinking about patterns....

T - Aren't you? Are you?......what's a pattern?

S - Something that goes over and over again....

The teacher frequently demonstrates the various ways in which Stacy's material might be manipulated. In doing so he seems to want to present as many options as possible. As he demonstrates, his actions are not pre-scripted. While he has a store of possible manipulations arising out of his prior experience, he is exploring those that seem to suggest themselves out of a consideration of Stacy's materials. As he works he is careful to try not to impose a solution

T - See, this is the way I think...it's not necessarily the way you think....

He tries to help Stacy stand back from the interface and develop a sense of making a real piece of music. He does this by referring several times to a potential audience, trying to have Stacy evaluate her work from a more detached perspective.

A good deal of the teachers' efforts are concerned with helping Stacy to frame the task. He does this frequently by presenting questions that Stacy might want to consider in her work.

T - So what I want you to think about, is.....a piece of music usually has a beginning...
S - And an end...
T - And some stuff in the middle, so what I want you to think about is.... how would this piece start?...what would be the first thing that someone would hear, what would be the second thing that they would hear, what would be the third thing they would hear...how is this gonna capture their attention?....

T - …. how long do you want all that to go on for? How am I going to make them work towards a climax? How is it gonna build up? Or maybe it's going to build down, or maybe they're all going to stop or something. And the other thing then was, you have to pick a harmony mode...and you liked the major/minor harmony?

In these early interventions the teacher does not trying to simplify the problem by constraining the task. Rather he outlining all of the options at Stacy's disposal and lets her engage with the multiplicity of issues in a real way. Later however, he perceives a need to change this strategy. As she works in the sketch window, it becomes increasingly clear that Stacy is somewhat at a loss as to how to proceed. Despite the teacher offering lots of options regarding motive choice, stroke patterns and textures, the only opinion Stacy expresses is:

S – I'd rather strings....

She is comfortable with the idea of timbre, so expresses herself in this area. However she doesn't seem to be able to engage with the wider issues. The teacher notices this and changes his approach. He chooses two motives and says;

T - I want to see how many interesting ways you can put those two together.....using the green one and the yellow one, make a section that uses those two.

The teacher has again defined a constrained sub-task. He perceives that Stacy has a difficulty with framing the larger problem, so he is suggesting a smaller more constrained problem as a way of getting her 'unstuck'. The interface facilitates this shift in focus.

As work progresses the teacher becomes more proactive in terms of task definition. He works by questioning, offering Stacy a series of small decisions and then helps her to adjust her piece on the basis of these answers.

> T - The next thing then is….. do you want that gap between those ones and those ones ?
> T - How much...how many beats do you want in the gap there?
> T - Did you want them to end together or not?
> T - How long of a gap do you want here?

In trying to help her find an ending for her piece he says:

> T - You definitely think it doesn't need anything else at the end? Like (sings a sample ending).

From a tonal point of view, in so far as it is possible to be objective, Stacy's attempted ending ending would not be considered satisfactory. The teacher sees a number of possible solutions which might work. He tries to balance his desire to 'tell' Stacy these solutions with his awareness of the need to respect her autonomy as a composer.

> T - I'm not saying it needs it, I'm just asking...'cos there's lots of different ways to end...I'm just curious about how people think about endings.
> S - Yeah I'll try one.
> T - You don't have to…

This is a little disingenuous. Stacy may well realise that if the teacher didn't think there was a problem, he wouldn't be asking such repeated and focussed questions, and so feel that there must be something 'wrong'. Even though the teacher is saying 'you don't have to', the subtext may be 'you do have to'.

APPENDIX C DrumSteps Case Studies

APPENDIX C. DRUMSTEPS CASE STUDIES

Introduction

As in the Drumsteps case studies, a number of children made use of the software to construct a single piece of music over several sessions. From these studies, three were chosen for close analysis as representing aspects of interaction type – Conor, Ciara and Becky. As the Drumsteps software is different from Hyperscore in many fundamental respects, it is to be expected that the nature of these interactions may differ from those observed in the Hyperscore workshops. Specifically, kinaesthetically motivated actions were not observed. However, elements of procedurally motivated work were apparent, as well as both musical and visual interactions. As in the Hyperscore studies, a single case will be reported chronologically so as to give the reader some insight into the nature of the teaching and learning process, while the other two cases will be referred to under specific headings.

Drumsteps Case Study 1 – Conor

Introduction

Conor's case has been chosen to illustrate the nature and scope of the DrumSteps workshops, and as such will be described chronologically and in some detail. While Conor has little prior musical experience, he immediately relates to the Drumsteps application as a means to produce and organise sound. His case then, primarily illustrates musical engagement, as opposed to engagement through visual or other modes.

Session 1.

Initially the teacher introduces the software. He demonstrates how to place steps, how to set the step volume, how to place triggered sounds on a step, ladders and wormholes. He makes some steps, places a ball on the top and plays. He sets Conor a simple task – to make a single line of steps.

> T - Ok so just make one line of steps....all I want you to do today is use maybe some steps and some ladders....and you've got different kinds of ladders...and a ball, and make one line of stuff....and then make a second line of stuff in a minute, but just do that for the moment.

Conor immediately seems to understand the 'diagonal' movement inherent in the software.

> C - Can I make it go down like that? (he indicates a diagonal line running top to bottom, left to right by pointing at the screen).

Conor begins work. He starts to add in steps. He makes twenty-three moves, creating a long diagonal line of elements, starting in the top left-hand corner. He uses normal, silent and accented steps and a variety of four and three rung ladders, plus one triggered cymbal. He goes to the ball menu and auditions a variety of sounds. He settles on an open triangle sound, listens twice more to the sound and places the ball on the top step. He presses play, and the ball begins to move along the two steps at the top. He stops it immediately, before it can fall. He seems to have spotted the fact that there is a gap between this step and the next and realises that the ball will just fall down. He fills this gap with a step, and also two others further down the line, making a twenty-six element set (figure C1) then plays.

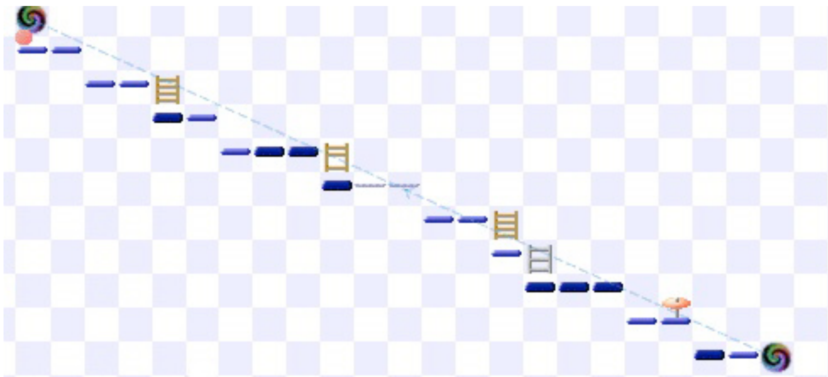


Figure C1 Conor's First Attempt

Conor has no problem manipulating the screen elements. He understands the principle of operation of the software immediately but at this point seems to have little idea what the musical result of his construction will be.

> T - Ok, now, do you know in your head what this sounds like?
> C - Mmmm, no, not really.
> T - Not really....if i say, could you clap that?
> C - Would I be able to?
> T - Would you be able to clap it?
> C - Probably not.

The teacher asks Conor to say what he thinks his construction might sound like.

> T - Ok, fair enough, so tell me what....what do you think its going to do? Describe to me what sort of sounds you're gonna hear as the ball goes along.
> C - (points with mouse to cymbal near end) Well down here you're gonna hear a sort of clang, and (uses mouse to trace path down steps) lots of little pings as it goes.....down, the ball.

While this is not a very clear description of the music, it does indicate a beginning of using the graphical score as a reference and extracting some information from it. Conor doesn't read music and so this may be the first time he has used any sort of symbol system to reference sound.

After some discussion relating to accented steps and wormholes, the teacher asks Conor to count the number of beats in his piece as it loops three times.

> T - Any idea
>
> C – Seventy-two.
>
> T - How many?
>
> C - Seventy-two I counted.
>
> T - Seventy-two!! Thats a big lot of beats, isn't it? Ok, play it again, and count it out loud for me.

The section consists of twenty-six beat units, but has thirty-four actual sound events. It is not clear which (if either) Conor is attempting to count. The teacher asks Conor to play the piece again and count out loud. He clearly counts sound events (rhythm) rather than beats (pulse). In counting the ladder units he counts multiple times, once for each rung of the ladder. The teacher addresses this issue by using a clapping exercise. He has Conor clap a steady beat, and then claps subdivisions, initially doing two claps for each one of Conor's.

> T - Now what am I doing?
>
> C- You're going faster'
>
> T - Faster - how much faster?
>
> C – A beat faster.

The teacher engages Conor in further clapping exercises, until such time as he is satisfied that Conor can make a distinction between pulse and rhythm.

> T - Ok, so when I ask you to count beats, what am I asking you to count- am I asking you to count all these little notes in between, or am I asking you to count the steady beat.
>
> C - The steady beat.

He then leaves Conor with the task of listening to his piece and trying to figure out how to clap a steady beat along with it. Conor listens a number of times to his piece. After a time he starts to build a second set of steps. He makes a seventeen-element group without listening. Then, having listened to several drum sounds, he selects a Low Conga ball timbre. He adds wormholes with the loop number set to three and links the wormholes. As he works, Conor twice accidentally adds a cymbal and later accidentally deletes his first step. In each case, he goes back and fixes the error, indicating that his work is not random.

When he plays back his piece, he notices something about the relative lengths of the two parts and how they relate to each other.

C - This ball (pointing to the second line of steps) always falls off.

He suggests a possible reason for this.

T - Before the other one is finished...well can you figure out why that is?
C - (points to first line of steps) Because that one’s longer.

He then finds a solution.

T - Before that one.... so if you wanted them to finish together, you’d have to make sure they had the same number of......the same number of what?
C - Eh bars.
T - Bars or....?
C - Beats, beats.

Conor may be using the word ‘bar’ here to indicate a step rather than a musical bar. He has identified an important aspect of each part, that of overall length. He has also specified something about the relationship between the parts in order for them to ‘go together’. The teacher returns to the initial question of the number of beats in the first step set.

T - Beats. Ok, and we were trying to…, did you figure out how many beats there are in this thing?
C – Yeah.
T -- How many?
C – Six.
T - You think there are six beats.
C –Yeah.
T - Ok so lets try and figure out what you’re counting as a beat...ok can you clap the beat along with it.

Conor counts along with the in a way that doesn’t seem connected to the sound. He stops counting half way through. A possible interpretation here is that he is counting some variable aggregation of steps and ladders as a beat unit, based on how these are represented in the software, i.e. sets of things which go together visually form a beat.

The teacher is unsure exactly what Conor’s construction of beat is, and so moves to examine this before trying to go any further. He hypothesises that Conor may be counting two step units as a single beat (see figure 7.2.1).

T – (points to first pair of steps) So I think you're counting that as a beat, am I right, and that would be two beats (second pair of steps).

C - (quietly) Yeah.

The teacher taps this beat for Conor as the steps play – it adds up to thirteen double beats. He then moves to help Conor re-orient his sense of beat.

T - Ok so what if, there's lots of ways, there's lots of things you can count as a beat)...how many steps are in that (points to first double step) how many steps are in that first line?

C - Two I think.

T - Two, so say we counted that as two beats.

Conor seems to understand. They play the section again and Conor counts.

T - Ok so how many?

C – Twenty-six. (the correct number)

So Conor is capable of counting the correct number of beats in single step beat units. The teacher then tries to move up the beat hierarchy and have Conor reconsider the set in terms of two-step beats. He is trying to have Conor consider the same material from two different perspectives as a way of accessing the notion of pulse, independent of unit size. Conor has difficulty with this concept. The teacher attempts to give several examples of the same idea but Conor doesn't seem to get it. Eventually he builds a set of four doubles, plays it and counts the beat, accenting every second.

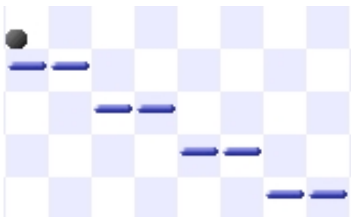


Figure C2 'Double' beats example

T – One-two-Three-four-Five-six-Seven-eight

T - How many did I get?

C – Eight.

T – That's counting (counts single beats)....now what if I just count these (taps double beats)...how many beats will I get now?

C – Four.

T - Lets try it - (they listen) - Ok so the number of beats we get depends on whether we count ....one step as a beat, or....

C – Two.

Conor finally seems to be making progress. After a conversation about different ways to divide up numbers, eventually Conor comes to the realisation that half of twenty-six is thirteen, so his original twenty-six step set could also be counted as thirteen ‘double’ beats.

They return to counting beats in single step units. They describe each step set in terms of their single-step length (twenty-six and seventeen units respectively) and Conor seems to understand that the difference in lengths is why the two sets fail to end together. The teacher leaves Conor to ‘play around’ for a few minutes before the session ends. Conor moves the mouse over the longer set from bottom to top, one element at a time. He is clearly counting the elements (he counts from bottom to top but he counts each flat sub-group of steps from left to right, indicating an internal perception of grouping based on the graphic). He begins to add elements to the shorter set, increasing its length to twenty-five elements. One of the wormholes is offset by a beat, so that the total length of this set is now twenty-six units (figure C3).

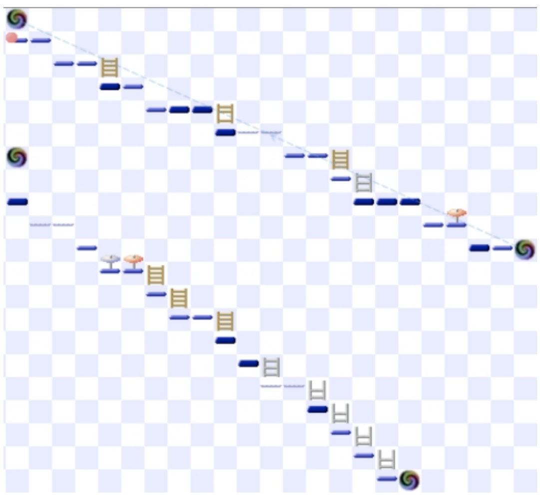


Figure C3 Conor’s Twenty-six Beat Pair

Session 2.

The second session begins with the teacher making some observations about Conor’s work so far.

> T -....and as you look at each ball going along, can you tell what each ball is doing?
>
> C – Yeah.
>
> T – What’s also interesting is, if you look at the ladders, ok, this is probably just an accident, but its actually quite a good accident in that if you look at the way the ladders go, we’ve a ladder here but none of the ladders necessarily match up - this one is doing a ladder when this one isn’t, and this one is doing ladders when this one isn’t (points to screen to illustrate)...so lets just play it again.

He plays back and points to the ladders in each part to illustrate that they are not sounding at the same time.

> T - Do you hear the ladders bouncing back and forward - do you hear the way that echoes back and forward between them, which is quite cool...
> T – What's very interesting in music sometimes is, if two parts are doing stuff...like if I'm playing a drum and you're playing a drum, and were both playing together, and I do something like dagadagadagadaga dum bom bom and I keep playing and then you do (same rhythm) after me.......
> C – Yeah.
> T - That could be quite interesting 'cos it's like almost a conversation between the two drums.
> C – Yeah.

In this instance the teacher is using Conor's work to surface a number of key ideas. He draws his attention to the fact that the ladder subdivisions are not concurrent in each part, but rather complement each other by being offset. Further, he uses the idea of 'conversation' to refer to the idea of imitation between parts. This notion of relationships between the inner detail of his parts becomes an important factor in Conor's later work. The teacher responds to Conor's piece in an unscripted way. He abstracts the underlying principles that may be drawn and tries to elucidate them. In this case, relationships between parts, the importance of having different material in each part and imitation between parts are referred to. The teacher tries to ground the work by having the students 'imagine' a real world example, and refers specifically to aspects of the representation to illustrate the points made.

The teacher then introduces a new technique. He demonstrates the use of 'boxes' to trap a ball and so create a pulse. He further illustrates ideas relating to rhythmic hierarchies by making different sized boxes and asking Conor about the possible results.

> T - Do you notice anything about those two balls....are they together or not?
> C - That one, the black one is a bit faster.
> T – Why?
> C - Because it's in a smaller….
> T – 'Cos it's in a smaller space, do you see that?
> T – That's a very interesting observation, well spotted - so why is that? It's like two people walking isn't it? If one person has a shorter step and one person has a bit longer step.....so they're out of step and every so often they go together.
> C- Yeah.

Again the teacher makes reference to kinaesthetic ideas in support of the concept in question. He then introduces the functional musical meaning of the 'box' technique.

T - Ok so what's good about that is...once I put that in there, that has a very distinctive sound, once I put that in, what does that do for you in the music when you hear it?....what's its job? Can you hear that it's very steady?

C – Yeah.

T - Ok, so no matter what else is happening, what's this doing?

C - It keeps on beating.

The teacher then sets a new task for the day which is to "make one line of stuff that is some definite number of beats...and you should be able to tell me it's that number of beats...."

Conor uses a combination of steps and ladders to make something that appears to be twenty beat units. He puts in a wormhole pair, links them, then counts the elements from top to bottom, pointing with the mouse. He listens. He counts the elements again from bottom to top. At this point it is very clear that he is associating each element with a single beat unit, so that ladders now get only one count, despite making multiple sounds.

T - OK so you're doing that - how many beats have you got here?

C - Fifteen I think......fifteen or twenty

T - Well which is it - fifteen or twenty - fifteen or twenty are not the same, are they?

C - Twenty!

T - Well play it?

They listen.

T - How many?

C – Twenty.

Conor has correctly identified the number of beats in his piece. He then goes on to make another set of steps. It also has twenty beats. As he works he stops several times and counts the number of beats.

T - OK, so what are we doing now?

C – I'm doing another one....

T - Mmmm?

C - (Points to his new set of steps)...That has twenty as well.

T - (counts the steps) - So it does, yeah - so you think they'll match up?

C - Yep...well hopefully.

Conor places and links wormholes round the new set and they listen. Both balls start and stop together. He starts to make a new set of steps. It quickly becomes apparent that he is building a repeating unit consisting of four flat steps and a ladder - a five beat unit in all - and that he is making four of these in a row (figure C4). The teacher arrives and Conor says;

C - They all have twenty.

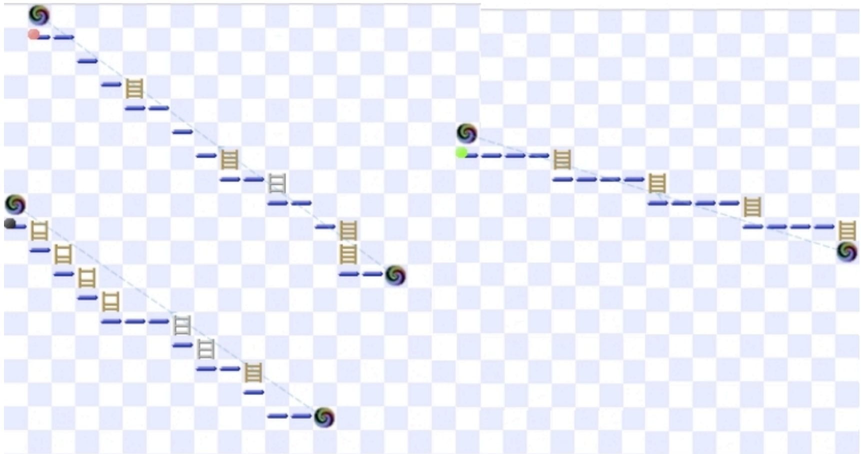


Figure C4 Conor three parts

Conor has managed to make three parts that work together in terms of their total beat length. He has further hit on the idea of repetition within a part and has worked out that a five beat unit repeated four times will equal the length of the other voices. Internal ladder gestures within parts are again placed so as not to coincide. The teacher questions him about this.

T - Together....together....(pointing the mouse back and forwards as the two parts diverge)
T - Now, did you do that deliberately?
C – Yeah.

Conor has demonstrated intent with respect to at least some aspect of the internal detail of the rhythmic patterns he has made. The teacher pursues this notion of intent, trying to discover if Conor has any internal musical representation of his rhythms.

T - Ok, now, would you be able to clap or tap any of these rhythms?
C - I might be able to clap that one there (points to the third set - in fives).
T - So what do you think that one might sound like?

Conor claps one beat for each of the four flat steps and then accurately subdivides in four for the ladder. His internal representation has each of the steps in the flat sections sounding, when in fact they do not. He has however, successfully constructed the rhythmic meaning of the four-rung ladder and can place it within the context of a regular pulse.

His construction of boundaries within his larger groups is interesting. The teacher traces the path of the ball over the steps with the mouse, saying 'babababaBom' at the junction between a ladder and the following step. He points to one of these junctions and says;

> T - How many claps in that?
>
> C – Five.
>
> T - Five - four in the ladder and one in the bottom, so it's like the ladder is 'babababa' and…….
>
> C - (claps and says..) Bom
>
> T - And then the next step is bom.

Conor associates the four-rung ladder and the step that follows it as a natural five note grouping. However, when questioned, he can reconfigure his viewpoint to consider it as a four-note group followed by a single note. This ability to view the same set of musical events from different perspectives is fundamental to his learning.

The teacher formalises the idea of repetition and ostinato with respect to Conor's third set of steps. He takes Conor's five beat unit and encloses it in two wormholes.

> T - This is doing..(traces with mouse and chants the rhythm - the same thing four times)….so it's doing the same thing four times, isn't it?
>
> C – Yeah.
>
> T - So could you make it do all of that by just doing this... (he makes a single five beat figure) and if I put a wormhole there and a wormhole there...
>
> C – Yeah.
>
> T - And then what would happen?
>
> C - It...it'll do the same.
>
> T - It'll do the same but....
>
> C – It'll finish before the other ones.
>
> T - It'll finish before the other one....so how many times would I have to make that go, to be the same as this going once....?
>
> C – Four.

Conor sees the relationship between the smaller five-beat group repeating four times and the larger, twenty-beat aggregations. The teacher further extends the comparison by asking how many times the five-beat unit might need to repeat in order to match with the longer units if they themselves were also repeating.

> T -.....if all of this was going to play twice.......?

C – You'd need eight of those.

The teacher then sets Conor a new task, to make a piece of music for four drums to play that would make use of these ideas about repetition and rhythmic unit relationships.

T -So we'll imagine something like eight beats, and you're gonna make some music for four different instruments, that's going to add up to eight beats, that are all going to play together....now remember you could just do something simple like make a four-beat, but make it do twice as much, couldn't you?

C – Yeah.

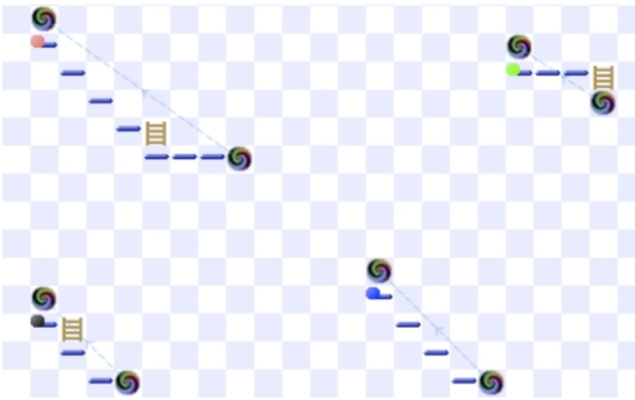


Figure C5 Conor's 8 beat piece

Conor works very quickly to make a four-part piece (see figure C5). He completes a single eight-step unit and sets it to four repeats. He makes three other four-step units and in each case sets them to eight repeats, balancing the first eight-beat unit. He uses ladders sparingly, just once in three of the sets and not at all in the fourth, but places them so as not to coincide. He doesn't listen to any of the sets until he is finished. It seems that he is attending to overall unit length, but not inner detail. The teacher returns and questions him on his piece.

T - Ok, what's your working number here?

C - That one, that one and that one are eight, that one is four.

Conor is interpreting 'working number' to mean number of times each set repeats, rather than the number of steps in each unit. The teacher misunderstands.

T - Ok say that to me again...I think you said that backwards.

C - (points to the 8-beat unit) That one is four...

The teacher is attending to the number of steps in each unit while Conor is attending to the number of times each unit repeats. The teacher investigates further by having Conor count each of the step sets in turn and state his understanding of the relationships between them.

T - That one is......(waits for answer) this one is how many beats...(counts one, two, three, four, five, six, seven, eight).

C – Eight.

T - This one is (Pointing to a four-beat unit)?

C – Four.

T - This one is?

C – Four.

T - And this one is one, two...?

C – Four.

T - So in the time that this one goes once (the eight-beat group), all of these will go ...

C – Twice.

Conor's understanding having been clarified, the session ends.

Session 3

The teacher introduces the idea of meter. He first asks Conor to close his eyes and say over how many beat units is his piece repeating. He then does a simple clapping exercise. He claps a simple unaccented pulse and again asks Conor to say over how many beats is the unit repeating.

T - Do you know?

C - Four beats.

T - So what makes you think its four?

C – 'Cos you keep on doing. (claps and counts one, two, three, four)

T - How do you know what I'm counting in my head? Couldn't I be going (claps and counts one to four repeating)

C – Yeah.

T - You don't know, do you?

C- No.

T - If I just clap you don't know……

The teacher returns to Conor's piece. He turns down the volume of all the step sets except for the set of plain steps and plays back, having Conor listen with his eyes closed.

T - Ok, now that's just going on and on - Now if you didn't know that that was a four......

C – You wouldn't know...

The teacher then asks them to think about how to let the listener know what the repeating unit is.

> T - So if someone was listening to me clapping, how could I tell them what kind of a beat it was, whether it was a four- beat or a seven-beat or a three-beat.

Conor suggests introducing variety within the repeating unit.

> C - You could do a rest, or you could do a 'ti-ti.'
> T - You could do a rest or a ti-ti, or what's the simplest one you could do is just do this……

He claps with accents every four.

> C – Make one louder.

The teacher then claps a beat and taps a pulse every four with his foot.

> T - What kind of a beat is that?
> C – It's a steady beat.
> T – It's a steady beat but how many every, repeats is it doing?
> C - One.....every four.

The teacher has introduced the idea of meter and modeled a number of techniques to create a sense of meter in a piece, including placing rests or subdivisions in a repeating unit, use of accents and interaction between parts. In doing so he moves fluidly from use of the software to kinaesthetic demonstration and back. He then asks Conor what will happen next in his piece.

> T - What happens next - Is it going to do the same thing, or is it going to go on more and do some more - If its going to do some more, would it be the same or different?
> C – Different.
> T - Different, so.....?

He demonstrates how to make consecutive repeating units using linked wormholes and asks Conor to think about what sort of repeating unit might follow on from his beginning.

> T - So the question is, how are you going to make this piece longer in an interesting way, and in a way that different from what you've done?...So you've done an 8-beat, so what might you do next to make this different....well you could do another 8-beat, but you could do different kinds of rhythms, or you could do some other kind of a beat.

Conor works very quickly and deliberately to complete two new sections by extending three of the four voices to three repeating units. All his units are variations on simple four and eight beat patterns. He uses ladders sparingly, in different places in each voice and includes accented steps in three of the four voices. He matches numbers of wormhole repeats so that fours and eights balance (figure C6).

Figure C6 Conor extends his piece

The teacher then moves to investigate the extent to which he has internalised the musical ideas he has constructed, specifically with respect to the ladders as beat sub divisions (figure 7.2.7). He claps the rhythm of one of Conor's rhythmic units and asks Conor to clap it back. Conor claps but does five beats instead of four for the ladder, plus a sixth for the following step.

Figure C7 Ladder/Step combination

After a couple of attempts, Conor claps the ladder step combination correctly. The teacher then refers to the representation on the screen to make the distinction between the four claps which comprise the ladder and the step which follows it.

> T – So when you do 'babababa –bom', you're doing like the four beats of the ladder (pointing to ladder on screen he says slowly..) 'ba ba ba ba'….and then a 'Bom', is when it hits the step underneath, so 'babababa Bom' (clapping along)…do that…

Conor now claps correctly up to speed. The teacher has him now try to clap the entire figure again. He succeeds on the second attempt this time.

In this interaction, the teacher is concerned that Conor should have a clear internal representation of the music he is creating. He needs to satisfy himself that Conor is not just moving elements around on the screen, but actually understands and can construct their musical meaning. He does this by a series of clapping exercises, in each case tying the particular rhythmic unit to its equivalent DrumSteps manifestation.

Session 4.

In this session Conor continues to extend his piece by completing a fourth, and then a fifth section in each of the four voices. Again his working unit is a four beat group. As the piece has developed, one voice has eight beat sections, while all the others have four beat units, repeating twice as often. He maintains this pattern in his new section. After he has built his new section, he tests it by listening. One of the balls seems to finish later then the others. He listens again and hovers the mouse over the relevant section, as if he is aware of the problem. The teacher tries the strategy of having Conor imagine himself as the ball to see if he can figure out the problem.

> T –….try and imagine in your mind what the ball will actually do….imagine you're the ball…so you're falling out here, your going across here and you're going down there…try and imagine in your mind how many beats that's going to take….
>
> C – There's too big a gap.
>
> T – There's too big a gap – so that means what, it's gonna take the ball..?
>
> C – Longer.
>
> T – Longer to fall there, so is that going to put like an extra beat or something?
>
> C – Yeah.
>
> T – So it wouldn't be the same as the others…ok, good, so maybe that's the problem, so what's the solution?
>
> C – To move it……up a bit.
>
> F

Conor sees the issue and suggests a solution. Furthermore, he understands that the empty grid square through which the ball falls adds a beat to the section, effectively acting as a rest.

As they listen to the playback again, Conor says

> C – See that cymbal there, that one there and that cymbal there (he points to the cymbals in voices '2','3' and '4').
>
> T – Oh, what do you notice about them?
>
> C – They're all playing at number three, I did that on purpose!
>
> T – So you have all those three cymbals happening at the same time deliberately?
>
> C – Yeah.
>
> T –Very good, so you knew exactly where to put them to make them sound at the same time?
>
> C – Yeah.

This clearly indicates that Conor not only has begun to build some knowledge of the internal structure of each unit and voice separately, but also knows something about the manner in which they interact as they play. He has expressed this knowledge by making a deliberate gesture - having a cymbal sound in each of the three voices simultaneously.

The teacher initiates a conversation about the ways in which Conor might introduce variety to his piece. Conor suggests a couple of options.

> T – So what kind of surprising things can you do that would catch people by surprise.
> C – Make a loud noise.
>
> T – If you have all this noise going on and everybody's playing like mad – what's the most surprising thing you could do…
> C – It all stops?

Again, the teacher couches the discussion in a real-world context – what would 'catch people by surprise', what would happen 'if everybody was playing like mad'. He asks Conor to think about how he might do something surprising in his piece.

> T –….so your next plan is, how do I do something that's completely different – either, maybe, stop, or maybe they'll all do something together, or maybe you'll do something else…so think really hard about what would be the most surprising thing you could do now.

Conor adds a fifth section to each voice in his piece. He maintains the same basic plan, with an eight beat unit in one voice and fours in the other three voices. He seems to want to add exactly the same rhythm to each voice (figure 7.2.8). Again the teacher first establishes his internal representation of the music and then questions him as to his intent.

> T – (points to the end of one voice) What's this one here?
> C – 'Bom, bom bababa' (He says this spontaneously as the teacher points to each element in turn).
> T – Is that deliberate? Did you want this one to be the same as that one?
> C – Yeah.

Figure C8 Voice endings (reconstruction)

The teacher discusses his ending. As it stands the piece finishes quite abruptly. The teacher suggests some sort of an ending gesture and gives several examples. He asks Conor what he would prefer.

> T - Do you want it to be quiet at the end or do you want it to be like 'bam bababa bam bam bam phsswwshhh' (Cymbal sound, loud).
> C – Quiet.
> T – Quiet at the end….you don't want a big bang at the end?
> C – No.

The teacher describes how a real drum ensemble would be able to play a gradual diminuendo at the end, although this is not a feature that is supported by the software and the session ends.

Session 5

In this session, Conor completes his piece and the teacher engages him in an extended discussion of its various musical aspects. At the start of this session, Conor reconsiders his ending. He remakes the single eight beat unit as a four beat unit with twice the repeats, so matching the other three voices. He also places a single extra step at the end of each figure, despite what he said in the previous session about not wanting an ending gesture.

> T – They all end together – very good – is there anything else that you'd put on that last step?
> C – No I didn't put anything on it…
> T – You didn't put anything – there's nothing you want to put on it to make the ending any different or…
> C – Actually I might put a cymbal on it.
> T – Oh you might put a cymbal on it…

Conor completes his piece by adding a cymbal to the final step in one voice (figure 7.2.9).

Figure C9 Conor's finished piece

For the remainder of this session, the teacher engages Conor in a variety of clapping exercises in order to find out exactly to what extent he has internalised his piece. He asks Conor to clap the rhythm of his final unit. Conor claps incorrectly, but he does have the triplet ladder rhythm correct and a steady pulse.

> C – Nah (he knows he has not clapped correctly).
> T – (points) Well there's a rest there, so do it?

This time Conor claps the rhythm correctly, but also claps the final gesture step as part of the group. After some prompting from the teacher, he claps the rhythm correctly, without the final step. The teacher then asks him to repeat the rhythm a number of times, but he seems to get lost after the first repeat. After a number of attempts, the teacher says;

> T – I'll make my finger be the ball and you clap.

The teacher traces the path the ball would take over the steps. Conor claps along. There is a definite improvement as he progresses. Initially he misses just one beat (the first on each repeat) but after a number of repetitions he begins to get this right. The teacher asks him to just clap the triplet ladder, which he does confidently and accurately. It seems that the separate representation of the triplet as a ladder and the act of tracing over the steps as he claps have helped Conor to create a boundary between it and the following step.

During the final session, Conor expresses some of his learning over the course of the workshops. He is aware of the musical function of his ending gesture.

> T – What did you do at the end, so we'd know it was the end?

C –Just a sort of cymbal there (points).

Despite not being able to effect local tempo variation, Conor has understood the idea of decellerando and its possible functional effect at the end of a piece.

C – Well you know at the end, some bands, they get slower and quieter at the end.

Conor is aware of the limits of his knowledge. He knows something about the musical meaning of his moves in DrumSteps, but doesn't claim a complete understanding.

T –Did you find that, that you sort of knew with the steps and ladders what kind of sounds they would make?
C – Sort of.

He has also learned something about the importance of the relationship between voices.

T – So if two drums are gonna play together…..?
C – They'd have to do the same number of beats…

This is the same construction used by Kevin when talking about motives. Conor has some internal representation about the relationships between parts in terms of their absolute lengths.

Here Conor demonstrates some understanding of meter as a function of the interaction between parts.

T – Ok so, what if I have one drum doing a five beat, could I make another drum do something that would tell me it was a five.
C – Every five beats, the other drum could do one loud beat.
T – So you mean (claps two part example as described)
T – So if were listening to music and were trying to find out what the beat is, sometimes one drum doesn't tell us so we need..?
C – Two.

The teacher questions Conor as to his composing process, specifically with respect to his use of the interface. Conor refers to his work as an experiment – putting elements in to see what they would sound like.

T – As you're building your piece, as you're putting stuff in, are you concentrating more on what you think you might sound like when you're building it, or are you trying to build something because it looks a certain way, or some combination of both….

C – I'd be putting them in to see what it would sound like as well.

Conor states a definite intent with regard to the lengths of individual rhythmic units, the number of times they repeat and their relationship to each other.

C – Yeah, well I wanted it all to be, three of them I wanted to be eight beats, four eight beats, and another one I wanted to be eight beats and repeat four times.

Conor seems to have an awareness of his own process and how it changed as he worked. Initially he was more experimental, but as he gained an understanding of and control over the medium, he moved towards a more convergent mode of operation.

T – What percentage of the time were you just messing around to see what things sounded like, and what percentage of the time were you saying "I want to make this do this"?
C – Most of the time I'd be deciding I want this to do….
T – Most of the time you were deciding, and did you find when you first started, there was more goofing around…
C – Yeah.
T – And then as you went on you started to…?
C – Yeah.

Conor seems to be more comfortable when he knows he has the support of a teacher.

T – Do you prefer to do your own stuff or do you prefer to have someone telling you what you're supposed to be doing?
C – Someone telling me….

At the end of the conversation, the teacher asks the Conor to clap some rhythms from step/ladder notation written on flash cards. The first card is a simple crochet, crochet, quaver-quaver, crochet rhythm. Conor gets this right on the first attempt. The second card contains a dotted crochet-quaver unit, represented by a two rung ladder. Conor claps incorrectly, but knows that it is not right. When asked to clap the ladder and step at the end, he claps three times, but the dotted note relationship is not clear. However, he does make the connection between the number of rungs in the ladder and the number of sound events. Conor did not make use of any dotted rhythms in his piece, so this may be the first time he has encountered this particular construction.

The third card consists of a more complex ladder set, containing sets of four semi-quavers and a quaver-semi-quaver combination. Conor is asked to clap each ladder in turn. He claps the first two correctly. In the third ladder (quaver and two semi-quavers) he claps four times with a slight hesitation after the first rung. On a second attempt, he claps it with the three ladders correctly, but missing the final step. He is clearly watching notation as he counts. He tries it again. This time it is correct but with an extra beat on the end.

While Conor does not clap everything correctly, he is able to abstract some degree of musical meaning from the ladder representation. The implication here is that in making his piece, he does have at least some understanding of the musical outcome even before hearing the playback. There is therefore a likelihood of least some degree of musical (as opposed to graphical) intent in his work.

Drumsteps Case Study 2 – Ciara

Introduction

Ciara's case is the first of two subsidiary cases which will be introduced in support of the primary case. In this respect, Ciara's case differs from Conor's in that her initial work is less musically considered, but over the course of the workshops, she exhibits a greater degree of development with respect to her compositional process. As the workshops progress, she moves from initial visual engagement with the interface to a more reflective musical interaction. As with the Hyperscore subsidiary studies, her case will be described and analysed under the headings of Composing Process, Musical Interaction and Engagement and Teaching intervention and Strategy.

Ciara's Composing Process

Having been introduced to the software, Ciara spends some time in experimenting. She has been asked by the teacher to;

> T – Make a line of stuff using the ladders and cymbals and so on and just see what it sounds like.

She doesn't initially appreciate the operation of the software. She makes a line of elements but places elements vertically. When she tries to play the piece, the ball falls over the first step then stops. She erases everything and starts again. She asks the teacher;

> C – Do you have to go in a step way?

Her initial working style is impulsive. She has not thought through the implications of her moves. She has not yet made the connection between the path of the ball and the sound produced. She puts in elements and then sees what happens, rather than specifically trying to produce a sound output.

In her next effort, she manages to make an irregular diagonal line of elements. There are gaps, and some horizontal step groups protrude so as to cause the ball to miss the following steps. After replacing steps in a variety of configurations, she eventually comes to an understanding of how the interface works. She then starts to move beyond superficial engagement with the interface and makes decisions on musical grounds. Her line of steps is seven beats long. The teacher asks her to make something that goes with it. She makes a line of steps that has six beats. A discussion ensues regarding numbers of beats.

> T – I said to you this one to go with that one – so what does that mean – I don't know, there's lots of ways it could go with it…I'm asking you what you…
> C – They have to sort of be the same…
> T – The same?
> C – Yeah.
> T – How the same, the same in what way?
> C – The same…….how many beats are in it.
> T – You think there should be the same number of beats in it?
> C – Yeah.

Asked how she could make this happen, she says;

> C – Just add a beat.
> T – And maybe add a beat….and then see what happens when you loop them together.

Ciara has attended to unit length and decided to make an adjustment to her piece.

Figure C1 Ciara's Seven Beat Figures

This is the first time she has made a decision on clearly musical grounds.

In the second session, Ciara moves further from her initial impulsive style and begins to plan what result she wishes to achieve and act accordingly. She is asked to make a piece for a number of drummers to play. She has some clear ideas about what this should be like before she starts.

T – So how many drummers do you think might reasonably play together?

C – Three.

T – And are they all going to play the same thing?

C – Nope (very definite).

T – So they're probably going to play different stuff?

C – Yeah.

T – Is there something about the number of beats that each of them will play….?

C – They have to play all the same…

T – Play the same – your saying so if one person is going to play an eight beat something, someone else is going to have to play an eight beat something.

C – No no no – they just have to be the same length, they wouldn't have to be the same beat…

Ciara shows signs of beginning to reflect on her work and apply some criteria to it. She initially makes a four beat unit that she then extends to seven beat units. Her next moves indicate this growing awareness of the need to apply some criteria to her work. She is asked to make a new rhythm to 'go with' the one she has. As she works she stops and counts regularly. Her first effort has five elements. She counts on the screen pointing at each element in turn. She adds two more plain steps and counts the new set, audibly seven, then she counts the first set, appears to get eight then counts it again. She adds one ladder to the new set. She is clearly working with a purpose here. She has an idea about the required length of the new step set and is counting elements to make sure she achieves this. She is applying criteria with respect to the length of her step set and its relationship to the previous set.

As she works, she begins to develop a problem solving approach. The new line of steps she has made is diagonal, right-to-left. When she tries to listen, the ball goes right and falls off the first step. She reacts by first experimenting with the wormhole position, deleting and redrawing the ball and deleting the first step so that the ball starts on the second. This is an interesting contrast to her reaction in the first session when her piece didn't behave as expected. In that instance, she deleted everything and started again. In this case she tries a series of experimental moves with wormhole, ball and step to try to solve the problem before calling the teacher for assistance.

C - See it keeps going…what's it doing?

T – Well, did you take that ball away at any point and put another one in?

C – Oh yeah, I did…..

T – And what did you forget to do?

C – Tell it to go right.

She quickly realizes the solution in conversation.

Later in the same session, Ciara indicates an awareness of the importance of strategic listening. She is asked to make a third set of steps to go with the previous two. After completing the steps, she lowers the volume of the previous two sets so as to hear it on its own. This is a strategy that was demonstrated by the teacher in the first session. Ciara now applies this strategy without being prompted so as to ‘test’ her work. Towards the end of the session, after adding a simple box ‘pulse’ figure, Ciara listens to her work again. One of the balls is set to snare drum timbre, which is relatively loud. Ciara adjusts the snare drum ball to a lower volume so as to balance the parts. Again, she is listening to the results and adjusting musical parameters on that basis. In the third session, Ciara begins to extend her piece. She shows further evidence of planning with respect to unit length. She adds a five beat unit to the first step set, later followed by equivalent units in the other parts (see figure CA2).

Figure CA2 Ciara’s work in progress

The teacher questions her as she works.

> T – Now you had something that was eight beats, and they were all eight beats and this was two fours right?
>
> C – Yeah they were two fours.
>
> T – Now, this one then is a five.
>
> C – Yeah and I’m going to do another five there (pointing to the end of the lower set).
>
> T – And what are you going to do here (pointing to the end of the rightmost set).
>
> C – A five.
>
> T – But they’ll be different fives from that – they won’t be exactly the same?
>
> C – Yeah….different ladders.

Ciara clearly has a plan as to how she will proceed. In her planning, she is conceiving of multiple parts and has defined in advance what the relationship will be between them, both in terms of their length and their internal content. She is thinking in more aggregated units and can focus on a number of parts simultaneously. She notices that the third set is running right to left and will soon cross with the second part. The teacher suggests using a wall to turn the ball. Ciara sees the problem and points with her finger to show how the ball will move. She is planning ahead so as to make good use of screen space.

After conversation with the teacher, she adds a new section to each of the three voices. This section is based on a six/three proportional unit. She is maintaining the same idea of rhythmic hierarchy and proportionality as before, but is implementing it with a three-beat unit rather than a four. She is applying the same method but with new material.

She quickly completes each section without listening, sets the wormholes and listens to the final result. As she has already demonstrated some ability to clap rhythms, it might be reasonable to suppose that she does not need to listen because she has some degree of confidence as to the outcome.

Later, it becomes clear that Ciara regards the ‘pulse’ box created earlier as a separate part. She expresses the wish to add a ‘three’ to this part as she has done for the other three voices. Initially she doesn’t see the problem.

> T – This ball is in this box…
>
> C – Yeah.
>
> T – So how is it going to get out of there?
>
> C – (Silence………)

She suggests a work around.

> C – No…we could put another ball in…..but that would start at the same time.

In doing so, Ciara is showing the ability to depart from her original plan, which was to make a piece for three principle voices. She feels that her piece needs another moving voice, so moves to add one, using the trapdoor and trigger to start the new voice.

As she works to complete her piece, Ciara applies criteria at a more aggregated level, considering her piece in a holistic way. The teacher questions her about how she will make an ending

> C – The two…I just like the drums. That’s all….I didn’t do any more of those cymbals.
>
> T – You didn’t do any more of the cymbals.
>
> C – Yeah, ‘cos I didn’t like them.
>
> T – What you’re going to have to do is you’re going to have to figure out what’s the ending going to be.
>
> C – I’m going to do cymbals at the end.
>
> T – Cymbals at the end...ok.
>
> C – And the start…see that’s going to be my start, cos there’s two much cymbals in the first three….first four.
>
> T – Too much cymbals in the first four…so then you didn’t do so many cymbals in the rest of them.
>
> C – Yeah…that could be the middle bit and at the end I’ll do more cymbals.
>
> T – Cymbals at the end, ok.

Ciara is aware of the need for variety through her piece. She has tried to differentiate between sections by using different base units. She has now discovered a second technique, using cymbals for expressive effect as another way of distinguishing sections from each other.

Later she says:

> C – I'm making an ending…..I'm making eight.
> T – (Counts one to eight).
> C – But these are all going to be cymbals…no ladders, 'cos there's loads of ladders in the middle bit.

At no point in the process does Ciara ever clap a rhythm first and then try to make it. Her modus operandi seems to be to manipulate elements on the screen and then figure out something about it afterwards. Having said that, she does have some initial ideas with regard to unit length and relationships between parts. There is some question of her intent with regard to the specific internal structure of the units and subdivisions though. At this level of granularity, she may primarily be manipulating graphical elements rather than musical units. Her use of triggered sounds and accented steps seems to be somewhat arbitrary.

Musical Interaction and Learning

Ciara engages with concrete and specific musical ideas at a variety of levels, including musical rudiments, structures, higher-level ideas (change, variety, relationships between things, expressive gesture) and compositional strategies.

Ciara engages with accent.

> C – That ones just a bit stronger then the rest of them
> T – Did you hear that one being louder?
> C – Yeah.
> T – So that's like an accented step, so that one is louder.

She also engages with texture. She places two balls over the ladder, one immediately and one a grid space up, then plays. One ball follows the other.

> C – I have two balls going at the same time.

She begins to make the distinction between beat and rhythm. She makes a row of steps using basic steps and ladders. The total length is six beat-units.

T – Now, how many beats is in that?

C – Eh…..(silence, may be counting)…eight

This is the total number of note events rather than beats. When asked, she points and counts, clearly including each rung of the ladder as a beat. After a series of clapping exercises, Ciara begins to make the distinction.

T – And if you put in a ladder like that one….?

C – That's four beats.

T – Four claps.

C – Four claps.

T – But it would still be only…

C – One beat.

Later conversation indicates that this perception of beat as distinct from rhythmic subdivision is becoming fixed.

T – The ladder only gets actually …?

C – One beat.

Ciara engages with unit length.

T - ….how many claps are you doing in the time it takes the ball to get from there (points to the first step) until it falls in there (points to the lower wormhole)…

C – Seven (there are six).

T – Watch it again.

T – How many?

C – Six.

Ciara also attends to rhythmic hierarchy. She is aware of the number of times units of different length must repeat in order to work together.

T – Think about this – this is an eight and this is an eight. If you made something that was a four…that was just a four…

C – Yeah

T – How many times would it have to loop to match up?

C – How many times would it have to loop – twice!

Having extended her piece to three parts, she says;

C – I like that one – that ones nice. That's doing eight times at a time, that's doing four and that's doing four.

She has set the loop values appropriately so that all parts finish together.

She begins to experiment with tempo. Having created a two-part texture, she listens to it at three successively faster tempos before returning to an intermediate tempo setting.

T – You seemed to be doing something slightly mad at the end there – you turned up the tempo, did you?
C – Yeah, I turned it up really high.
T – Ok so tell me now about this….what did you do?….you….changed the one on the right?
C – Oh yeah, because it was too slow.

Ciara engages with timbre. Initially she chooses the same timbre for each ball. The teacher suggests that she choose two different timbres for balls in two parts.

T – So you can hear the sounds more clearly if they're different.
C – Yeah

Later, she spontaneously chooses different timbres for all parts.

She builds a formal understanding of the idea of rest. In a manner similar to Kevin working in Hyperscore, she initially says that a rest, represented by a silent step, should not be counted. She has already demonstrated an enactive understanding of this by clapping the rhythm correctly. However when asked to say how many beats are in the unit, she doesn't count it.

T – Do you count that one, as a beat?
C – Oh,….no, because you cant hear it can you?

After a conversation remarkably similar to that with Kevin, described earlier, she reformulates her understanding to include counting the rest as a beat.

C – So there's eight of them.
T – So there's eight, but one of them is what?
C – You can't hear it.
C – You, its still a beat, but you….
T – I did a clap, a clap….
C – A rest……

Ciara demonstrates understanding of pulse. The teacher builds a one-beat box as a metronome and plays back the two parts.

T- Now what's that guy doing (points to metronome ball)

C - Just going back and forward..

T – And in music what's it doing.

C – Its clicking.

T – Its clicking…and what is it clicking…..

C – It's like a clock….

T – It's like a clock….and what do we call that?

C – The beat.

Ciara engages with the idea of meter. The teacher asks her how a listener might tell the length of the repeating unit in a section of her piece. He claps a repeating four-beat unit but with a single subdivided beat to illustrate. Ciara spontaneously joins in.

T – There's no way that you can tell…. if it's a one, a two, a five, a seven..

C – Nah.

T – But once you put a ladder in…

C – You know what it is….

Ciara engages with repetition and with relationships between group lengths.

T – Ok did you notice anything……which one finished first?

C – That one (points to screen).

T – Why?

C – Because it's smaller.

T – Because it's smaller – because there's less beats in it?

C – Yeah.

She also starts to build an understanding of what it means for different voices to go together. She identifies this to mean units in different voices having the same overall length, but not necessarily having the same content.

T – You think there should be the same number of beats in it?

C – Yeah.

T – But would it do exactly the same thing, with all the exact same ladders and cymbals and everything?

C – But then it would just be exactly the same…..

T – So you think it might have exactly the same number of beats but it might have different stuff inside it?

C – Yeah

Ciara is concerned with the overall form of her piece. She makes decisions about the content of particular sections in relationship to each other. She understands the importance of having some aspect of her piece change over time.

C – No, I already did four beats….I've four, five and eight.

C – Ok so, what number will I pick?

C – Ill try three 'cos I've done eight, four, five.

She is clearly thinking of change from section to section in terms of unit length, which in fact equates to meter.

Ciara further explores ideas of relationship, proportionality and hierarchy.

T – This is an eight and this is a four….(points to two step sets)

C – Yeah.

T – What if you did the equivalent with, if one was a six..one would be a…..?

C – Three.

She explores the idea of contrast between the content of different sections, using triggered cymbal sounds.

C – I'm going to do cymbals at the end.

T – Cymbals at the end..ok.

C – And the start…see that's going to be my start, 'cos there's too much cymbals in the first three….first four.

T – Too much cymbals in the first four…so then you didn't do so many cymbals in the rest of them.

C – Yeah…that could be the middle bit and at the end I'll do more cymbals.

She makes a decision about expressive gesture at the end of her piece

C – I decided that, sometimes, a ball…they aren't gonna stop at the same time, like a ball is gonna do it on its own for a few minutes.

T – Ok so you don't want all the balls stopping together.

C – No.

T – That's fine…they don't have to.

C – They’re all going to gradually sort of stop.

Some of Ciara’s learning is in the area of perception. She learns new ways to perceive and think about musical objects and ideas. Much of the learning occurs through interactions instigated by the teacher. The concepts or ideas raised are the explored and validated in Ciara’s own work, facilitated by the interface. Much of this interaction is drawn into the physical/kinaesthetic domain, despite working in a virtual environment. In this respect Ciara’s rhythmic perception and her ability to clap a variety of rhythms accurately to a pulse improves over the course of the five sessions. The degree to which this aspect of her learning is a function of the interface is open to question. It is clear however, that the act of creating a piece of music using the software provides a context and motivation for this improvement to occur.

Teaching Interventions and Strategies

The teachers approach in working with Ciara follows patterns described in previous sections. Again a number of types of intervention are observed, facilitated by a variety of intervention strategies.

Initial teacher interventions are concerned with generating familiarity with the interface. In the first session he demonstrates steps, ladders, timbres and folders and also the triggers. He also demonstrates how to loop using the wormhole, including right click to set lifespan. He then defines an initial task, designed to encourage Ciara to explore this functionality.

> T – Make a line of stuff using the ladders and cymbals and so on and just see what it sounds like.

At this stage, there is no specific musical requirement beyond ‘seeing what it sounds like’. As Ciara’s work progresses, the teacher makes more focused interventions in the area of task definition and strategy. At the beginning of the second session, he outlines the overall task.

> T – So what I want you to do is…I want you to try to make a piece for four different drums, with four different kinds of sounds, and each drum is going to do something that’s eight beats…that’s rule one.
> C – Ok.
> T – And rule two is, whatever they do has to go together…whatever you think goes together – so some drummer does something, some drummer does something else that goes with it…its not really a rule, its just a…
> T – But the most important rule is….you’re only allowed do something if you can clap it for me or tap it for me.
> C – Ok.

The suggestion that there be four drummers has arisen out of a conversation with Ciara. The teacher adds to this by suggesting the idea that different parts should go together and adds the constraint that Ciara should be able to clap anything she makes. This constraint is a reflection of the teachers concern that the interface may facilitate superficial work motivated by graphical rather than musical concerns. It attempts to test the notion that if Ciara is forced to clap anything she makes, she will have to construct an internal representation of the musical material, and so interact with music rather than just the interface.

The teacher varies between setting local tasks that access particular musical ideas and maintaining a view of the overall goal.

> T – Will you're piece of music just start like that, straight in? it might….or will there be some start that you can imagine….and the next thing is, how long will it do that for and what will it do next?

Where possible he encourages Ciara to make decisions herself regarding her piece.

> T – Ok so are you sure you want that much or do you maybe….listen to it again?
> T – Was that too short, too long, the right amount?

He allows the problem to remain complex so that Ciara may choose what she will attend to in her work. He also encourages her to view the task as if she were composing a piece for real musicians to play.

> T – Now what do I want to happen overall here – what do I want to be the same and what do I want to be different….for each drummer…you know what I mean…this drummer is doing something, maybe he wants to do something different, maybe he wants to do something different, maybe he wants to do something different (pointing to individual voices on screen).

He sometimes models particular strategies, for example demonstrating the effect of choosing different timbres as a way of clearly hearing different voices.

> C – That sounds ok.
> T – Now can you hear more clearly….
> C – Yeah - That they're different – yeah, that one, yeah….when it goes down the ladder….

The teacher frequently acts to make Ciara aware of the various attributes of her working materials. Again a variety of strategies are employed. He asks focused questions.

> T – So you've made this thing……how many beats long is it?
> C – Don't know.

T – How would you find out?

He asks her to clap her rhythms.

T – As it plays could you clap me the beat along with it?

Often this type of intervention is designed to elicit some understanding of Ciara's internal representation of her music and so define areas where more specific information is needed. In discussing various musical ideas, he continually refers to the graphical representation as a way of having Ciara focus on the perceptual issue at hand.

T – I think you're right, it is seven beats…think about the ladder at the top of that – how many beats does that ladder get?
C – I think two (sotto voce, might be 'or four…')
T – It's the four rungs, 'dadadada' and then the 'Dum' is the next beat – it's the step underneath the ladder, isn't it?
C – Yeah.

He tries to use the particular animated aspect of the interface as a way of having Ciara construct an understanding. By having Ciara follow the ball as it plays, he tries to have her shift her perspective, so that she perceives the section in question from a procedural standpoint rather than as a static object, enabling her to abstract structural information.

T – The ball is going to go down here, its going to go bom bom bom bom tatatata bom…its going to start again…
C – Yeah.
T – And you're clapping along the beat….how many claps are you doing in the time it takes the ball to get from there (points to first step) until it falls in there (points to bottom wormhole)…do you understand the question now
C – Yeah.
T – Ok good.

Some interventions employ several strategies simultaneously, for example, looking at the screen representation as the piece plays and clapping along while counting.

Throughout the composition process, the teacher takes opportunities to explore basic rhythmic and musical concepts at a variety of levels. He uses the interface to model various musical ideas, for example constructing a single beat box as a metronome to point up the idea of beat.

T –….now what's that guy doing (points to metronome ball)

C - Just going back and forward.

T – And in music what's it doing?

C – Its clicking.

T – Its clicking…and what is it clicking…..

C – The beat.

T – The beat, the back, the steady beat, or another word is pulse.

He again uses combined representation and kinaesthetic strategies to explore ideas such as rhythmic subdivision. In this instance, Ciara has made a rhythm using a three-rung (triplet) ladder in combination with a single step beat.

T – Look, that's the beat….tap the table……..

Ciara taps along….

C – I think it's three….

They play the new step set again and tap along. Ciara is tapping three for the ladder. The teacher says:

T – tatata tum…isn't it?

C – Yeah

He further reinforces the difference between threes and fours by clapping.

T – How many was I doing there for every one of yours…

C – A lot.

T – A lot, how many's a lot…..exactly?

C – You're doing four…

Later he uses a series of focused questions to surface the notion of rest. Ciara has made a short rhythmic unit that includes a silent step.

T – Do you count that one, as a beat?

C – Oh,….no, because you cant hear it can you?

T – You cant hear it, ok good, right, you cant hear it, but, but is there…there's no sound right?

C – Yeah.

T – But is there time?

C – Oh yeah.

In discussing meter and accent, he tries to have Ciara shift her perspective so as to consider the effect of her work on a real audience.

> T – Well you could count, but I mean you're not going to count because you're going to be playing a drum right – what could you do in what you played, to make somebody know…what kind of a beat it was.

The teacher tries to help Ciara to develop criteria by which she might judge her work.

> T – I said to you this one to go with that one – so what does that mean – I don't know, there's lots of ways it could go with it…I'm asking you what you…
> C – They have to sort of be the same…
> T – The same?
> C – Yeah.
> T – How the same, the same in what way?
> C – The same…….how many beats are in it.
> T – You think there should be the same number of beats in it?
> C – Yeah.

He models various effects and techniques, pointing up why they work. In this instance he has made two short rhythmic sections with ladders, but has placed the ladders on different beats so that they may be clearly heard. He points to the ladder in each part as it happens.

> T – So you can hear the sounds more clearly if they're different?
> C – Yeah.

Later he does a similar exercise to demonstrate the effect of different timbres in each part.

> T – So that's one important thing that if you're going to make music for lots of drums to play, probably you want them to have different sounds…
> C – Yeah.

Many teacher interventions serve a dual purpose, simultaneously designed to raise issues and to give him some insight into Ciara's understanding as a basis for his next move.

> T – Ok so tell me now about this….what did you do?….you….changed the one on the right?
> C – Oh yeah because it was too slow.
> T – It was too slow?
> C – Yeah.
> T – So what did you do – why don't you show me exactly – point the mouse at what you did.

He demonstrates continued concern that Ciara correctly understands the musical meaning of what she has built.

T – Can you clap the first one? Can you still remember the first one?

He engages with Ciara's materials and makes suggestions based on his perceptions of them.

T – Ok, now, so is there any reason why they couldn't do…a third thing…?
C – A third thing.
T – In other words, they've all done eight beats, then they've all done five beats
C – And four beats.
T – Now they could do four beats, could they?

Finally, he continually tries to balance the need for intervention with his desire to empower Ciara and have her make the important decisions.

T –Well I don't know…what do you think sounds good?

The teacher's work is characterized throughout by fluid movement between a variety of strategies and the balancing of conflicting demands. His decisions are made on the fly and in response to his perception of Ciara's needs at any given time.

DrumSteps Case Study 3 - Becky

Introduction

Becky's case is remarkable for the contrast it presents to all the other cases detailed above. Her work is marked by a lack of musical interaction or engagement, despite proactive intervention on the part of the teacher. Such engagement as does take place alternates between process driven interaction and the construction of visual shapes. For this reason, Becky's case will be described in terms of construction process, musical interaction and engagement and engagement with on-musical concepts.

Becky's Construction Process

Becky is first introduced to the software including steps, silent, normal and accented. She builds a set of steps. It consists of a normal, accent and silent steps diagonally, followed by two steps directly under the last, in such a way that they will not be in the path of a ball. She then goes and experiments with the cymbal menu, adding cymbals to the first couple of steps then randomly to the others. There doesn't seem to be any particular intent, musical or otherwise.

> T – So what do you think is gonna happen when you put a ball in there that's gonna make that stuff play?
> B – I don't know…

Becky seems unwilling to seek help from the teacher. While the teacher tries to explain she continues to make moves adding and deleting elements. Becky continues to randomly add elements. At one point she listens and makes some edits, but it's not clear if this is for any musical reason. She places a triggered sound on every step. The teacher calls her attention to this, but she keeps working without engaging in discussion. She continues to add elements to her step set consisting of a variety of accented and unaccented steps, ladders and triggers (figure B1).

At this point it is clear that she is not operating out of any musical plan. There is no evidence of a sense of a pulse or repeating unit, nor is there any sense in which she is deploying the various elements in any functionally meaningful way. As she works, she plays back her piece several times, but it is not clear that she is listening to the result or making decisions on any musical basis. It is not clear if she has internalized any part of the piece. It seems to be more about randomly using all the available elements.

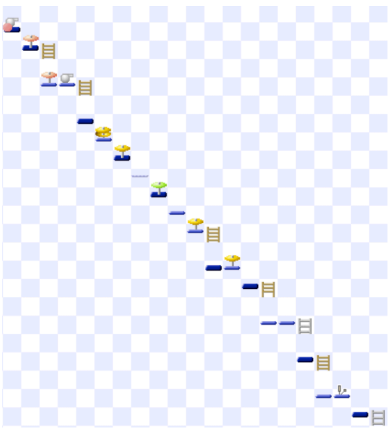


Figure B1 Becky's first attempt

The teacher questions Becky as to her intent. She indicates that she has no particular musical intent.

> T – Right, so tell me something about this mad sounding piece that you made.
> B – I just made anything.

He asks Becky if she can clap the rhythm of what she has made. She can clap a steady pulse along with her playback, but cannot clap the rhythm. She claps rapidly and randomly on ladder elements and claps on silent steps and in gaps. The teacher engages her in similar clapping exercises to those with Conor and Ciara, focusing on the distinction between pulse and beat and also touching on the idea of rest, but with limited effect.

At the start of the second session the teacher tries to define a constrained musical task in similar terms to those used with Ciara. He ask her to make a piece for a number of drummers to play, where the parts go together and also asks that she should be able to clap any rhythm she makes.

Becky continues to work in a similar, apparently random fashion and produces an outcome very similar to that in the first session.

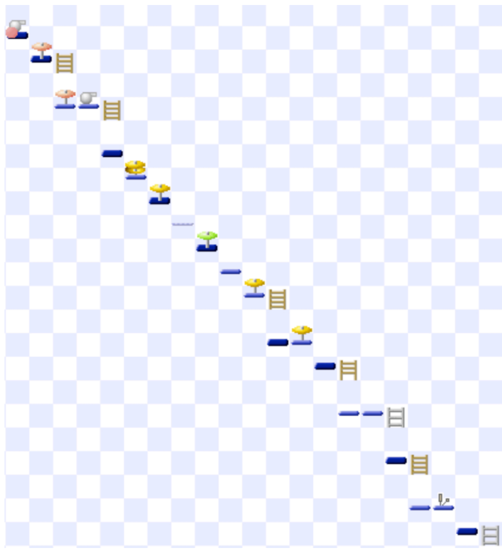


Figure B2 Becky's second attempt

At this point it is clear that Becky is still interacting with the interface, without any definite musical purpose. The teacher defines a more constrained task.

> T – Eight beats…ok, exactly eight beats….and I want you to make something else that's eight beats….that goes with it.

Becky builds a set of steps that is seven beats long, including a four-rung ladder. She seems to have tried to make an eight beat unit, but counted the ladder as two beats.

> T – So there's seven things only…..
> B – I thought the ladder goes twice only….

The teacher engages her in a series of clapping and counting exercises, until eventually she seems to understand the beat/rhythm distinction.

> T – So how many more beats do you need to add to this to make it eight?

B – One more.

She adds a step to her first set. She quickly builds a second set of steps. It includes a gap, which it appears she might be counting as a beat. She stops and traces with her finger the path the ball would take over the steps, as if counting beats. She may be trying to evaluate her work against some criteria. The path length of the second (right-hand) step set is eight beats (figure 7.4.3).

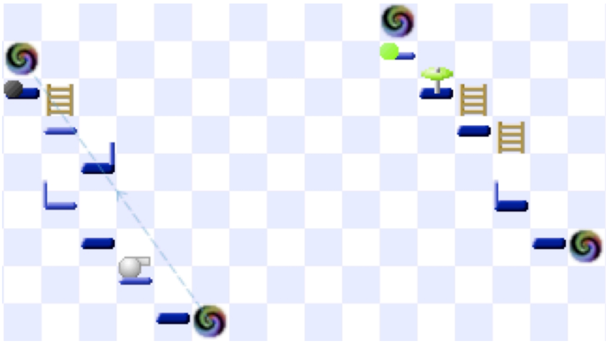


Figure B3 Becky eight beats

It appears that Becky has counted beats correctly. However in conversation it is revealed that she has been counting the wall as an element (although it takes no time and has no effect), but not the rest represented by the gap under the second ladder.

Becky has no clear idea as to how to proceed with her piece.

T – The next question is, do you want something to happen at the same time as that, or do you want to say, 'that's the start' and now make something different happen…
B – I don't know.

The teacher asks a more specific question

T – Ok the first thing is, does that feel like it happens the right number of times or should it happen more times, or less times or…what do you think…
B – A bit of both.
T – A bit of both- more times and less times?
B – Yeah (pointing to screen) more and less (indicates more pointing to the the left-hand set, and less on the right-hand set).

Becky seems to be indicating that the two step-sets should repeat different numbers of times.

T – Ok if you're going to make something else happen, is it going to be kind of the same or kind of different?

B – Kind of different.

T – Ok so what ways is it going to be different?

B – There could be a bit more ladders or something…

Becky's language is that of the interface not of music. She says 'put ladders' not 'put shorter notes'. She still has no plan.

T – Now is there any other way that it could be different?

B – You could put more black holes.

Again Becky is suggesting putting in more elements. In this case, the suggestion to put in more "black holes" has no musical point. She is clearly thinking in terms of the interface and the screen objects rather than any associated musical meaning.

The teacher suggests a similar approach to that taken by Ciara, which is. to make a new section with a different number of beats. He offers four different musical alternatives to generate variety. However, Becky chooses none of these. After a protracted period of time adding and deleting elements from the left hand step set, she seems to have an idea. She adds eight diagonal steps to the set on the right, but going left so as to intersect with the set on the left. She then works very deliberately to extend both sets of steps, and changes the direction of the right-hand set so as to make them converge (figure 7.4.4). Becky is clearly thinking about, and in terms of the functionality of the interface. She is building a structure or a dynamic set of events or a path that is not necessarily related any musical outcome.

Figure B4 Becky's initial convergence idea

She is asked to describe what she has done.

B – Mmm…. I put a blank, I moved the black hole from there and there (points where wormholes were, right hand set) and there (at bottom of right hand set, at gap between ladder and steps below), and made another stairs down so they would both…come out there, they just keep repeating that.

Her answer seems entirely concerned with just placement of graphical elements. Her motivation seems to be concerned with how the balls will animate.

> T – Ok so a bit about…what you've done is that you've made a plan for the way you want the ball to go on the screen
>
> B – Yeah.

Becky describes how the two balls will follow each other.

> B – Yeah….it's a game of chasing…

For the first time, Becky seems to have a plan as to how she will proceed.

> B – I was thinking of actually doing a third tune.
>
> T – To go along with this?
>
> B – Yeah put them in there (indicating with the mouse in the gap between the two step sets).
>
> B – Then I could put a ball there and it would start going down (indicates the ball path with the mouse, down the right hand set.)
>
> T – Put it in the middle?
>
> B – That would be three ones chasing each other.

Her motivation is clearly animation rather than music. Becky quickly adds one, and then another sets of steps to her piece, all causing balls to converge as before (figure 7.4.5).

Figure B5 Convergence extended

The effect is that all the balls follow each other into the wormhole and reroute back to the start of the left hand set. Two of the balls merge at the wormhole. Their path lengths to reach this point are the same. After several abortive attempts to engage Becky in a musical conversation, the teacher suggests that she think clearly about the path length of each step set.

T – So, what you're trying to do is, you're trying to make sure that every ball gets there (pointing to last step before wormhole) after some different number of beats…

T _ So that's a twelve?

B – Yeah.

T – That's a fourteen.

B – Yeah.

T – That's a fifteen.

T – Now if you have one two, three…if you did four or five or six steps up there (suggesting a spur of different length).

B – I think I'll do a six or a four.

T – And then that, this one would get there a lot later – so see how that works.

Becky quickly completes a variety of steps and balls, all designed to create an animation where balls converge at the wormhole and then follow each other to the top of the first step set (figure 7.5.6).

Figure B6 Becky First Section Completed

Becky takes a different approach to creating the second part of her piece. In this instance she seems motivated by graphical concerns.

B – I've an idea for something to do?

T – You have an idea for something to do? What's your idea….?

B – I'm gonna shape it kind of like a diamond….then the two would go down… (she makes pointing gesture with her finger indicating the two different paths, one left and one right) then.. they'd both converge and fall down there (again she indicates the converging by bringing here index and second fingers together and making a downward pointing gesture)

Becky quickly makes a follow on section, shaped like the first part of a diamond (figure 7.5.7).

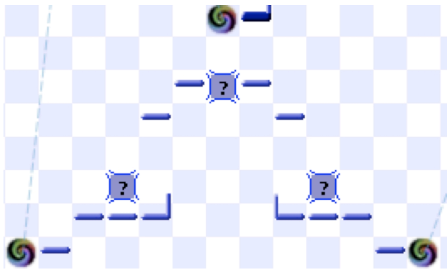


Figure B7 Becky Diamond Shape

Her use of the randomizer is interesting. Its musical function would be to send balls over different paths so as to create a sense of variety. Both of her paths are symmetrical, so in fact the randomizer serves no musical function here. She is treating it as a physical 'router' rather than a musical instruction.

Becky completes her piece as shown (figure 7.5.8).

Figure B8 Becky Second Section

While she doesn't maintain an exact symmetry, the ending section is broadly diamond shaped. She routes all balls into a series of boxes in the end. Having made the diamond shape, she reverts to procedurally motivated actions. She places wormholes in her diamond shape that reroute the balls back to the start. She plays her piece and says.

B – I…got it!!

As she works, her moves are concerned with causing the balls to move in various directions so as to achieve this goal. She shows no musical intent.

Becky doesn't seem to use the software as a means of engaging with music. Her work is unconcerned with the sound output. In the very early stages of her work, she seems to begin to engage with unit length as a motivating factor, but quickly abandons this in favour of an approach based on animation, process and graphical form. She does engage in quite complex reasoning relating to ball paths, path lengths, cause and effect and shows the ability to predict and solve potential problems. Her initial process is random until she frames the task in these terms, after which she works purposefully to achieve her goals.

Musical Engagement and Interaction

Becky does not seem to consider the musical aspects of the task at hand. The teacher makes many attempts to have her form an understanding of pulse and subdivision with limited success. Initially she can clap a pulse along with her piece and attempt subdivisions for ladders, although these are inaccurate. When counting beats she is inaccurate. She demonstrates similar misconceptions to all the other workshop participants with respect to both pulse/rhythm issues and rests.

> T – Ok, so the question here is, actually this is interesting, the question is what do you count…..like with a ladder, how many counts does it get?
> B – Most of them get four..except…
>
> T – See, like in there…and there's another one down here….now does that get a count or not….do you count that gap?
> B – Well yeah, I think you do.
> T – You think you do?
> B – Oh no, count the gap…no.

The teacher engages her in a variety of clapping exercises, but she doesn't seem to make progress.

> T – Four hits…like a ladder (pointing to a four-rung ladder) is….?
> B – Four.
> T – How many beats…its four hits….
> B – Four hits.
> T – But how many beats?
> B – Two beats.

In the next session she makes a new line of steps. Despite being asked to make something that is eight beats long, her step set is twenty beats and random in content. The teacher asks her if she knows how many beats it has, but she does not know.

> T - How many beats is all of this?
>
> B - How many beats?
>
> T – Yes
>
> B – (silence……..)
>
> T – Have you any idea – how would you figure it out?
>
> B – (silence)

The teacher counts the piece along with her. She indicates that she may have been wrong because she counted the gaps. This is in fact incorrect. The gaps should be counted as beats.

She is again asked to make something that is eight beats long. This time she succeeds. However in conversation it emerges that she arrives at a total of eight beats by counting the ladder as two beats and not counting the gap. Again she has not understood.

Later, after she hits on the idea of having multiple balls arrive consecutively at the same point, the teacher again asks her to count beats in the path length of one of the balls (which is fifteen beats). Becky counts incorrectly.

> T – How many did you get?
>
> B – Sixteen.

The teacher has her count again, and notices that she is counting the wormhole as a beat.

> T – You're counting the wormhole as a beat…
>
> B – Yeah.

This indicates something about Becky's ongoing problem with counting beats. She doesn't seem to be counting beats aurally. Rather she is counting elements on the screen. The wormhole element makes no sound and takes no time in playback and yet Becky is counting it as a beat based on its visual presence.

By a process of trial and error she eventually manages to realize her idea of how the balls should animate. It is not clear if she has ever fully mastered the concept of beat. There is no sense in which she works out the path length required to make the balls animate as she wants and then constructs a path with the appropriate number of beats.

The only musical idea that Becky spontaneously engages with is timbre. She seems fascinated by the variety of sounds available to her. She spends a considerable amount of time auditioning ball sounds before placing them and spontaneously chooses different sounds for each ball.

As Becky's work is almost entirely predicated on controlling animation rather than sound, she fails to engage with as wide a variety of musical concepts and ideas as either Conor or Ciara. She doesn't make any regular repeating units, and so does not engage with unit length or meter. Her use of accents and triggers is mostly random, so the idea of regular subdivisions within a unit eludes her. She does think a little about the number of balls running in parallel, but never makes a connection to this as representing a number of musical voices or a number of drummers playing simultaneously, despite the teacher's attempts to raise this idea.

While the notion of rest arises in the context of gaps in her step sets, it is never clear if she moves this idea beyond the interface to form a general understanding of rest in music. She does engage with pulse as described above, but again seems to define it in terms of graphical elements.

As Becky has not engaged with many basic musical rudiments, her work never approaches a stage where higher-level musical concepts might be raised. There is no sense in which her piece has any musical form (although it does have graphical and procedural form). She does not plan her work from any musical standpoint, demonstrates no strategies for making progress and does not engage in a meaningful way with the musical relationships between parts, how the piece changes over time, variation, contrast or expressive musical gesture.

Engagement with Non-Musical Concepts

Becky's piece is primarily procedural. Her engagement as she works is with how the balls move on the screen and how they interact with the static elements. Having defined the task in this context, she works by a process of trial and error to achieve the desired result. In doing so she engages with some elements of problem solving. For example, when having balls move from one path to another she needs to effect a change in ball direction. She spontaneously figures out how to do this using the wall element. She consistently demonstrates an awareness of cause-and-effect with respect to the elements she is manipulating.

> B – Mmm…. I put a blank, I moved the black hole from there and there and there and made another stairs down so they would both come out there, they just keep repeating that.

> B –I could either go there or there but it would be better to put them there cos they could both go there. If I put them there that would just probably fall off, unless I done something else…

Becky's work points up one of the main issues in working with graphical interfaces for music composition. Her engagement is with the interface and not with the musical ideas it represents. She defines the task in terms of the interface and works on that basis. For this reason she makes little progress in terms of musical learning. She does engage with a variety of extra-musical concepts with limited success.

Teaching Interventions and Strategies

Initially the teacher adopts a similar approach with Becky to that taken with both Conor and Ciara. He introduces the software and leaves her to experiment for a time. On his return, he notices that she has added a trigger to almost every step. He draws her attention to this.

> T – Now are you sure you want a whistle on every step? You can if you want, but if you don't want to, just be careful….I'm not saying you shouldn't….

> T – So just make sure you decide whether you want one of these or whether you just want a plain step each time, ok?

As the teacher is talking, Becky continues to add elements to her piece. It is not clear if she has paid attention to what the teacher is saying.

He moves to investigate Becky's perceptions regarding pulse and rhythmic subdivision.

> T – Ok, so the question here is, actually this is interesting, the question is what do you count…..like with a ladder, how many counts does it get?

Becky's answer indicates that she is counting subdivisions as beats. Later in the conversation it emerges that Becky is also failing to count gaps or rests as beats. The teacher engages Becky in a series of clapping exercises designed to remedy these misconceptions. He tries to satisfy himself that she now understands. After a considerable time spent working on the beat/rhythm distinction, it is still not clear whether Becky has understood. The teacher tries to use the interface functionality to help. He creates a 'metronome' box to play along with Becky's piece and point up the underlying pulse.

> T – So what you want to try and do is count how many of these happen (pointing to the metronome ball) while this plays and that will tell us how many beats we have.

After further counting, Becky seems to be beginning to understand. The teacher tries to have Becky move forward with the task at hand. He asks her how she might extend her piece. In questioning Becky, the teacher is consistently seeks to focus on musical aspects of the task. Becky's answers in most cases are couched in terms of the interface rather than the underlying musical ideas.

T – Ok so what ways is it going to be different.
B – There could be a bit more ladders or something.

T – Now is there any other way that it could be different?
B – You could put more black holes.
T – What are you going to add, how are you going to add more?
B – You know when they fall out of the wormhole, you could put in, put in some more steps.

Becky talks about the way the balls move rather than the musical effect. The teacher has endeavoured to have Becky engage in a musical composition task but her progress so far has been limited. He then sees that she is beginning to form a plan of action with respect to ball movements rather than musical outcomes, and questions her on this.

T – Ok so a bit about…what you've done is that you've made a plan for the way you want the ball to go on the screen.
B – Yeah.
T – And you've decided you want it to come down here (right hand set) and join up with this other ball and go on the same (makes loop with finger on screen to indicate a repeating left hand set, figure 7.5.6)
B – Yeah.
T – Right, so maybe it's about where the ball goes and maybe not so much about what the actual clapping sounded like?
B – Mm-huh.

The teacher might prefer that Becky would engage with the task in a musical way. However, he is willing to allow her to set her own agenda and define the task on her own terms and tries to find ways to help Becky to realize and extend her idea. Later he engages her in further clapping and counting exercises and makes efforts to use her material to surface musical ideas, again with limited success

By the final session, the teacher seems to accept that Becky is operating out of a completely visual/procedural perspective. He demonstrates the randomizer function and begins to assign her a task. Becky has her own idea however (her diamond shape) and the teacher allows her to pursue this. When Becky has completed her new section, the teacher engages her in discussion. The discussion in this instance is conducted in terms of Becky's priorities and focuses on the animation aspects.

T – Ok so what way did you link these wormholes – this one is linked to….that one is it?
B – Yeah and that one is linked to that one….then they go down that one and start from there again.

The teacher is not raising musical issues here, but he is checking whether Becky understands her piece on her own terms

APPENDIX D Online Pieces

Appendix D. ONLINE COMPOSITIONS

Musical Criteria for Analysis of Online Pieces

1. DrumSteps.

Lower level parameters (small scale structural units).

- **Note values** – Steps were used to control note duration or the time between note events. There was some element of regularity or pattern in the relationships between single step and multiple step groups.

- **Unit lengths** – There was some sense of defined and discreet units. This may have been by repetition of figures or by using single or chained wormhole pairs. There was a sense of structured grouping of specific elements.

- **Hierarchies** – There was a sense of hierarchical relationships either within a voice/section or between voices/ sections e.g. use of ladders to subdivide within a section, change in section length from one section to another, relationships between section lengths in different voices, relationships between wormhole repeat loops in parallel voices.

- **Pulse** – There was an awareness of the default single-step pulse in the placement of elements, or evidence of engagement with pulse by use of multiple step pulse units

- **Meter** – There was use of repeating groups either manually or using wormholes (if wormholes, there should be clear relationships between multiple voices) or hierarchical relationships between parts, and/or accents/triggers to define metric units.

- **Accent** – There was functional use within a rhythmic unit to point up a beat or to establish meter.

- **Tempo** – There was change to the default setting (very high tempo may not indicate muscal engagement)

- **Timbre** – Different timbres were used. There was an attempt to match timbre to rhythmic content (idiomatic or functional use of timbre).

- **Rests** – There was use of silence as a structural feature within groups.

- **Texture** – There were a defined number of voices, possibly distinguished by timbre and/or rhythmic content.

Higher Level Parameters

- **Pattern** - There were distinctive or recognizable rhythmic patterns ie units which repeated or appear ed in different places

- **Repetition** – The same rhythmic units or subunits were used a number of times in different places or contexts (this may be done using wormholes or manually)

- **Variation** – There were changes to an established pattern.

- **Voice entries -** Voices entered in turn or in a structured manner. Events in one voice were used to cue other voice entries.

- **Structure** – There was a sense of overall form or structure. There were clear sections, or there was clear plan or evolution through the piece. There was an overall sense of form or of events unfolding in a structured manner.

- **Change/Development** – There was a sense of structured change over time.

- **Gesture** – There were beginning or ending gestures.

- **Unifying features –** There was a sense of motivic repetition, pattern or style/genre which binds the piece together.

2. Hyperscore Pieces

Lower Level Parameters

Motive Window

Rhythmic

- There was a clear rhythmic structure (Long/short notes).
- Notes were placed against a pulse.
- There was a sense of division by measure.
- The overall lengths of the motives were generally regular.
- There was a sense of rhythmic pattern.
- There was a sense of internal rhythmic development.
- There were relationships between motives with respect to length or internal rhythmic structure.

Melodic

- There was a clear sense of melodic shape, which may have been linear, triadic, intervallic or some combination of these.
- There was a clear tonal sense.
- There was a sense of melodic or intervallic pattern.
- There was a sense of internal melodic development (sequence, inversion, retrograde).
- There was asense of variety among or relationships between motives**.**

Sketch Window

- There was alignment of beginnings/endings and or alignment of internal features.
- There were relationship between parts as deployed.
- There was functional use of motives.
- There was use of straight lines.
- There was structured use of contour (as opposed to physical gesture).
- There were relationships between harmonic gesture and strokes.

Higher Level Parameters

- There was an overall shape or structure. There were clear sections.
- There was structured manipulation of texture and/or voice entry/exits.
- There was structural use of variation.
- There was evidence of structured change or development over time.
- There were clear relationships between things.
- There was evidence of expressive gesture**.**

<u>Examples of Categories</u>

Drumsteps Compositions

Musical.

Pieces in this category were those that were judged to exhibit significant engagement with those objective musical elements as defined in the criteria above. The following are examples of pieces assigned to the musical category.

Musical Example 1

Musical 1

Each figure in this piece is clearly musically organized. For example, the structure labeled '1' above has the following musical structure.

Musical Example 1 – Excerpt 1

It is eight beats long and subdivided in a manner that indicates a clear awareness of pulse. The repetition over an eight beat unit further demonstrates engagement with meter. Structures 2, 4, and 5 are based on four beat repeating units. Structures 2 and 4 use triggered elements (whistles, cymbals) placed so as to make regular accented subdivisions of the repeating unit. The repeating four or eight beat units create a sense of structural relationship between voices. The Structure marked 3 is the only figure not based on a four or eight beat unit. Its musical structure is shown below.

Musical Example 1 – Excerpt 2

It is in fact seven beats long, but does demonstrate an awareness of subdivision. Voices in the piece enter in turn, in the order 3, 1, 2, 4, 5, so that the piece builds cumulatively over time. Voice entries are not all regular in terms of the beat on which each voice enters. Voice 1 enters after eleven beats. Voice 2 enters five beats after voice 1. Thereafter there is an element of regularity in that voice 4 enters after two full repeats of voice 2, and voice 5 enters after three full repetitions of voice 4.

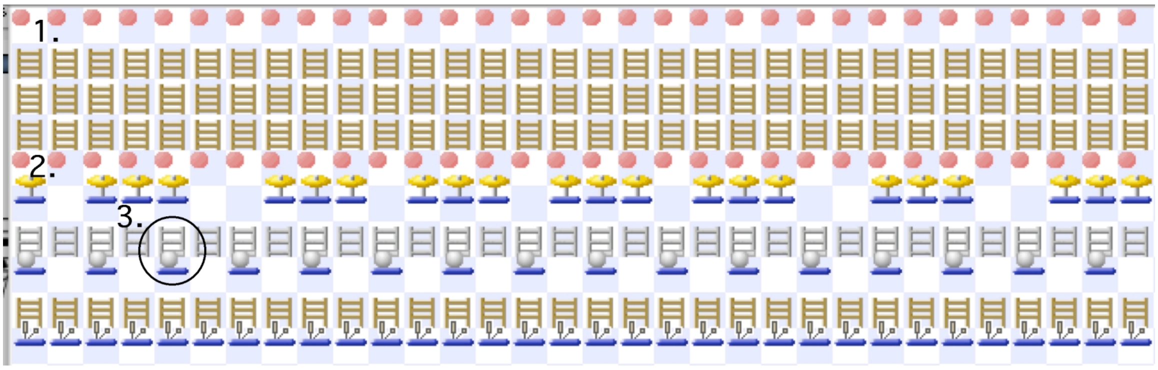
Musical Example 2

While this piece is not so clearly musically organized as example 1, it does embody a degree of musical thought. Each group of elements performs a specific musical function. Structure 1 provides alternating cymbal sounds on every second beat, Structures 2 and 7, while geographically separated, comprise a single musical line consisting of the same rhythmic pattern repeated twice, each repeat ending with a cymbal gesture. Structures 4 and 8 operate in a similar manner but with different internal rhythmic structure. Each of these groupings (2/7 and 4/8) have the same overall structure and run in parallel. Structures 5 and 6 employ the technique of paired balls with different pitch to create their effect. In group 5, balls on the left sound with high agogo timbre, while balls on the right sound as low agogo. As they repeat through the wormhole, they strike the steps alternately, producing an alternating pitch ostinato. While there are clear relationships between certain groups, metric relationships throughout the piece are inconsistent. The alternating agogo sounds produce a definite two or four metric effect, while the ladder units are based on seven beat groupings separated by five beat gaps. Nevertheless there is evidence of clear musical structure and engagement.

Visual/Construction

Pieces in this category were those that seemed to be organized on the basis of manipulation of the static elements to produce results that while graphically or visually coherent, did not produce a musically coherent outcome. These were pieces that appeared to be either based on the idea of 'constructing' using the various elements, or those where elements were organized into some geometric or other visual pattern. In many cases, pieces in this category seemed to have elements of each aspect and so it was not felt to be either useful or practicable to attempt a further subdivision. Examples of each broad type are given below.

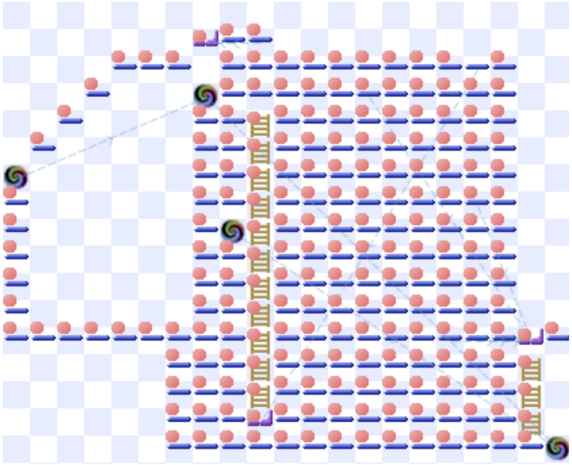
Visual Example 1



Visual Example 1

This piece is clearly based on manipulation of the visual elements. In playback, it demonstrates little musical organization beyond that imposed by the interface. Elements are arranged in horizontal bands with little regard as to the musical effect. There is an element of redundancy in that many elements such as those circled at 3. are not in the path of any ball and so will produce no sound. All the balls in row 1 are of the same timbre (side stick) as are all those in row 2. (mute cuica). There is no sense of clearly distinguished voices, discreet units, regular meter or relationships between things beyond the obvious visual groupings.

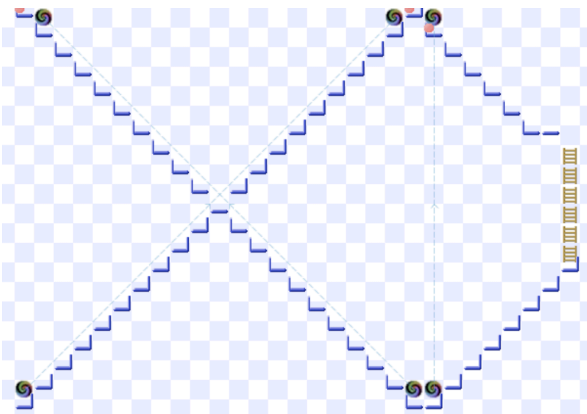
Visual Example 2



Visual Example 2

The piece shown seems to be constructed by organization of a small range of the available elements. Steps are organized into a tower, the regularity of which is broken by two sets of ladders. There is a branching section on the left, the function of which is unclear. The upper left wormhole pair is redundant. A ball is placed on every step. All balls have the same timbre (the default side stick). Approximately half the balls are set to begin right and half to begin left. There is some element of procedural organization in that those balls that begin right pass through the bottom right wormhole and are routed down the central ladder set before ending in the trapdoor at the foot of the ladder. There is no evidence of any musical engagement. The musical output is simply a continuous chatter of semi-quavers.

Visual Example 3

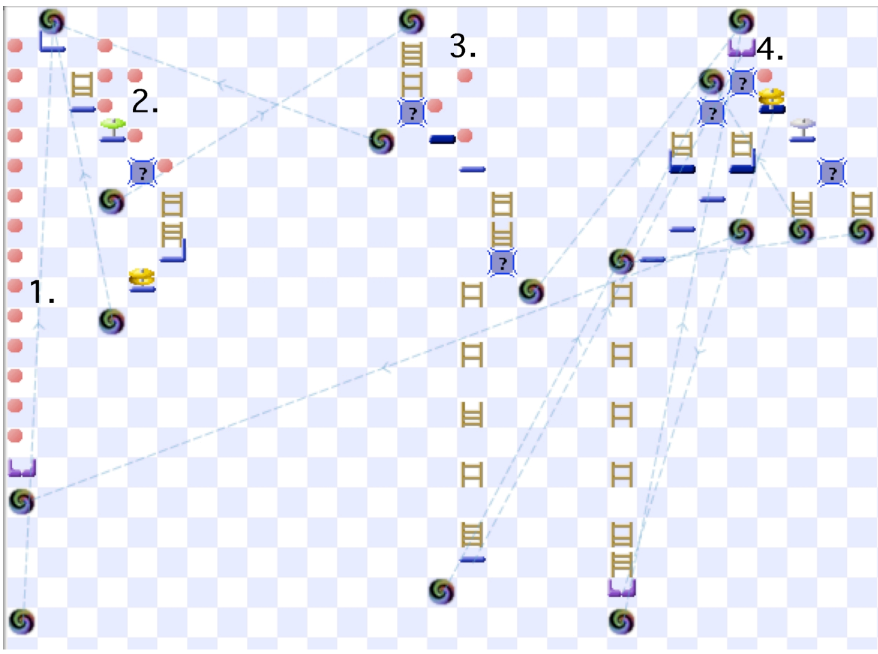


Visual Example 3

The piece shown is clearly visually structured. Two balls follow a symmetric pattern, crossing in the middle. Each path is composed of plain steps and is nineteen beats long. The third path on the right is twenty-two beats long and again is primarily comprised of plain steps broken with a six-ladder group. Each ball repeats its path ten times (the default wormhole repeat). All balls have the same timbre (the default, side stick). There is no evidence of musical structure or organisation, nor is there change or progress over time, with the exception that the different path lengths cause the rightmost ball to get progressively out of syncronisation with the other two. However, as there are no distinguishing musical features against which to measure this, there is no aural effect.

Procedural

This category is characterized by evidence of structure in how the balls move over the fixed elements. While this implies structure in the elements themselves, the effect is predominantly in the sphere of animation rather than in any static visual gesture.

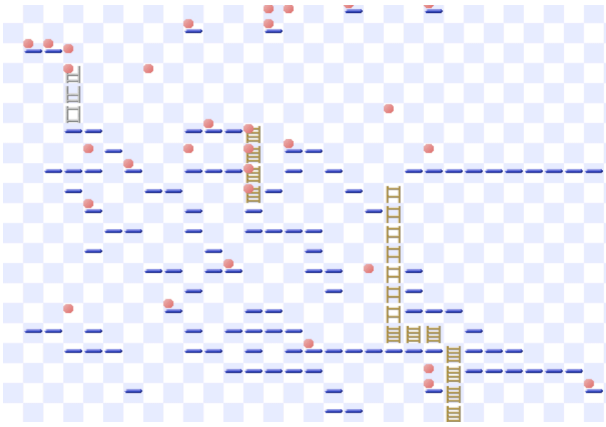


Procedural 1

This example is typical of many pieces in this category. While a full description would be overly complex, a brief sketch will be provided. This piece, in common with many others in the category, uses the randomizer element to drive a complex animation process. Balls on the left (1) fall into the trapdoor. When the trapdoor is opened, they proceed into group 2. At this point all these balls are merged and moving together. The randomizer in 2 causes some of these to split out into the wormhole where they are routed into set 3. The remainders are routed back to the top of set 2 where this process repeats until all balls are routed into set 3. In set 3 a similar process occurs so that balls progress into set 4 or are routed back to set 2. Eventually over time, all balls migrate right where they are rerouted back to 1. While there are local elements of musical organization, for example the alternating ladder/space arrangements centre-right, the primary organizing principle here is in the animation.

No Organisation

These are pieces which displayed no discernable organizing factors. By definition it is difficult to comment on these in a structured way, but a number of examples will be presented so as to illustrate the category.



No Organisation 1

No Organisation 2

No Organisation 3

Pieces in this category are characterized by random positioning of static elements and balls around the screen. There is generally no sense of balls as musical voices. Elements are not grouped in meaningful ways. There is frequently redundancy in positioning of elements and deployment of wormholes in a structurally meaningless way. There is no sense of visual pattern or of procedural control over the animation.

Hyperscore Compositions

Introduction

As the application was much more complex and there were many degrees of freedom available to the user, many of which were interrelated, broad descriptors were used for categorization. There was again a degree of spillover between categories, so evidence of particular organising features was considered in context.

Hyperscore pieces were consigned to categories in a similar manner to DrumSteps pieces. A division was made between those pieces that showed evidence of musical organization and those that were organized by other means or showed no significant organization. Those pieces which showed some level of musical organization were further subdivided into those which were organized solely at the motive level and those which were organized at both motive and sketch level. Pieces that displayed no evidence of musical organization were divided into those that were primarily visual, those which were primarily gestural and those which exhibited no significant organization.

Pieces that were defined as primarily visual were those pieces that exhibited evidence of organization based on graphical concerns (visual patterns, geometric shapes, pictorial elements). Pieces that were defined as primarily gestural were those where lines drawn seemed to be a function of an intuitive physical gesture rather than an attempt to manipulate musical material. Pieces that were found to be musically organized at the motive level only were similarly subdivided into visual and graphical sub-categories on the basis of the contents of their sketch windows.

In some cases, particularly at the motive level, perceived musical features or structures may in fact have been the result of non-musical intent. For example, a symmetric melodic contour that might appear to be musically organized may in fact have been the result of visual engagement. In these cases, as motivation cannot be known, these pieces were assigned to the musical category.

The following are examples which illustrate the various categories to which pieces were assigned according to the criteria described above.

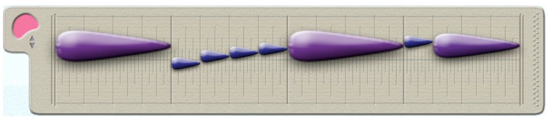
Musical

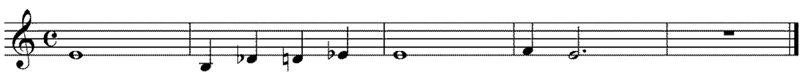
This category was divided into those pieces that showed evidence of musical organization at both motive and sketch level and those which were musically organized at motive level only**.** Some pieces that were musically organised at motive level only showed evidence of either gestural or visual organization in the sketch window**.**

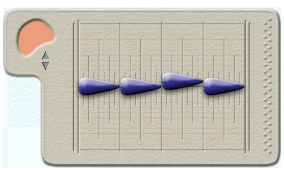
Musical - Motive and Sketch

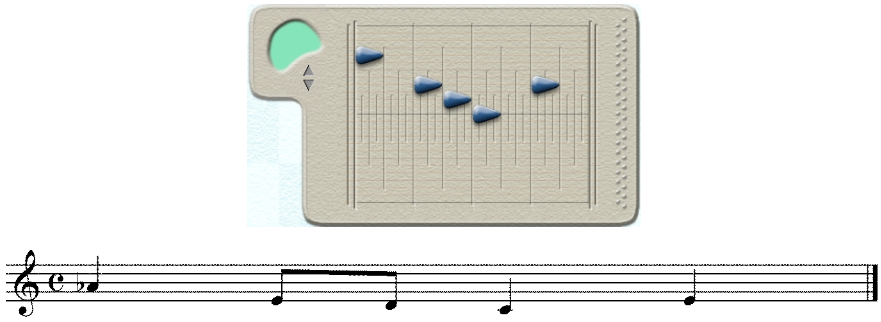
Example 1

The following piece displays considerable musical organization at both sketch and motive level. The piece contains seven motives, three of which are shown below.





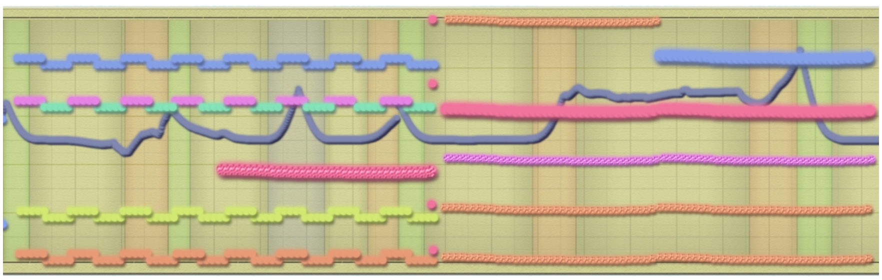




Musical Example 1 – Motives

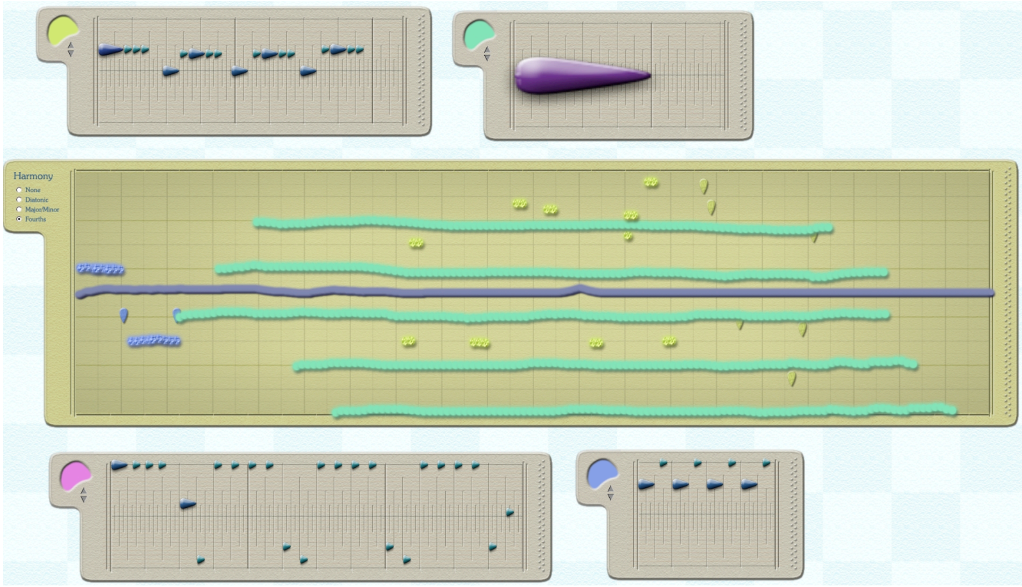
Each motive is characterized by a strong sense of rhythmic structure. Notes are placed against a pulse. Motives are varied in length. A range of note values is used. Each motive has either a strong melodic contour or characteristic intervallic structure, with some evidence of tonal awareness in six of the seven motives.

Motives are deployed in the sketch window in a structured way. Stroke lengths match numbers of motivic repeats, while alignment of stroke beginnings and endings is accurate throughout. The piece is clearly sectional, and creates variety through changes in motivic deployment and texture. Junctions between sections are marked with an 'ending' gesture (the dots in the figure). There is clear awareness of function, with the orange motive used primarily as a bass line throughout, while a single-note blue motive is used as a melody line. Manipulation of the harmony line aligns with significant detail in the strokes.



Musical Example 1 - Sketch

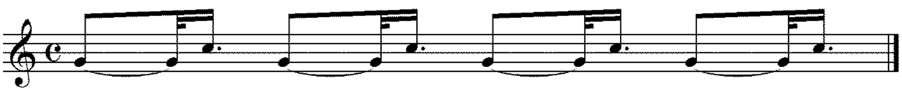
Example 2



Musical Example 2

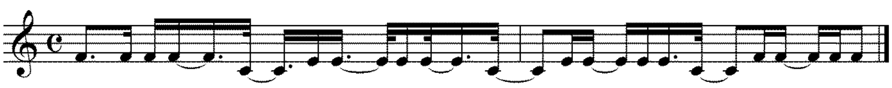
While shorter and less ambitious in scope than the previous example, it shows evidence of definite musical organization at both sketch and motive level. The musical structure of the motives is shown below.

Blue

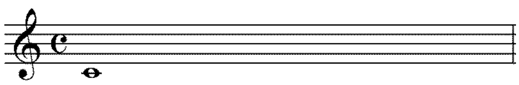


Purple

Yellow



Green



Example 2 Motives.

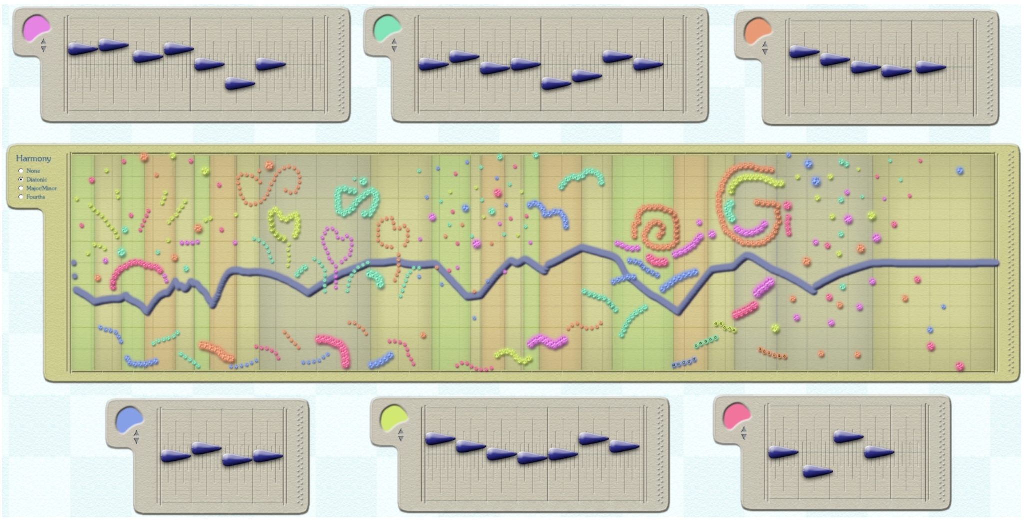
The first three motives are characterised by a strong sense of rhythmic pattern allied to intervallic structure. In both the purple (measure 1) and yellow (second half of measure 1 into measure two) motives there are short inner sections where notes are slightly misaligned with the pulse, producing rhythmic irregularity. Similar occurrences were observed a number of times during the workshops. In these workshop cases, the intent generally was to produce regularity. Rhythmic irregularity was usually a function of inaccurate perception or lack of awareness rather than intent. One might suggest that a similar situation exists here, and that with appropriate mentoring this composer would produce a more rhythmically regular output.

The sketch window here is quite sparse. However, such work as is in evidence is musically structured. The blue strokes at the start are matched to motive length. The two strokes are punctuated with a ‘chord droplet’ gesture. In the following passage, the long green strokes are placed so as to outline a series of fifths, i.e. they are all either doh or soh. Stroke entries are rhythmically regular and aligned, as are exits.

While this piece also has more random elements such as the short yellow strokes interspersed throughout, and there is no sense of large-scale musical structure, there is evidence of musical engagement at a variety of levels.

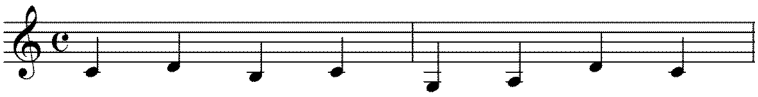
Musical Motive –Visual Sketch

A significant number of pieces were musically organized at the motive level only. Of these, many displayed evidence of either visual or gestural features at the sketch level. The following piece is an example of a piece organised musically at the motive level, but visually motivated in the sketch window.



Musical Motive-Visual Sketch Example

In this case, the motives were organized both rhythmically and melodically, with a strong tonal sense throughout. For example, the following motive (green) is clearly centered around a ‘c’.

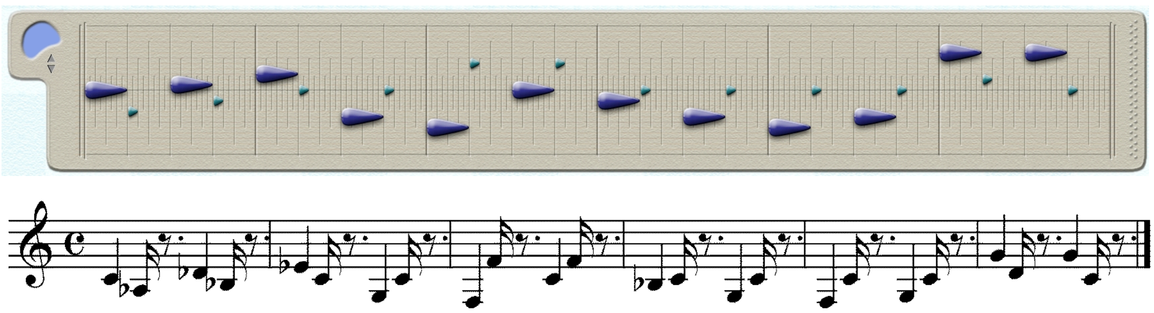


Green Motive Score

Despite the organized nature of the motives, there is little evidence of musical structure in the sketch window. The musical organization that does exist is provided by the automatic harmonization algorithm. Gestures in the harmony line bear no relation to the stroke content. The sketch window is characterized by random gestures interspersed with visual figures such as heart shapes, figures-of eight and the loops and 'G' shaped whorls in the latter half of the piece.

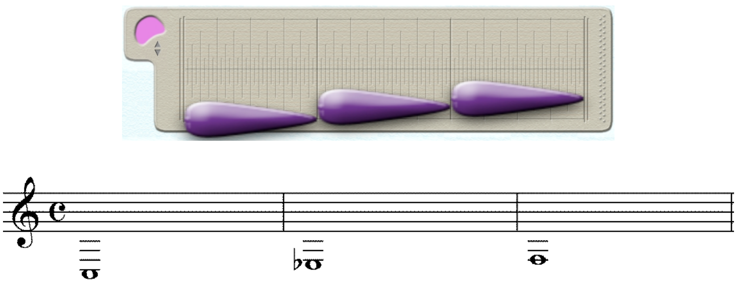
Musical Motive – Gestural Sketch

This piece displays significant musical organization at the motive level, but is primarily gestural at the sketch level. It contains six motives, three of which are shown. The first is based on variations on a two-note figure arranged in a flowing melodic contour.



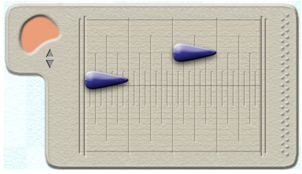
Musical Motive-Gestural Sketch – Blue Motive

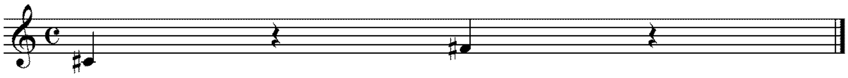
The second motive is a simple rising three –note scalar figure.



Purple Motive

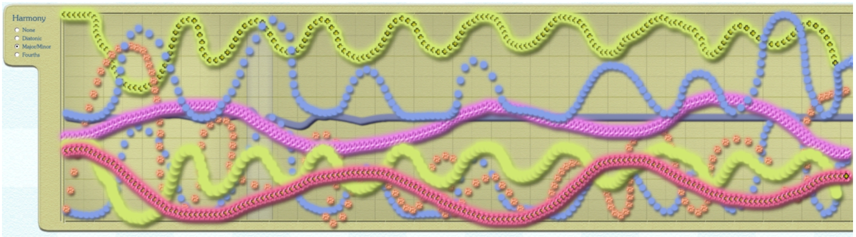
A third motive is a simple two-note rising fourth.





Orange Motive

While all the motives show evidence of either rhythmic or melodic organization, their deployment in the sketch window is almost entirely gestural.



Musical Motive- Gestural Sketch Excerpt

The sketch window is almost entirely composed of characteristic sweeping lines that are most likely a function of an intuitive physical gesture rather than any musical intent. Parts are not distinguished by pitch range, nor is there any sense of voices entering in an organized way. The piece is in three main sections. The first is shown above. The second is similar in character with the exception that the texture gradually thickens through the section, while the third is simply a copy of the first with a few extra strokes added. The harmony is set to major/minor which, in tandem with the organized nature of the motives, produces a relatively pleasing effect, despite the lack of musical structure.

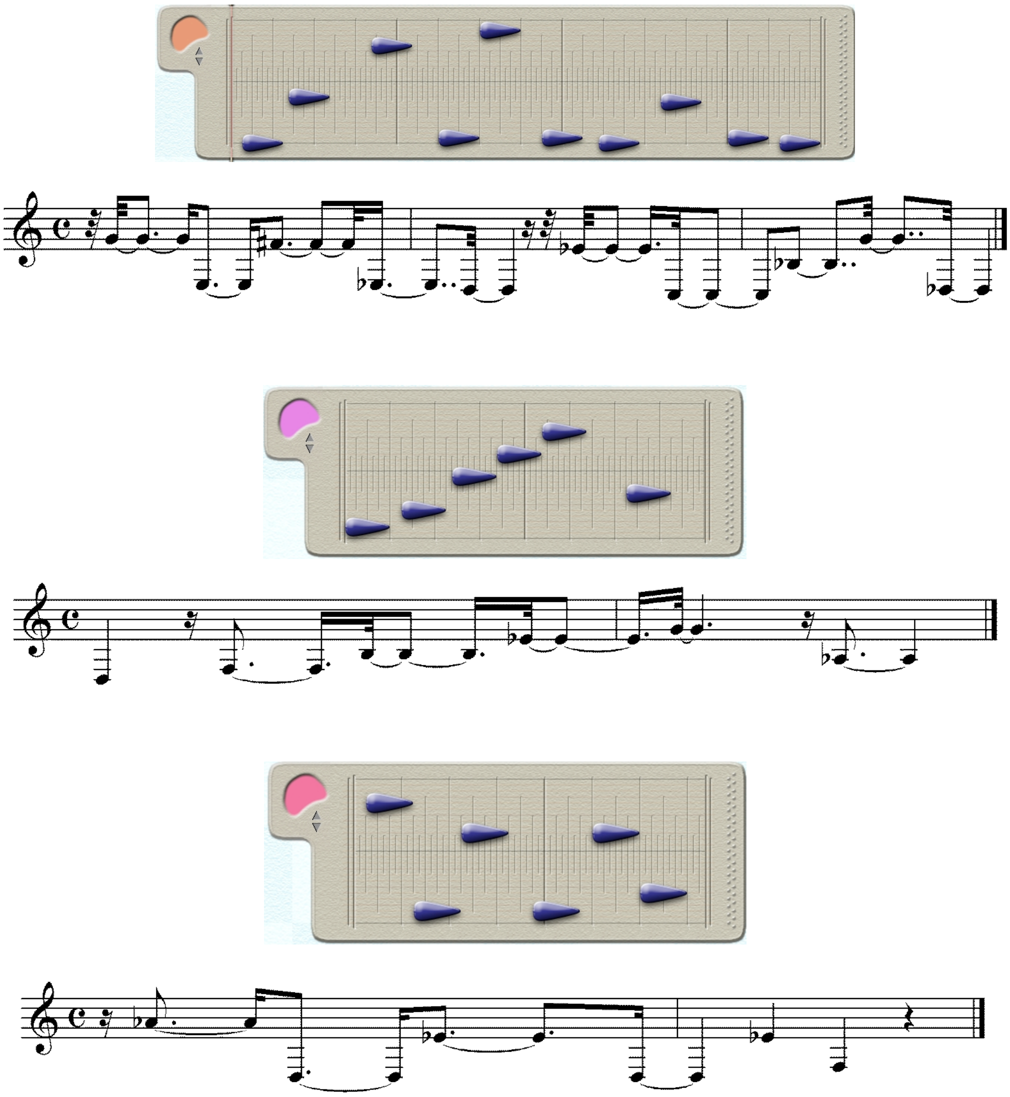
Non-Musical

These were pieces that did not show significant evidence of musical organization or structure beyond that imposed by the software. This category was subdivided into those pieces that showed evidence of other organizing factors (visual or gestural) and those that had no discernable organizing factors. An example of each sub-category is given below.

Visual

Example 1

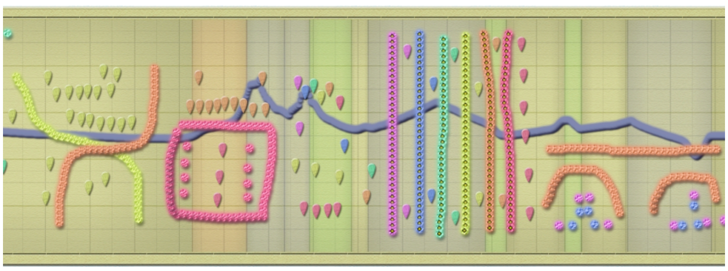
This piece contains eight motives, three of which are shown below.



Visual Example 1 – Motives

All of the motives in the piece consist of quarter notes only. Notes are placed erratically with respect to pulse. There is almost no sense of melody or organized pitch contour nor is there any tonal organization present.

The sketch window consists of an intricate set of strokes, dots and droplets. There are no clear voices, nor is there any sense of alignment between strokes. In so far as there is any organizing principle, it is based on a series of visual gestures. A section of the sketch window is shown below.

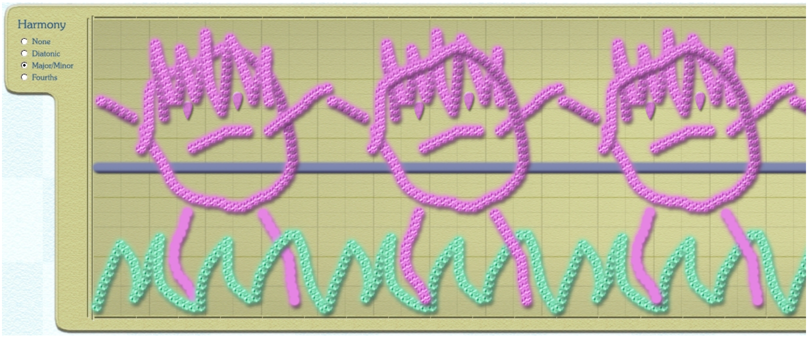


Visual Example 1 – Sketch excerpt

Elements of geometric shape, symmetry and color predominate. There is no sense of strokes being used to manipulate motivic material in any structured way. For example, the parallel vertical strokes, despite their length, will each produce a single pitch unrelated to the motivic content. The user is clearly concerned with making a graphical rather than aural gesture.

Example 2

In extreme cases of graphical engagement, users simply drew pictures in the sketch window, for example, the following piece (called Dance of the Pot Belly People) shown below.

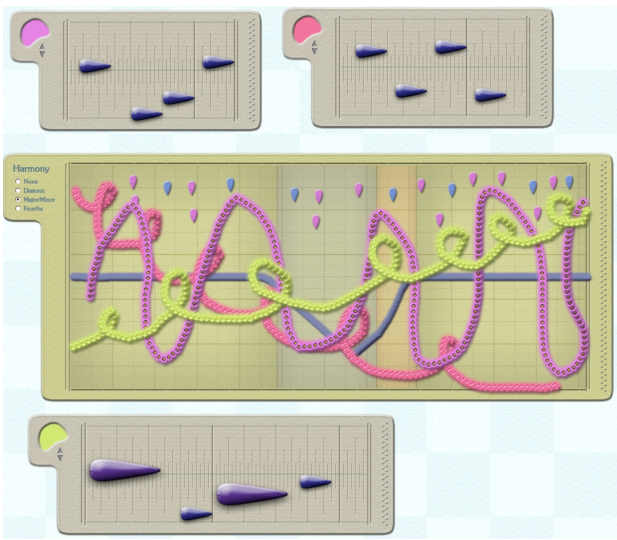


Visual Example 2 Sketch excerpt

While there is clearly no musical intent, the musical effect is not unpleasant, due to the organizing effect of the harmonization algorithm.

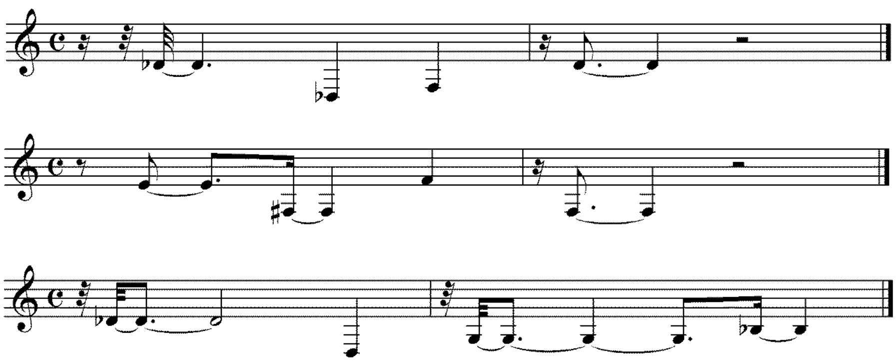
Gestural

The following piece exemplifies those submissions which were primarily gestural in nature.



Gestural Example 1

The motives display no significant musical organization from either the rhythmic or melodic perspective.



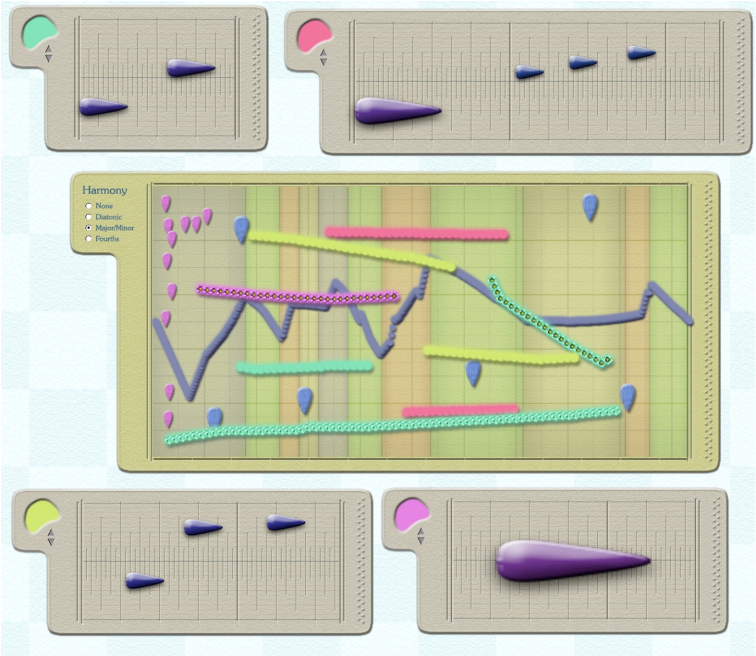
Gestural Example Motives (Score)

The sketch window consists simply of three strokes, two in a spiral pattern and one wavy line. These are most like likely a function of intuitive physical gesture and are accompanied by a series of droplets randomly distributed in the upper part of the window. There is a single harmony line manipulation but this is unrelated to any significant stroke event.

No Organisation.

In a number of cases, there were no significant organizational features found. In the following piece, for example, some of the motives were too trivial to merit analysis, but in so far as it is possible to comment on their content, there is no significant musical organization in evidence, with the possible exception of the three note rising figure in the purple motive.

No Organisation Example Motives (Score)



No Organisation Example Piece

The sketch window consists of a series of diagonal strokes placed with no apparent intent with regard to voice entries or alignment between parts. Droplets of various sizes are placed throughout. While there may possibly have been an element of graphical intent in some aspects of placement, it was felt that this factor is not strongly enough in evidence to merit inclusion in that category.