An Investigation of Teaching Approaches in a Non-formal Setting: An Exploratory Case Study of Irish CoderDojos

This Thesis is being submitted for the Degree of

Doctor of Philosophy,

at the School of Computer Science and Statistics,

Trinity College Dublin

2023

Abeer Sulaiman M Alsheaibi

Declaration

I declare that this thesis has not been submitted as an exercise for a degree at this or any other university and it is entirely my own work.

I agree to deposit this thesis on the University's open access institutional repository or allow the library to do so on my behalf, subject to Irish Copyright Legislation and Trinity College Library conditions of use and acknowledgement.

Name: Abeer Alsheaibi

Signed:

Dedicated to the memory of my grandmother

Hailah Al-Haddad

Acknowledgements

I wish to thank my supervisors, Glenn Strong and Dr. Meriel Huggard, for their guidance and encouragement. I would also like to thank Dr. Aidan Seery and Dr. Alison Egan for their insightful comments and suggestions.

I would like to extend massive thanks to my family for their endless love, support, and encouragement. To my wonderful mum and dad for always trusting and supporting me throughout my life and for always being so proud of me. To my beautiful siblings, Shatha, Doha, Mohammed, Saleh, Khaled, and Mashal, for their endless love and for always being there for me. I am truly blessed.

To my dear friends, Amal, Fatimah, Mezna, Latifah, and Sakthi and to my colleagues, Fasih, Kasturi, Mags, Mona, Nilesh, Pannu, Sourojit, and Zamzam, who have become close friends, I am very grateful to have met such amazing people like you through this journey.

I wish to thank the Irish CoderDojo community, especially the mentors who participated in this work for their generosity and willingness to share their experiences with me; without their collaboration, this work could not be completed.

Finally, I would like to thank the Ministry of Education in Saudi Arabia and Qassim University for awarding me with a scholarship that allowed me to conduct this thesis.

Abstract

In a world where digital technologies are playing an ever-increasing role in peoples' professional and personal lives, it is essential that individuals acquire the computer literacy skills needed to achieve their full potential. The development of young peoples' computer literacy has been the focus of many government, industry, and volunteer-led initiatives around the world. One such initiative is the CoderDojo movement. CoderDojo is a non-formal international network of volunteer-led, free, independent, community-based computer programming clubs for young people that was established in Ireland in 2011. Dojos are organised and run by volunteer mentors who are commonly computing professionals, university computing students, or previous participants. Significantly, however, they are not necessarily trained educators. Given the global popularity and impact of CoderDojos and initiatives like it, educators are curious to know which teaching approaches adopted play in their success. So far, there have been few studies of the teaching approaches used in CoderDojos.

This thesis explores the teaching approaches mentors choose to implement while teaching programming within the context of CoderDojo in Ireland, as well as the relationship between these approaches and the CoderDojo ethos and the expectations of the CoderDojo Foundation. This research utilises Vygotsky's social constructivism as a paradigm in order to answer the stated research questions, which focus on the views, insights, and experiences of 19 mentors. An exploratory case study design was adopted to allow for deeper insight into this particular context. Data collection included in-depth semi-structured interviews, observations of Dojos, and CoderDojos documents. Data analysis was carried out on multiple levels using thematic analysis to identify emergent themes.

The findings of this thesis validate that CoderDojo offers a learning framework scaffold

that is rooted in social constructivism. The non-traditional learning environments offered by CoderDojos are learner-centered as they are project-oriented and provide hands-on practical experience in a social and fun environment. The Dojo environment appears to move away from the traditional student/teacher relationship as well as the usual boundaries that exist in traditional classrooms. The traditional role of the teacher is replaced by computing-related professionals or computing-related graduate students who support and guide learners without a fixed structure and without facilitating a classroom hierarchy.

This study provides insights into the teaching approaches used within the context of CoderDojo and also sheds light on some of the issues that might obstruct learning. With the Irish National Council for Curriculum and Assessment (NCCA) currently working on reviewing and redeveloping the curriculum to make computer literacy an essential part of the Irish education system, this thesis could provide educationalists and curriculum makers with insight and understanding into how young people at CoderDojos are learning computing, and may help them assess which strategies and approaches might transfer to traditional educational classrooms.

Contents

List of Figures

List of Tables

Chapter 1

Introduction

1.1 Introduction

The technological transformation of the world around us has highlighted the need for individuals to develop their digital skills. Over the past decades, educators, students, developers, and administrators have expressed a growing concern about a lack of knowledge about technologies (Blikstein, 2013; Dugger, 2001; Szymkowiak et al., 2021). Particular attention has focused on a perceived deficit in young people's technological competencies (Balanskat & Engelhardt, 2015; Bresnihan et al., 2015) and how this digital skills gap can be removed. Suggestions for addressing this gap include the incorporation of innovative technology in learning and the development of best practices for technology usage (Barron et al., 2011; European Commission, 2021), as well as addressing the challenges young people face in acquiring digital skills and technological fluency (Bellanca, 2010; Kafai et al., 2020; Vivian et al., 2014).

According to the National Research Council (2000), fluency in technology is "the ability to reformulate knowledge, to express oneself creatively and appropriately, and to

produce and generate information rather than simply to comprehend it" (p.9). The Council notes that fluency with technology "goes beyond traditional notions of computer literacy (and) requires a deeper, more essential understanding and mastery of information technology for information processing, communication, and problem solving" (National Research Council, 2000, p. 15). Improving 'technological fluency' used to focus on formal education and more specifically, higher education (Resnick, 2002). However, recently there has been a growing awareness that non-formal learning settings and after-school coding clubs play a vital role in boosting digital competencies and skills (Byrne et al., 2019; Lawlor et al., 2020).

These non-formal learning settings and coding clubs fill the perceived gap created by the slow pace with which the formal school curriculum has developed initiatives to introduce computer science. Some of these initiatives include the CoderDojo Movement, Girls Who Code[1], and Code Club[2]. These clubs have led to a rapid expansion in the number of young people acquiring programming skills in non-formal learning settings (Aivaloglou & Hermans, 2019; Begel & Ko, 2019; Bresnihan et al., 2020; Strong et al., 2017).

Despite the popularity of such non-formal initiatives in general, and CoderDojo in particular, the role of pedagogy and teaching practices in such contexts remains under explored (Alsheaibi et al., 2020; Kim & Keyhani, 2019; Lawlor et al., 2020). To address this gap, this thesis seeks to increase our knowledge of the CoderDojo movement and the teaching approaches and practices that are implemented within this movement. Taking an exploratory case study approach, this study utilises Vygotsky's social constructivism as a framework to explore the views, insights, and experiences of 19 mentors. In doing so this study not only seeks to increase our knowledge of what approaches CoderDojos

[1]Girls Who Code is an international nonprofit organization that aims to support and increase the number of women in computer science.

[2]Code Club is a global network of free after-school coding clubs for nine to 13 years old.

use, but also to better understand what makes them successful and how some of these successes might be used in other computing educational settings.

This chapter presents an introduction to the research context outlining the significance of this study. Next, it highlights the research questions and objectives, followed by an outline of the research framework and methods the researcher used to conduct the study. It also presents a discussion of the researcher's position and reflexivity. The final section provides a roadmap to the topics covered in the remaining chapters.

1.2 Research Context

The context for this study resides within CoderDojo. The CoderDojo movement is a grassroots non-profit network of volunteer-led, free, independent, community-based computer programming clubs for young people[3] (see Figure 1.1). CoderDojo aims to give young people the opportunity to learn to code in a social and safe environment. In these programming clubs (called Dojos) young people between seven and 17 years of age (called Ninjas), learn coding, develop websites, create games, construct mobile applications, and explore technology in a social and creative environment. In addition to learning technology, attendees meet people with similar interests and improve their skills in collaboration, problem solving, presenting, and confidence-building (Alsheaibi et al., 2020; McKelvey & Cowan, 2017a).

Figure 1.1: CoderDojo Logo

[3]https://coderdojo.com/en/about

The CoderDojo movement was originally initiated by James Whelton and Bill Liao in Cork, Ireland in 2011. James Whelton received notoriety for hacking the iPod Nano when he was 17 years old (Molly, 2011). As a result, other students became interested in learning coding. James launched a coding club in his school in Cork and started mentoring his peers in some basic website development. Due to the popularity of James' coding club, he met Bill Liao, an entrepreneur who saw the positive possibilities in these clubs and decided to grow the project on a bigger scale. Since then, the movement has expanded enormously.

Table 1.1 shows the growth in CoderDojo numbers both globally and in Ireland from 2011-2016. The movement continues to grow. In 2021, there were over 3,900 verified Dojos, reaching over 270,000 young people in 115 countries worldwide, including 238 active Dojos within Ireland (CoderDojo Foundation, 2021). Part of the reason for the constant growth of CoderDojos in Ireland is that many schools do not offer computer science subjects.

Year	**Globally**	**Ireland**
2011	1	1
2012	64	35
2013	105	72
2014	388	120
2015	740	169
2016	1014	206

Table 1.1: CoderDojo Numbers

The CoderDojo Foundation was officially formed in 2013 in Dublin, Ireland in order to support the global CoderDojo community, assist in establishing new Dojos with needed resources, and help in creating community development initiatives. The CoderDojo Foundation works to create global awareness about technology and the importance of programming among young people.

The CoderDojo handbook presents the organization's philosophical perspective (Coder-

Dojo Foundation, 2019), and acts as a guide to mentors, children, and parents. Five ethos inform the philosophy of the CoderDojo movement and serve as the foundation of any Dojo session (see Figure 1.2). Those ideals are reflected in the expectations of mentors' practice. Specifically, mentors are assumed to be committed to encouraging collaboration, peer-to-peer learning, and project-based learning between young people in a social and fun environment. As presented in their handbook (CoderDojo Foundation, 2019), the five ethos framing the CoderDojo movement are as follows:

1. **Collaboration and teamwork:** Mentors are recommended to encourage Ninjas to work in teams. The movement believes teamwork can help young people better understand their individual strengths and learn how to work with others and assist their peers.

2. **Changemakers:** Mentors are recommended to encourage Ninjas to work on projects of interest to them and to consider introducing projects that have a positive social, environmental, or community impact in order to help Ninjas identify opportunities to positively influence the world around them. In addition, mentors are encouraged to empower young people with lifelong skills through collaboration, presenting their projects, and supporting their peers to develop their communication skills and build their confidence.

3. **CoderDojo is informal and fun:** The movement stresses that Dojos are clubs, not classrooms, and the atmosphere in a Dojo should be fun and social. Mentors are advised not to give instructions but instead to encourage Ninjas to explore coding and create technology that interests them.

4. **Inclusive and free:** Participation in CoderDojo is always free and open to all regardless of their gender, religion, race, or sexual orientation.

5. **CoderDojo is open source:** Ninjas are encouraged to use open-source software, which is free of charge. The movement believes using open-source software allows

Ninjas to learn to contribute to these tools as their programming skills develop, thereby giving back to the community and becoming an active technology creator.

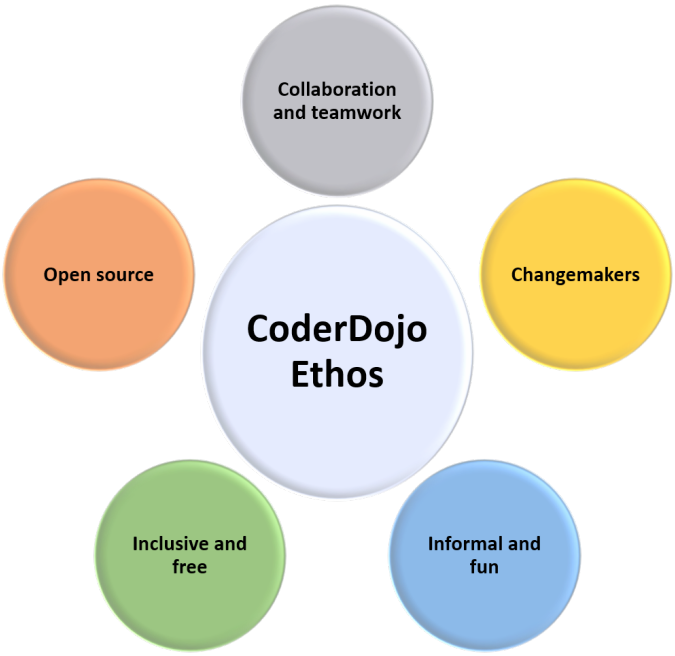


Figure 1.2: CoderDojo Ethos

Dojos are usually organised and delivered by volunteer mentors. According to the CoderDojo Foundation, mentors are "volunteers who provide support, guidance, and encouragement to the Ninjas in completing their projects and developing their skills" (CoderDojo Foundation, 2019, p. 9). The Foundation emphasises that mentors are different from teachers; mentors are encouraged to foster independent learning rather than directly delivering solutions to their Ninjas: "The role of a mentor is not the same as that of a teacher or lecturer. Mentors help Ninjas work through problems and encourage their efforts rather than directly delivering solutions" (CoderDojo Foundation, 2019, p. 9).

Mentors might be professionals, teachers, parents, students, or previous Ninjas. The CoderDojo Foundation surveyed the global verified CoderDojo community in 2019 and found that 49% of volunteers work in science, technology, engineering, and mathematics (STEM), 19% were professional educators, 17% were parents of a participant, 5%

were students, and the remaining 10% were librarians, youth workers, retirees, or not specified (CoderDojo Foundation, 2020).

Dojos encourage mentors to help young people progress and ensure that they reach their potential when a desire to learn more exists. They do not have explicit regulations imposed on them by external bodies. The Foundation offers some educational resources such as coding activities, programming lessons, and project ideas to assist mentors while running Dojos, especially mentors with no coding or teaching experience. However, mentors are free to use any learning pedagogy they find appropriate (Alsheaibi et al., 2020; McKelvey & Cowan, 2017a).

Dojos can assemble in various places such as schools, colleges, community centers or companies like Google, Facebook, etc. The tools and technologies accessible to Ninjas vary at different Dojos and may include access to software, hardware, learning materials, and the internet. Besides learning to code, young people get to meet other young people with common interests in a more social manner. The social elements of CoderDojos aim to foster enjoyment and collaboration in learning (Sheridan et al., 2016). Within Dojos there is a focus on showing the power of technology, and its ability to change the world, along with encouragement of community, peer learning, and independent learning (Alsheaibi et al., 2020; McKelvey & Cowan, 2017a).

Given the increasing popularity of non-formal coding initiatives like CoderDojo in society, it is vital to understand what teaching approaches are implemented in such unique learning contexts. The findings of this study will be of interest to researchers and educators, laying the groundwork for future research into teaching practices as community-based coding initiatives continue to become more popular.

1.3 Research Questions and Objectives

Teaching is an essential part of the learning process and its main objective is to transfer knowledge and skill to learners. Blikstein and Moghadam (2019) define teaching as the process of attending to learners' needs, experiences, and feelings, including intervening so that they learn particular things and go beyond the given. 'Teaching approaches' is an essential concept used throughout this thesis and thus, it is important to define it. A review of the literature, however, finds that this term has different meanings for different scholars. For example, some use it to describe learning theories like constructivism and behaviourism (Lenjani, 2016; Steele, 2005). Others use it to refer to learning environments like learner-centered learning and teacher-centered learning (Brown, 2003; Scheurs & Dumbraveanu, 2014; Stephan, 2020). Still others use it to refer to a set of principles, beliefs, or ideas about the nature of learning that are translated into instructional practices in the classroom, such as project-based learning, collaboration, and autonomous learning (Dilekli, 2020; Haapaniemi et al., 2021; Okudan & Rzasa, 2006). This last definition aligns with what this thesis is trying to explore and thus, this definition of teaching approaches is adopted in this thesis.

Teaching practices is another important term in this thesis. It is commonly used to reflect certain actions carried out while teaching in the classroom, such as preparing materials, giving feedback, using a particular learning tool/software, etc. (Bietenbeck, 2014; MacSuga-Gage et al., 2012). The relation between the two terms is that a collection of teaching practices can contribute to or lead to a particular teaching approach.

One notable feature about teaching in Dojos is that they rely on volunteer mentors to help guide young people to learn how to code. These mentors are often drawn from the ranks of interested parents, undergraduate students, and computing professionals whose qualifications and experience of teaching is limited in scope. Significantly, men-

tors are not necessarily trained on how to teach. The global popularity and impact of CoderDojo (and initiatives like it) has caused educators to ask what role the teaching approaches adopted play in their success (Aivaloglou & Hermans, 2019; Bresnihan et al., 2020; Lawlor et al., 2020).

There is limited research on teaching approaches and practices used in non-formal learning environments generally speaking (Aivaloglou & Hermans, 2019; Blikstein & Moghadam, 2019; Lawlor et al., 2020). Therefore, this study adopted an exploratory approach to further explore teaching approaches in the context of CoderDojo. While the participants and findings are particular to the context of CoderDojo in Ireland, this study hopes to generate broader, novel insights into the non-formal teaching approaches in the field of computing education.

The main objective of this research is to explore current teaching approaches mentors implement within Dojos in Ireland, and the alignment between those approaches and the CoderDojo recommended teaching practices and ethos. Therefore, the primary research question guiding this study is as follows:

- What teaching approaches do mentors commonly implement within Dojos in Ireland?

Based on the primary research question, the secondary research questions are:

- To what extent do mentors' teaching approaches align with the recommended teaching practices of the CoderDojo movement?
- To what extent is the CoderDojo ethos reflected in the teaching approaches used within Dojos in Ireland?

The researcher in this study is conscious of the fact that the CoderDojo movement does not adopt any prescribed teaching approaches. Moreover, any teaching approaches practised at different sites are the adopted theories of its mentors as no formal training (educational or otherwise) is provided to the mentors. Therefore, it is important to consider potential factors that might affect young people's ability to learn in such a distinctive context like CoderDojo.

1.4 Significance of the Study

Twenty-first century learning is commonly defined by the set of skills that society needs learners to have so that they can adapt to the significant shift from manufacturing to information and knowledge services in advanced economies (Binkley et al., 2012). While the set of skills needed varies, it usually includes creativity, critical thinking, problem solving, communications skills, and the ability to work with others (Dole et al., 2016; Fullan & Langworthy, 2013; Lawlor et al., 2018).

There is increasing demand for the formal education sector to develop skilled learners, rather than reproduce knowers of information who learn only to the test. However, there is a clear weakness in the actual ability of current educational systems to recognize and meet this demand (Blikstein & Moghadam, 2019; Fullan & Langworthy, 2013; Wagner, 2014). Research has indicated that current formal educational structures are not prepared to embrace the essential change needed to enable twenty-first century learning. To do so, formal education would need to shift away from a dominant behaviourist pedagogy where students learn through reinforcement and constant feedback in the form of test scores, homework marks, etc., and instead towards emancipatory and critical forms of learning. The widespread model of behaviourist practice is contrary to that which is required for engaged, learner-centred learning (Robinson, 2010; Wagner, 2012). A demand for this type of learning contributed to the creation

of many non-formal, socially driven initiatives, which can fulfill the perceived gap in formal educational systems.

Computer programming is just the type of twenty-first century skill future generations will need (Conneely et al., 2013; Nouri et al., 2020; Vee, 2013). Computer programming teaching and learning has been explored for decades (Fisher, 2019; Goldenson, 1996; Hazzan et al., 2020; Pea & Kurland, 1984; Robins et al., 2003), yet most of the research has focused on teaching and learning programming within the context of formal education such as higher education and schools. Little research currently focuses on teaching and learning coding within non-formal learning environments such as the distinctive context of a CoderDojo, where learning is not constrained by any predefined curriculum, structure, or pedagogy. Moreover, with the increasing popularity of non-formal coding initiatives like CoderDojo, it is vital to understand teaching approaches that are implemented in such unique learning contexts. The findings of this study will be of interest to researchers and educators, laying the groundwork for future research into teaching practices within community-based coding initiatives, which continue to be popular.

The findings of this study reveal a system whereby young people appear to have autonomy in their learning, projects reflect personal interests, and young people are encouraged to achieve personal victories within a social environment supporting learner-centred learning. This study also shows that CoderDojo facilitates a learning environment where learners can have fun and enjoy themselves while learning to code. With the current interest in coding for young people both globally and in Ireland, CoderDojo may disclose important insights that could help inform the teaching of computer programming to pupils within the movement and in other contexts.

The findings of this study will also be valuable in providing guidance for the CoderDojo Foundation to improve the quality of services provided to its community. Moreover,

the findings from this study can provide insight into the teaching approaches used in non-formal contexts to teach computing, in which educationists often are replaced with computing professionals. The findings of this study have the potential to guide policymakers at the National Council for Curriculum and Assessment (NCCA) in Ireland where the creation and development of a computer programming curriculum for pupils is currently an ongoing process (see subsection 2.4.1).

1.5 Research Paradigm and Methods

This research investigates the teaching approaches that underpin current mentoring within Dojos and explores their relationship with the CoderDojo ethos. This research utilises a social constructivism paradigm in order to answer the primary and secondary research questions. The epistemological position of social constructivism assumes that "understanding is gained by an active process of construction rather than by a passive assimilation of information or rote memorization" (Greeno et al., 1996). This paradigm aims to construct the meaning carried within social contexts by conducting interviews and observing participants.

A qualitative research approach is usually chosen when the aim of a study is to understand a phenomenon in its context. Such an approach is rooted in a "system of concepts, assumptions, expectations, beliefs, and theories that supports and informs the research" (Maxwell, 2013). The key philosophical assumption of qualitative research is that reality is constructed by individuals interacting with their social worlds. Thus, a qualitative approach is best suited for this research as this approach seeks to understand the teaching approaches favoured by CoderDojo mentors.

To answer the research questions, data are collected through semi-structured interviews with 19 mentors from 12 Irish Dojos, on-site observations of four Dojos, and an in-

depth analysis of CoderDojo documents. The data analysis has been completed using the thematic analysis technique employing NVivo software.

1.6 Researcher Position and Reflexivity

Robson (2002) defines reflexivity as "an awareness of the ways in which the researcher as an individual with a particular social identity and background has an impact on the research process" (p.172). The position of the researcher with respect to the research needs consideration as it is impossible to separate the background and beliefs of the researcher from the research. In qualitative research, the researcher could be the greatest threat to trustworthiness (Poggenpoel & Myburgh, 2003). Bias management is another big challenge in qualitative studies (Chenail, 2011). Reflexivity helps the researcher to identify areas of possible bias and then attempt to eliminate these from their study in the collection and analysis of data. However, throughout this study, the researcher was aware that reflexivity is only partial at the best of times as it is not possible for a researcher to eliminate things they are not aware of (Robson, 2002).

The motive and choice of topic for this study originated from the researcher's background in computer science and previous professions both as a technical trainer and then as a lecturer of computer programming modules within a Computer Science Department at a third-level education. During that time, the researcher began developing an interest in education, which led her to start reviewing the literature related to computing education.

As the researcher is originally from Saudi Arabia, conducting her study in an Irish context, she is careful to consider the cultural variations and educational differences between the two countries. Even though the educational systems in both countries are largely classroom based, teach for exams and lack computing subjects, community-

based coding initiatives are not as common in Saudi as they are in Ireland. Therefore, the researcher spent considerable time studying and interacting with such initiatives, particularly the CoderDojo movement, to better understand them.

In this study, the researcher is the sole researcher or 'human instrument' who interacts with all participants (Crotty, 1998). Therefore, she trys to identify and be aware of any possible preconceptions, thoughts, or biases that might originate from her own background, identity, or worldview in order to limit the possible effects of them. Any possible bias the researcher is aware of is well documented throughout this thesis.

1.7 Thesis Structure

The following is the thesis' structure and layout:

Chapter One: Introduction. This chapter provides the relevant background and context of this thesis. It introduces the research questions and objectives as well as the significance of this study. It outlines the chosen research framework and methods, and presents the researcher's position and reflexivity. The introduction chapter concludes with a roadmap for the thesis.

Chapter Two: Literature Review. This chapter discusses literature related to the constructivist approach to learning with a focus on social constructivism as the research paradigm guiding this study. It explores the field of computer science education, placing a spotlight on computing education in Ireland, within which this study is situated. In addition, it discusses literature related to teaching and learning programming in non-formal contexts, identifying a number of common characteristics in such contexts. Previous research on the CoderDojo movement is highlighted, signifying a gap in literature as well as the importance of this

study.

Chapter Three: Methodology. This chapter describes the research methodology. It discusses the study design and data generation process. It also highlights the validity, reliability, and ethical considerations the researcher follows in order to ensure the study's rigour and trustworthiness.

Chapter Four: Data Analysis. This chapter demonstrates the process of data analysis. It discusses the approach the researcher selected to analyse the data set. It explains how themes were identified using thematic analysis by providing step-by-step guidelines in data coding and the identification of themes.

Chapter Five: Results. This chapter presents the participant and Dojo profiles covered by this study. The themes resulting from this study are highlighted and supported with direct quotations and figures. The triangulation of data is clarified and the basis for the next chapter is established.

Chapter Six: Discussion. This chapter discusses the findings of the research and presents the response to the research questions posed. It discusses how the teaching approaches identified through data analysis contributed to making CoderDojos a learner-centered learning environment for young people.

Chapter Seven: Conclusion and Recommendations. This chapter presents the contribution of this study, suggestions for future research, research limitations, and final concluding remarks.

Chapter 2

Literature Review

2.1 Introduction

Constructivist theorists from the pre-computer age, such as Piaget and Vygotsky, provided significant learning theories that are relevant to, and have implications on, computing education today. Such implications are more noticeable in the less formal learning settings within which this study is placed. The research study documented in this thesis is situated within a constructivist context and this chapter provides a detailed discussion of this approach to learning, highlighting the commonality between this learning theory and less formal learning settings.

The chapter begins with a review of constructivist approaches to learning. Social constructivism was chosen as the theoretical framework guiding this study and is discussed in detail in this chapter. In addition, this chapter explores the field of computer science education, placing a spotlight on computing education in Ireland, where this study took place. Next, it presents literature related to non-formal learning, which is the learning context of this study. A discussion of the learning and teaching of programming in a

non-formal context is then highlighted. Lastly, the literature surrounding the CoderDojo movement is reviewed. Through that, the review sets out to identify a gap of in-depth empirical research on teaching approaches that are commonly implemented in CoderDojos and, ultimately, arguing the case for the research study undertaken.

2.2 A Constructivist Approach to Learning

Learning is a process of acquiring new understanding, knowledge, behaviours, skills, values, attitudes, and preferences (Gross, 2010). Two prominent theoretical positions that have influenced conceptions of learning are behavioural theory and cognitive theory (Blikstein & Moghadam, 2019). These two theoretical positions provide quite different perspectives from which to understand the nature of learning.

Behavioural learning theory views learning as a process of conditioning by instruction, which guides and shapes an individual's learning through sequences of stimuli, responses, feedback, and assessment (Blikstein & Moghadam, 2019). Behaviourism ignores the role of mental operations in the learning process and associates learning with observable behavioural outcomes that can be measured. The teacher-centered approach to teaching and learning that is commonly used in formal education has evolved from behaviourism (Blikstein & Moghadam, 2019). In this approach, learning is characterised by direct instruction, through which teachers are seen as authority figures and experts. Students are considered passive receivers of information where learning is typically assessed and measured via assignments and exams.

Behaviourist approaches to learning are criticised for their dismissal of the differences between learners as well as for their heavy reliance on extrinsic learner motivation (learners are not motivated to learn based on personal interest but based on a desire to meet expectations set by educators, such as grades (Claxton, 2013; Robinson, 2010).

Some scholars have suggested that the widely used behaviourist approaches conflict with those that are required for engaged, self-motivated, and learner-centered learning (Blikstein & Moghadam, 2019; Robinson, 2010; Wagner, 2014).

Cognitive learning theory is a reaction to behavioural learning theory. It is concerned with the internal mental constructions and activities of the learner and gives preference to their learning interests. It rejects the idea that learning occurs solely based on observable behaviour that can be measured. Instead, it focuses on problem-solving skills that are developed through the learner's experience when forming solutions to problems (Blikstein & Moghadam, 2019).

The constructivist approach to teaching and learning has evolved from cognitivism where the learner is at the centre of the learning process. The following section discusses constructivism in further detail.

2.2.1 Individual Constructivism and Social Constructivism

Constructivism is a learning theory that focuses on the cognitive development and active role of learners in their own learning. Constructivism is based on the idea that learners actively construct meaning by linking new knowledge with their existing knowledge (Kalina & Powell, 2009). According to Ertmer and Newby (2013), constructivism theory is based on the following principles:

- An emphasis on learner control over their learning.
- An emphasis on the identification of the context in which the skills will be learned and subsequently applied.
- Supporting the use of problem-solving skills that enable learners to go beyond

the information given.

- Learning objectives that transfer knowledge and skills that enable learners to implement their knowledge in new problems/situations.

There are two strands of constructivism that provide related, but in some respects different, perspectives on learning: individual or cognitive constructivism and social constructivism. Individual constructivism is based on the work of Piaget (1950) and suggests a siloed, individualised view of learning. With individual constructivism, knowledge is not transferred from one person to another, but rather individuals construct knowledge by making connections between old and new experiences. Piaget (1950) rejected the behavioural concept that learning is a passive assimilation of given knowledge. Rather, he argued that learning is a dynamic process that includes successive stages of adaptation to reality and that learners actively construct knowledge by synthesising their own theories of the world. The educational influence of this theory has inspired numerous important educational principles like discovery in learning, acceptance of individual differences, and the creation of knowledge by learners, rather than knowledge being forced on them by others (Amineh & Asl, 2015; UCD Teaching and Learning, 2020).

Social constructivism is based on the work of Vygotsky (1978) who reoriented constructivism from the individualistic perspective of individual constructivism to a sociocultural perspective. It is built upon the idea that learners engage more deeply with their learning when actively involved and when learning as part of a group (Byrne et al., 2015; Kalina & Powell, 2009). Social constructivism emphasises that learning is a social process in which learners explore concepts that are of interest to them and negotiate the meaning of those concepts with others, providing a strong foundation for deep and engaged learning.

Social constructivism has four main characteristics shared by all learning approaches that evolve from it:

- Reality is constructed through human activity.
- Knowledge is a human product, constructed within social and cultural contexts.
- Meaningful learning occurs when a learner is engaged in social activities.
- The learning process is strongly collaborative.

(Amineh & Asl, 2015; Kim, 2001; Lave & Wenger, 1999).

Social constructivism offers a significant alternative to behavioural teaching and learning approaches. It moves away from the teacher-centered approach, which focuses on the learning materials, to an approach built upon learning and meaning through social interdependence. Due to its characteristics, social constructivism offers learners authentic learning experiences and purposeful interactions with each other in an environment of mutual respect and collaborative engagement (Kim, 2001).

Social constructivist approaches to learning have recently become popular in less formal settings like Boy/Girl Scouts and coding clubs (Ghadiri et al., 2018; Lawlor et al., 2020; Vallory, 2012). CoderDojos' learning environments embrace the principles of constructivism. The Dojo setting provides a relaxed environment where tasks are not compulsory and where the Ninjas are afforded a level of independence, free to choose to participate or not. As no assessment occurs in Dojos, the pressure of curriculum delivery and meeting deadlines is eliminated from mentors' duties and is replaced with interpreting problems and articulation of action until a target (coding a concept) is accomplished. Moreover, the learning taking place in CoderDojos is embedded within a social context that places emphasis on learners working in groups and interacting

with each other. The learning environment of the CoderDojo aligns with Vygotsky's theory of social constructivism, which emphasizes the role of the educator as a mentor and facilitator (called a mentor in the CD context) who provides guidance to learners. Therefore, social constructivism guided the researcher in this study as a lens for exploring and understanding the teaching approaches taking place in CoderDojos.

The following sections discuss in further detail three major concepts that constructivism in general, and social constructivism in particular, are built upon. These are learner-centered learning, redefining the role of the teacher, and a Zone of Proximal Development (ZPD).

2.2.2 Learner-Centered Learning

Social constructivism sets the fundamental theoretical foundation for Learner-Centred Learning (LCL). It is based on the epistemological belief that knowledge is subjective and constructed individually rather than that existing as external to the learner (Hains & Smith, 2012). Constructivist strategies are often called learner-centered because of their emphasis on learners as active learners (Hains & Smith, 2012; McCombs & Whisler, 1997). McCombs and Whisler (1997) define learner-centredness as:

> The perspective that couples focus on individual learners (their heredity, experiences, perspectives, backgrounds, talents, interests, capacities, and needs) with a focus on learning (the best available knowledge about learning and how it occurs and about teaching practices that are most effective in promoting the highest levels of motivation, learning, and achievement for all learners) (p.9).

In order to promote a social environment for learning, learning should be structured

to support individual production of knowledge by assisting learners in engaging in personalised tasks and meaningful conversation around the activity. Moreover, a learner-centered approach is about making learning an interactive process where the educator is just the facilitator.

Social constructivist theorists argue that learning and the social context in which that learning is taking place are inseparable (Hains & Smith, 2012; McCombs & Whisler, 1997). Therefore, learner-centered approaches are based on working together as a group and learning together. Wang (2007) argues that

> Collaborative learning, based on sociocultural learning theories, provides learners with more effective learning opportunities. They engage in class activities, interact with others and solve problems or complete tasks, think and talk about their thinking and explore answers to the problems or tasks. The teacher acts as a motivator to encourage divergent answers and develop students' critical thinking. In this learning environment, students' independent and reflective thinking skills will be improved (p.150).

Research studies on the efficiency of learner-centered pedagogies continue to expand. Numerous studies have concluded that LCL develops learners by focusing on real-world skills like decision-making, problem-solving, higher-order thinking, and collaboration skills (An & Mindrila, 2020; Bransford et al., 2000; Reigeluth & Garfinkle, 1992). According to An and Reigeluth (2011), LCL environments increase a learner's motivation to learn because a learner feels they have ownership of their learning and also are accepted and supported. These feelings lead to more in-depth understanding, and learners are more likely to be involved and willing to learn.

Blumberg (2019) argues that educators choosing to adopt a learner-centered approach

to teaching can employ different teaching practices. Consequently, learner-centered teaching practices are not necessarily the same from one classroom to another (McCombs, 2008). An and Reigeluth (2011) agree that learner-centered teaching practices do not take only one form, but rather share the following common characteristics: learner autonomy, the educator serving as a facilitator, social support, and authentic and collaborative experiences. Learner-centered teaching approaches include, but are not limited to, project-based learning, problem-based learning, autonomous learning, and collaboration, all incorporated within a social environment.

In learner-centered environments, fun is an additional important factor to achieve better learning outcomes, particularly for young people. Young people are often more motivated to engage in activities for the experience of learning itself when they perceive learning as enjoyable and valuable, rather than because they are looking for particular information (Packer, 2006). A number of studies have shown that promoting an LCL environment introduces the fun factor into the classroom (Duncan & Buskirk-Cohen, 2011; Mardell et al., 2016; Weimer, 2013). Most studies on LCL emphasize the significance of fun as a key ingredient in helping young people achieve improved learning results.

2.2.3 Redefining the Role of the Teacher

A variety of variables influence the performance and achievement of learners, including personal characteristics, learning context-related variables, and personal experiences. However, data consistently suggest that among all factors, teachers have the most significant impact on learner outcomes (Chetty et al., 2014; Opper, 2019; Scott, 2015). Teaching can be defined as engagement with learners to facilitate their understanding and application of knowledge, concepts, and processes (Mufti & Peace, 2012). The role of a teacher is often formal and ongoing, usually carried out at a school or another con-

text of formal education. It typically involves content selection, delivery, assessment, and reflection.

The teacher's role in this technological era has become both challenging and promising. Educational systems are expected to shift from establishments with a heavy emphasis on teaching to organisations with a greater emphasis on learning (Byrne et al., 2019; Keiler, 2018; Parsons et al., 2018). Accordingly, the teacher's role needs to transform from one of expertise to one of support and guidance.

The needed shift in the teacher role is already emphasised in constructivism. Constructivist learning theory states that "students construct knowledge rather than merely receive and store knowledge transmitted by the teacher" (Ben-Ari, 2001, p. 45). Social constructivism builds even further on the idea of changing the teacher's role, referring to them as a More Knowledgeable Other (MKO). In Vygotsky's (1978) theory of social constructivism, more knowledgeable others are those who have a better understanding or a higher ability level than the learner with respect to a particular concept, task, or activity. The MKO is typically thought of as being a teacher, mentor, or older adult, but the MKO could also be a peer or a younger person (Sentance et al., 2019). The key is that an MKO must have more knowledge about the subject being learned than the learner does.

It is important to note that even though social constructivism shifts its emphasis from teacher towards more learner-centered learning approaches, the role of the teacher continues to be essential. Social constructivist researchers stress that teachers should prepare learners to tackle collaborative and problem-solving scenarios that are persistent and lack clear solutions as well as support their development towards becoming active and independent learners (Byrne et al., 2015; Scott, 2015). For that to happen, Scott (2015) argues that teachers should become 'learning coaches', which is a very different role from a traditional classroom teacher role. Teachers as learning coaches

may provide guidance to help learners develop skills, but their main role is to offer the kinds of support that will guide learners towards attaining their learning goals (Bull & Gilbert, 2012; Hirschman & Wood, 2018).

Moreover, teachers should emphasise learners' intellectual curiosity, problem identification, problem-solving skills, and their capacity to construct new knowledge with others (Bull & Gilbert, 2012; Fisher et al., 2016). Teachers should not expect to be the experts in every subject, but rather proficient in figuring out, along with their learners, "how to do something, how to find out something, or how to use something to do something new" (Scott, 2015, p. 14). This approach to teaching requires teachers to adopt a facilitator-led approach, which involves teachers interacting with learners to help, guide, and assist with solving problems learners may encounter in the completion of their work. King (1993) argues that teachers should act as a 'guide on the side' instead of the 'sage on the stage', helping learners to discover their own meaning rather than instructing and controlling all classroom activities.

The literature promoting social constructivist approaches to learning often uses the terms 'facilitator' and 'mentor' interchangeably to replace the term 'teacher'. However, there are differences. Facilitation most often refers to working with a group of learners to support them in using their collective resources to achieve their collective goals (Hunter, 2009). As such, facilitators do not necessarily have subject matter expertise (Pierce et al., 2000). On the other hand, mentoring generally refers to working with individuals to support them to achieve their own goals. Mentors usually have subject matter expertise but not necessarily an educational background on how to teach (Haggard et al., 2011).

The definition of mentor by Haggard et al. (2011) aligns with the mentor's role in CoderDojos. Within the context of CoderDojo, the term 'mentor' is used to refer to a technically skilled individual who is not necessarily trained as an educator but who

guides Dojo attendees and facilitates their learning and project work during sessions (Alsheaibi et al., 2020). Furthermore, the CoderDojo Foundation emphasises that, "The role of a mentor is not the same as that of a teacher or lecturer. Mentors help Ninjas work through problems and encourage their efforts rather than directly delivering solutions" (CoderDojo Foundation, 2019, p. 9). The researcher of this study argues that the context of CoderDojo also embraces the concept of MKO in various ways. CoderDojo mentors, who are typically computing professionals, can be seen as MKOs since they "provide support, guidance, and encouragement to the Ninjas in completing their projects and developing their skills" (CoderDojo Foundation, 2019, p. 9). The CoderDojo Foundation also emphasises that its attendees "learn how to work with others and assist their peers" (CoderDojo Foundation, 2019, p. 41), which is also a form of MKO highlighted by Vygotsky (1978).

2.2.4 Zone of Proximal Development

The Zone of proximal development (ZPD) is a key concept within Vygotsky's theory of social constructivism. The term 'proximal' indicates that the assistance provided to the learner goes just slightly beyond their current competence, building on and complementing their existing abilities. According to Vygotsky (1978), the ZPD is the distance between what a learner can do independently and what they can do in collaboration with an adult or more capable peers. ZPD learning objectives assert that "what is in the zone of proximal development today will be the actual development level tomorrow" (Vygotsky, 1978, p. 87).

The ZPD has become synonymous in the literature with the term 'scaffolding'. The term scaffolding was introduced by Wood et al. (1976), who describe scaffolding as a process that facilitates a novice learner "to solve a problem, carry out a task or achieve a goal which would be beyond his unassisted efforts" (Wood et al., 1976, p. 90). The

concept of ZPD acknowledges that some assistance is needed to bridge the learning gap. This assistance can take many forms, including educators and peers as MKOs. It can also be in the form of artefacts such as books, wall displays, or even a computer (Sentance et al., 2019). In this sense, educators play a critical role in breaking down tasks into doable components with the explicit purpose of supporting, guiding, and directing learners in their learning process, thereby, constructing knowledge and expanding learners ZPD (An & Mindrila, 2020; Duckworth, 2009). As learners demonstrate an understanding of given tasks and acquire an ability to complete similar tasks independently, the level of assistance can be gradually reduced and ultimately withdrawn.

Social contstructivism is not only a learning theory that applies to the context of this study, but also is a research paradigm that this study uses. The next section discusses social contructivism as a research paradigm.

2.3 Social Constructivism as A Research Paradigm

Research paradigms can be theoretical frameworks or beliefs the researcher brings to the research process, or they can be theories or theoretical orientations that direct the research practice (Creswell & Poth, 2018). The research paradigm offers the researcher a road map, setting out the different theoretical, instrumental, and methodological foundations needed for carrying out the research. It also provides guidelines for selecting how to collect, analyse, and report on research findings (Creswell, 2005). There are many research paradigms and these paradigms continue to expand. Many of these research paradigms have originally stemmed from the following:

Positivism/Post-Positivism is a paradigm guided by the principles of objectivity and relies on measurement and evidence (Alharahsheh & Pius, 2020). In this

paradigm, knowledge is revealed from a measurable and quantifiable observation of activities, actions, and reactions. Positivism argues that if something is not measurable, it cannot be known for certain. Hence, this paradigm is closely associated with quantitative methods of data collection, such as sampling, surveys, and questionnaires. Researchers in this paradigm usually start with a theory, and then collect data, to either support or reject the chosen theory (Alharahsheh & Pius, 2020).

Critical/Transformative is a paradigm based on the assumption that multiple realities are constructed by social, political, cultural, economic, racial, ethnic, gendered, and disability values (Culler, 2010). For critical researchers, the purpose is not simply to explore and represent reality. Rather, researchers aim for a social set-up based on equality for all participants (Culler, 2010). Hence, critical researchers deliberately adopt ethical, moral, and political standards to judge research findings. This paradigm commonly uses both qualitative and quantitative techniques to better understand the variation in community relationships, support social justice, and ultimately assure transformative change.

Interpretivism/Social Constructivism is a paradigm based on the assumption that reality is socially constructed (Marshall & Rossman, 2016). Social constructivist researchers tend to rely on the participants' views of the context being studied and recognise the impact of their own background and experiences on the research (Creswell, 2014). Social constructivists typically do not start their research with a theory but rather "generate or inductively develop a theory or pattern of meanings" (Creswell, 2014, p. 9) throughout the research process. Social constructivist researchers commonly rely on qualitative data collection methods such as interviews, participant observation, documents, and diaries.

This study attempts to explore the teaching approaches mentors implement while teaching in Dojos. In a non-formal voluntary setting such as CoderDojos, mentors

come into a learning environment (Dojo) with different experiences, abilities, and expectations. Therefore, it is reasonable to assume that they would practice different teaching approaches. Mentors' teaching practices undergo constant alteration due to the interactions between mentors and Ninjas. While positivist approaches rely on measurable entities, it is not appropriate to measure social interactions. Thus, adopting a paradigm that relies on objective reality using quantitative measurements like positivism is not appropriate for this study. Nor will critical paradigm serve the purpose of this study since the researcher seeks only to explore the study context without any pre-existing assumptions or intentions of making changes to the context.

Social constructivism is a paradigm with a closer emphasis on the social context. Key to social constructivism is the idea that the creation of knowledge cannot be separated from the social environment in which it is formed (Jackson & Sorensen, 2006). While positivists seek 'the truth', the social constructivism paradigm assumes that 'truth' is a varying, socially constructed, and ever-changing notion (Marshall & Rossman, 2016). According to this paradigm, researchers create reality through their participants' interactions and their interpretations of those interactions, as opposed to it simply existing and researchers working to discover it. The meanings the researcher constructs using this paradigm have power beyond the individual people who create them.

Social constructivism emphasises the importance of culture and context in the process of knowledge construction and accumulation (Eisner, 2017). Researchers operating within this paradigm are interested in how participants come to socially agree, or disagree, about what is real and true. As the CoderDojo movement was founded on and operates within voluntary and community-based principles, understanding mentors' backgrounds, experiences, expectations, and their relationship with their Ninjas is critical in order to better understand the CoderDojo learning environment. Accordingly, and for the purpose of this study, the researcher deems social constructivism as the appropriate framework to explore the different teaching approaches taking place within

Dojos. Furthermore, social constructivism was chosen as a framework for this study because it places participants' behaviour in the context of social constructs evolving from the same philosophical presumptions outlined by Vygotsky (1978) and reviewed earlier in subsection 2.2.1.

In this section, the social constructivist setting for the study detailed in this thesis has been presented. In the following section, the focus shifts to the field of computer science education within which this thesis is situated.

2.4 Computer Science Education

Today, computer literacy is essential to preparing people for the world they live in. In the past, learners were equipped with the skills required to fill routine manual or essential labour roles. However, today's economy and industries are very different as computers and machines have started filling the roles that once employed many people. Therefore, larger numbers of people are currently working in jobs that require higher levels of thinking and communication skills.

At a time when computers were big and too expensive, teaching computing to young people was not common. However, as computational technologies become inexpensive, Computer Science Education (CSED) slowly started to enter schools worldwide. Starting in the mid-2000s, there has been a big shift in education to focus on STEM education, and CSED became an essential part of the learning process (Martín-Páez et al., 2019; National Research Council, 2012; Sırakaya & Alsancak Sırakaya, 2022). As technologies have become more pervasive in our lives, the demand for educated and technologically literate citizens has continued to increase. The need for young people to become future producers of technology, rather than merely consumers of it, has become a major focus for researchers and policymakers. Today, educators continue to

push ahead with plans to add computing to the formal educational systems in schools' curricula (Blikstein & Moghadam, 2019; Hof & Bürgi, 2021; McGarr & Johnston, 2020).

The creation of the Logo language by Seymour Papert, Cynthia Solomon, and Wally Feurzeig in 1967 is widely considered to be the beginning of CSED (Blikstein & Moghadam, 2019). The Logo language is the first programming language explicitly designed for children (Papert, 1980). Papert conceptualised computers as machines capable of representing almost any idea and that ability makes them a powerful learning tool because learners can use them to build, test, and share their own ideas (Harel & Papert, 1991). He speculated that children's code is an externalisation of their understanding and so in debugging their code they are effectively debugging their own thinking.

Influenced by his work with children, Papert developed a learning approach named constructionism, which is based on Piaget's constructivism. Constructionism argues that when children have opportunities to learn a programming language and to create computational projects to express themselves, they are likely to encounter powerful ideas from different disciplines and to think about their own thinking (Harel & Papert, 1991). Both Piaget and Papert believed that knowledge is created by the child's active participation in the learning process. However, while constructivism focuses on the interests and abilities of children to solve certain tasks in order to accomplish specific educational objectives, constructionism pays more attention to the manner of learning (also called the art of learning) (Ackermann, 2001).

Many have built upon Papert's initial effort to develop ways to increase the popularity of CSED among young people. These efforts include the creation of the Scratch (Lian et al., 2022), Blockly (Luo et al., 2020), NetLogo (Musaeus & Musaeus, 2019), and Alice (Costa et al., 2020) programming environments, the launch of organisations such as

the Computer Science Teachers Association (CSTA)[1] and the creation of organisations that provide computing learning opportunities such as CoderDojo, Girls Who Code, Code Club, etc.

Today, the literature presents different practices that educators can implement for teaching programming. Teaching practices include using lectures to deliver concepts to large cohorts (Broadbent et al., 2018) and completing programming tasks either individually (Topalli & Cagiltay, 2018), in pairs (Wei et al., 2021), or in small groups (Scherer et al., 2020). However, there is not much general agreement on which practice(s) are the most effective in helping learners learn how to program. Therefore, deciding the best approach to teaching programming has always been difficult.

Some of the literature focuses on the role educators should adopt when teaching computing. Sentance and Csizmadia (2017) propose using a facilitator-led approach to teaching, encouraging educators to share knowledge and expertise and contribute their understanding of computing phenomena. Learning computing requires learners to develop the skills to manage projects, discuss ideas, and build the confidence to communicate and work in teams in order to be able to work in a professional capacity. Changing an educator's role to that of a facilitator or mentor gives learners the opportunity to engage with groups, contribute to team tasks, and ensure equal contributions from all group members participating in activities. Accordingly, educators involved in teaching programming should adopt strategies to help learners develop project management and teamwork skills alongside the essentials of programming (Beecher, 2018). Fessakis et al. (2013) argue that it is not a lack of tools that hinders progress in computing education but rather the development of properly designed learning activities and supporting material which can be integrated into teaching practices by "well informed and prepared teachers" (p.89).

[1]CSTA is an international body founded by the Association for Computing Machinery [ACM].

Overall, CSED has shown how new teaching roles can evolve and how productive collaboration in the classroom can be facilitated. These increase the potential of project-based learning approaches, open up possibilities for innovative ways to organise learning environments, and much more (Blikstein & Moghadam, 2019; Lunn et al., 2021; Malmi et al., 2014; Randolph, 2007). Since computer science only became an academic discipline in the late 1960s, CSED is still a relatively young field with a less substantial research base (Blikstein & Moghadam, 2019). Therefore, exploring and assessing new and existing computing teaching approaches through research is vital as our world becomes more technologically and digitally connected.

There has been a growth of research related to CSED in recent years focused on discovering new teaching approaches and practices both in Ireland and internationally. Several journals and conferences continue to emerge allowing researchers in this area to publish and to share their research. Some of the topmost sources for CSED researchers include:

- *ACM Technical Symposium on Computer Science Education (SIGCSE)*[2]
- *IEEE Frontiers in Education (FIE) Conference*[3]
- *ACM Transactions on Computing Education (TOCE)*[4]
- *ACM Conference on International Computing Education Research (ICER)*[5]
- *ACM Conference on Innovation and Technology in Computer Science Education (ITiCSE)*[6]

[2]https://www.sigcse.org/
[3]https://2023.fie-conference.org/
[4]https://dl.acm.org/journal/toce
[5]https://dl.acm.org/conference/icer
[6]https://iticse.acm.org/

- *Australasian Computing Education Conference (ACE)*[7]
- *Koli Calling International Conference on Computing Education Research*[8]
- *Computer Science Education Journal (CSEJ)*[9]

The following subsection focuses on CSED in Ireland; as the study underpinning this thesis was conducted in Ireland.

2.4.1 Computer Science Education in the Irish Context

The Computer Education Society of Ireland (CESI)[10] was founded in 1973 to encourage teachers to prepare students for a future in the computer era. The CESI involved pioneering educators interested in introducing computing in school subjects to enhance student development rather than to drive economic or employment concerns (Oldham, 2015). Between the 1970s and 1980s, public, private, and voluntary bodies within Ireland started collaborating to bring about the introduction of a computing curriculum into Irish schools (Bresnihan et al., 2015; Moynihan, 1986). Despite the organisations offering training and hardware to teachers, these attempts were not successful (Murphy, 2018). Computer science as a subject is still almost absent from, or a relatively recent addition to, the K-12 curriculum in Ireland (Connolly et al., 2022).

The limited provision of computing in schools has led to concerns that Ireland will be left behind (Maguire & Power, 2015; O'Briain, 2014). James Whelton (co-founder of the CoderDojo movement) states that "we are turning Irish school kids into consumers of technology, not creators of technology" (Kennedy, 2011). The slow pace

[7]https://aceconference.github.io/
[8]https://www.kolicalling.fi/
[9]https://ppjp.ulm.ac.id/journals/index.php/csej
[10]http://www.cesi.ie/about-cesi/

in developing initiatives to introduce computing within the formal school curriculum around the world has spurred the creation of socially driven initiatives like CoderDojo, Girls Who Code, and Code Club to fill the perceived gap in computing knowledge. These initiatives have led to a rapid expansion in the number of young people who are acquiring computing skills in non-formal learning environments in Ireland (Alsheaibi et al., 2020; Begel & Ko, 2019; Strong et al., 2017). More recently, there have been efforts to expand computing education in formal settings. One such initiative is the *Digital Strategy for Schools 2015-2020* (Department of Education, 2015), launched by the Irish Department of Education.

Education in Ireland is centralised and the Department of Education determines national educational policy and curriculum. The Irish educational system consists of pre-school, primary, and secondary or post-primary schools. Children aged three to five who attend pre-school are eligible for free education at approved pre-school facilities. Children between the ages of five and 12 attend primary school for eight years as part of their public education. Two cycles of three years each make up post-primary education; the first cycle, known as junior cycle or lower secondary, spans years one through three, while the second spans years four through six, known as senior cycle or upper secondary.

In 2016, the National Council for Curriculum and Assessment (NCCA) in Ireland set out the *Coding in Primary Schools Initiative*, which aims to increase the level of computing skills among students (NCCA, 2019). The initiative has two phases:

Phase 1 began in September 2017 to document the practice of teachers and schools in 15 schools across Ireland that implemented the coding syllabus.

Phase 2 took place between May 2018 and February 2019 in 25 schools and aimed to work with selected schools to explore teachers' experiences in implementing

coding in their classrooms. Teachers were not familiar with or had not taught coding in their classrooms before.

Analysing the outcomes of Phase 1 and Phase 2 revealed that students benefited from learning the core concepts of coding. Moreover, implementing a playful, student-centered, and project-based pedagogy was considered an effective teaching approach by the teachers (NCCA, 2019). However, in 2020, the NCCA's 'Plans of Work' initiative was terminated and replaced with a new plan to review and redevelop the primary curriculum and make technology part of the curriculum in all subjects instead of a separate one (NCCA, 2020). As of September 2022, the new plan is still under development and is expected to be launched in 2023 (NCCA, 2022).

In post-primary schools, students are offered an optional short course in coding that covers three main topics: introduction to computer science, computing systems, and coding (NCCA, 2018a). In this course, teachers decide the learning activities and pedagogy needed to help students tackle skills that are compatible with coding. These skills include thinking creatively, expressing ideas, goal setting, working with others, and taking ownership of their learning (NCCA, 2018a). Assessment in this course is open to adaptation with teachers involved in designing assessment criteria.

In September 2018, a new 'Leaving Certificate Computer Science' optional subject was introduced to post-primary schools as a pilot scheme to be officially examined for the first time in 2020 (NCCA, 2018b). According to NCCA, the subject offers hands-on and in-depth exposure to computing. Assessment in this course involves a final examination worth 70% and project work for the remaining 30%. This course was designed to support a student-centered approach to teaching with teachers encouraged to use practices that support students in brainstorming solutions and developing problem solving skills. The subject was only available in 40 upper secondary schools across Ireland in

2018 with the first cohort of students from the selected schools to sit exams in 2020. The subject was then rolled out nationally in September 2020 for examination in 2022 (NCCA, 2018b).

The Irish Department of Education aspires to "realise the potential of digital technologies to enhance teaching, learning, and assessment so that Ireland's young people become engaged thinkers, active learners, knowledge constructors and global citizens to participate fully in society and the economy" (Department of Education, 2015, p. 5). Yet, the lack of appropriate teaching approaches is one of the main challenges facing the implementation of computer science subjects in Irish schools (Lawlor et al., 2020; Murphy, 2018). With the ongoing development of schools' curricula, further research is required to address appropriate teaching pedagogies in order to facilitate learners' construction of new knowledge.

The gap in computing education in schools seems to have a negative influence on students in higher education. Computer science students' non-progression rates in Ireland are alarming, with a large number of students struggling to progress every year. The Higher Education Authority's most recent report noted that the non-progression rate of students in computing related disciplines for the year 2019/2020 was 15%, which is one of the highest non-progression rates across all disciplines (Higher Education Authority, 2020). Students' difficulty passing programming modules was identified as the main reason students decided to drop out (Quille & Bergin, 2019).

Much of the educational efforts and initiatives described in this section take place in formal learning environments. Formal learning is usually located in institutions dedicated to education or training, structured via learning objectives, facilitated by a teacher or trainer, and leads to certifications from schools and universities (European Commission, 2001). In contrast, the CoderDojo movement falls into the non-formal learning category. Therefore, it is important to provide an overview of this form of

learning in order to understand the learning environments offered by CoderDojos.

2.5 Non-formal Learning

Non-formal learning emerged in the 1960s as a response to a continuously changing educational landscape, which desired a greater emphasis on out-of-school learning (La Belle, 1982; Rogers, 2005). Since then, researchers have attempted to define non-formal learning in terms of the attributes and dimensions it entails. According to Coombs and Ahmed (1974), non-formal learning entails any organised activities that take place outside the area of formal learning. However, such definitions are criticised for their imprecision and ambiguity. The ambiguity in such non-formal learning definitions arises from:

- The difficulty of defining non-formal learning without invoking a comparison with formal learning.
- The frequency with which non-formal learning is used interchangeably with informal learning.
- Non-formal learning can involve a wide range of spaces.

(Rogers, 2005; Romi & Schmida, 2009)

As a result, in practice, little distinction is made throughout the literature between informal and non-formal learning and the terms seem to be used interchangeably.

Part of the ambiguity of terms also stems from the fact that learning can take place in different settings, for different reasons, using different sources of knowledge. Thus, exact standards do not always fully apply to a particular context. In practice, elements

of both formality and informality can be discerned in almost all actual learning situations. In other words, formality and informality are not discrete types of learning, but rather represent attributes of it. Accordingly, Werquin (2010) attempted to redefine non-formal learning to make it more flexible, and therefore, of more practical use.

Werquin (2010) argues that non-formal learning stands somewhere in between formal and informal learning. Non-formal learning is partly organised and may have some defined learning objectives. It occurs in a planned but highly adaptable manner in institutions, organisations, and situations beyond the spheres of formal or informal learning. It shares the characteristic of being mediated with formal education, but the motivation for learning may be wholly intrinsic to the learner. Figure 2.1 highlights the flexibility Werquin's definition of non-formal learning offers.

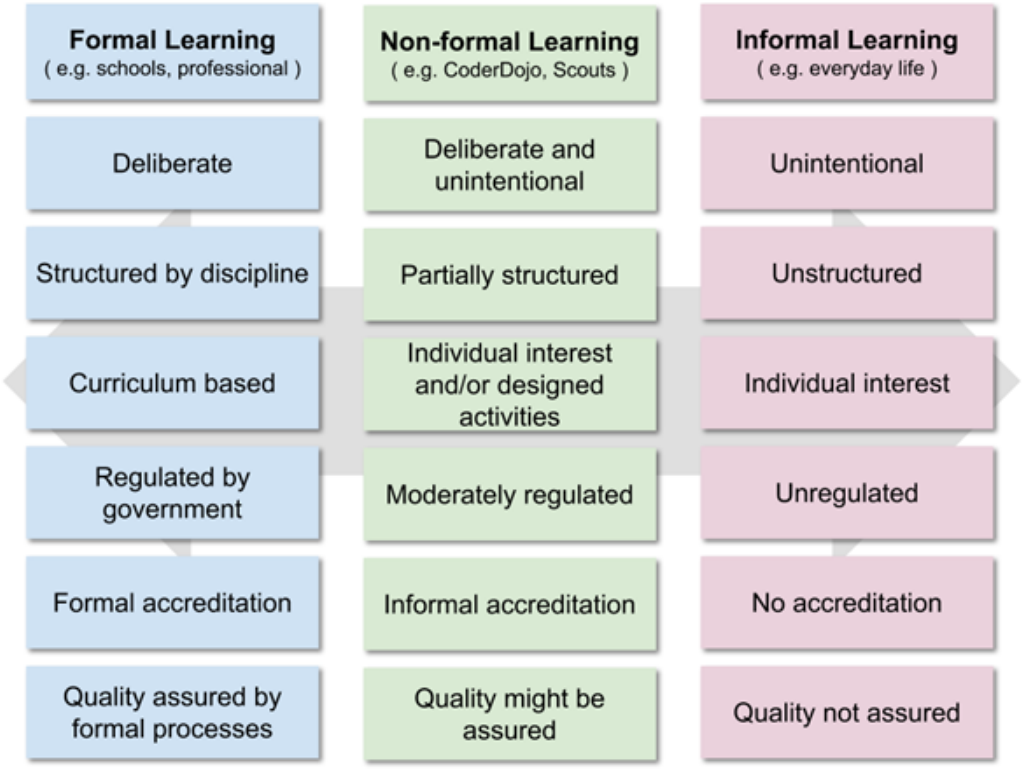


Figure 2.1: Formal, Non-formal and Informal Learning
Adapted from (Werquin, 2010)

Since the CoderDojo movement is a non-formal, volunteer-led, and community-based coding initiative, Dojos are different from one another. For example, some Dojos can

be more structured than others in terms of the given activities and mentor involvement with Ninjas. Werquin's (2010) definition of non-formal learning highlights the basic criteria that define each type of learning, while simultaneously providing more flexibility within its definition of non-formal learning when criteria fall along the spectrum between formal and informal learning. This flexibility allows for the capture of the variations between Dojos. Hence, for the purposes of this study, Werquin's (2010) definition of non-formal learning was adopted.

Within the flexibility that Werquin's (2010) definition offers, there are a number of characteristics that are constantly associated with non-formal learning contexts. An essential characteristic is that non-formal learning contexts promote more egalitarian and less hierarchical relations among learners and educators (Madjar & Cohen-Malayev, 2013; Taylor, 2006). Batlle (2019) argues that the flexible, free, and egalitarian environment non-formal learning provides to participants is the main reason behind its popularity. Moreover, this flexibility contributes to faster adaptation in the non-formal learning contexts to the needs of individuals and society.

Participation in non-formal learning is usually voluntary and driven by intrinsic motivation (Colley et al., 2002; Dib, 1988; Eshach, 2007). Non-formal learning organisers tend to put more emphasis on activities intended to support certain groups of the population like young people, adults, etc. (Colley et al., 2002; Willems, 2015). This quality allows for faster development of non-formal learning programmes and approaches that are more emergent and initiated from learners' interests and needs (Kiilakoski & Kivijärvi, 2015).

Following the World Education Forum in UNESCO (2000), interest in non-formal learning started to evolve globally (Johnson & Majewska, 2022). Currently, there are indications that non-formal learning is gaining popularity with various groups at various levels. Several development agencies have started to provide support for the

provision of non-formal learning, particularly to young people like the United Nations Children's Fund (UNICEF), the European Commission (EC), and the United States Agency for International Development (USAID). Yet, there is standing criticism from a research perspective regarding the efficacy of these non-formal initiatives and the lack of exploration of the role of pedagogy and teaching approaches (Batlle, 2019; Blikstein & Moghadam, 2019; Johnson & Majewska, 2022). Thus, further research is required to better understand these learning contexts.

Since the CoderDojo movement is focused on helping young people learn how to code, the following section places the spotlight on teaching and learning programming in non-formal contexts.

2.6 Teaching and Learning Programming in Non-formal Contexts

As many countries move towards a 'computing for all' mindset, non-formal computing learning options are becoming a popular way to reach young people and promote the development of their computing knowledge, skills, and confidence. In addition, they provide a complementary experience to that offered by traditional schooling. Recent research on non-formal computing education has shown that less formal learning environments contribute to increased learning (Batlle, 2019; Ghadiri et al., 2018; Terrazas-Marín, 2018; Tisza et al., 2020).

Non-formal contexts do not have the same constraints imposed by formal learning contexts (Lawlor et al., 2018; Tisza et al., 2020). Arguably, the existing formal educational systems are not prepared to embrace the essential change required to improve young people's computing skills (Dole et al., 2016; Verger et al., 2019). Such changes would demand a shift from the prevalent teaching practices based on teacher-centered

pedagogies to those based on a learner-centered approach (Claxton, 2013; Robinson, 2010).

Less formal education initiatives promoting learner involvement in computing have been encouraged in many countries around the world. Yet, there is standing criticism from a research perspective regarding the efficacy of these non-formal initiatives and the lack of exploration of pedagogy and teaching approaches (Buckingham & Willett, 2013; Kim & Keyhani, 2019; Lawlor et al., 2020). Thus, further research is required to better understand pedagogy and teaching approaches that educators employ in these learning contexts in order to facilitate learners' construction of new knowledge.

Many strategies for teaching and learning programming skills in non-formal contexts have evolved over the years. A careful review of the literature related to programming in non-formal contexts identified a number of common characteristics in relation to teaching and learning. These characteristics are considered in more detail in the following subsections.

2.6.1 Autonomous Learning

Autonomous learning was first used in the field of applied linguistics and went on to become a primary objective of education today (Johnson & Majewska, 2022; Kalyaniwala & Ciekanski, 2021). Definitions of learning autonomy center around learners taking more responsibility for what they learn, how they learn, and when they learn. Holec (1981), one of the first advocates of autonomy in teaching, define autonomous learning as "the capacity to take charge of one's own learning" (p.3), whereas Littlewood (1999) defines autonomous learning as "involving students' capacity to use their learning independently of teachers" (p.73). Murphy (2011) argues that, "Despite the lack of a single, universal theory of autonomy, there is agreement on the educational importance

of developing autonomy and that autonomy can take a variety of forms, depending on learning context and learner characteristics" (p.17), and to different degrees as a result of the characteristics of each learner (Yurdakul, 2017).

Boud (1988) proposes autonomy as an approach to educational practice that emphasises the learner's independence and responsibility. In non-formal contexts, Keenan (1999) argues that 'freedom of will' is a central part of the capacity to make learning choices. McKelvey and Cowan's (2017a) study on CoderDojos found that Dojos appeared to offer Ninjas a learning atmosphere that encourages them to work independently in order to reach their personal goals.

The role of educators in promoting autonomous learning is key. Even though learner autonomy is grounded on learner independence and active attitude towards learning (Yan, 2012), Masouleh and Jooneghani (2012) claim that the capacity of learners to take responsibility for their own learning is not innate but must be taught. Moreover, the whole learning process would result in low efficiency or even fall into disorder without the guidance and supervision of facilitators (Yan, 2012). Hence, facilitators have an essential role to foster autonomous learning tendencies by reflecting on their own beliefs, practices, and experiences of the teaching/learning situation (Little, 1991).

2.6.2 Collaboration

Collaborative learning can be defined as a set of teaching and learning strategies that encourage learner collaboration in small groups of two to five in order to optimise their own and each other's learning outcomes (Johnson & Johnson, 1999). According to Ridgway and Passey (1991), learning experiences that promote collaboration create an atmosphere designed to help the learner succeed. In terms of computing pedagogy in particular, Zendler (2018) claims that collaboration creates opportunities for learners

to take responsibility for their learning through projects designed to provide them with different experiences and perceptions of computing. Mishra and Henriksen (2018) interpret programming as a 'creative process' and argue that educators should consider integrating collaborative projects into computing lessons as a way to help learners improve "solutions far greater than would be possible with simply a human being working alone" (p.73). Ben-Ari (2001) also suggests that organising learners into teams working on computing-related projects creates opportunities for them to discover solutions and practice applying concepts, supported by their peers.

Studies have shown that progress in the implementation of collaborative learning is more evident in non-formal learning environments than it is in formal classrooms (Lawlor et al., 2020; Morgan et al., 2008; Vallory, 2012). However, collaboration requires appropriate pedagogical support to be effective in educational settings (Mason, 2020). Therefore, being in a non-formal learning environment alone does not guarantee that learners will be able to successfully collaborate to achieve various learning objectives. Different studies focus on developing learning activities that can help educators apply computing activities that are pedagogically appropriate to improve learners' social and cognitive skills and that will enable them to learn collaboratively (Higgins et al., 2012; Katterfeldt et al., 2018; Lingard & Barkataki, 2011; Mason, 2020).

2.6.3 Peer Learning

While collaborative learning occurs peer-to-peer or in larger groups, peer learning, or peer instruction, is a type of collaborative learning that involves learners working in pairs or small groups to discuss concepts or solve problems (Boud et al., 1999). Traditionally, peer learning refers to learners interacting informally with each other outside formal teaching classes (Falchikov, 2003). However, recently peer learning has been included as part of more formal learning contexts, with learners being asked to

work together to achieve a variety of learning outcomes (Falchikov, 2003; Resnick & Robinson, 2017). In peer learning, learners learn with and from each other, usually within the same class or cohort (Falchikov, 2003). Interaction with peers can result in the development of cognitive and intellectual skills and an increase in knowledge and understanding (Falchikov, 2003; Resnick & Robinson, 2017).

Vygotsky (1978) believed that co-operation between peers is likely to encourage a meaningful exchange of thoughts and discussions. He stressed the value of the cognitive conflict that multiple perspectives can bring, and deemed co-operation essential for the development of critical thinking and objectivity. Vygotsky (1978) also argued that a lot of learning happens in the company of, and due to, one's peers when implementing learning terms like ZPD and MKO. He claimed that the range of skills that can be developed with peer collaboration or adult guidance is greater than anything that can be attained alone.

Peer learning is commonly perceived as an important element in the learning taking place in non-formal contexts. In non-formal computing contexts, peer learning is often a type of collaborative learning that involves learners working in pairs or small groups to discuss concepts or find solutions to problems. Hackathons[11] are a good example of a non-formal learning setting where learners get to work together to solve a programming problem. Studies conclude that hackathons provide opportunities for a significant amount of peer learning (Begel & Ko, 2019; Nandi & Mandernach, 2016). During these hackathons, mentors from educational and industrial institutions provide participants with hands-on support, troubleshooting, and advice. Nandi and Mandernach (2016) find that hackathon participants spend quality time practicing the skill of working together collaboratively. Learners are motivated to participate in these hackathons

[11]Hackathons are large events where people gather to complete projects in collaborative programming teams.

mainly for the social appeal of working in a fun environment with new people and new technology (Warner & Guo, 2017).

2.6.4 Social Environment

Social constructivism views learning as a social process in which learners explore concepts that are of interest to them and negotiate the meaning of those concepts with others, providing a strong foundation for deep and engaged learning. Thus, Edwards-Schachter et al. (2015) and OECD (2013) propose that learning is enhanced when young people are inspired through a social learning environment.

A positive social environment is essential to facilitate optimally adaptive learner outcomes such as motivation, achievement, and learning (Eccles et al., 1998). Traditionally, in more formal learning settings, learners are expected to learn independently (Martin, 2004), while in less formal settings, they are given opportunities to mix and connect with peers (Denson et al., 2015). Over the past years, research into informal and non-formal education has shown that less formal learning environments increase learner motivation and the ability to learn (Mohr-Schroeder et al., 2014; Roberts et al., 2018).

Leat and Lin (2003) argue that accomplishing the objective of getting learners to think about their learning requires a social constructivist approach because learning and understanding are social activities where deep learning and higher-order thinking largely depend on talk and interaction. Social constructivism would relax formality in favour of the encouragement of the learning community (Bonk & Cunningham, 2012; Kalina & Powell, 2009). Learning contexts outside formal education like scouts, coding clubs, etc. have demonstrated efficacy and commitment in delivering a better social learning environment compared to formal education (Greeno et al., 1996; Vallory,

2012).

Numerous studies have established a link between social environment and creativity, claiming that creativity of learners is strongly influenced by social context (Hennessey, 1995; Patston et al., 2021; Semrád & Škrabal, 2017; Sternberg & Kaufman, 2010). The concept of 'creativity' has been a long-standing, desirable quality within education. In the literature, there is almost no agreement on a definition of creativity. However, Patston et al. (2021) argue that definitions of creativity have always had two main components: originality or novelty and task appropriateness or usefulness. Plucker et al. (2004) suggest that "creativity is the interaction between aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context" (p.90).

Today, a growing number of countries have emphasized creativity in their official curricula and national programs. In Ireland, where this study takes place, there is an increasing focus on the role of creativity in education and society. For example, Creative Ireland[12] is a recent national government program attempting to inspire and transform people, places, and communities via creativity. They define creativity as "the capacity of individuals and organisations to transcend accepted ideas and norms and by drawing on imagination to create new ideas that bring additional value to human activity".

2.6.5 Project-based Learning

Project-Based Learning (PBL) is an active learner-centered teaching approach that organises learning around projects and that has its roots in constructivism (Scarbrough

[12]https://www.creativeireland.gov.ie/en/

et al., 2004). It is characterised by learners' autonomy, constructive investigations, collaboration, communication and reflection to address real-world challenges (Kokotsaki et al., 2016). There is research that shows that inquiry-based learning approaches such as PBL lead to deeper, more sustained learning that can be transmitted into other situations and problems (Barron & Darling-Hammond, 2008; Bell, 2010).

According to Dole et al. (2016), for the PBL approach to be successfully implemented in class, educators should adopt the role of facilitator or guide rather than position themselves as the source of knowledge. With educator support, learners select authentic problems or challenges, conduct research, and find solutions for real audiences over an extended period of time (Barron & Darling-Hammond, 2008; Fisher et al., 2016). Moreover, when learners choose projects that are of personal interest to them, they feel ownership over their learning (William, 1998).

Due to its characteristics, the PBL approach is commonly used in non-formal contexts in general, and programming in particular (Fisher et al., 2016; Giannakos, 2020). In contrast, implementing PBL as a teaching approach in a formal education system that is teacher-centered and based on curriculum and assessment can be challenging, and change is required for it to be successfully employed (Dole et al., 2016).

2.6.6 Fun

The *Oxford English Dictionary* defines fun as "amusement, especially lively or playful". As an adjective, the word is described as "amusing, entertaining, enjoyable". In literature, definitions of fun are commonly discussed as an outcome of an act and/or engaging in an activity and generally emphasise entertainment and enjoyment of the process rather than its practical value (Chan et al., 2019). While there is limited agreement among researchers about the definition of fun, this study adopts Quigley's (2017)

definition that fun is "an affective state during which one feels in control, loses the perception of time and space, lets off social inhibitions, meets the appropriate level of challenge, and is dominated by positive emotions while the levels of negative emotions remain as low" (p.274).

Designing fun and engaging learning activities is essential to attract learners in general, and young people in particular, to programming. Fun commonly plays an essential part in non-formal coding clubs as a way to promote learning, especially among young people. A number of studies have found a correlation between fun and an increased motivation to learn coding in non-formal settings (Long, 2007; Tisza & Markopoulos, 2023; Tisza et al., 2022).

Many programming languages that are designed for young people (for example Scratch[13] and Snap![14]) offer a visual and playful learning environment as a main design component. The use of these visual programming languages is very common in coding clubs like CoderDojos and Code Club.

To measure the impact of using visual programming languages to learn programming, Sáez-López et al. (2016) conducted a two-year long study that included 107 primary school students from five different schools in Spain, all of whom were using Scratch to learn programming. This study found that using Scratch significantly increased students' motivation, enthusiasm, and commitment to learning. Having fun while learning with Scratch was a major observation reported by students in this study. Accordingly, Sáez-López et al. (2016) recommended the implementation of visual programming languages in schools in order to develop students' programming skills.

[13]Scratch is a free visual programming language designed mainly for children where they can create interactive stories, games, and animations using building blocks.

[14]Snap! is a free, block-based educational visual programming for children.

While previous research results were supportive of the positive contribution that fun makes to learning outcomes, other studies were less conclusive regarding its role. For example, when Sim et al. (2006) investigated fun and learning in a study involving the use of educational software with seven and eight year old children, they found no correlation between fun and learning. Iten and Petko (2016) had similar findings in a study with young people between the ages of 10 and 13 years old. However, it should be noted that both studies were conducted in formal education contexts and learning was measured by the difference between students' post and pre-test scores. Similar studies would be difficult to duplicate in non-formal contexts where assessment is not part of the learning process in these contexts. In sum, while links between fun and motivation to learn are recognised, the contribution of fun to improving learners' programming skills in non-formal contexts is still under-explored.

Having reviewed the common characteristics of the learning of programming in non-formal contexts, the final section of this chapter focuses on the specific context of this study. In particular, the existing literature related to the CoderDojo movement can now be reviewed and the gap in the literature that this study aims to address is clearly highlighted.

2.7 CoderDojos in the Literature

CoderDojo is the context within which this study's research questions are situated (see section 1.3) and so this chapter presents a thorough review of existing studies that has been conducted on and about CoderDojos.

From its inception in 2011, CoderDojo has grown to become an international movement that runs coding clubs to inspire young people ages seven to 17 to learn computer programming (see section 1.2). In the first five years of the CoderDojo movement, a

number of review papers were published to highlight certain aspects of the movement's ethos and its importance to the community. These papers shed light on the voluntary nature of CoderDojos (Gartside & Strachan, 2015; Hensman, 2014), their inclusion of girls and children with disabilities (Aivaloglou & Hermans, 2019; Lee et al., 2020; Quigley, 2017), the relaxed learning environment they provide to attendees (Vannini & Ferri, 2015; Ward, 2016), and the learning opportunities they offer to young people (Heintz et al., 2015; McInerney & Margaria, 2015; Wyffels et al., 2014). Some of these reviews are written by participating members of the movement itself (typically mentors), sharing their thoughts and first-hand experiences with CoderDojos (Gartside & Strachan, 2015; Hensman, 2014; Vannini & Ferri, 2015; Ward, 2016). These reviews often demonstrate a positive attitude toward the movement, arguing that Dojos promote key programming and social skills among young people. Although some of these review papers do not necessarily aim to provide in-depth analyses of the movement, the researcher of this study finds them to be very helpful as they provided insider insights, particularly in the early stages of this research.

Many studies on CoderDojos focus mainly on the young people who attended Dojos (Ninjas). They discuss topics like the knowledge and skills Ninjas gain (McKelvey & Cowan, 2017a; Sheridan et al., 2016), their motivation (Butler et al., 2018), and their overall experiences attending Dojos (McKelvey & Cowan, 2017b, 2018). For example, Sheridan et al. (2016) explored the knowledge and understanding that Ninjas acquire while attending Dojos. The study covered Dojos from different European countries, namely Ireland, the UK, Spain, and Poland. Due to the non-formal nature of CoderDojos and because they do not use any kind of learning assessment, study mentors were asked to complete skills analysis templates for 10 random Ninjas attending their Dojo. The results of this study suggest that some Ninjas attain basic computing knowledge like the ability to write simple lines of code as well as good communication skills demonstrated through their ability to verbally discuss any issue they had with a mentor or peer.

Another study that explored young people's experiences at CoderDojos in Ireland in more depth was that of McKelvey (2017). This study utilised a mixed methods approach to explore Ninjas' views, perceptions, and experiences in four CoderDojo locations within Ireland. In this study, Ninjas were observed, completed a survey, and participated in focus group interviews. The results from this study indicated that in contrast to traditional classroom environments (where learning is frequently associated with negative emotions like stress and anxiety, which can directly affect a student's academic motivation and performance), CoderDojos offered a social and assessment-free learning environment that contributed to young people feeling more empowered and exhibiting greater motivation to learn. Butler et al. (2018) reinforced this as they found CoderDojos increased young people's motivation because Ninjas perceived Dojos as an independent, relaxed, and fun learning environment. In their study, Butler et al. (2018) employed an exploratory qualitative design collecting data from three focus groups. Participants (Ninjas) were from Irish CoderDojos and were recruited via the CoderDojo Foundation. In addition to increasing learning motivation, results from this study suggested that Ninjas perceived CoderDojos to be a highly autonomy-supportive learning environment that fostered their need for competence and relatedness (Butler et al., 2018).

In 2017, Quigley tried to discover various relevant factors that could attract more girls and balance gender disparity in Scottish CoderDojos. The data collected for this study comprised 5,829 Ninjas from 36 Dojos located throughout Scotland during a four-year period. The CoderDojo movement strives to provide an inclusive environment for young people of all ages, genders, races, and physical or mental impairments (CoderDojo Foundation, 2019). 'Girls Only Dojo' is one of the movement initiatives to promote coding among girls. However, the study concluded that girls-only Dojos were not an effective way to improve the gender balance at Dojos overall. A girl whose first Dojo is a girls-only was five times less likely to go on to attend another Dojo session than a girl whose first Dojo was a mixed Dojo. Quigley (2017) argued that Dojo organisers need

to give more consideration to the activities assigned to the girls attending Dojos. In particular, these activities should demonstrate high levels of creativity by incorporating music, art, and literature combined with clearly defined outcomes. It was found that these activities tend to attract more girls resulting in a better gender balance (Quigley, 2017).

Another study by Aivaloglou and Hermans (2019) also attempted to explore ways to improve gender differences in CoderDojos and Code Club based on mentors' perceptions. Based on survey responses from 98 mentors, the study found that girls prefer projects based on storytelling combined with visual and creative ideas, whereas boys tended to be more interested in robots and gaming. This study aligns with Quigley's (2017) findings that more consideration is needed when designing activities for Dojo attendees.

Another study that focuses on inclusion is that of Lee et al. (2020). It analysed the participation of adolescents with certain disabilities in CoderDojos. In this study, the data from a three years longitudinal survey of 53 autistic adolescents was analysed to evaluate different programs that can possibly help them develop interests in STEM and develop social skills. One Dojo was among other initiatives included in that study. In that particular Dojo, mentors were a mix of computing undergraduates and occupational therapy undergraduates who focus on supporting the children's social communication and emotional regulation. While findings are preliminary, CoderDojo is found to improve autistic children's confidence, self-esteem, social relationships, and interactions with other people. Lee et al. (2020) concluded that STEM programs focusing on developing skills in an emotionally supportive environment can enable autistic adolescents to effectively develop for the workforce.

Another area of study for researchers has been CoderDojos' open and flexible learning environment, which provides a rich space to test new learning tools and teaching

approaches. For example, one study experimented with Ozobot[15], which aims to help elementary school students develop coding skills (Körber et al., 2021). However, the study did not meet its objectives because this particular tool only functions well within formal classes where everyone works on the same activity, which is not typically the case in CoderDojos.

Another study tested the implementation of a flipped classroom[16] in a CoderDojo setting (Bheemaiah, 2020). This study only experimented with a single flipped classroom in one Dojo as a starting point for a larger project intended to evaluate the effects of flipped classrooms on independent learning and creativity in formal learning settings. The results of this study show promising outcomes in the CoderDojo setting in terms of improving the motivation of learners. It was the researcher's intention to extend their study to more formal settings but this has yet to be reported.

Communities of Practice (COP) is another learning concept tested in CoderDojo settings. COP have existed for as long as people have been learning and exchanging their experiences. Wenger (1999) defines COP as "a group of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (p.73). COP has been used in education for over 30 years and was initially developed to provide a template for examining the learning taking place in a social environment (Li et al., 2009). It often focuses on sharing best practices and finding new solutions to solve problems related to a particular domain (Pereles et al., 2005). Interaction on a regular basis (face-to-face or online meetings) is an important part of this practice. O'Keeffe et al. (2019) observed that there was very little to no interaction between CoderDojos. Hence, it was suggested that the introduction of a COP to improve communication amongst Dojos would be beneficial. The study conducted ten

[15]Ozobot is a small robot that is designed as an introduction to coding https://ozobot.com/.
[16]Flipped classroom is a form of active learning pedagogy that has its roots in constructivism.

semi-structured interviews with 10 CoderDojo mentors from eight Dojos to measure the likelihood of COP being implemented effectively within the CoderDojos community. The interview questions focused on the main aspects of COP namely (participation[17], learning [18], and knowledge[19]) to determine if they are prominent characteristics in CoderDojos. From the analysis of the interview data, it was concluded that COP would be suitable and effective to implement within CoderDojo communities. Furthermore, it would increase communication, collaboration, and knowledge sharing among CoderDojos' participants (O'Keeffe et al., 2019).

While the previous studies used CoderDojos as a research context to test different learning tools and theories, Egan and Gurhy's (2020) study used a CoderDojo non-formal learning setting in a formal class. Moreover, Egan and Gurhy (2020) developed a CoderDojo module in an attempt to imitate the learning setting of the CoderDojos. This CoderDojo module was introduced to a pre-service teacher education institution in Ireland on a pilot basis. Its aim was to enable pre-service teachers to gain experience with basic coding so they could assist their students when they start teaching. The research followed an explanatory mixed methods design. In this study, 19 participants completed a self-efficacy and attitude to coding survey before their first Dojo session and again after their final session. Also, semi-structured focus group interviews were conducted with the participants upon completion of the course to discuss their experiences. The results drawn from the surveys and focus groups indicated an increase in coding self-efficacy, positive attitudes towards coding, and a successful CoderDojo experience for participants. However, the details of this CoderDojo-based pilot course design are not shared in that paper.

It should be noted that the previous studies considered above have either explored the

[17]Participation refers to members constructing knowledge through participation.
[18]Learning is taking place outside a formal setting.
[19]Knowledge is categorized by collaboration and constructivism.

impact of CoderDojos on Ninjas or have used CoderDojos as a research context to test different learning tools and theories. Little research has been done to explore the teaching approaches and practices mentors use while teaching in Dojos. One study by Aivaloglou and Hermans (2019) attempted to understand how programming is taught in non-formal coding clubs, specifically CoderDojos and Code Clubs. In this study, data was collected through a survey designed for mentors teaching in coding clubs and 98 responses were received. The study found that a majority of mentors (71%) selected the option, "The students work independently on their own projects, and I help if they need me". Other mentors (37%) highlighted that students tended to work in groups and helped each other where needed. Overall, mentors seemed to combine multiple teaching approaches like project-based learning, independent learning, and pair programming.

2.8 Conclusion

This chapter provided a detailed exploration of the literature within which this thesis is situated. In particular, it provided a review of the literature on a constructivist approach to learning and social constructivism, the theoretical framework guiding this study, was discussed in detail. A comprehensive review of the literature on CSED, both in the general and in Irish contexts, was provided. The literature related to non-formal learning was also considered in detail, noting the limited research in this area and thus, indicating a gap in the literature that highlights the importance and significance of this study.

A carefully considered review of previous research on the CoderDojo movement, the context of this research, was also included. Through that review, it can be seen that there has been little in-depth empirical research conducted on the teaching approaches that are commonly implemented in CoderDojos. This thesis, therefore, aims to address

this gap by exploring CoderDojo mentors' teaching approaches and whether they align with the movement's ethos and recommendations. The learning setting of a Dojo, where young people are learning in a non-formal context about computer programming and are guided by mentors who, in most cases, have no formal training as educators, provides a unique and novel environment for a deep exploration of how the teaching practices of mentors evolve to suit the needs of the Ninjas.

Chapter 3

Methodology

3.1 Introduction

The main research question in this study focuses on the teaching approaches commonly used by CoderDojo mentors in Ireland. Due to the limited research on teaching approaches used in non-formal learning environments in general, and in CoderDojos in particular, the researcher adopts an exploratory case study approach for this study. While the participants and findings are particular to their contexts, this study hopes to generate broader, novel insights about teaching approaches in non-formal settings.

This chapter restates the primary research question and describes the related secondary questions along with the research objectives. In addition, it discusses the research design, including how the research instruments were developed, why an exploratory case study was adopted, and from what sources data were generated. It also highlights the validity, reliability, and ethical considerations the researcher follows in order to ensure the study's rigour and trustworthiness.

3.2 Research Questions and Objectives

The chosen methodology for the research is greatly influenced by the issue or problem that is being explored. The main objective of this research is to explore current teaching approaches mentors implement within Dojos in Ireland, and the alignment between those approaches and the CoderDojo ethos. Thus, the primary research question guiding this study is as follows:

- What teaching approaches do mentors commonly implement within Dojos in Ireland?

Based on the primary research question, the secondary research questions are:

- To what extent do mentors' teaching approaches align with the recommended teaching practices of the CoderDojo movement?
- To what extent is the CoderDojo ethos reflected in the teaching approaches used within Dojos in Ireland?

Figure 3.1 provides an overview of the methodology design of this study. Social constructivism was adopted as a research paradigm guiding this study (see section 2.3). This particular paradigm incorporates a research design that relies on qualitative data collection methods such as interviews, observations, documents, etc. This study adopted a qualitative case study approach in which data were generated via semi-structured interviews, observation of Dojos, and CoderDojo documents (all of these artefacts are further discussed throughout this chapter). Based on the research paradigm and design chosen for this study, thematic analysis was used to analyse the data set.

Thematic analysis is an approach that is commonly used in qualitative studies and is further discussed in a separate chapter on the study's analysis of data (see chapter 4).

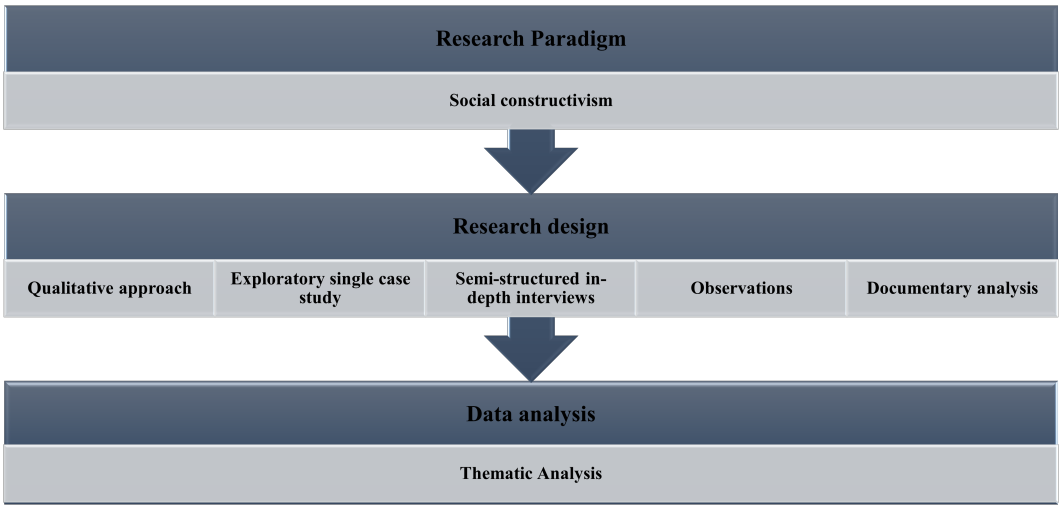


Figure 3.1: Design of the Study

3.3 Research Design

3.3.1 Research Approaches

There are three different approaches the researcher can choose from when conducting a study: quantitative, qualitative, or mixed research approaches.

Quantitative research is based only on numerical data and is driven by rigorous statistical rules. Quantitative research's major advantages include testing hypotheses and theories, fast processing of large amounts of data, generalisable results, and decreasing researcher bias (Johnson & Christensen, 2019).

Qualitative research is based on collecting and analyzing non-numerical data in order to understand concepts, opinions, or experiences. Qualitative research is characterised by strengths like the ability to understand the meaning that people construct, having an in-depth understanding of a particular phenomenon, its

dynamic nature, taking into account contexts, and the ability to generate new theories (Johnson & Christensen, 2019).

Mixed research is a combination of quantitative and qualitative approaches.

Selecting the appropriate research approach cannot be based solely on the researcher's preference. The research paradigm is a major factor to consider to determine the appropriate research approach (Mulisa, 2022). As discussed in section 2.3, social constructivism was chosen to be the research paradigm guiding this study. Social constructivism is a paradigm with a closer emphasis on the social context. In this paradigm, knowledge is created through participants' views and interactions and the researchers' interpretations of those interactions.

This study seeks to explore the approaches mentors use while teaching in a non-formal voluntary context. Mentors enter the CoderDojo environment with different backgrounds, abilities, and experiences, and their understanding, motives, and views for choosing certain teaching approaches over others may vary. Thus, choosing a quantitative approach that relies on objective reality using quantitative measurements is not appropriate for this study. A mixed methods approach has its limitations too. Mixed research can be challenging for a single researcher to execute as it is more expensive and time consuming (Bazeley, 2004). Another main disadvantage of this approach is that when a researcher tries to quantify qualitative data, it tends to lose its flexibility and depth, which is one of the main advantages of qualitative research (Bazeley, 2004). Therefore, the researcher deemed a qualitative approach to be most appropriate for conducting this study.

Qualitative research aims to explore diversity rather than to quantify elements (Kumar, 2019). Creswell and Poth (2018) define qualitative research as

> An inquiry process of understanding based on a distinct methodological approach to inquiry that explores a social or human problem. The researcher builds a complex, holistic picture; analyses words; reports detailed views of participants; and conducts the study in a natural setting (p.326).

This study takes place in the natural setting of CoderDojo, with an emphasis on contexts, and is emergent, evolving, and primarily interpretive. Hence, this study uses a qualitative approach to explore and understand the social phenomenon of CoderDojos using a social constructivism paradigm as a guiding principle.

3.3.2 Research Methods

Within the social constructivism paradigm, there are different research methods that the researchers can choose from for the context of their study. Common methods used include grounded theory, action research, ethnography, phenomenology, and case studies (Creswell & Poth, 2018; Merriam & Tisdell, 2015) (see Table 3.1). The researcher has to pay close attention to which method is best suited for their study. In particular, the researcher has to make sure the chosen method serves their research objectives and provides data that will answer the stated questions.

Research Method	Rationale
Grounded theory	Developing theory driven from data analysis
Action research	Iterative development of theory to change practice
Ethnography	Describing and interpreting cultural phenomena
Phenomenology	Exploration of the lived experience
Case study	Exploring phenomena within a particular context

Table 3.1: Qualitative Methods
Adapted from (Creswell, 2005)

Grounded theory is a qualitative method that enables researchers to study a particular context or process in order to develop new theories that describe or explain

that context/process (De Villiers, 2005). In grounded theory, the process of data collection and data analysis is iterative until theoretical saturation is reached. Since producing a new theory is not an objective of this study, but rather exploring and assessing the teaching approaches commonly used within CoderDojos In Ireland, the grounded theory method was eliminated by the researcher.

Action research is a research method that aims to simultaneously explore a context or phenomenon in order to solve an issue in that particular context/phenomenon (Baskerville, 1999). It involves action, evaluation, and reflection in order to improve a particular situation. Since exploring and observing the teaching approaches commonly implemented in the CoderDojo context is the focus of this study, rather than making an intervention, the action research method was eliminated by the researcher.

Ethnography is a qualitative research method in which a researcher (typically an ethnographer) studies a particular social or cultural group with the aim of better understanding it (Myers, 1999). It often explores cultural phenomena by close observation of the group from the inside. The researcher needs to spend months and perhaps years observing and studying participants' everyday lives and learning about their culture, conventions, and practices in order to identify patterns. As this study seeks to identify patterns within the data set in order to explore the commonly used teaching approaches within Dojos, ethnography research is not suitable for the purpose of this study.

Phenomenology is a qualitative method as well as a philosophy that explores the individuals' experience of a phenomenon (Mingers, 1992). Since participants' experiences as mentors in CoderDojos are not the objective of this study, a phenomenology method was found inappropriate.

Case study is a qualitative method defined as "a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon

within its real-life context using multiple sources of evidence" (Robson, 2002, p. 146). It attempts to examine contemporary phenomena in their real-life situations in order to propose a rich description of these phenomena (Yin, 2017). The CoderDojo movement is an Irish contemporary phenomenon with little in-depth empirical research conducted on the teaching approaches that are commonly implemented in CoderDojos. A case study method can help address this gap in knowledge through its ability to provide a rich description of a particular phenomenon. Moreover, case study is commonly used for exploring issues in educational contexts as it provides opportunities to "study things in their natural settings, attempting to make sense of or interpret phenomena in terms of the meanings people bring to them" (Denzin & Lincoln, 2011, p. 3). Therefore, the researcher deems the case study approach to be appropriate to explore the teaching approaches implemented within the context of CoderDojos in Ireland with the purpose of developing an in-depth understanding of these approaches.

3.3.3 Exploratory Case Study

Unlike approaches that focus attention on a few selected variables within a phenomenon, a case study approach is holistic, attempting to capture the totality of a phenomenon (Yin, 2017). Merriam and Tisdell (2015) argue case studies provide researchers with "an in-depth description and analysis of a bounded system" (p.39). The in-depth description and deep understanding this approach offers come mainly from its ability to incorporate different sources of data, combined with an intensive and detailed analysis. These data are usually driven from interviews, focus groups, observations, documents, and organizational records.

Two types of qualitative case study designs are frequently used in educational research contexts. The first is the single-case design, which intensively investigates a single

situation with the purpose of examining the relationship of multiple variables within a bounded context (Hamilton & Corbett-Whittier, 2012). The second is a multi-case design, which synthesises the lessons learned from a number of cases to develop more generalised explanations (Hamilton & Corbett-Whittier, 2012). This study uses a single-case study rather than a multi-case design. A single case study design provides space for in-depth examination of the chosen case in its real-world context (Merriam & Tisdell, 2015) thus, making it a valid choice for this research in which the main objective is to explore and understand teaching approaches commonly used in one bounded context (CoderDojos in Ireland). Although single-case designs are criticised for vulnerability because "you will put all your eggs in one basket" (Yin, 2009, p. 61), single-case is considered more appropriate for this study, "because the researcher wishes to understand the particular in-depth [in this case, teaching approaches mentors choose to implement], not to find out what is generally true of the many" (Merriam & Tisdell, 2015, p. 254).

According to Leung (2015) "most qualitative research studies, if not all, are meant to study a specific issue or phenomenon in a certain population or ethnic group, of a focused locality in a particular context, hence generalizability of qualitative research findings is usually not an expected attribute" (p.326). While it has often been argued that case study research in general, and single cases in particular, cannot be generalised (Blaikie, 2007), a key strength of case studies is the depth it provides through interpretations and deep understanding of context, processes, and outcomes (Denzin & Lincoln, 2011). This study seeks to address the lack of empirical research conducted on the teaching approaches in CoderDojos setting by including 19 participants from 12 different Dojos around Ireland.

Regardless of whether a researcher chooses a single-case or multi-case design, what constitutes a particular case must be identified. 'Case' is a term that is commonly used when referring to processes, communities, or organisations in a contemporary

setting (Bryman, 2016). In this study, the case is the teaching approaches mentors commonly used within CoderDojos in Ireland. Moreover, every case study needs to have clear boundaries. The boundaries of the case are geographical, temporal, and demographic. This case study is bounded geographically by the 12 Dojos from six Irish counties (Dublin, Limerick, Cork, Galway, Wicklow, Laois). Six counties are chosen in this study because they were the counties from which participants responded in an open call throughout the country. Demographically, this study includes active mentors of different genders from diverse backgrounds in terms of education, profession, experience, and years of mentoring. Temporarily, the case is bounded by the years 2019 to 2020.

Case studies can be either exploratory, explanatory, or descriptive (Yin, 2009) (see Table 3.2). Both explanatory and descriptive case studies require a well-defined problem or theory in a well-researched context available at the beginning of the study (Mills et al., 2010). An exploratory case study aims to investigate distinct phenomena characterized by a lack of detailed preliminary research (Mills et al., 2010). As there is limited research regarding teaching approaches used in non-formal learning environments for computing education for young people in general (see section 2.5), and in the context of CoderDojo in particular (see section 2.7), an exploratory case study was deemed appropriate for this study.

Case Study Type	**Research purpose**
Exploratory	Aims to find answers to the questions of 'what' or 'who'. Often combine different data collection methods such as interviews, questionnaires, observations etc.
Explanatory	Aims to answer 'how' or 'why' questions with little control on behalf of researcher over occurrence of events. This type focuses on phenomena within the contexts of real-life situations.
Descriptive	Aims to analyse the sequence of interpersonal events after a certain amount of time has passed.

Table 3.2: Types and Purposes of Case Studies According to Yin (2009)

Moreover, this study aims to explore the teaching approaches commonly implemented

within the context of CoderDojos in Ireland with the purpose of developing an in-depth understanding of these approaches. Implementing an exploratory case study enables the researcher to gain multiple perspectives from mentors regarding their roles and the teaching practices they tend to implement in their Dojos. An exploratory case study provides balance, breadth, and depth to the study.

This exploratory case study is grounded in the real-life social context of volunteering mentors teaching young people how to code in a non-formal learning environment in Ireland. Again, the emphasis of this study is not to measure, provide statistical information, or make predictions, but to achieve an in-depth understanding of teaching approaches evolving in the non-formal environment of CoderDojo. Implementing an exploratory case study with individual in-depth interviews facilitates a much deeper understanding of the mentors' experiences, their teaching practices, their expectations, and the challenges they face while mentoring.

3.4 Data Generation Process

Generating data for any research can be undertaken through primary data, secondary data, or both. Primary data refers to the raw data collected by researchers for a specific purpose, such as interviews and observations. Secondary data refers to the data taken from existing sources such as documents, journal articles, and reports. Three qualitative data collection methods are used in this study: semi-structured interviews and observations are used as primary data generation methods; data collected through a review of existing documents are secondary data.

This section covers the sampling strategies and pilot study along with the interview, observation, and document analysis methods used in this study. These are important components of the data generation process because they ensure the quality of the

research.

3.4.1 Participant Recruitment

Participants for this study were recruited using purposive and snowball sampling. Purposive sampling is a non-probability sampling strategy where participants are chosen in a deliberate manner to ensure the sample is relevant to the research questions (Bryman, 2016). The researcher has to be clear in their mind what the criteria are that will be relevant to the inclusion or exclusion of units of analysis ('units' could be sites, people, or something else) (Bryman, 2016). As this study aims to explore the teaching approaches CoderDojo mentors implement within Dojos in Ireland, the following criteria are used to identify case study participants:

- Participants must be actively mentoring. While no minimum period of mentoring in Dojos is required, it is understood that 'active mentoring' meant recently, and more than once.
- Participants must be over the age of 18.
- Participants must be mentoring in a Dojo in the country of Ireland.

To recruit participants, an online Google form was published through the CoderDojo Foundation monthly email update in September 2019 as well as on social media platforms (Facebook, Twitter, and Slack) (see Appendix A). The Google form introduced participants to the overall idea of the research and asked for demographic information, including gender, age, education level, and teaching experience. The form also sought participants' agreement to be interviewed by providing their email address for the researcher to contact them.

Demographic information was collected at this stage because the researcher wanted to see if there was any variance of responses among participants (e.g. gender, age, level of education, etc.). Since the request for participants was made public through different online platforms, there was no control over who volunteered and the sample was beholden to the respondents who completed the inquiry form and responded to the online invitations to schedule an interview.

Snowball sampling is a recruitment technique in which research participants are asked to help the researcher identify other prospective participants (Creswell & Poth, 2018). The researcher used snowball sampling due to some difficulty faced in recruiting more participants. Thus, using this sampling technique helped the researcher to reach more participants for this study.

3.4.2 Pilot Study

A pilot study allows the researcher to alleviate possible ethical concerns by tackling issues like gaining familiarity with the study environment, refining the research objectives to collect useful data, and eliminating any risk factors that might affect the study (Thabane et al., 2010). Pilot studies also allow the researcher to review and test their interview skills as well as their interviewing style in order to refine the interview questions prior to conducting formal research (Creswell & Poth, 2018). Moreover, a pilot study helps the researcher attain some assessment of the validity of questions asked and the reliability of the data that will be collected (Thabane et al., 2010).

In this study, the interview protocol was pre-tested to ensure clarity and to eliminate any misunderstanding. Pre-testing the interviews was done by reviewing the questions with a few academic experts and revising them accordingly. The interview questions were then piloted with two colleagues and one Dojo mentor. The interviewers' sug-

gestions were then taken into consideration and the interview questions were revised accordingly. For example, the initial plan was to interview participants in one session. However, after piloting the interview questions, the researcher realised that one session would take too long and participants might get exhausted. She therefore decided to divide the interview into two sessions.

3.4.3 Data Collection

Data collection for this study included participant interviews, on-site Dojo observations, and analysis of CoderDojo documents. Participants were chosen because they were the ones who responded in an open call throughout the country (see subsection 3.4.1). The observed Dojos were also selected based on the mentors' willingness to be observed. The researcher had the chance to only observe four Dojos prior to the COVID-19 pandemic when on-site observations no longer were allowed. Data was collected between December 2019 and July 2020. Due to the COVID-19 pandemic, there was an interruption in data collection (the interviewing process) between mid-March 2020 until June 2020 when the process resumed again.

Data were collected until saturation was met. Merriam and Tisdell (2015) define saturation as "the point at which you realize no new information, insights, or understandings are forthcoming" (p.183). In this study, the researcher began to reach saturation after the first 10 participants, but with the interruption in data collection, the researcher made the decision to interview an additional 9 participants to build credibility in the findings.

Semi-structured Interviews

Brinkmann and Kvale (2015) define the research interview as "an interchange of views between two persons conversing about a theme of mutual interest" (p.2). Likewise, Creswell and Poth (2018) describe the interview as an evolving face-to-face conversation among two persons discussing common themes of interest. Brinkmann and Kvale (2015) suggest that interviews attempt to understand the world from the participants' points of view in order to explain the meaning of their experiences and to find scientific explanations of these experiences.

Based on the degree of structure used to generate data, interviews are categorised into structured, semi-structured, and unstructured:

Structured interviews involve asking participants the same questions with the same wording and in the same order. Typically used in quantitative research (Creswell & Poth, 2018).

Semi-structured interviews involve asking participants a set of open-ended questions on a particular topic of interest combined with follow-up questions to further explore responses. Commonly used in qualitative and mixed methods research (Creswell & Poth, 2018).

Unstructured interviews involve asking informal and flexible open-ended questions that do not rely on a premeditated set of questions in the data-gathering process (Creswell & Poth, 2018).

Interviews can be carried out in person, via telephone, or video call using software such as Zoom or Skype and ideally the interview should be recorded (Brinkmann & Kvale, 2015). Following the interview, the recording is transcribed. The recording

and transcript together constitute the materials to be used in the data analysis stage (Brinkmann & Kvale, 2015). In this study, semi-structured interviews were conducted to gain in-depth insights into the mentors' teaching practices while mentoring in Dojos. Semi-structured interviews were considered more appropriate for this study as they are more dynamic and fluid and a better fit for the exploratory nature of this research. Using a more structured interview had the potential to bring bias to the findings by steering participants into a discussion directed by the researcher along with the limited opportunity to build on topics or ideas brought up by participants (Kulavuz-Onal, 2011). On the other hand, using unstructured interviews can make the interview process time-consuming as it can cause the participants to take more time when answering the questions, creating a low response rate and low quality results (Brinkmann & Kvale, 2015).

When using semi-structured interviews, the researcher has a list of open-ended questions designed around a set of guiding topics or themes rather than a list of prepared questions (Merriam & Tisdell, 2015). It is very important that the researcher does not dominate the conversation and knows how to listen (Cousin, 2008). The objective of semi-structured interviews is not to tell participants what to say but rather to propose paths to conceptualise issues and to create connections that "coalesce into emerging responses" (Holstein & Gubrium, 2003, p. 123). Hence, semi-structured interviews offer the opportunity to explore complex beliefs, knowledge, and experiences, which gives it a significant advantage over quantitative methods where such open-ended interviews cannot be incorporated (Lodico et al., 2010).

A group of 19 mentors from 12 different Dojos around Ireland participated in this study. Each mentor was interviewed on two different occasions where each interview focused on specific themes. The detailed structure and protocol used for each interview are outlined in Appendix B. The interview design was based on the following seven stages of an interview inquiry by Brinkmann and Kvale (2015):

1. **Thematising:** Develop the purpose of the investigation well before the interviews start.

2. **Designing:** Plan the interview questions to be asked to the study participants, making sure they serve the purpose of the investigation.

3. **Interviewing:** Conduct the interviews based on an interview protocol and with a reflective approach to the knowledge sought.

4. **Transcribing:** Prepare the interview materials for analysis, which typically includes a transcription from oral speech to written text.

5. **Analysing:** Decide which mode of analysis is most appropriate for the interviews.

6. **Verifying:** Verify the validity, reliability, and generalisability of the findings of the interviews.

7. **Reporting:** Write down the findings of the study and the methods applied following clear scientific criteria.

Table 3.3 features the previous seven stages of an interview design the researcher followed in this study. While the interview questions in this study were planned in a systematic and consistent order (see Appendix B), during the interview the researcher would ask follow-up questions for the purpose of clarification and/or elaboration depending on the progress of the interview.

Interviewing Mentors This study used interviews to explore the teaching approaches used in Dojos from the perspective of participants (the mentors) (Brinkmann & Kvale, 2015). Mentors who filled in the online form (see Appendix A) and expressed an interest in participating in the interview process were contacted via email to arrange times and dates for the interviews. 19 mentors from 12 different Dojos from six Irish counties (Dublin, Limerick, Cork, Galway, Wicklow, Laois) volunteered to participate

1. Thematising	Exploring CoderDojo mentors' teaching practices while mentoring in Dojos.
2. Designing	Planning the interview questions to be asked to CoderDojo mentors from different Dojos in Ireland (see Appendix B).
3. Interviewing	Conducting individual participant interviews using a semi-structured interview protocol that includes a mix of open-ended questions and follow-up 'why' and 'how' questions. Each interview was approximately 20 to 30 minutes and was audio-recorded.
4. Transcribing	Transcribing all interviews verbatim.
5. Analysing	Analysing interview data using thematic analysis with Nvivo qualitative software.
6. Verifying	Verifying findings and interpretations through reliability and validity checks (see section 3.5 for more details).
7. Reporting	Reporting results and interpretations (see chapter 5 and chapter 6).

Table 3.3: Seven Stages of an Interview Design with Mentors (Based on Brinkmann and Kvale (2015))

in this study. All were interviewed either face to face (5 mentors) or via Zoom (14 mentors).

At the beginning of each interview, the researcher introduced herself and gave a brief overview of the issues being investigated. Only after receiving a participant's permission did the researcher start recording the interview. In order to have a rich and relaxed conversation with the participants, the researcher did not put any time restrictions on the interviews. However, most interview sessions took between 20-30 minutes. The first and second interviews were scheduled one to two weeks apart based on the researcher and participants' availability. Though the interview questions were planned in a systematic and consistent order (see Appendix B), the researcher asked follow-up questions for clarification and elaboration.

Observation

Observation is a powerful data collection tool frequently used in qualitative studies in general, and case studies in particular (Kawulich, 2005). Marshall and Rossman (2016) defines observation as, "the systematic description of events, behaviours, and artifacts in the social setting chosen for study" (p.79). As a means of data collection, observation has many advantages in research. It is an important data collection method that enables the researcher to access data that might not be usually accessible. In addition, according to Schmuck (2006), observation provides researchers with the opportunity to note any non-verbal expression of feelings, interactions between participants, and the time spent on different activities. Erlandson et al. (1993) argue that observation enables researchers to describe situations through their five senses, leading to a 'written photograph' of the research environment.

In qualitative research, observations can be overt (participants know they are being observed) or covert (participants do not know they are being observed). This study adopts overt observation as it allows the researcher to be honest with the participants and avoids ethical problems like deception or lack of informed consent. It should be noted, however, that researcher presence can have an influence on the participants (Savage, 2000). For example, participants might know the objectives of the observation process and change their behaviour in a way that they think is expected or desired by the researcher.

Despite the benefits of using participant observation, challenges do exist. As Schensul et al. (1999) note, one of the challenges to participant observation is that the quality depends on the researcher's ability to observe, document, and interpret what happens. A researcher's range of pre-conceptions can also affect the observation (Slack & Rowley, 2001). Therefore, in this study, participant observation is used along with interviews

and review of archival documents, as well as a number of validity measures, to help reduce researcher bias (see section 3.5).

Observation of Dojos

The second phase of data collection took place between February and March of 2020. Overt observations were conducted at four different Dojos from two Irish counties (three in Dublin and one in Wicklow). One Dojo session usually takes between one and a half to two hours. Therefore, depending on how long the Dojo session was, each observation session lasted between one and a half to two hours. The observations were conducted in Dojos where at least one mentor had participated in the interview process and completed both interviewing sessions. This requirement gave the researcher the opportunity to get a feeling for their teaching practices through the interviews before observations took place in that particular Dojo.

Dojos were selected for observation based on mentors' willingness to be observed. At the end of the second interview carried out prior to the COVID-19 pandemic (when on-site observations were still allowed) the researcher asked each participating mentor whether they were comfortable with the researcher attending and observing one of their sessions. If the mentor agreed to be observed, a suitable date for the researcher to visit their Dojo was set. Each respective mentor who agreed to be observed arranged for the visit by verbally announcing the planned visit to the other mentors, parents, and children attending the Dojo on the decided date and obtained their approval for the visit. Once their initial approval was received, the researcher (through the participating mentor) distributed the information and consent forms (see Appendix E and Appendix F) to those who would be in attendance on the day of the observation. This gave time for the other mentors and parents to sign the forms before the actual visit.

All four Dojos were observed for the full duration of their sessions, which were usually

90-120 minutes. During each observation, a photo was taken to capture and record the Dojo space. The researcher did not use a structured observation protocol but instead used open note-taking to freely make notes regarding what was observed. Moreover, the observation process involved note-taking (every 2 minutes) to capture the essence of the Dojos by observing the teaching approaches mentors used, the interactions between mentors and Ninjas, and the extent to which the CoderDojo ethos was reflected within Dojos. Observing the Ninjas and their parents was not essential to the immediate task (focusing on the mentors), but doing so added to a more holistic understanding of the CoderDojo dynamic. Appendix H presents an example of notes that were taken from one of the observed Dojos (Dojo B).

Documentary Analysis

In addition to interviews and observations, data was also collected through the review of all available articles, reports, and documents published by the CoderDojo Foundation. These documents were used as secondary data in this study. Supplementing interviews with documents helps researchers develop a better understanding of the context (Creswell & Poth, 2018). Accordingly, all available articles, reports, and documents on CoderDojo were reviewed. These documents included handbooks, studies, policies and strategies, and reference materials made available by the CoderDojo Foundation. Review of these materials was important in order to cross-validate the data gathered through the interviews and observations. A summary of these documents is highlighted in Table 3.4.

3.5 Validity and Reliability of The Chosen Methodology

Evaluating research quality is essential in the research process (Bell & Stephen, 2014). The quality of qualitative research can be challenged if certain validation and reliability

Document name	Publication year
CoderDojo Annual Reports	2013–2022
CoderDojo Recommended Practice	2014
Recognition of Learning Gained Through Informal and Non-formal Coding Activities	2016
Learning Guides (CoderDojo Ethos: Implementation and Practice & inspiring Ninjas: How to be a CoderDojo Mentor)	2016
CoderDojo Best Practice and Policy Recommendations Report	2017
CoderDojo Champions' Handbook	2019
The CoderDojo Charter	Not stated
CoderDojo ECHO (Ethos, Culture, Happiness, and Outcomes)	Not stated

Table 3.4: CoderDojo Documents

precautions are not taken to ensure its rigour and trustworthiness. The validation and reliability precautions used in this study are as follows:

3.5.1 Validity

Validity shows whether an instrument measures or describes what it is expected to (Bell & Stephen, 2014). In qualitative research, the emphasis is placed on finding the 'truth' as experienced by the participants. Creswell and Poth (2018) describe nine strategies frequently used by qualitative researchers during the validation process and provide general guidance on how to implement these strategies. Creswell and Poth (2018) recommend a qualitative researcher apply at least two validation strategies in any given study. These strategies are organised into three groups based on the lens each strategy represents (researcher's lens, participant's lens, and reader's lens). In this study, six validation strategies were applied and are further discussed below:

Researcher's lens. The researcher should check the accuracy of their qualitative study by adopting any of the following validation strategies:

- **Triangulation of multiple data sources**. According to Creswell and

Poth (2018), "triangulation is a validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study" (p.126). Triangulation involves the use of different data sources to increase the variety of data that contributes to the researcher's understanding and thus, increases the credibility of the findings (Golafshani, 2003).

Triangulation was used as a validity strategy in this study. The case study design used in this study allows for multiple sources to be used in order to strengthen the research: data was collected through semi-structured interviews with mentors, Dojo observations, and CoderDojo documents (see Figure 3.2). Using triangulation, each part of the triadic data set was not treated as a separate unit, but rather it was analysed from a holistic perspective to enhance the understanding and the validity of the data. In this study, observations were carried out in four out of 12 Dojos; in all the observed Dojos, mentors were interviewed beforehand. This requirement gave the researcher the opportunity to get a feeling for their teaching practices through the interviews before observations took place in that particular Dojo. As such, the semi-structured interviews are connected with the Dojo observations and both were integrated with and compared against the existing documents. Using multiple sources of data allowed for the discovery of different aspects of CoderDojos' social reality.

- **Clarifying researcher bias**. In qualitative studies, it is critical to strengthen the research validity by clarifying researcher bias (Creswell & Poth, 2018). Implementing this validation strategy, the researcher would disclose their awareness of the biases, values, and experiences that they bring to the study from the outset of the study. Thus, the reader understands the position from which the researcher undertakes the study.

  While designing this study and before collecting data, the researcher tracked

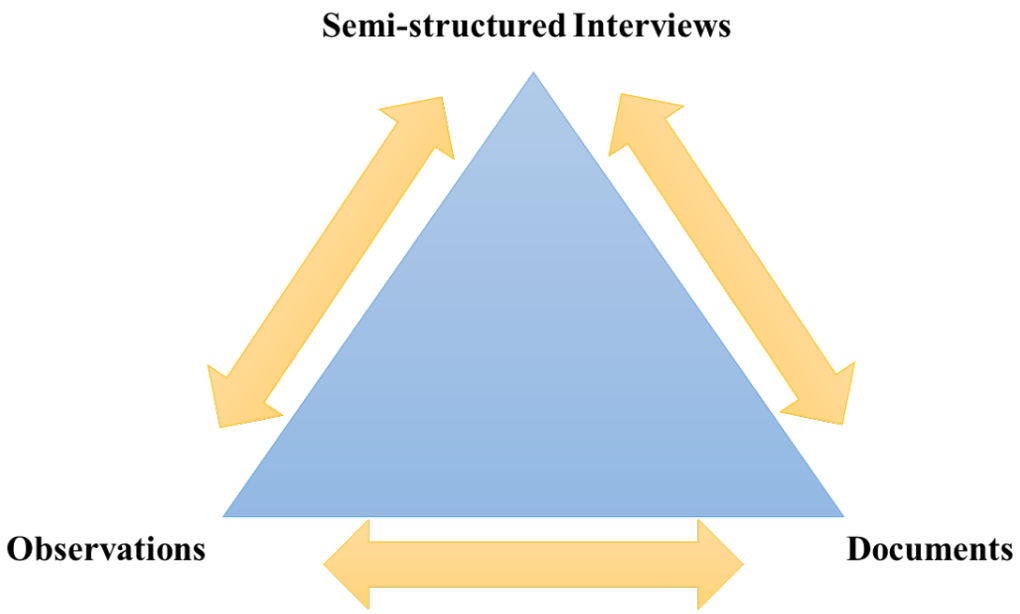


Figure 3.2: Sources of Data Used in this Study

any potential bias that might occur. In section 1.6, the researcher attempted to disclose her awareness of the biases that she may bring to the study based on her background and past experiences. Biases between participants of this study were minimised as the researcher conducted all the interviews herself. Also, during the interviews, the following procedures were followed to minimise bias and improve reliability (as recommended by Creswell and Poth (2018)):

- Following the same interview protocol in each interview to ensure consistency (see Appendix B).
- All interviews were recorded and transcribed. The recordings and transcriptions were double checked to ensure no mistakes were made during transcription.
- Consistent coding categories that led to important themes in the data were initiated.
- Consistent connections of different themes through comparison and con-

trast were done.

- **Reporting disconfirming evidence**. The goal of most qualitative studies is to find common patterns within the data set. Yet, not all evidence will necessarily fit the resulting patterns. This validation strategy is based on reporting on the evidence that goes against the discovered pattern(s) (Creswell & Poth, 2018). Through that reporting, the researcher provides a realistic assessment of the context under study and thus increases the validity of the findings.

Participant's lens. The study participants can play a significant role in the following validation strategies:

- **Seeking participant feedback**. The researcher can ask for participant feedback to evaluate the credibility of the findings (Merriam & Tisdell, 2015). According to Creswell and Poth (2018), seeking participant feedback is commonly used in qualitative research where the researcher shares data analysis, interpretations, and conclusions with the participants, giving them the opportunity to assess the accuracy and credibility of the findings and the researcher's interpretations and thus increases the validity of the findings. Lincoln and Guba (1985) emphasise it is "the most critical technique for establishing credibility" (p.314).

  Seeking participant feedback was a component of the validation process in this study. In this study, the researcher shared both early and final interpretations with the participants and asked them to reflect on accuracy in relation to their teaching experience in Dojos. This helped the researcher refine the study findings and interpretations in order to make sure they reflected the participants' teaching experience in CoderDojos.

- **Prolonged engagement in the field**. This validation strategy requires the researcher to spend as much time in the field as possible during the study

and before data collection in order to become familiar with the participants and the research site (Creswell & Poth, 2018). Incorporating this strategy, the researcher learns the culture and context in order to be able to validate possible misinformation introduced by themselves or others.

The researcher in this study spent considerable time familiarising herself with the CoderDojo movement and its mentors prior to data collection, through the following steps:

- Meeting with different members of the CoderDojo Foundation on different occasions to further understand the movement as well as the Foundation's role in it.
- Conducting a small-scale study that looked into the mentors' educational backgrounds as well as their previous teaching experience (see Alsheaibi et al., 2018).
- Designing and delivering training workshops to CoderDojo mentors (three workshops in total). In these workshops, mentors were introduced to a learning model (named Bridge21)[1] and how they might implement it in their Dojos. At the end of each workshop, the researcher sat with all the attending mentors and had a conversation about their Dojos and the challenges they faced as mentors, and received feedback on the workshop. Delivering these workshops and directly interacting with mentors helped the researcher gain more insight into the Dojo learning environment in general and the role of mentors in particular.
- Attending DojoCons[2], an annual community-led CoderDojo conference specifically organised for all the CoderDojo movement volunteers worldwide. The researcher attended the DojoCons from 2016 to 2019, participated in the conference panels, and shared her research objectives

[1] http://bridge21.ie/about-us/about-bridge-21/
[2] https://coderdojo.com/tag/dojocon/

and progress with the CoderDojo community.

  - Attending CoderDojo Coolest projects[3], another annual international event that takes place in Dublin where kids and their mentors get to compete and show their projects to a bigger audience. The researcher started attending this event in 2017 to engage in conversations with mentors, parents, and kids attending Dojos, and to become more familiar with the CoderDojo environment.

- **Collaborating with participants**. This validation strategy is based on the idea that the study is more likely to be supported when participants are involved throughout the research process (Creswell & Poth, 2018). Participants can be involved in different ways such as developing data collection protocols and contributing to data analysis and interpretation.

Reader's lens. Including others beyond the researcher and those involved in the research through one of the following validation strategies:

- **Having a peer review of the data and research process**. This strategy seeks an external view from someone who is familiar with the study context or the field of the study (Creswell, 2005). According to Scott and Marshall (1998), "The ultimate test is whether the research tools, and the results obtained, are accepted by other scholars as having validity" (p.687). The role of the peer includes keeping the researcher honest and asking questions about the framework, methods, interpretations, and analysis of the research. Using this strategy, validity can also be accomplished through peer-reviewed publications where expert scholars in the same field with no connection to the study accept the research process and approve the publication of the findings.

[3]https://dublin.ie/study/stories/coderdojos-coolest-projects/

Throughout the duration of this study, the researcher discussed this research with her supervisors as well as other experts and colleagues. In addition, the chosen methodology and preliminary findings of this study were presented at the *Frontiers in Education (FIE) Conference*, and published in the conference proceedings, which is a peer-reviewed scholarly publication (see Alsheaibi et al., 2020).

- **Generating a rich, thick description**. Using this strategy, the researcher allows readers to make decisions regarding their study through the researcher's detailed description of the context under study (Creswell & Poth, 2018). The description enables readers to transfer information to other settings and to determine whether the findings can be replicated in other studies or contexts. This was accomplished in this study in the process of writing this thesis.
- **Enabling external audits**. The researcher facilitates auditing by an external consultant to examine the study methods and the analysis process to assess their accuracy. The auditor should not have any connection to the study or the context being explored (Creswell & Poth, 2018). Furthermore, in assessing the study, the auditor examines whether or not the findings, interpretations, and conclusions are supported by the data.

3.5.2 Reliability

The goal of reliability is to decrease the errors and bias in a study. Silverman (2019) defines reliability as "the degree to which the findings of a study are independent of accidental circumstance of their production" (p.83). A research tool is considered reliable when it is consistent and stable (Kumar, 2019). To demonstrate a transparent process, the researcher created an audit trail shared with her supervisors, which entails keeping a record of all stages of the research process, accessibility to the study design

and participant recruitment procedure, as well as interview transcripts, observational notes, and data analysis process.

Reliability also entails the ability to replicate the study and achieve the same or similar findings as the original study (Silverman, 2019). When studies are replicated, it means that it is more likely that those results can be generalised to the larger population. Given the use of a single case study, it can be more challenging to replicate the results of this study (see subsection 3.3.3). However, many researchers argue that the purpose of case study research is not to generalise findings, but rather to offer an in-depth description and analysis of the case under investigation (Creswell, 2014; Marshall & Rossman, 2016). Accordingly, particularity rather than generalisability was the key factor in this study. Yin (2017) suggests that with qualitative studies the goal should be to try to provide as much detail about the case study as possible so that researchers can follow a similar design. Accordingly, the researcher made sure to provide a detailed description of the methodology used in this study so that the research can be replicated in different contexts.

To increase the reliability of findings, it is important to create a mutual platform for coding and developing both an initial and final code list that is shared with other researchers (Creswell & Poth, 2018). During the data analysis phase, the researcher of this study worked closely with her supervisors as well as with Ben Meehan, Nvivo software expert and consultant in qualitative data analysis. The process of data analysis is further discussed in chapter 4.

3.6 Ethical Considerations

Ethical considerations are critical for the conduct of research (Creswell & Poth, 2018). Qualitative methods are used to investigate personal or private opinions, requiring

ethical considerations to be examined before proceeding with the research. Ethical approval was obtained from the Research Ethics Committee in the School of Computer Science and Statistics at Trinity College Dublin before starting the data generation phase of this study (see Appendix C).

CoderDojo mentors were the primary focus of this research. Therefore, signed consent was obtained from all mentors who participated in the interview process in this study. In addition, signed consent was also obtained from mentors and parents prior to the researcher's on-site observation. The ethical principles applied throughout the data collection stages are further explained in Table 3.5.

Ethical principles	**Description**
Access to Dojos	Obtain access and acceptance from the mentors in the Dojos that participated in this study. This was undertaken before the start of data collection.
Signed Consent	A signed consent of the participants to give the right to accept or refuse voluntary participation in this study. Participants were handed an information sheet and a consent form before participating in the interviews and/or observation.
Anonymity of Participants	All data generated from interviews and observations was anonymised without reference to any particular participant.
Confidentiality	The data were kept strictly confidential and only used for research purposes.

Table 3.5: Ethical Principles Used in this Study

3.7 Conclusion

This chapter outlined the research design that was used to answer the research questions stated in this study. It outlined the qualitative exploratory case study design used and argued that this approach was the appropriate one to provide rich descriptive insights to contribute to the little research that has been done on the teaching approaches and practices mentors use while teaching in Dojos. The data generation process, the

applied validity and reliability procedures, and the ethical considerations used in this study were also discussed. In the next chapter, the researcher will discuss the data analysis procedure.

Chapter 4

Data Analysis

4.1 Introduction

This chapter demonstrates the process of data analysis. It discusses the approach the researcher selected to analyse the data set. It explains how themes were identified using thematic analysis by providing step-by-step guidelines in data coding and identification of themes. As an illustration of the process of theme generation, a more detailed look at how the study themes evolved from the data set is provided.

4.2 Inductive Approach to Data Analysis

Data analysis involves organising the generated data, reducing it into themes, and presenting findings. Taylor and Ussher (2001) argue that "themes do not just lay about waiting to be discovered, they do not simply emerge, but must be actively sought out" (p.310). In qualitative research, there are two commonly used approaches to analyse data and develop knowledge: inductive and deductive reasoning (Ormston et al., 2014).

A deductive approach is a top-down approach that is useful when the research aims to test a theory to then examine how the data set supports that theory (Kennedy & Thornburg, 2018). It tends to provide a less rich description of the data overall, and a more detailed analysis of some aspects of the data (Ormston et al., 2014). An inductive approach is a bottom-up approach that is useful when there are no previous studies dealing with the context, and therefore the coded themes are derived directly from the data set (Kennedy & Thornburg, 2018). It allows research findings to emerge from the frequent, dominant, or significant themes inherent in the data set, without the restraints imposed by a specific theory (Ormston et al., 2014). It should be noted that both approaches may start with a guiding theory or framework about the studied context, however, that does not mean there is a commitment to stay within this theory or framework (Braun & Clarke, 2019).

The research questions and objectives determine whether one uses inductive or deductive approaches. Research of an explanatory or descriptive nature typically implements a deductive approach. In such studies, there is usually a well-defined theory or framework the researcher is trying to compare the data against. In the case of the current study, there does not exist a theory about how mentors of CoderDojos select teaching approaches nor is there a theory about how those practices align with the CoderDojo ethos. In research such as this, which is of an exploratory nature, an inductive approach is more suitable.

4.3 Thematic Analysis

There are two popular approaches used to analyse data within inductive reasoning: content analysis (CA) and thematic analysis (TA). CA is a data analysis technique used to determine and quantify the presence of certain keywords, codes, or themes within a data set in order to explain a certain context (Vaismoradi et al., 2013). TA is

a data analysis technique that entails searching across a data set to identify, analyze, and report repeated patterns (Braun & Clarke, 2006).

While CA focuses on the re-occurrence of keywords or codes at a more surface-level of analysis, TA focuses on extracting high-level themes from the data set (Vaismoradi et al., 2013). In TA, a theme refers to a specific pattern found that captures some essential information about the data in relation to the research questions and features patterned meanings across the data set (Braun & Clarke, 2006). TA is a commonly used approach in many fields, mainly for its richness and flexibility (Nowell et al., 2017). Since quantifying the frequency of different codes and themes is not the aim of this study, TA is more appropriate.

The main objective of this research is to explore current teaching approaches mentors implement within Dojos in Ireland through a social constructivism lens. TA is described as a theoretically flexible method rather than "a theoretically informed and constrained methodology" (Braun & Clarke, 2019, p. 583). Hence, this approach resonates with this study's social constructivist framework and is deemed an appropriate method to be used. This study followed Braun and Clarke's (2006) six-steps approach to TA:

1. Familiarisation of data.
2. Generating initial codes.
3. Searching for themes.
4. Reviewing themes.
5. Defining and naming themes.
6. Interpretation and reporting.

The six-step approach to TA allows the researcher to actively describe the data generation process and analysis, which enables the reader to assess the credibility and validity of the process (Nowell et al., 2017). The steps are iterative in nature, offering the researcher the needed flexibility, complexity, and structure to examine comprehensively and to interpret systematically. All these qualities are needed for comprehensive qualitative data analysis. Each step in the six-step approach is explained further in the next sections.

4.3.1 Step 1: Familiarisation of Data

The familiarisation phase is common in any form of qualitative analysis. It entails reading and re-reading the entire data set in order to become very familiar with the data. The first step of the TA involved listening to the interview recordings, transcribing the interviews, reviewing the transcripts multiple times, and writing down initial thoughts to become familiar with the data. Interviews were recorded using a digital recorder and the audio files were transferred and saved on an encrypted personal computer.

During this phase, the researcher set about familiarising herself with the data by first listening to each interview recording once before transcribing that particular recording. The first playback of each interview recording required 'active listening', hence the researcher did not take any notes at this point. The researcher performed active listening in order to develop an understanding of the main areas addressed in each interview. The researcher started transcribing the interviews immediately after the active listening playback. All recordings were transcribed by the researcher herself to reach a better level of familiarity with the data. When the transcription of all interviews was complete, the researcher read each transcript numerous times. At this point, the researcher wrote down casual observations of initial trends in the data.

In the final stage of this step, all transcripts, notes, and documents were uploaded to NVivo 12 Plus. Silver and Lewins (2014) encourage the use of a software medium in qualitative studies to support data analysis and facilitate handling the collected data. Using NVivo helped the researcher undertake the analysis by employing the computer's capacity to manage, record, sort, match, and link data. It helped the researcher arrange different files and different data sources all within one project, allowing for fast navigation through data. NVivo did not have any effect on the coding or theme generation process. Using NVivo, the researcher created a separate folder for each data source (documents, interviews, and observations) and sub-folders under every data source that included all participants' transcripts, Dojo observation notes and CoderDojo movement documents (see Appendix G).

4.3.2 Step 2: Generating Initial Codes

The second step of TA was generating the initial codes. Codes are the first fundamental building blocks of themes. According to Saldaña (2016), "A code in qualitative inquiry is most often a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data" (p.4). This step of the analysis was recursive and gradually included the entire data set. Generating the code list, finding suitable codes, and writing clear descriptions to represent each of the codes, were essential steps to ensure that the connotations of each code were clear. The initial codes were given suitable labels that helped in the later analysis and synthesis of themes. In this step, some of the codes evolved from participants' language and terminology, while other codes were created based on the concept being articulated. For example, the code 'agile approach' came from the participants' own language while the code 'mentoring challenges' was created by the researcher based on the context being discussed (see Table 4.1).

Agile approach	Finding own voice	Motivation to start mentoring
Asking questions	Friends influence	No need for training
Assignments	Fun	Number of mentors per session
Attendance inconsistency	Gender balance	Old Dojos
Best practices	Giving Feedback	Online Dojo sessions
Breaktime	Increase confidence	Parents/guardians influence
Bridging gap in schools	Increase interest in Computing	Particular projects
Career opportunities	Informal learning	Passion for education
Children with disabilities	Inspire Ninjas	Patience
Class setup	Interest in teaching	Peer learning
CoderDojo motto	Lead mentor	Playing while learning
CoderDojo philosophy	Learner interests	Presentation skills
CoderDojo vs CodeClube	Learning by doing	Previous training
Communication skills	Learning independency	Problem solving skills
Community-led	Learning outcomes	Recruiting mentors
Coolest projects	Learning together	Relationship with the Foundation
Covid influence	Mentor awareness of Ninjas skill levels	Resources shortage
Creativity	Mentor role	Self-taught
Curriculum alternative	Mentoring challenges	Session planning
Different skills levels among Ninjas	Mentoring strategies	Session structure
Dojo uniqueness	Mentors background	Sharing knowledge
Dojos not schools	Mentors characteristics	Social environment
Educational resources	Mentors interaction	Teaching experience
Encourage to learn	Mentors relying on each other	Unwillingness to collaborate
Engagement during session	Mentors shortage	Venue limitations
Evaluation	Motivation to keep mentoring	Working for the Foundation

Table 4.1: Codes Resulted from Initial Coding

This process of coding relies on the researcher using their own judgement in the identification and generation of codes. Thus, during this step, the researcher created a shared folder with her supervisors that included all generated codes and had periodic

meetings to discuss these codes and make sure they reflected the data. Moreover, the list of provisional codes evolved and expanded as the data were constantly reviewed. Doing so increased the reliability of the research findings (Jackson & Bazeley, 2019).

During this phase, and with every new cycle of analysis of the data, the codes were reviewed to see if similar concepts had been labelled with different codes. Reviewing codes helped avoid unnecessary duplication and reduced the number of codes required. As coding progressed, the number of new codes decreased as the data reached saturation. In this stage, the code list was considered a 'start list' (Lotto, 1986, p. 58) to allow the researcher to organise data extracts for further analysis (Lotto, 1986). Figure 4.1 shows a snapshot of the preliminary coding process of one participant's (Mentor 1) interview transcript using NVivo. The highlighted text produced three codes: 'Be cool' (a CoderDojo motto), 'informal learning', and 'fun'. Figure 4.2 shows another snapshot of the code 'independent learner' across the whole data set (interviews, observations, documents). The code 'independent learner' was spotted 41 times in 16 different files. There were 78 codes generated in this phase. Initial codes as identified in Table 4.1 have been colour-coded to correspond to the final themes which emerged (shown later in Table 4.2), to illustrate the linkages.

4.3.3 Step 3: Searching for Themes

The searching for themes step started after the whole data set was coded. The focus shifted from the interpretation of individual data items within the data set to the interpretation of aggregated meaning and meaningfulness across the whole data set. Furthermore, this step in the data analysis process involved collating the generated codes into potential themes. During this stage, the researcher started to think about the potential links between various codes as well as the possible connections for an

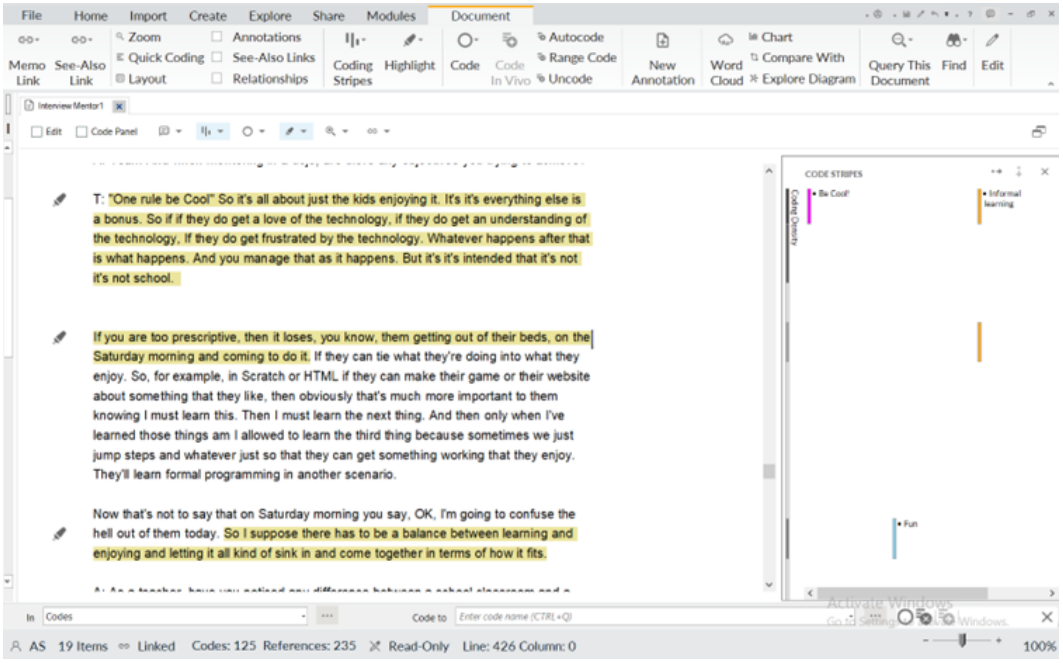


Figure 4.1: Initial Coding Example for Mentor 1 Using NVivo

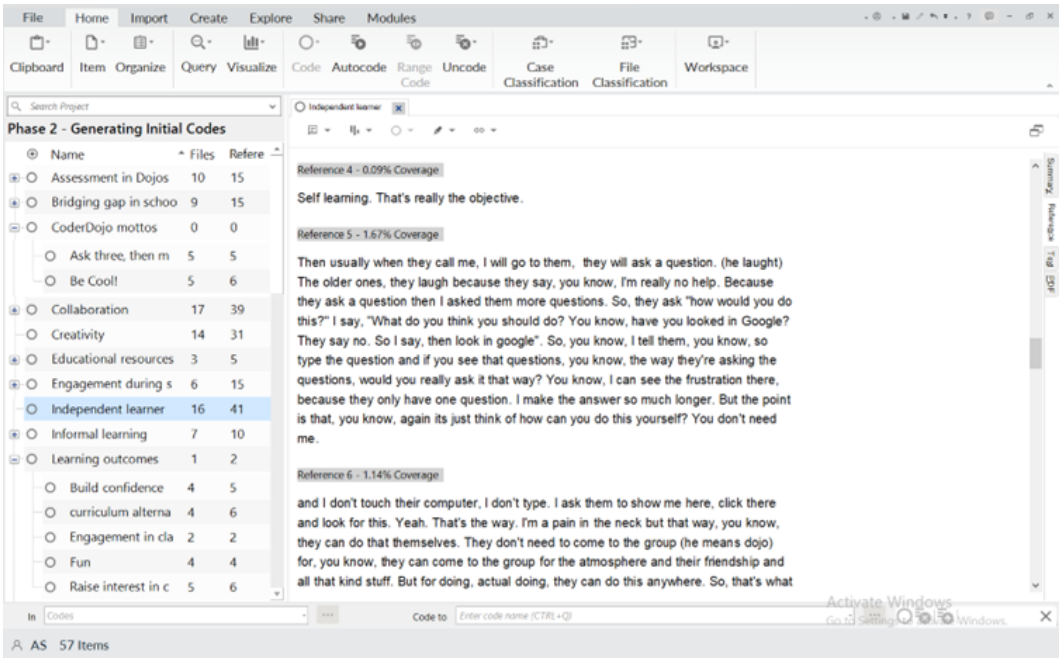


Figure 4.2: The Code 'independent learner' Across the Data Set

overarching theme. Through comparing and contrasting, themes started to emerge showing commonalities between participants.

In this phase, the researcher was trying to identify themes by exploring and pursuing links between the various codes that were generated in the previous step. Yet, the

researcher kept in mind the research questions and the key study point desired: 'The teaching approaches mentors commonly implement within Dojos in Ireland'. Figure 4.3 highlights one of many attempts in which the researcher tried to make sense of the codes and explored possible relations between them across the data set.

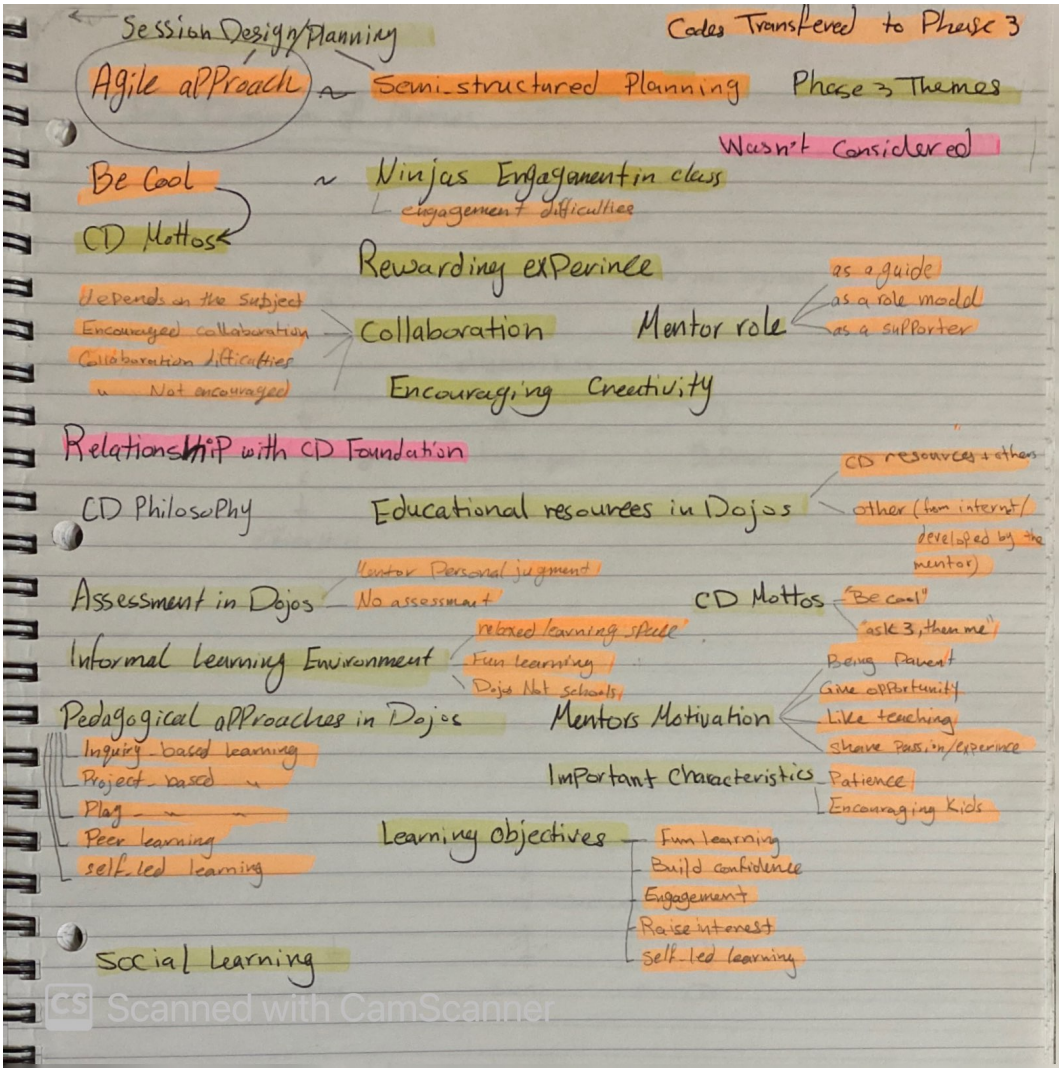


Figure 4.3: Searching for Themes

Following are the initial themes that started to evolve during this phase:

- **Self-led learning** and **mentor role** are two preliminary themes that evolved during this phase. 'Self-led learning' has emerged as a theme because there was a substantial emphasis in the data set on Ninjas becoming independent learners and developing control over their own learning with mentors only facilitating and

supporting their learning. 'Mentor role' has also emerged due to the heavy stress in both interviews and CoderDojo documents on the vital role of the mentor as a facilitator and co-learner. Figure 4.4 illustrates the two preliminary themes ('self-led learning' and 'mentor role'), their sub-themes, and the relationship between them, combined with passages to demonstrate each sub-theme from the data set.

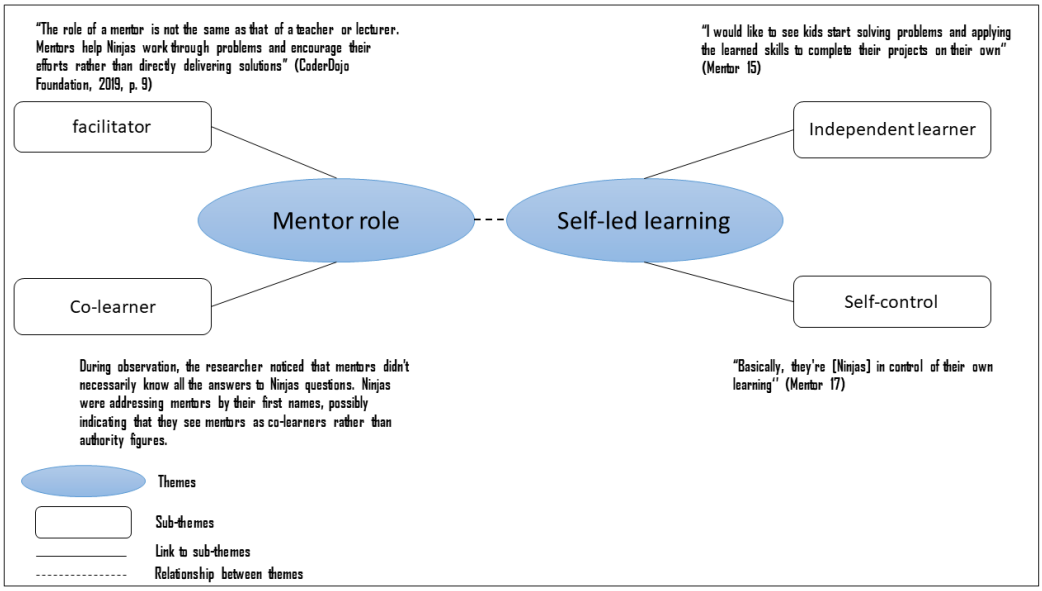


Figure 4.4: Preliminary Thematic Map for 'Self-led Learning' and 'Mentor Role' Themes

- **Collaboration** is a preliminary theme that emerged during this phase. The strong emphasis on collaboration within the CoderDojo official documents as one of the movement's fundamental ethos had a major contribution on the development of this theme. In the interview data set, some participants emphasized the importance of encouraging collaboration in their Dojos. Accordingly, 'collaboration encouraged' emerged as a sub-theme of this theme. However, the majority of participants expressed views about Ninjas collaborating that, in practice, did not particularly align with those of the CoderDojo ethos. Furthermore, based on the interviews and observational data, the researcher found a significant contradiction between the CoderDojo movement's recommendations on collaboration and the actual practice in Dojos. This contradiction contributed to the development of two additional sub-themes: 'lack of collaboration' in Dojos except for some

specific situations making it 'case dependent'. Figure 4.5 illustrates the collaboration theme, its sub-themes, and the relationship between them, combined with passages to demonstrate each sub-theme from the data set.

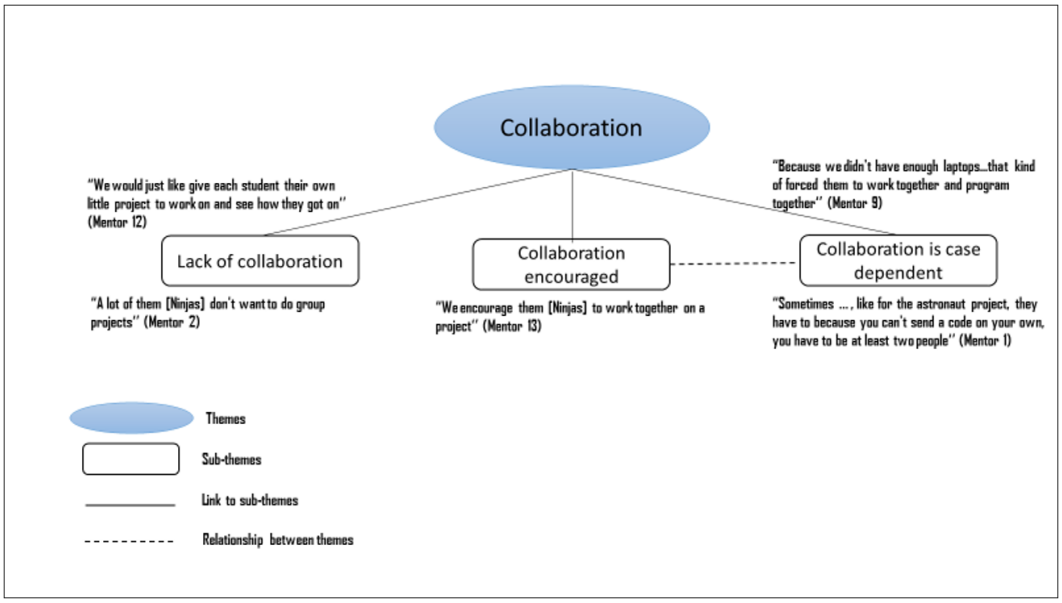


Figure 4.5: Preliminary Thematic Map for Collaboration Theme

- **Social learning** was another theme that evolved during this phase. The CoderDojo movement characterises itself as a 'social movement' that offers young people an out-of-school learning experience. The CoderDojo movement documents and the participants in this study emphasised that the social context of CoderDojo encouraged learning among young people attending Dojos. Observational data also captured Dojos as social and relaxed coding clubs for young people. Moreover, the absence of school uniforms, timetables, and curriculum, along with the mentors' perspectives toward Dojos and their role in them, have contributed to creating such a social learning environment.

  The data collected for this study indicated that peer learning and creativity were direct results of the social environment CoderDojos offered to its attendees. As a result, 'peer learning' and 'creativity' were sub-themes within the social learning theme as highlighted in Figure 4.6.

- **Project-based learning** (PBL) evolved from the data set as a commonly im-

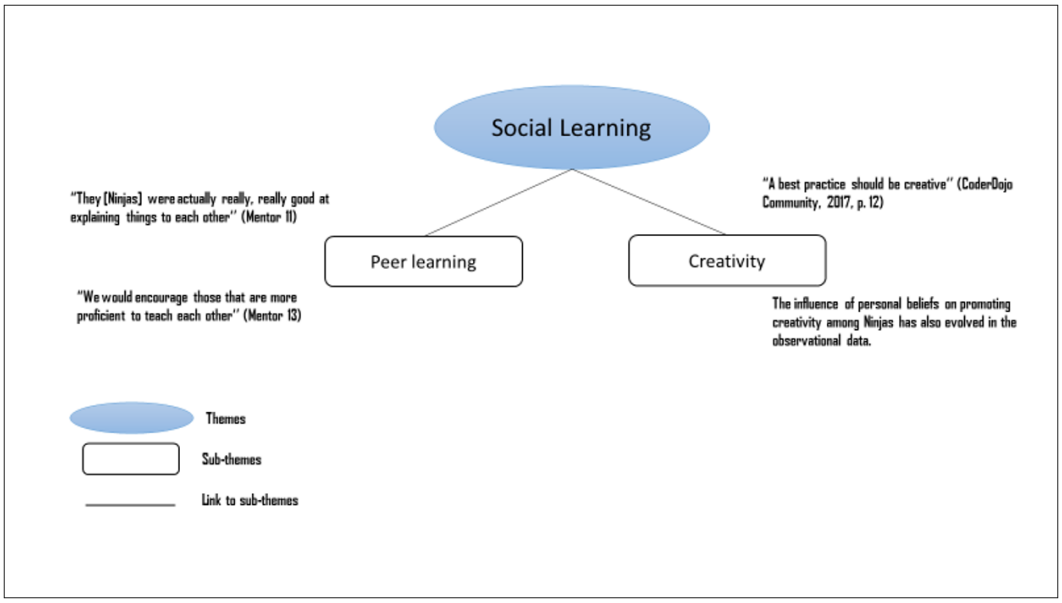


Figure 4.6: Thematic Map for Social Learning Theme

plemented teaching approach within Dojos. The PBL approach was adopted in all Dojos covered by this study to replace the need for a curriculum in the formal learning setting, which led to the development of 'curriculum alternatives' as a sub-theme. According to participants, choosing a project to work on was often based on learner interests, which contributed to the emergence of the second sub-theme, 'learner interests'. CoderDojo community initiatives like Sushi cards[1] and Coolest Projects[2] seem to have a significant role in facilitating the adoption of PBL as a teaching approach within Dojos. Accordingly, 'community initiatives' was another sub-theme under the PBL theme. This theme and its sub-themes are illustrated in Figure 4.7.

- **Fun** was another common thread in the data set, especially among the interview participants. Mentors generally believed that promoting a fun atmosphere in their Dojos was an essential factor in improving Ninjas' coding skills. Participants establishing a link between fun and Ninjas learning coding led to the development

[1]Sushi cards are double-sided laminated cards that are used within CoderDojos to communicate programming concepts.

[2]Coolest Projects is an annual international event where kids get to compete and show their projects to a bigger audience.

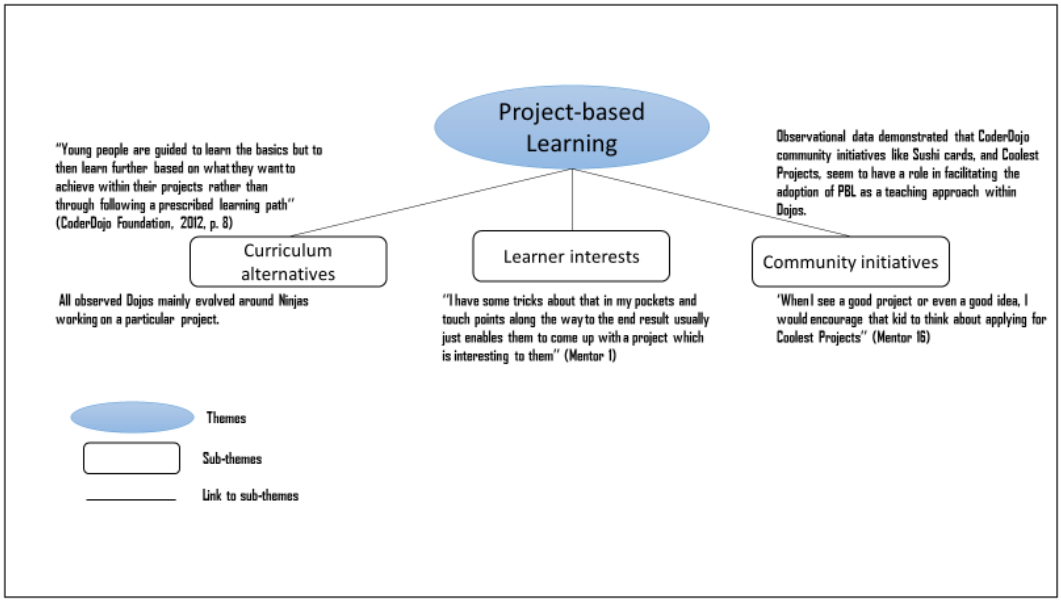


Figure 4.7: Thematic Map for PBL Theme

of 'learning coding' as a sub-theme. Many participants demonstrated that Ninjas having fun was the ultimate desired outcome of their sessions, arguing that Dojos are not schools. Hence, 'fun as an ultimate outcome' and 'Dojos not schools' were two additional sub-themes within this theme. The fun theme and its sub-themes are represented in Figure 4.8.

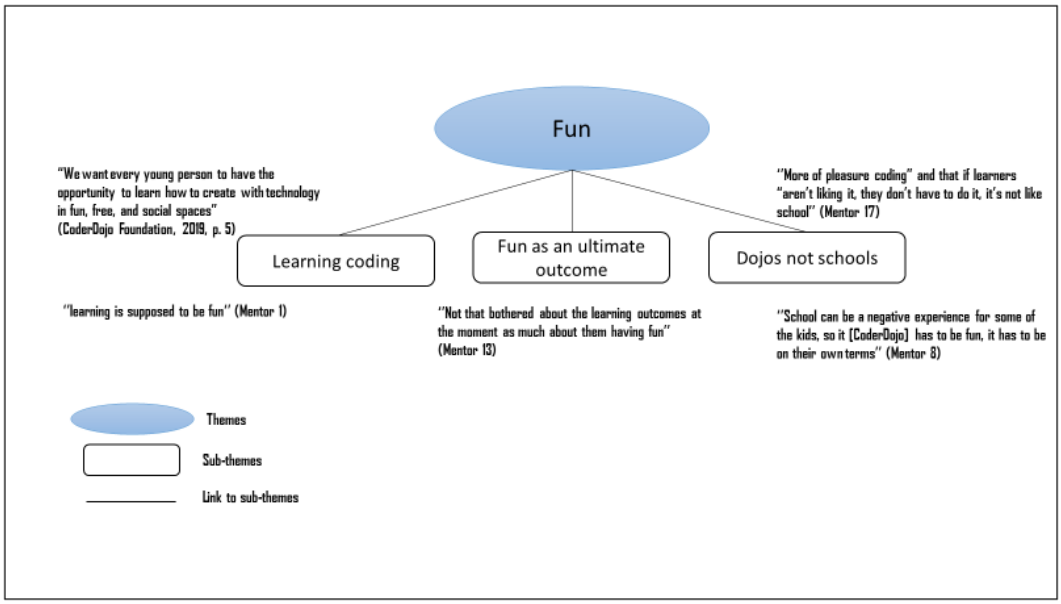


Figure 4.8: Thematic Map for Fun Theme

4.3.4 Step 4: Reviewing Themes

In step four of TA, the researcher reviewed the themes making sure they tell a convincing story about the data (Braun & Clarke, 2006, 2019). This phase also included defining the nature of each theme and the relationship between the themes and sub-themes. It is common to find that some preliminary themes may not function well as meaningful interpretations of the data on their own, or may not provide information that answers the research questions. In this phase, the preliminary themes 'self-led learning', 'mentor role', and 'collaboration' that emerged in the previous phase were further reviewed, while the remaining three themes: social learning, project-based learning, and fun stayed the same.

The two preliminary themes 'self-led learning' and 'mentor role' (see Figure 4.4) were merged into one theme. Moreover, the researcher noticed that the preliminary theme 'mentor role' was inseparable from 'self-led learning' as the data set repeatedly established a major link between encouraging independent learning in Dojos and the way mentors should teach. Therefore, the researcher decided that 'mentor role' would tell a more convincing story as a sub-theme of 'self-led learning' rather than as a separate theme. Figure 4.9 illustrates how the two preliminary themes were merged into one theme.

The theme 'collaboration' was also reviewed in this phase. In the previous phase, this theme had three sub-themes: lack of collaboration, collaboration encouraged, and collaboration is case dependent (see Figure 4.5). However, the researcher noticed that even with the strong emphasis on collaboration within the CoderDojo documents as one of the movement's fundamental ethos, the whole data set did not support it enough to become a separate sub-theme. It is valid to highlight that the few participants who stated that collaboration was taking place in their Dojos were participating in long-

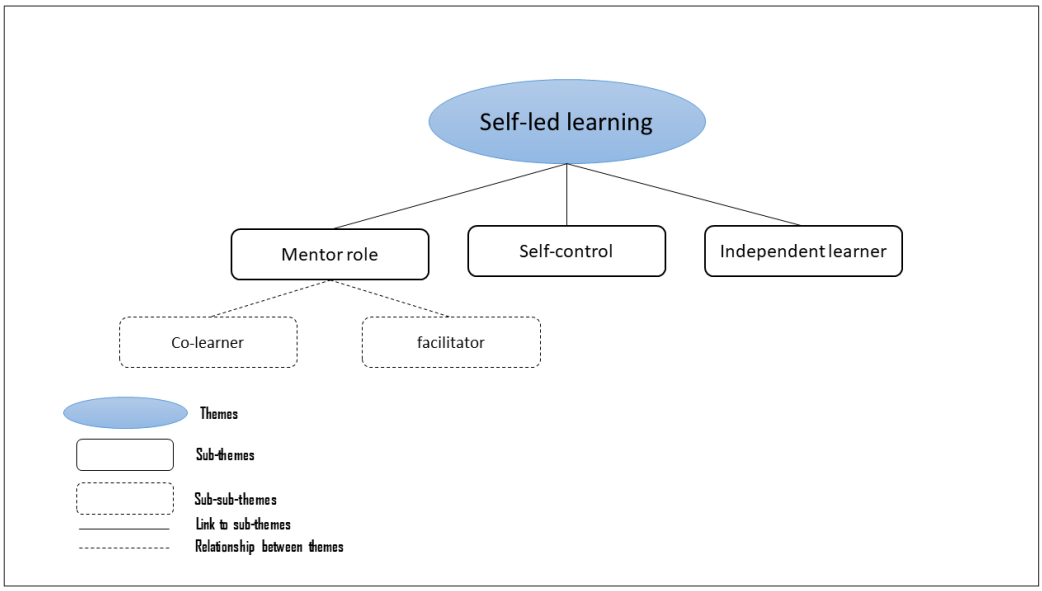


Figure 4.9: Thematic Map Demonstrates the Merging of Two Preliminary Themes into One Theme

time running Dojos. In a long-time running Dojo, there are usually higher chances of Ninjas being more familiar with each other, which can make collaboration easier. Hence, the researcher decided that pointing to the existence of collaboration in some Dojos was circumstantial and therefore, would be more suitable to be placed under the sub-theme 'collaboration is case dependent' as illustrated in Figure 4.10.

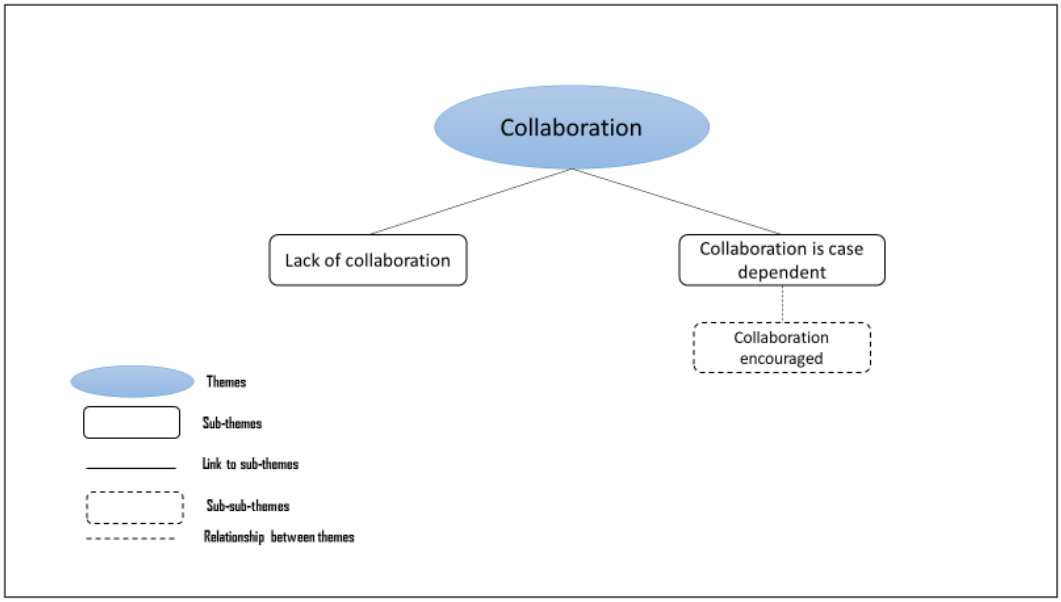


Figure 4.10: Thematic Map Demonstrates the Merging of Two Sub-themes into One Sub-theme

4.3.5 Step 5: Defining and Naming Themes

The fifth step continued the data analysis process and focused on generating clear definitions and names for every overarching theme as well as identifying the essence of what each theme was about (Braun & Clarke, 2006). In this phase, the researcher continued to review the language used to name each theme in order to ensure the language reflected the study context. In this phase, the names of two themes that were developed in the previous phases: 'self-led learning' and 'social learning' were modified into 'autonomous learning' and 'social environment' respectively. Other themes, however, remained the same in this phase.

The language used to name the theme 'self-led learning' originated from the CoderDojo documents to describe the independent learning taking place in Dojos. This language was reviewed and ultimately changed to 'autonomous learning'. The process by which that decision was made is as follows. The researcher had to review the literature to make sure the chosen theme name actually reflected the kind of independent learning taking place in Dojos specifically. In reviewing the literature, many terms were used to represent independent learning, including self-directed learning (SDL), self-regulated learning (SRL), autonomous learning, and self-teaching. The differences between these terms were often delicate and inconsistent, which led to them being used interchangeably by many researchers.

SDL and SRL are two of the most frequently used terms to highlight independent learning in the literature. Due to its adult education roots, SDL insists the learner is responsible for the whole learning process (from determining goals to designing and implementing the learning task), which tends to eliminate the instructor role (Saks & Leijen, 2014; Voskamp et al., 2020). In SRL, however, the emphasis is on independently achieving a learning task designed by the instructor who has a clear set of learning

objectives and is mostly studied in school settings (Saks & Leijen, 2014; Voskamp et al., 2020).

Neither of these terms was found appropriate by the researcher to describe the nature of independent learning within CoderDojos. SDL minimises the role of mentors in the classroom and transfers the entire learning process to the learner, which does not fit with the nature of CoderDojo, in which mentors are an essential part of the movement. On the other hand, with SRL, mentors are expected to prepare learning materials and tasks and set clear learning objectives. Again, this does not commonly take place in non-formal learning environments like CoderDojos.

Reviewing the literature, the researcher found 'autonomous learning' to be a suitable term to describe the extent of independent learning taking place in CoderDojos as it fits anywhere in the spectrum between SDL and SRL. Definitions of learning autonomy evolve around the idea of learners taking more responsibility for what they learn, how they learn, and when they learn. Holec (1981), one of the first advocates of autonomy in teaching, defines autonomous learning as "the capacity to take charge of one's own learning" (p.3). Littlewood (1999) defines autonomous learning as "involving students' capacity to use their learning independently of teachers" (p.73). Murphy (2011) argues that "despite the lack of a single, universal theory of autonomy, there is agreement on the educational importance of developing autonomy and that autonomy can take a variety of forms, depending on learning context and learner characteristics" (p.17). CoderDojos are usually different in terms of the mentors' involvement in the learning process and Ninjas' reliance on mentors. Thus, due to the independent learning nature of CoderDojos that generally exists (albeit to varying extents) 'learner autonomy' was deemed an appropriate name by the researcher to label the independent learning taking place in CoderDojos.

The theme 'social learning' was also modified to 'social environment'. Besides learning,

the social context that CoderDojos aim to provide to young people includes other important factors like ethnic diversity, girls' empowerment, and relationships among peers. The researcher figured that the social environment CoderDojos seek to provide to Ninjas covers broader areas than only learning. Thus, the researcher deemed 'social environment' as a theme name more appropriate than 'social learning'.

4.3.6 Step 6: Interpretation and Reporting

The final step in the data analysis process involved a final check on the resulting themes and sub-themes and producing the final written report. Five core themes were identified through the six-step approach as important factors that impacted CoderDojo mentors: (1) Autonomous learning, (2) collaboration, (3) social environment, (4) project-based learning, and (5) fun (see Table 4.2; colours used in this table show the linkage to the initial codes listed in Table 4.1). Each theme identified a distinctive dimension that affects and reflects mentors' teaching practices while mentoring in Dojos.

Themes	**Sub-themes**
1. Autonomous Learning	• Independent learner • Self-control • Mentor role
2. Collaboration	• Lack of collaboration • Collaboration is case dependent
3. Social Environment	• Peer learning • Creativity
4. Project-based Learning	• Learner interests • Community initiatives • Curriculum alternative
5. Fun	• Learning coding • Fun as an ultimate outcome • Dojos not schools

Table 4.2: Themes and Sub-themes of this Study

While writing this thesis, quotations from participants were used to support and emphasise the themes identified. The researcher developed assertions by interpreting and linking the data to constructs in the literature. The findings are presented in detail in

chapter 5.

4.4 Conclusion

This chapter outlined the inductive approach that was used to analyse the data set in this study. It illustrated the six-step approach to TA as defined by Braun and Clarke (2006). This chapter demonstrated how mentors' teaching approaches were discovered and how insiders' insights were interpreted from the data set. Lastly, the five core themes identified through the data analysis are presented, which are to be further discussed in the next chapter.

Chapter 5

Results

5.1 Introduction

This chapter starts with an overview of the research participants and the observed Dojos from which the data was generated. It presents the themes that emerged from the data set. Themes are supported with excerpts from participant interviews and associated observational data and CoderDojo documents.

The main objective of this research is to explore current teaching approaches mentors implement within Dojos in Ireland, and the alignment between those approaches and the CoderDojo ethos. Implementing the methodology presented in chapter 3, this chapter discusses the themes the researcher identified by exploring the following primary research question and sub-questions:

- What teaching approaches do mentors commonly implement within Dojos in Ireland?
  - To what extent do mentors' teaching approaches align with the recom-

mended teaching practices of the CoderDojo movement?

- To what extent is the CoderDojo ethos reflected in the teaching approaches used within Dojos in Ireland?

5.2 Participant and Dojo Profiles

This section highlights the background of this study participants. Before interviews were conducted, an online Google form was used to collect demographic information including gender, age, education level, and years of mentoring, etc. (see Appendix A). For confidentiality reasons, the names of the interviewees, their Dojos, and any information that might reveal their identities has been altered. A unique letter was given to represent each Dojo.

19 mentors from 12 different Dojos around Ireland were interviewed on two separate occasions. Twelve (63.2%) participants identified as male and the remaining seven (36.8%) identified as female. These percentages are in keeping with findings reported in the CoderDojo Foundation's annual report from 2019. It noted that out of 672 survey respondents, 61.1% of mentors identified as male and 37.6% identified as female, while 1.3% preferred not to say (CoderDojo Foundation, 2020). While the male to female ratio in the CoderDojo Foundation annual report aligns with the demographic ratio in this study, it is worth mentioning that the Foundation reports on the movement globally rather than locally.

This research focused on studying the pedagogical skills of its participants. Therefore, the researcher did not do an in-depth investigation on the geographical implications of the study. Yet, she included in the study questionnaire the basic location identity featured in most survey questions in order to be informed of the breadth of this research within Ireland. Participants came from six counties of Ireland (Dublin, Limerick, Cork,

Galway, Wicklow, Laois) with most participants coming from Dublin as shown in Table 5.1 and Figure 5.1.

Name	Gender	Age	Level of education	P/S	DI	Years of mentoring
Mentor 1	M	50–59	Bachelor's Degree	P	A	3–5
Mentor 2	F	40–49	Postgraduate Diploma	P	B	> 6
Mentor 3	M	50–59	Bachelor's Degree	P	C	> 6
Mentor 4	M	40–49	Master's Degree	P	D	> 6
Mentor 5	F	50–59	Postgraduate Diploma	P	D	> 6
Mentor 6	M	40–49	Bachelor's Degree	P	E	3–5
Mentor 7	M	40–49	Doctoral Degree	P	E	> 6
Mentor 8	F	40–49	Bachelor's Degree	P	F	First
Mentor 9	F	18–25	Leaving Certificate (or equivalent)	S	G	1–2
Mentor 10	F	18–25	Leaving Certificate (or equivalent)	S	G	1–2
Mentor 11	F	18–25	Bachelor's Degree	S	G	1–2
Mentor 12	M	18–25	Leaving Certificate (or equivalent)	S	G	3–5
Mentor 13	M	50–59	Junior Certificate (or equivalent)	P	H	> 6
Mentor 14	M	25–29	Master's Degree	P	I	First
Mentor 15	M	30–39	Doctoral Degree	P	I	1–2
Mentor 16	M	25–29	Master's Degree	P	I	1–2
Mentor 17	M	18–25	Leaving Certificate (or equivalent)	S	J	3–5
Mentor 18	F	25–29	Leaving Certificate (or equivalent)	P	K	> 6
Mentor 19	M	50–59	Master's Degree	P	L	> 6

Table 5.1: Key Characteristics of Interview Participants, where P/S Represents the Professional (P)/Student(S), DI Represents (Dojo Id).

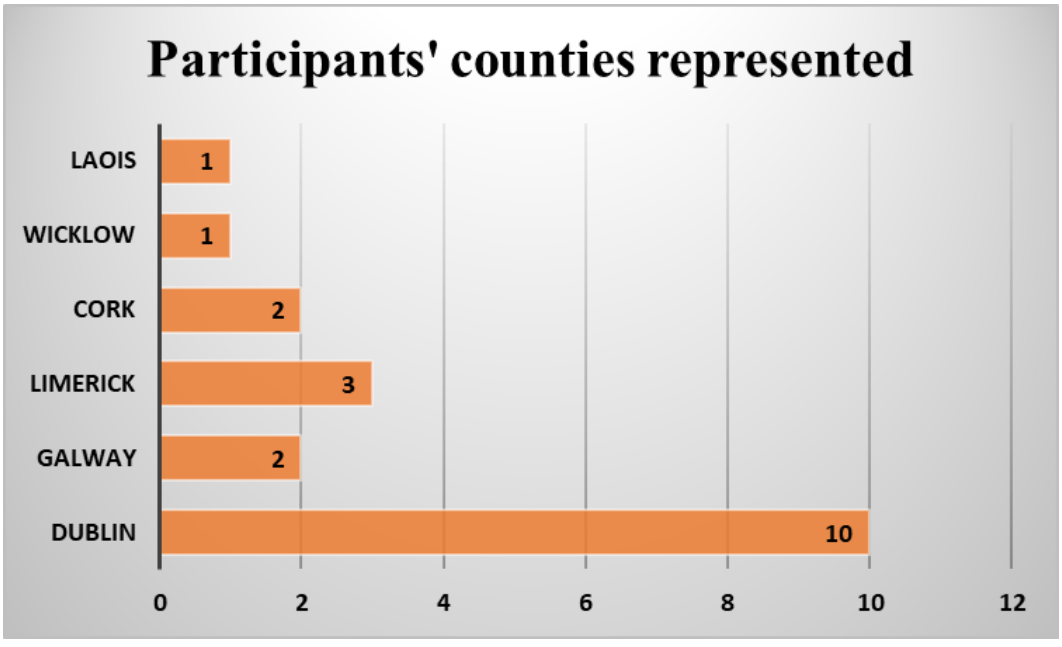


Figure 5.1: Interview Participants' Counties

The age of participants varied between 18-25 and 50-59. Figure 5.2 illustrates that

within the age ranges listed, only one participant belonged to the 30-39 age range, and none of the participants was over the age of 60.

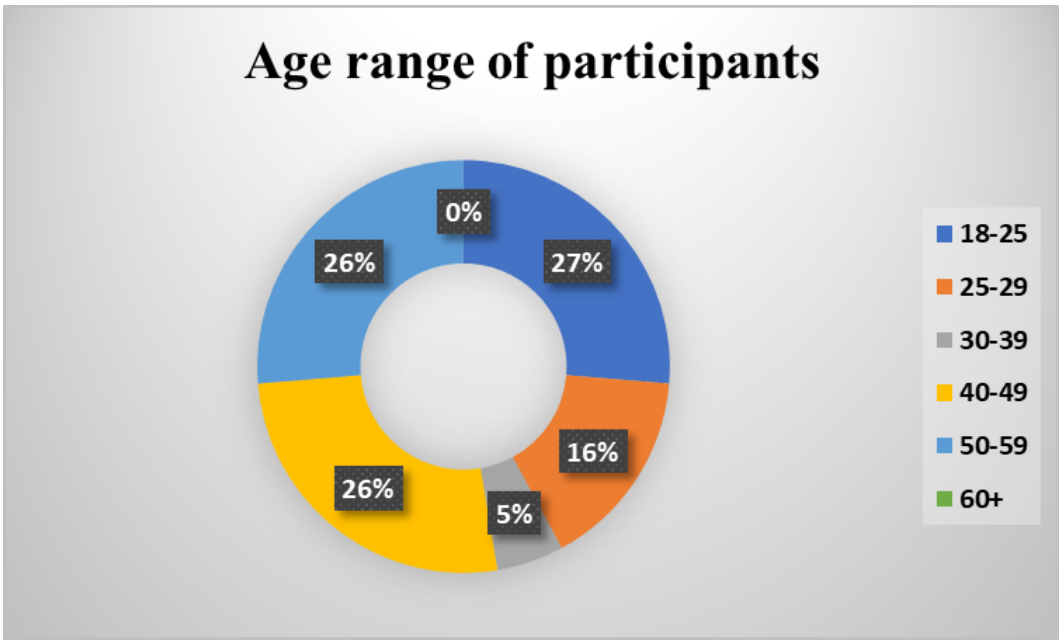


Figure 5.2: Interview Participants' Age Range

As shown in Figure 5.3, participants had various levels of educational backgrounds. The largest group of participants held either a Bachelor's degree or Leaving Certificate degree, with those possessing a Master's degree as the next largest group, and so on. Four out of five Leaving Certificate holders were undergraduate students enrolled in computing-related subjects at the time of the interviews. Most participants worked in IT-related professions, while two participants worked in teaching-related professions. It should be noted that all participants are volunteer mentors and none of them have had any mentoring training before or after they started mentoring in Dojos.

Purposive and snowball sampling were used to recruit participants for this study (see subsection 3.4.1). Once mentors volunteered to be interviewed, Dojos were selected based on the mentor's willingness to be observed. The researcher had the chance to only observe four Dojos prior to the COVID-19 pandemic when on-site observations were still allowed. Dojos A, B, C, and D outlined in Table 5.1 were the observed Dojos in this study. Table 5.2 highlights the key characteristics of the observed Dojos in this

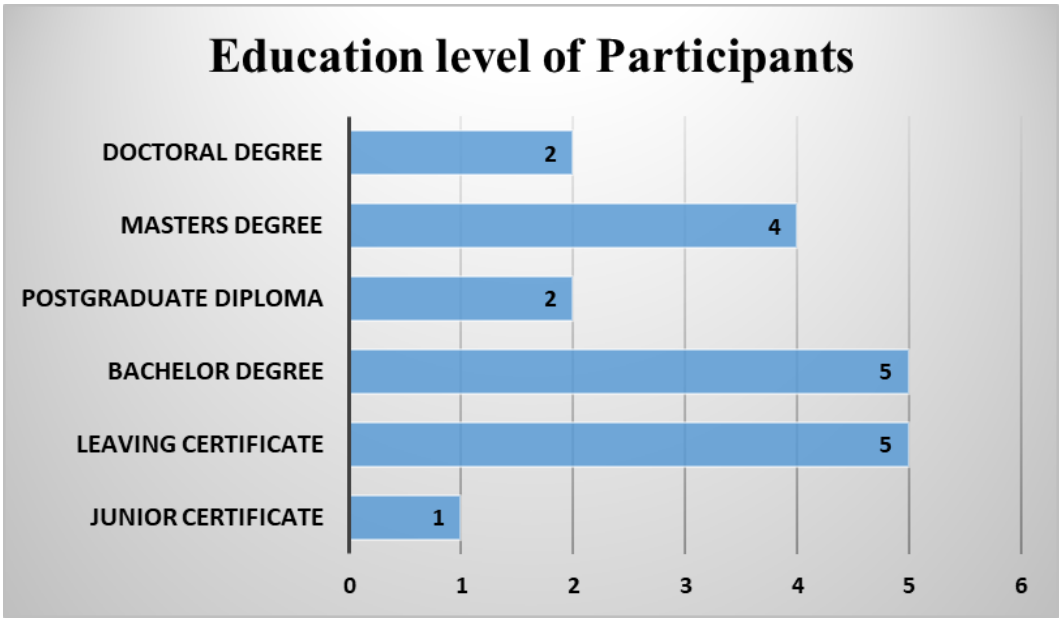


Figure 5.3: Participants' Education Level

study. These Dojos were from two Irish counties: Wicklow (Dojo A) and Dublin (Dojos B, C, and D). The observed Dojos had been running for more than three years with mentors over 40 and with at least three years of mentoring experience at the time this research was carried out. Due to the limitations of the initial setup (only being able to observe four Dojos), the researcher acknowledges that only partial observational data were collected, and the results may not necessarily be reflective of all Dojos included in this study.

The observational data offered the researcher insight into the complex relationships between various elements at each Dojo. Conducting observations helped the researcher identify any subtle changes to mentors' teaching practices as well as any additional influences such as the parent involvement, room layout, tools available, and the reactions of the young people being in such an environment. Having provided an overview of the research participants and the observed Dojos, the findings are presented in the next section.

Dojo ID	Venue	Day/Time	Number of Ninjas in class	Ninja coding Level	Number of mentors in class
A	Post Primary School	Weekly on Saturdays. Session 1: 1.00pm–2.30pm	4 (1 boy, 3 girls)	Mainly beginners	1 male
		Session 2: 2.30pm–4.00pm	6 (3 boys, 3 girls)	Mainly advanced	
B	Third-level institution	Weekly on Saturdays. 10.00am–12.00pm	20 (13 boys, 7 girls)	Mainly beginners	4 (2 males, 2 females)
C	Secondary School	Weekly on Wednesdays. 7.30pm–9.00pm	9 (6 boys, 3 girls)	Mainly advanced	1 male
D	Third-level institution	Weekly on Wednesdays. 6.30pm–8.20pm	18 (10 boys, 8 girls)	Mainly advanced	3 (2 males, 1 female)

Table 5.2: Dojos Profiles

5.3 Threads of Commonality

This study incorporated Thematic Analysis (TA) based on the principles set out by Braun and Clarke (2006) (see section 4.3). It should be noted that this study had an exploratory nature and was designed to elicit common threads and themes in the data set. Five core themes emerged through the data analysis as important teaching principles to CoderDojo mentors:

1. Autonomous learning
2. Collaboration
3. Social environment
4. Project-based learning
5. Fun

As shown in Figure 5.4, each theme has distinctive dimensions that affect and reflect mentors' teaching practices while mentoring in Dojos.

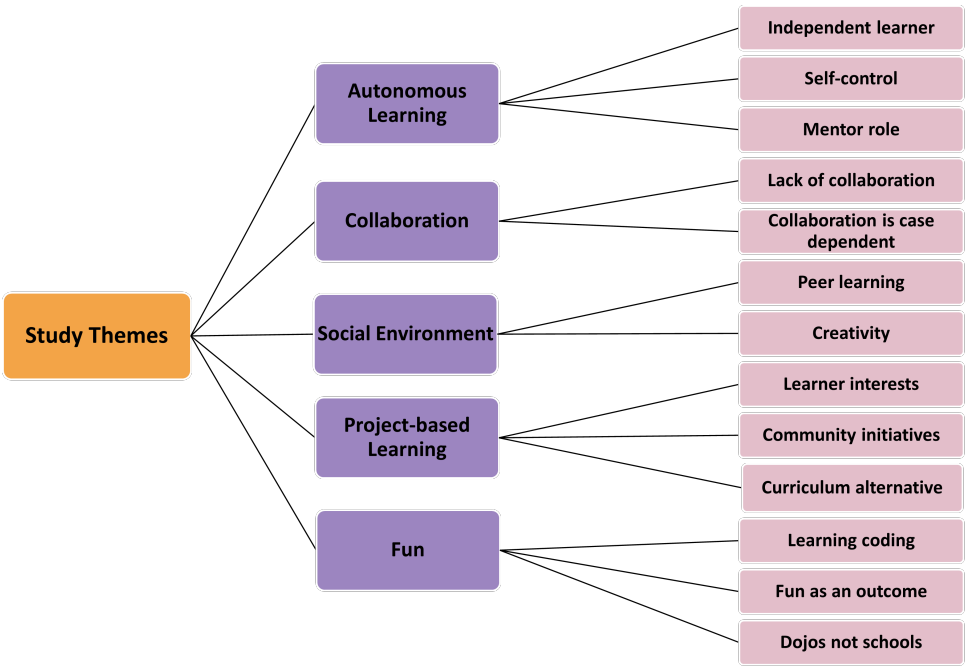


Figure 5.4: Themes and Sub-themes of this Study

5.3.1 Theme 1 – Autonomous Learning

According to the CoderDojo Foundation, *"At Dojos, Ninjas are encouraged to explore coding and creating with technology by applying these skills to their interests. They are encouraged to develop lifelong competencies and a passion for learning. Allow Ninjas to direct their skill development by choosing what they want to learn"* (CoderDojo Foundation, 2019, p. 44). In this study, autonomous learning emerged as a theme because there was a substantial emphasis in the data set on Ninjas becoming 'independent learners' and developing 'self-control' over their own learning. In the interview data set, autonomous learning was an emergent theme among all participants. During interviews, participants repeatedly established a major link between embracing autonomous learning in their Dojos and the way they perceived their 'role as mentors'.

As a result, autonomous learning evolved as a theme with 'independent learner', 'self-

control', and 'mentor role' as common threads (sub-themes) within this theme as highlighted in Figure 5.5. This sub-section discusses the three sub-themes and concludes with an overview of the levels of autonomy in Dojos drawn from the observational data.

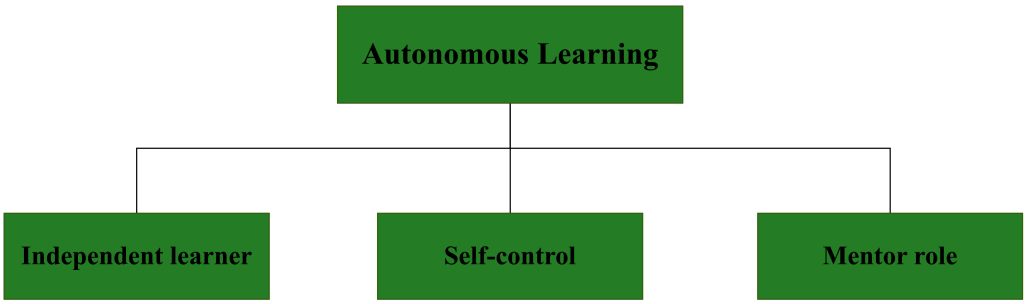


Figure 5.5: Autonomous Learning Sub-themes

Independent Learner

All participants believe the learner's ability to learn independently is an important skill for Ninja development. When asked about their learning objective, some mentors named autonomous learning as the most important learning objective for young people to master. For example, Mentor 16 noted,

> *"Self-learning, that's really the objective."*

Similarly, Mentor 15 remarked,

> *"I would like to see kids start solving problems and applying the learned skills to complete their projects on their own."*

Encouraging Ninjas to become independent learners was a common teaching practice among participants in order to promote autonomous learning skills with their attendees.

Participants used different terms to express the importance of learning autonomously in their teaching, including 'self-dependent' and 'learn to learn',

> *"I want the kids to do the tasks and be more self-dependent while doing it."* (Mentor 14)

> *"What we wanted was people that have kids that can learn to learn."* (Mentor 4)

Mentor 9 pointed out that while he taught Ninjas how to code, his ultimate goal was to get learners to realise they could do the work on their own

> *"...'Oh, you don't need me to do this, I'm here to help you, and after I'm gone you can build on it yourself'."*

Similarly, Mentor 12 emphasised encouraging learners to decide for themselves, stating,

> *"You want to teach them something, but you also want to help guide [so they can] decide for themselves."*

Mentor 17 expressed that learning independently goes beyond learning how to code,

> *"Beyond the learning to code, obviously, the learning to teach yourself."*

Self-control

Providing learners with a sense of control over their own learning was also an evolving thread between participants to encourage autonomous learning. As Mentor 17 put it,

> *"Basically, they're [Ninjas] in control of their own learning."*

Mentor 19 also emphasised the importance of handing over control to learners in his class by stating,

> *"They [children] have to believe that in some sense, or some way, they're in control of their destiny, or they're in control of what they're actually doing."*

He also explained the reason behind it,

> *"Because I allow them to dictate the subject, they feel that they want to do it because they know that they chose the subjects."*

A sense of self-control was encouraged in different ways in different Dojos. Some Dojos provided young people with the ability to choose the coding subjects they wanted to learn. According to Mentor 10,

> *"They [kids] kind of work on whatever they want to work on."*

In the observed Dojos B and C, sessions were divided into different subjects where young people got to choose the subject they wanted to learn. Other Dojos put young

people in charge of choosing projects to work on that matched their interests. For example, Mentor 7 remarked,

> *"I let them pick out the projects they want to do."*

Although mentors encourage Ninjas to choose their projects, they also assisted Ninjas in finding those projects and activities they were interested in doing,

> *"We'll refer them to resources on the website...I would say, 'OK, off you go, try working through those worksheets and doing things you like'."* (Mentor 5)

Some participants used the term 'freedom' to express the handover of control to learners. Mentor 17 believed freedom to be the

> *"Essence of computer science"* and explained, *"We give them freedom, in that feeling of like figuring out their own way of learning."*

Another participant encouraged freedom in his Dojo via organising what he referred to as 'free sessions',

> *"Free session is something I'm trying to get more of this year, which is kind of to say 'OK, this week I'm not going to show you anything, it's just make something yourself'."* (Mentor 6)

Mentor Role

The CoderDojo movement recommendations stress that *"The role of a mentor is not the same as that of a teacher or lecturer. Mentors help Ninjas work through problems and encourage their efforts rather than directly delivering solutions"* (CoderDojo Foundation, 2019, p. 9). During their interviews, participants often established a link between embracing autonomous learning in their classes and the way they perceived their role as mentors. Mentor 11 stated,

> *"Mentoring, I suppose, is giving someone all the tools in their own tool box to learn how to code themselves."*

Mentor 13 referred to a mentor as

> *"Really just someone who's there to help the kids learn in whatever guise they think that takes."*

Mentor 16 emphasised that part of his role was

> *"Making sure the kids kind of know how to teach themselves."*

Participants tended to characterise their role as facilitators, supporters, and co-learners rather than instructors, guiding the learners and keeping everyone together rather than dictating what happened next:

> *"It's more of supporting them and letting them explore their own ideas and letting them explore their own interests."* (Mentor 15)

> *"In terms of mentoring, [it] is like helping the kids figure out how to Google for like documentation and how to read that documentation...I let them choose their own thing and let them tinker as well, and I suppose, I just go around and I help them."* (Mentor 8)

In this study, Dojo mentors' value and adoption of an autonomous learning approach to teaching seemed to originate and be highly influenced by their own experiences as independent learners themselves whether that was part of their learning journey or work history. Mentor 18, who noted she was self-taught, emphasised the importance of improving a learner's ability to self-teach,

> *"I know that there's an innate ability in people to learn anyway, and then sometimes, it's just guiding them to the right resources and helping them understand how to read those things and stuff like that."*

Beyond learning to code, Mentor 7 pointed out that

> *"...They [children] leave with the ability to go find stuff better than they did when they came in."*

Not having a specific curriculum with learning objectives within CoderDojo might have contributed to the way mentors perceived their role. As Mentor 1 noted,

> *"The whole criteria for the day are you pick something that they can get excited about or they can succeed in that hour period."*

Compared to more formal educational systems, mentors do not have the pressure of delivering specific content or meeting exact learning objectives. Moreover, with the

volunteer nature of CoderDojo and not always having a sufficient number of mentors, promoting autonomous learning and more independent learners can make Dojos more sustainable.

Based on the interviews as well as the observations, Ninjas in beginner sessions tended to rely more on mentors to help them choose appropriate projects to work on and guide them through the task. In the observed beginner sessions, mentors had selected a project in advance for Ninjas to work on that they thought was appropriate for the Ninjas' level. The mentors guided them and showed them the tools they needed to finish the project. Ninjas in the mainly advanced sessions tended to be less dependent on their mentors and tended to choose their own projects and figure out ways to complete them; thus, mentors tended to be less involved in these sessions. This aligned with the CoderDojo movement recommendations that *"At CoderDojo we encourage established Ninjas to rely on themselves and their peers, rather than just on the mentors"* (CoderDojo Foundation, 2019, p. 22)

The observation data showed that continuity across sessions varied from Dojo to Dojo. In some Dojos, they continued to work on the same project across a number of sessions and in others they completed a single project during a session. In both beginner and advanced sessions, it was up to the Ninja to decide whether or not to follow their mentor's suggestions. This practice aligned with the CoderDojo movement recommendation that *"Young people are not forced to follow a set learning path. They are introduced to explore concepts in programming and are then encouraged to experiment further through their own individual projects"* (CoderDojo Foundation, 2012, p. 8).

Varying Levels of Autonomy

Based on the resources available (venue space, available mentors, etc.) and the way mentors decide to structure their Dojo sessions, a Dojo is usually either divided into different classes based on Ninja coding skills level (beginners to advanced) or coding interests (Scratch, HTML, Java, etc.). Beginners are usually children who have recently joined the Dojo with minimum coding skills, while advanced Ninjas are children who have been attending Dojos regularly and/or have a good understanding of basic coding principles. When sessions are divided based on Ninjas' coding interests, visual programming languages like Scratch tend to draw mainly beginners. In contrast, scripting languages like Java and Python tend to have mainly advanced Ninjas.

CoderDojo mentors tended to be less involved in sessions with mainly advanced Ninjas and therefore, learner independence was observed more in those sessions than in beginner sessions. In the advanced sessions, Ninjas seemed to be active and more in control over their learning in terms of choosing a project to work on. Mentors tended to step aside and wait for any questions or problems Ninjas might come across in their projects. However, in the beginner sessions, mentors tended to be more involved in the children's learning process by suggesting project ideas for Ninjas to work on as well as taking them through the solution process in a more detailed manner, usually using a whiteboard or projector.

5.3.2 Theme 2 – Collaboration

The CoderDojo Foundation documents emphasise collaboration and teamwork as one of the movement's essential ethos (CoderDojo Foundation, 2012, 2019). Promoting collaboration between Ninjas is also considered a recommended practice in the CoderDojo community (CoderDojo Community, 2017). The Foundation believes collaboration

should become an essential part of a Dojo session and encourages it as an opportunity for young people attending Dojos to learn from each other: *"Different people have different strengths, and learning from each other is one of the great benefits of working in groups"* (CoderDojo Foundation, 2019, p. 41). The Foundation then suggests that mentors promote collaboration in their sessions by *"encouraging Ninjas to self-organise into teams. This can help them to better understand their individual strengths, and to learn how to work with others and assist their peers"* (CoderDojo Foundation, 2019, p. 41).

The strong emphasis on collaboration within the CoderDojo official documents as one of the movement's fundamental ethos had a major contribution into the development of this theme. However, it should be noted that several mentors expressed views about Ninjas collaborating that, in practice, did not particularly align with those of the CoderDojo ethos. Furthermore, based on the data generated from interviews and observations, the researcher found a significant contradiction between the CoderDojo movement recommendations on collaboration and the generated data. This contradiction contributed to an actual 'lack of collaboration' in Dojos except for some specific situations making it 'case dependent' as shown in Figure 5.6

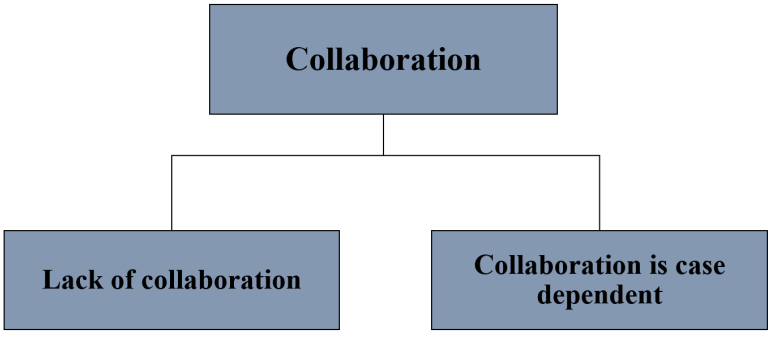


Figure 5.6: Collaboration Sub-themes

Lack of Collaboration

The data set indicates that lack of collaboration was common within Dojos. Due to the non-formal nature of CoderDojos where young people have a sense of control over their own learning, mentors find it challenging to promote collaboration when young people are not up for it. Furthermore, many participants find it challenging to actively promote collaboration in their Dojos mainly because of the unwillingness of Ninjas to collaborate with each other. Mentor 2 explained,

> *"A lot of them [Ninjas] don't want to do group projects."*

Some mentors, like Mentor 10, indicated that attendees often resisted the mentor's attempts to work together,

> *"We did some peer programming with them [Ninjas] just introduced them to the idea of teamwork, didn't work!"*

Mentor 2 and Mentor 10 attributed the Ninjas' unwillingness to collaborate to possibly not being familiar with each other. They remarked,

> *"They [Ninjas] just don't know each other."* (Mentor 2)
>
> *"They [children] just don't know the person they're with...they are okay to like talk to them but maybe not work in a project together."* (Mentor 10)

Mentor 11 stated,

"It depends on the personality,"

and noted some young people refuse to collaborate because they sought ownership of their work

> *"That [collaboration] would be cheating for the other person and their work was theirs and the other person would get the credit for their work."*

Another mentor, Mentor 16, also touched on the Ninja's personality or the *"nature of the Ninjas"* suggesting that,

> *"Many of them have challenges around social skills or mixing with people if they're very good and very technical and they think that their answer is the best answer."*

Other participants, however, suggested other reasons for the lack of collaboration in their Dojos. Some mentors indicated that the autonomous learning environment CoderDojo provides encourages a more independent learning journey for the learner and therefore contradicts the concept of collaboration. As a result, mentors with this belief tended to refrain from promoting collaboration in their sessions. As one mentor explained,

> *"The collaboration thing, I think the problem with that is because CoderDojo is about providing a space for kids to come and sort of, you know, follow their ideas or their passions or you know, their crazy ideas. And for us to help them by guiding them or giving them some direction... We've kind of always not had a collaborative environment if that makes sense, and it's*

very hard to create a collaborative environment when the whole ethos of it is, you know, you just come do your thing...so it's hard to then say, 'would you work on this project together?' " (Mentor 19)

Mentor 8 described CoderDojo as a *"quite personalised"* learning environment and for that reason she pointed out,

"I don't run it as a whole group...It's very much everybody could be doing something different."

Similarly, Mentor 12 argued that CoderDojo was *"more individualised"* and indicated that therefore,

"We would just like give each student their own little project to work on and see how they got on."

Mentor 15 also stated,

"One of the things we decided not to really push was the collaborative projects; kids have different interests and we wanted to embrace that."

Some participants indicated that the lack of collaboration was because Ninjas have different skill levels which limit mentors from incorporating collaboration in their sessions. For example, Mentor 17 remarked,

"It was more of just giving them a project and getting them to work on it individually, and because the projects were so varied in skill levels, we

couldn't really put them in teams, you know, because the kids were on different levels."

In Dojos, Ninjas are of different ages and sometimes come from different schools. For this reason, some participants highlighted a lack of socialisation among young people as Ninjas are less familiar with each other, making it harder for them to work together:

"They are all from different schools and so some of them do know each other, but generally they don't know each other when they come into the room. So, they know each other from Saturday morning, in our case as we run Dojo obviously, but they don't know each other socially particularly...Kind of know the people they know but I don't see the mixing that much, so that might be a stress." (Mentor 6)

Another challenge to collaboration is attendance. In Dojos, Ninjas are not obliged to attend every session. Rather, it is up to the Ninjas to decide whether they wish to attend. This meant some would come once, some every week, some regularly, and some sporadically. The inconsistent nature of attendance and lack of structure could make it difficult to promote collaboration among CoderDojo attendees. As one mentor noted,

"I think we have to get more organised to do things like that [group projects]. So, it can be difficult when you're at this sort of up and down nature of our group and the high churn of different numbers of kids. It makes it a little bit harder to do that." (Mentor 7)

Participants also indicated that in order for them to be able to facilitate collaboration, a certain room arrangement need to be created that was not always possible:

> *"So, we run the Dojo from the university. The university lends us a room somewhere, and we arrive, they have a certain set up and we need to leave exactly how we find the room. So, it means that you need people to organise, you know, physically the room and when we leave you need people to reorganise physically the rooms and that becomes more difficult."* (Mentor 4)

> *"The room layout affects in a very dramatic way. For example, even by being a Dojo in a school and in the school all of the desks are separated and everybody works by themselves so what we try to do in some of the rooms or as possible is pull the desks together and get people working as a company project. So, what I'm saying about the room layout is that it's kind of having an impact on people's mindset."* (Mentor 3)

In addition, mentors' own lack of experience with collaboration could also be an impediment. For example, Mentor 16 questioned whether collaboration was actually beneficial enough for him to promote it in his Dojo. He remarked,

> *"I don't know because I think you would have to ask if we supported it better, would that be a good thing? So, I can't answer, this isn't something I've really tried that much."*

In summary, even though lack of collaboration was common among participants, reasoning as to why there was a lack of collaboration varied among them. This finding also aligned with the observational data. In the four observed Dojos, young people tended to work on their projects individually. There were particular situations in Dojos A and C in which two siblings worked together on a project because they were sharing the same laptop. In all four Dojos, however, Ninjas were casually talking and playing with each other but not necessarily discussing things that were related to their projects.

The different rationales participants provided for the current lack of collaboration might suggest an existing gap in communication among mentors within the CoderDojo community itself. In many cases during the interviews, participants seemed to only be aware of what was taking place within their own Dojo and not anywhere else in the community. In addition, the lack of collaboration among participants might also suggest an existing contradiction within the movement's guidelines that resulted in the lack of collaboration. Moreover, the movement's promotion of *'organised chaos'* that is *"an energetic blend of imagination, experimentation, and learner-led skill development"* (CoderDojo Foundation, 2019, p. 9) might have created a contradict understanding for some mentors on how collaborative can fit in such learning environment as Mentor 19 elaborated earlier,

> *"The collaboration thing, I think the problem with that is, because CoderDojo is about providing a space for kids to come and sort of, you know, follow their ideas or their passions or you know, their crazy ideas. And for us to help them by guiding them or giving them some direction...We've kind of always not had a collaborative environment, if that makes sense, and it's very hard to create a collaborative environment when the whole ethos of it is, you know, you just come do your thing...so it's hard to then say, 'would you work on this project together?' "*

Collaboration is Case Dependent

Another sub-theme related to collaboration was that collaboration is case dependent. Even though participants highlighted an existing lack of collaboration within Dojos; a number of them pointed out situations in which Ninjas do collaborate. Moreover, participants indicated that in certain situations Ninjas do have to work together. For example, participants noted that in some instances Ninjas had to collaborate in order

to be able to work on a particular project that could only be completed by a team. As Mentor 1 pointed out,

> *"Sometimes for the projects, like for the astronaut project, they have to because you can't send a code on your own, you have to be at least two people."*

When asked about the level of collaboration in his Dojo, Mentor 3 answered,

> *"It depends. So, for example, let's say for the Arduino*[1] *and the Inventor*[2] *it's pretty much an individual thing and that is because you do kind of very simple stuff. But for the microbits*[3] *they usually work in groups. So, for example, all microbits have a function so they can talk to one another...for this to make sense you need a minimum of two working together, and depending on the project you may have the entire room working together. So, kind of that it's very much dependent on the technology."*

In other situations, Ninjas have to work together due to a shortage in Dojo resources like hardware. As Mentor 2 noted,

> *"So, for example, when we do Lego Mindstorms*[4]*, they have to work in groups."*

[1]Arduino is an open-source electronics platform based on easy-to-use hardware and software.

[2]Inventor is a computer-aided design application for 3D mechanical design, simulation, visualization, and documentation developed by Autodesk.

[3]Microbit is a pocket-sized computer transforming digital skills learning.

[4]Lego Mindstorms is a hardware and software structure which is produced by Lego for the development of programmable robots based on Lego building blocks.

Mentor 2 on to explain the reason for collaboration in this case was because they

> *"Only have five Lego Mindstorms."*

In other cases, a shortage of resources is due to socioeconomic circumstances. For example, Dojo G (listed in Table 5.1) is located in a socio-economically disadvantaged area where many attendees do not have access to personal computers. Therefore, their Dojo provides them with laptops. As Mentor 9 highlighted,

> *"We didn't make a conscious effort to do it [collaboration]."*

But also admitted,

> *"Because we didn't have enough laptops...that kind of forced them to work together and program together."*

In few cases mentors actively promoted collaboration in their Dojos. These participants expressed positive views toward collaboration and thought collaboration was encouraged in their Dojos. It is valid to highlight that all participants who stated that collaboration was taking place in their Dojos are in long-time running Dojos (Dojos E, H, and K). As some mentors highlighted, Ninjas' unwillingness to collaborate might be attributed to their lack of familiarity with each other. In well-established Dojos, there are higher chances of Ninjas being more familiar with each other, which makes collaboration easier. Mentor experience might also be a contributing factor since all mentors where collaboration was encouraged had at least three years of mentoring experience in their respective Dojos. This suggests that through their accumulative mentoring experience, they have figured out how to encourage collaboration in their sessions. Mentor 13, for example, highlighted that mentors in his Dojo

"Encourage them [Ninjas] to work together on a project so that they can enter the national competitions."

This facilitation of interaction between Ninjas exemplifies the Vygotsky concept of learning from a 'More Knowledgeable Other' (MKO) where Ninjas have the opportunity to learn from their mentors as well as their peers.

In other cases, collaboration was an incremental progression. For example, Mentor 6 disclosed that in his Dojo working on projects was

"A little bit more in groups now, before they would do it individually."

He then tried to explain the reason behind it,

"But as they have been there longer and got to know each other better and maybe in the room with the grouped tables, they're getting to know each other and make friends."

Similarly, Mentor 18 reported that seating arrangements in her Dojo where they have four to five kids sharing one table have promoted better social interaction among them. She explained,

"We let the kids sit wherever they want to...they more often than not already formed their groups kind of accidentally."

5.3.3 Theme 3 – Social Environment

Social environment was another theme that evolved from the data set of this study. Moreover, the data collected for this study suggested that peer learning and creativity were direct results of the social environment CoderDojos offer to its attendees. As a result, 'peer learning' and 'creativity' were sub-themes within the social environment theme as highlighted in Figure 5.7.

The CoderDojo movement characterises itself as a 'social movement' that offers young people an out-of-school learning experience. Its mission is *"to give young people around the world the opportunity to learn to code in a social and safe environment"* (CoderDojo Foundation, 2019, p. 7).

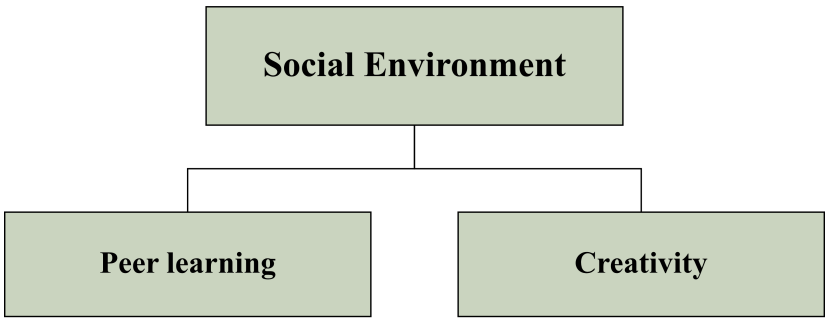


Figure 5.7: Social Environment Sub-themes

During the interviews, participants described Dojos using words like 'relaxed', 'friendly', and 'non-competitive', and viewed these characteristics as contributing factors to the social aspects of CoderDojos. For example, Mentor 5 said about her Dojo:

> *"It is very relaxed and laid back."*

Mentor 10 agreed and noted Dojos are

> *"Kind of relaxed and friendly."*

While Mentor 9 described her Dojo mission as,

> *"Introducing kids to coding in a non-competitive, not kind of dead lamey way."*

Observational data also captured Dojos as social and relaxed coding clubs for young people. Even when Dojos were taking place in school settings as in Dojos A and C (see Table 5.2), young people seemed to socialise, move freely, and feel comfortable around each other. The absence of school uniforms, timetables, and curriculum, along with the mentors' perspectives toward Dojos and their role in them, might have contributed to creating such a social learning environment. It was also noted that Ninjas were addressing mentors by their first names, possibly indicating that they see mentors as co-learners rather than authority figures.

Another social aspect of CoderDojo was the parents attending Dojos. In some cases, parents were sitting beside their children, discussing projects, and figuring out solutions together, demonstrating collaboration between Ninjas and their parents. The noise level in the observed Dojos was consistently higher than a typical classroom environment as Ninjas were openly discussing the project at hand with mentors and parents, and freely moving around and talking to others in the class. This suggested that Dojos are providing a social and relaxed context for learning based on trust, respect, and personal responsibility.

Peer Learning

Both the CoderDojo movement documents and the participants in this study emphasised that the social context of CoderDojo encouraged better engagement among young people attending Dojos. Peer learning was one of the sub-themes of the social learning environment. *'Ask three, then me!'* is one of the CoderDojo movement mottos, which basically states that when a Ninja encounters a problem, they should first try to solve it by themselves, then look for a solution on the internet, then turn to another Ninja for assistance, before finally asking a mentor for help. According to CoderDojo, implementing that motto encourages peer-to-peer learning and the development of independent problem-solving skills. Even though participants were not particularly aware that the motto existed, peer learning was an emerging theme among participants.

The interviews showed that even though attendees tended to work on their projects individually, mentors would encourage them to help each other when they had questions, rather than getting answers directly from mentors. For example, Mentor 13 stated,

> *"So even though we might know how to do it, we might say 'Look, you know, go over there and help them with their project.' "*

Along these same lines, Mentor 12 commented that learners asking each other questions was

> *"Like any project in real life."*

Similarly, Mentor 14 observed that encouraging learners to ask each other questions

"Allow[ed] for certain, limited, hands-on help."

Mentor 3 noted that when Ninjas ask him questions, he often directs them to ask their questions to another peer in order to encourage interaction between them. Yet, Mentor 3 noted that before doing so he would

"Have a rough idea of the difficulty of the question."

Based on that, if he felt the question level

"Would expect that it would be understood and resolved by another child," he would say, *"Well, can you ask them to help you?"*

While in other cases, he might say,

"Let's have a look at the question, and decide what to do."

The researcher understood this as a teaching practice used consciously by mentors to encourage peer learning.

Mentor 11 observed that when encouraging young people to discuss questions with each other,

"They [Ninjas] were actually really, really good at explaining things to each other."

She thought the reason for this was because when kids have just learned something new, they are better at explaining it to their classmates. Another mentor described the rule he implemented at his Dojo,

> *"So, at the beginning of the session, I always tell them the same thing, you know, that they have, before they ask a mentor, they have to do five things. So, ask the person on their right, then ask the person on the left, then the person in the front, and then the person in the back. And if they still haven't got an answer, then Google it. And if they still haven't got an answer, then call a mentor."* (Mentor 4)

Yet, the same mentor was not quite sure that peer learning was actually practised in his Dojo. He explained,

> *"Most of the time that we work as individuals, we tried to encourage them to work as, if not as teams, at least as friends. So, for example, if you're working on a project, I'm working on my own project but we talk to each other and we exchange ideas. So, we encourage that a lot, but the results are not [he paused] I couldn't really measure the results, whether we're any good at it or not."* (Mentor 4)

Mentor 12 expressed a similar point view,

> *"We try to get them to talk to the kids if they had a question, but then they would have to ask us quite a lot as well!"*

Beyond Ninjas asking each other questions, the CoderDojo movement is trying to promote the concept of 'youth mentors' in Dojos. Basically, a Ninja who has gained some

experience at their Dojo would become a youth mentor and pass his/her knowledge on to less experienced Ninjas. During participants' interviews, some mentors showed enthusiasm toward implementing the youth mentor concept into their Dojo. Mentor 18 noted,

> *"Learning how to encourage the kids to mentor each other has always been fairly important to me."*

The reason Mentor 18 found 'youth mentors' to be important was

> *"to make sure that CoderDojo would be somewhat self-sustaining and have mentors going into the future."*

Moreover, one of the challenges that faces Dojos is mentor shortage; therefore, Mentor 18 felt

> *"Getting the kids to mentor each other was out of necessity."*

Similarly, Mentor 13 stated,

> *"We would encourage those that are more proficient (in many cases they are younger than some of them) to teach each other."*

This facilitation of interaction between Ninjas is another example of the Vygotsky concept of learning from a 'More Knowledgeable Other' (MKO) where regardless of age, the key is that MKO must have more knowledge about the subject being learned than the learner does.

In addition to *"learning from each other"*, Mentor 13 noted mentoring also positively affected the learning attitudes of young people. He recalled,

> *"We saw that when the kids were teaching each other, the kids got really good at Googling answers as [if] that forced them into a situation where they were the expert, they were the authority."*

Mentor 5 noted that besides verbally encouraging learners to mentor each other in her Dojo, she would

> *"Keep their mentor practice and give them a badge of their own,"* and therefore, *"some of them even come to me and say, 'can I do some mentoring?' "*

While observational data did not find clear evidence of peer learning actually taking place in Dojos, there was evident peer engagement. In all observed Dojos, young people seemed to socialise and feel comfortable around each other but not necessarily asking each other questions or mentoring one another. Moreover, even though Ninjas would have side talks with each other, they tended to ask questions and discuss their projects with their mentors or their parents, depending on who was in closer proximity to them when their questions arose.

Creativity

Part of CoderDojo's vision is a world where young people have the opportunity to learn how to code and be creative in a social environment. Encouraging and embracing creativity among young people was a common sub-theme among participants. The

movement claims the non-formal and social atmosphere of its clubs nourishes creativity and *"too much structure and rigid organisation can stifle creativity"* (CoderDojo Foundation, 2019, p. 9).

Furthermore, the *CoderDojo Best Practice And Policy Recommendations Report* includes a set of guiding principles that CoderDojos can consult and choose to meet. The report states, *"A best practice should be creative, imaginative, unconventional when applying the methodology, provide ingenious or infrequent solutions to solve problems or difficulties. In short, it must be innovative"* (CoderDojo Community, 2017, p. 12). Moreover, CoderDojo Foundation highlights creativity as part of their movement vision stating, *"CoderDojo's vision is a world where every child has the opportunity to learn how to code and to be creative in a safe and social environment"* (CoderDojo Foundation, 2012, p. 2). Yet, the CoderDojo documents do not provide mentors with further details on how to practically implement creativity in their Dojos.

Many participants showed a desire to build a creative learning environment for Ninjas attending their Dojos. Furthermore, different mentors used different strategies to promote creativity. Some participants would use educational resources they thought would encourage creativity among their attendees. As Mentor 8 noted,

> *"I introduce formally something new in each Dojo. So, there's always a new resource, a new and creative opportunity that I'll introduce and encourage people to do."*

Mentor 6 explained it as a process of,

> *"Kind of pointing out where they could tweak it [project] and play with it...so that everyone was kind of keen on trying that as you do this and then they*

get different results."

Other participants, however, would promote creativity by encouraging kids to follow their own curiosity. As Mentor 2 stated,

> *"Sometimes the kids will say 'and I wonder now if you could?' and I kind of go 'Let's see!' "*

Similarly, Mentor 1 expressed,

> *"If I can capture the child's imagination, that's really where I want to be."*

Some mentors pointed out mixing learning technology with other entertaining activities like arts and crafts created a better creative learning environment for their attendees. For example, Mentor 3 explained,

> *"What we try to do is we mix technology with arts and crafts. So, you kind of take the current things in paper and say something attached to that, so all we're trying to do is being creative and avoid being dry on the subject."*

Mentor 8, who was using a big conference room as their Dojo venue and had *"plenty of room for Ninjas to sit on computers and work on projects"*, tried promoting creativity by dividing the room into corners. Mentor 8 commented,

> *"We also have a sort of another section on the other end of the room, which is arts and crafts and in another corner, we have some table where I have*

lots of STEM-related magazines and books, and I have different tech toys or, you know, things like Lego."

All of these corners *"go on in the same space"* within a social context that allows *"everybody to mingle and sit around and chat."*

Some participants noted that building a creative atmosphere among young people was part of their role as a mentor. As Mentor 10 expressed,

"My role is to inspire kids to have an interest in coding...encouraging them to explore their ideas and be creative."

Other participants did not use the word 'creativity' per se, but used words like ideas, imagination, and curiosity, which could be linked to creativity. For example, Mentor 13 stated,

"I think it's [mentoring] giving people, the young people, the tools and the skills to pursue their own ideas and imaginations."

While Mentor 1 defined his job as

"To feed their curiosity in this regard and lead them to someplace where they can start realising what their aspiration is."

Mentor 1 explained further what he described as a 'creative task' used recently in his Dojo,

"I try to find things that really engage their imaginations as much as they can. Like we just finished our session last Saturday and the first project we took on is I'm transitioning them from block programming to textual and so I have something called the CodeCombat...They are doing one of the python projects, like the Astropy Project[5] *by the USA and European space agencies...it runs for 30 seconds on the space station. I did one with MasterCard too. Two boys...and their code ends up running over India."*

Similarly, Mentor 13 described using Minecraft creatively in his Dojo,

"Minecraft was the big thing...and we wanted to make a creative version of that...So, the project was to build the town in Minecraft, but it was initially how they sold the town from the last, you know, would take from now to 200 years' time. So, it was very much a futuristic version of the town, but they could only do it in creative mode. It wasn't the typical Minecraft type situation. And then they did a really good job of creating this 3D version of a town that they live in and that developed into a school project with some sponsorship."

Mentor 13 also argued that *"developing their [children] creative abilities"* was important for young people to feel *"personal fulfilment"* as *"they get a personal achievement and the reward is that they can share that with the club or the world as they wish."*

One participant noted the negative effect school environment can have on students' creativity and how CoderDojo is bridging the gap:

[5]Astropy Project is a community effort to develop a common core package for Astronomy in Python.

> *"It's [CoderDojo] completely different to a school type of situation where they, you know, they're kind of pressured in a way...it's kind of bridging the gap which the school system isn't doing or hasn't been doing at least very well, how to use computers creatively for writing their homework or doing a history lesson or whatever."* (Mentor 13)

Embracing children's creativity, however, was more frequently emphasised by some participants than others. For example, compared to other participants, Mentors 1, 8, and 13 highlighted creativity at least five times during their interviews along with richer details on how they implemented it in their classes. This suggests the role and influence personal beliefs have on mentors teaching practices in such non-formal environments compared with more structured, formal learning environments, where learning objectives are usually predefined.

The influence of personal beliefs on promoting creativity among Ninjas has also evolved in the observational data. In Dojo A, where Mentor 1 showed more personal interest in building a creative learning environment, the projects he suggested in his Dojo (shooting game for beginners and Teachable Machine for advanced) seemed to provide kids with more space to implement original thoughts and actions compared to the other observed Dojos where projects were more of a straightforward process. This could suggest that even though creativity as a concept was popular among participants, a clear understanding and implementation of creativity might be missing.

5.3.4 Theme 4 – Project-based Learning

The theme 'project-based learning' evolved from the data set as a commonly implemented teaching approach within Irish Dojos. PBL approach was adopted in Dojos to replace the need for a curriculum in the formal learning setting. CoderDojo commu-

nity initiatives like Sushi cards and Coolest Projects seem to have a significant role in facilitating the adoption of PBL as a teaching approach within Dojos.

PBL has evolved as a theme among all participants, while 'curriculum alternatives', 'learner interests', and 'community initiatives' were common threads within this theme as shown in Figure 5.8.

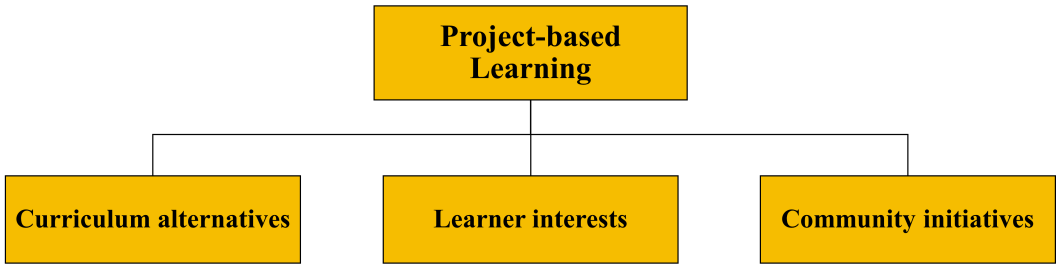


Figure 5.8: Project-based Learning Sub-themes

Curriculum Alternatives

As a non-formal learning movement, CoderDojos are *"not curriculum-based"* (CoderDojo Foundation, 2019, p. 44) and therefore, uses projects as an alternative learning tool to substitute curriculum in formal classrooms. When describing their Dojo sessions, all participants adopted a PBL approach as a fundamental part of their classes. These projects could be chosen by the Ninjas themselves or suggested to them by their mentors. Mentor 3 explained,

> *"We might have a project of displaying a LED name or a message, that would make up one project, and we do one project each week."*

In the same fashion, Mentor 12 noted,

> *"We would just like give each student their own little project to work on and see how they got on."*

While Mentor 11 remarked that as soon as they had enough children,

> *"they [children] would kind of start getting up their old projects from last week or starting a new project."*

In all observed Dojos, sessions mainly evolved around Ninjas working on a particular project. These projects were either the Ninja's own choice or proposed by mentors for the class to work on. This type of project set-up aligned with the CoderDojo movement recommendation of PBL that states, *"Young people are guided to learn the basics but to then learn further based on what they want to achieve within their projects rather than through following a prescribed learning path. They learn by exploring and creating actual projects, software or hardware"* (CoderDojo Foundation, 2012, p. 8). For example, in Dojo B, the session was about creating a webpage using HTML. Though all Ninjas were developing a webpage using HTML, everyone was working on different websites in terms of functionality and subject matter, based on the Ninja's preference.

Learner Interests

According to the CoderDojo Foundation *"Ninjas are guided to learn the basics and then encouraged to work on their own projects"* (CoderDojo Foundation, 2019, p. 44). According to participants, choosing a project to work on often was based on learner interests. Ninjas were encouraged to work on projects and themes that are of direct

interest to them. Young people are motivated by projects focused on a variety of topics such as space, video games, and so on, as several mentors pointed out:

> *"I have some tricks about that in my pockets and touch points along the way to the end result usually just enables them to come up with a project which is interesting to them."* (Mentor 1)

> *"We were using Microsoft products that work on hardware to build video games and they [kids] were building video games in the class and it's a very sneaky way to teach them computer science like looping structures and object-oriented programming."* (Mentor 13)

> *"On Christmas, I took some of our resources and tweak them a little bit, used my own version of them just for some fun little games."* (Mentor 19)

Community Initiatives

CoderDojo community initiatives like Sushi cards, and Coolest Projects, seem to have a role in facilitating the adoption of PBL as a teaching approach within Dojos. A common observation mentors agreed on was that Sushi cards helped Dojo attendees understand the coding basics. The following quotes refer to participants' use of Sushi cards:

> *"So, we kind of just let them work on their own, so they either pick [a] kind of a project off their heads so they just started making something and you support them and give them ideas, or sometimes they use the Sushi cards, and we recommend the Sushi cards to the people who kind of are there for the first time."* (Mentor 10)

> *"We have the basics like boat race, brain game, the Sushi cards that we always kind of do with the beginners, but that has kind of evolved with the older kids and we let them choose their projects and explore what they want to do themselves."* (Mentor 7)

> *"For any of the beginners, I would go in with either like a worksheet so like, you know, the Sushi cards or something like that; for the more advanced kids generally no, I'd be relying on their ability to choose something to work on."* (Mentor 18)

Coolest Projects is another CoderDojo community initiative to further encourage young people to showcase their projects in larger forums outside their Dojos. This has also contributed to the popularity of projects within CoderDojos. According to the CoderDojo Foundation records, in 2019, more than 680 young people from 15 countries participated and shared their projects in these international coding conventions. During interviews conducted for this study, some mentors highlighted this event as something they regularly bring into class in order to motivate their Ninjas to participate. Mentor 16 noted,

> *"When I see a good project or even a good idea, I would encourage that kid to think about applying for Coolest Projects."*

Initiatives like Coolest Projects seem to foster discussion among mentors to reflect on the learning process in order to encourage learners to participate in such events. Mentor 12 stated,

> *"Usually we [mentors] would have a little chat about Coolest Projects...every week we're talking about that, evaluating their [Ninjas] projects and persuading them to go first."*

Mentor 18 said that whenever she noticed a lack of motivation among Ninjas to complete their projects, she would use the Coolest Projects event as a tool to increase motivation in her Dojo. She explained,

> *"There was a lack of progression through the class and like not necessarily a motivator to go work on something at home, so Coolest Projects was like a tool, is like, 'Hey, Coolest Projects is coming up, have you done anything?'...It's still kind of amazing how much of Coolest Projects was intended to help me as a mentor more than it was explicitly to help the kids."*

5.3.5 Theme 5 – Fun

According to the CoderDojo Foundation, *"We want every young person to have the opportunity to learn how to create with technology in fun, free, and social spaces"* (CoderDojo Foundation, 2019, p. 5). Fun was a common thread in the data set, especially among the interview participants. Mentors generally believed that promoting a fun atmosphere in their Dojos was an essential factor to improve Ninjas' coding skills. Some participants demonstrated that Ninjas having fun was the ultimate desired outcome of their sessions, arguing that Dojos are not schools. Accordingly, this study data set revealed that fun was an important factor that mentors try to promote in their Dojos. 'Learning coding', 'fun as an ultimate outcome', and 'Dojos not schools' were common threads in this theme (see Figure 5.9).

Learning Coding

One of the main reasons mentors thought fun was important was that promoting fun tended to lead to better understanding of coding. For example, Mentor 1 argued,

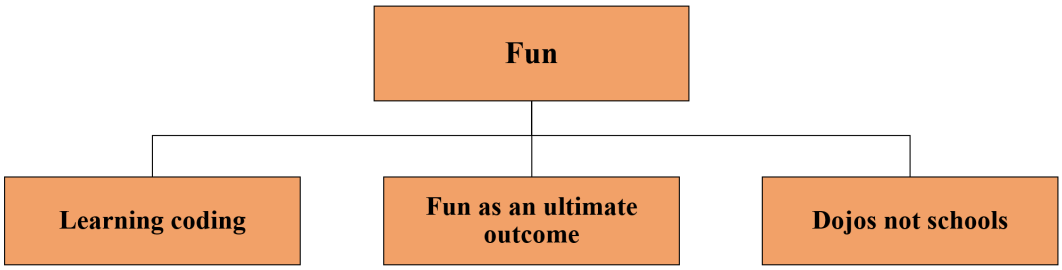


Figure 5.9: Fun Sub-themes

> *"If you want to keep someone engaged in a process, it's good to keep them entertained"*, emphasising that *"learning is supposed to be fun."*

Similarly, Mentor 19 reflected that he incorporated fun in his teaching approach

> *"From day one"*, indicating *"I'm a great believer that you can still learn a lot from that [fun]."*

Another participant noted that even though Dojos are meant for young people to learn coding, it is important to keep in mind it is taking place during

> *"Their free time"* and therefore, *"I would never want a kid leaving being like, 'Oh, I don't want to go back'...beyond just a standard, like, kid reaction of like, 'Ugh, I couldn't play'."* (Mentor 18)

Likewise, Mentor 2 emphasised,

> *"There has to be a balance between learning and enjoying and letting it all kind of sink in and come together in terms of how it fits."*

Mentor 15 pointed out that part of his role as a mentor is to

> *"Try to work together to help the kids learn and make it a fun experience."*

Mentor 14 declared that he wanted to show young people that computing can be fun. He stated,

> *"I hope to give the kids a little more exposure to how computer science can be fun"* in order for them to *"manifest their own ideas and desires and build their own programs."*

Another participant thought that fun could help in creating a relaxed non-competitive environment for children to learn coding,

> *"In our Dojo we try to introduce kids to coding in a fun and non-competitive...just like 'here you go, code for fun'."* (Mentor 9)

Another participant argued the fun factor she was trying to promote in her Dojo was due to her belief in the importance of a play-based learning approach. She argued,

> *"I'm perfectly OK with play and I always say it to them...I'm all in for play-based learning."* (Mentor 8)

Adopting fun as an educational perspective and linking it to play-based learning by this particular mentor (Mentor 8) could be associated with her previous experience in delivering Information and Communications Technology (ICT) youth training programs as well as facilitating digital tech clubs for girls before joining CoderDojo. That could be considered as an indication of the influence of having either previous teaching experience and/or training programs for mentors so they can be aware of different teaching approaches that exist, and how these approaches might contribute to their teaching in Dojos.

Fun as an Ultimate Outcome

For some other mentors, however, Ninjas having fun and enjoying their time was the ultimate desired outcome of their sessions, whether Ninjas ended up learning something new or not. As Mentor 3 noted,

> *"I tend to focus my attention on the projects that I pick for the kids, more on the fun that we get from doing them than the learning outcome at the moment."*

Likewise, Mentor 13 remarked that he was

> *"Not that bothered about the learning outcomes at the moment as much about them having fun."*

When Mentor 8 was asked about the outcomes she aimed to achieve from her teaching, she answered,

"Those happy kids! It's very much a fun club."

Mentor 11 noted,

> *"At the end of the day, like it's their free time,"* and then emphasized, *"The primary goal has always been to make sure the kids have fun first...I want them to enjoy what they're doing."*

Moreover, one participant highlighted that he believed the importance of the fun factor is the reason young people are choosing to attend Dojos in the first place,

> *"They're there to have fun really, mostly."* (Mentor 7)

One of the mottos the CoderDojo Foundation promotes in their community is *'One rule: be cool!'* They define 'cool' as *"Helping, sharing, supporting, encouraging, cooperating and being kind are all very cool"* (CoderDojo Foundation, 2019, p. 34). Mentor 2 used this motto to indicate that Dojos are spaces for young people to enjoy their time:

> *" 'One rule be cool,' so it's all about just the kids enjoying it, everything else is a bonus...if they do get a love of the technology, if they do get an understanding of the technology, if they do get frustrated by the technology, whatever happens after that is what happens."*

Dojos are not Schools

The fact that CoderDojos are non-formal coding clubs, seems to have largely contributed to the perception they are fun and relaxed places for young people to enjoy

their time. Many participants constantly emphasised that Dojos are not schools, but rather a place for young people to learn while having fun. This indicated that mentors potentially viewed schools as rigid and the opposite of fun. As Mentor 8 suggested,

> *"School can be a negative experience for some of the kids, so it [CoderDojo] has to be fun, it has to be on their own terms."*

Another participant justified promoting fun in his Dojo as

> *"Reinforcing the fact that it's not school."* (Mentor 4)

While Mentor 1 further explained that

> *"People don't want to come in for a lecture, they want to come in and enjoy themselves, and it should be fun."*

One participant described coding in Dojos as

> *"More of pleasure coding"* and that if learners *"aren't liking it, they don't have to do it, it's not like school."* (Mentor 17)

Mentor 6 talked about the Dojo environment and how fun can actually be more engaging for learners,

> *"I think the primary objective is for everyone to have fun. First and foremost, everybody has to have fun because I think, you know, it's a club, it's*

not school. We want people to enjoy what they're doing, that's the first step on getting them to engage and then you hope they're going to learn something."

The observations conducted as part of the study also revealed that even in Dojos with downsides such as poor room layout or limited resources, young people appeared to have fun and enjoyed being there. As the data revealed, Ninjas having fun and interacting with each other was more obvious in Dojos A, C, and D compared to Dojo B, which could be due to several different reasons. In Dojo A, even though Ninjas were working individually on their projects (shooting game), they were testing their crafts and using them to play with each other during class. In Dojos C and D, the room setup (group of Ninjas sharing and sitting around big tables) seemed to contribute to kids socialising and talking more with each other and therefore, learning while having fun was more pronounced in these three Dojos.

In contrast, the session in Dojo B was more structured as the lead mentor was explaining a code on slides presentation, followed by the young people implementing the code they saw to their own projects. This seemed to provide little time for playing around or interacting with each other. The room in Dojo B was a typical classroom setup (tables in rows), which may have also contributed to lessening the interaction between Ninjas.

Interviews and observations reinforced each other in suggesting that fun was an important factor in Dojos activities, and in so doing confirm the CoderDojo movement and Foundation recommendations that state, *"The atmosphere in a Dojo is fun and social."* (CoderDojo Foundation, 2019, p. 42).

5.4 Conclusion

This chapter highlighted a series of recurring themes that emerged from the data set. The findings were presented under five developed themes: autonomous learning, collaboration, social environment, project-based learning, and fun. Findings presented in this chapter suggest that CoderDojo mentors conceptualise Dojos as a relaxed, fun, and social learning environment supporting learner autonomy. These findings are interpreted and discussed in relation to the literature in the following chapter.

Chapter 6

Discussion

6.1 Introduction

This chapter discusses the research findings presented in the previous chapter in light of social constructivism, which is the theoretical framework that guides this study. The themes identified are set in the context of the existing literature. This chapter discusses how the teaching approaches identified contributed to making CoderDojos an LCL environment for young people. In addition, this chapter discusses how the teaching approaches and learning environments that exist in Dojos can inform the CoderDojo movement and potentially be implemented in more traditional learning settings. Finally, the research questions are revisited in light of the findings and discussion.

6.2 Increased Sense of Personal Responsibility for Learning

The findings of this study revealed that participants made frequent references to the importance of learner autonomy (see subsection 5.3.1). All participants emphasized that autonomous learning was a critical skill that young people needed to develop.

For example, Mentor 16 noted, "Self-learning, that's really the objective". The way autonomous learning was adopted amongst CoderDojo mentors aligns with Boud's (1988) research, which proposed autonomy as an educational practice that emphasised learner's independence and responsibility.

The issue of control in learning and specifically young people's perception of who is driving the learning, bears significantly on learners' motivation and their engagement with learning experiences (Ponton & Rhea, 2006). Allowing young people to choose what they want to learn and to follow their interests was heavily emphasised in the CoderDojo movement documents. According to the CoderDojo Foundation, "At Dojos, Ninjas are encouraged to explore coding and creating with technology by applying these skills to their interests. They are encouraged to develop lifelong competencies and a passion for learning. Allow Ninjas to direct their skill development by choosing what they want to learn" (CoderDojo Foundation, 2019, p. 44). In CoderDojo documents, learners are often viewed as the agents in their learning and are the source of inspiration for topics that mentors cover in their sessions. The influence of learners was noticeable in interviews and observational data. All the participants emphasised the importance of learner freedom and a sense of control when choosing a programming language to learn and/or a project to work on. For example, Mentor 17 believed freedom to be the "Essence of computer science" and explained, "We give them freedom, in that feeling of like figuring out their own way of learning". This finding corroborates Keenan's (1999) observation that in non-formal contexts, 'freedom of will' is a central part of the capacity to make learning choices.

Masouleh and Jooneghani (2012) argued that the capacity of young learners to take responsibility for their own learning is not innate but must be taught. Even though learner autonomy is grounded in learner independence and active attitude towards learning, the role of mentors in promoting autonomous learning is key. Without the guidance and supervision of mentors, the entire learning process would result in low

efficiency or even fall into disorder. An earlier study by McKelvey and Cowan (2017a) concluded that Ninjas appeared to be learning in an atmosphere that encouraged them to work independently. As mentors are an essential component of the learning atmosphere Dojos are offering, this study's findings can explain how mentors are encouraging Ninjas' independence in McKelvey and Cowan's study.

6.2.1 Mentors are not Teachers

The CoderDojo movement recommendations stress that, "The role of a mentor is not the same as that of a teacher or lecturer. Mentors help Ninjas work through problems and encourage their efforts rather than directly delivering solutions" (CoderDojo Foundation, 2019, p. 9). The findings of this study demonstrated that the role of mentors is different from that of an instructor or a teacher-led learning intervention. Adult mentors in CoderDojos acted as facilitators and were available to Ninjas in an unauthoritative manner, encouraging independent learning. In identifying this aspect in their teaching they were unconsciously validating the Vygotskian maxim: "What children can do together today, they can do alone tomorrow" (Vygotsky, 1978). This facilitation of interaction between mentors (who are usually computing experts) and Ninjas replicates Vygotsky's concept of learning from a 'More Knowledgeable Other' (MKO).

Little (1991) argue that learner autonomy and facilitator autonomy are interdependent, and that facilitators wishing to promote learner autonomy need to 'start with themselves' by reflecting on their own beliefs, practices, and experiences of the teaching/learning situation. The findings from this study indicate mentors' adoption of an autonomous learning approach has a notable influence on the way they perceive their role as mentors. During the interview process, mentors demonstrated a clear awareness of their role as facilitator, supporting young people to reach their potential, rather than

instructors directing them on what to do and not to do. As Mentor 14 remarked, "I believe mentoring is all about guidance". The way mentors perceived their role allowed for a more engaging experience for the young people and shifted the responsibility of the learning to the learners, providing them with ownership over their own learning and providing the learners with 'affordances' (Mercer, 2012). As Mentor 17 expressed it, "It's kind of let kids learn themselves...if they need help, we are there to help them".

In this study, mentors' adoption and high opinion of an autonomous learning approach seemed to originate and be highly influenced by their own experiences as independent learners, whether that experience was part of their learning journey or work history. Mentor 18, who noted she was self-taught, emphasised the importance of improving a learner's ability to self-teach, "I know that there's an innate ability in people to learn anyway, and then sometimes, it's just guiding them to the right resources and helping them understand how to read those things and stuff like that". This finding can contribute to a positive learning environment and foster success for learners to achieve their personal goals.

According to CoderDojo Foundation (2017), only about 16% of mentors come from an education background (teachers, lecturers, or educators) while the biggest percentage of mentors (46%) come from computing-related professions. Learners in the CoderDojo movement appeared to feel more empowered and demonstrated a greater passion for the discipline when mentors without an education background acted as guides and advisors with no prescribed theories of learning and no grading pressure (McKelvey & Cowan, 2018). This indicates the potential positive impact non-educators can have on learning.

Promoting autonomous learning involves both transferring responsibility and ensuring that learners can exercise that responsibility effectively. Depending on the learner's skill level and the way the mentor chose to structure the Dojo, the mentor would

either suggest a project for Ninjas to work on or let them choose what they wanted to do. Observational data in this study indicated a greater mentor involvement in the beginner Dojo sessions (where young people were mainly novice learners) compared to the advanced ones. Moreover, Ninjas who were novice learners in coding might not have had the skills needed to choose projects or know how and where to find quality information to solve problems they faced. The Dojo sessions did not have any clear rules, and yet young people seemed focused and studious. Overall, in this study mentors tended to perform as supporters, guides, and co-learners, acting as a 'guide on the side' (King, 1993) and helping Ninjas work through a project and lead their own learning process. The findings align with Vygotsky's concept of ZPD. Through ZPD, young people who are in the zone of proximal development for a certain task can almost complete the task independently but are not quite there yet. With a little assistance from certain people, they are able to complete the task successfully.

6.3 Lack of Collaboration and Peer Learning within Dojos

Social constructivism argues that knowledge develops as a result of social interaction, and is therefore a shared, rather than an individual, experience. This social construction of meaning suggests a learning context where meanings are co-constructed through communication and collaborative experiences. The CoderDojo movement states that collaboration is one of its essential ethos. According to the CoderDojo Foundation, "Different people have different strengths, and learning from each other is one of the great benefits of working in groups" (CoderDojo Foundation, 2019, p. 41). The Foundation also suggests that mentors promote collaboration in their sessions by "encouraging Ninjas to self-organise into teams. This can help them to better understand their individual strengths, and to learn how to work with others and assist their peers" (CoderDojo Foundation, 2019, p. 41).

Studies have shown that implementing collaborative learning is more frequent in non-formal learning environments than it is in formal classrooms (Lawlor et al., 2020; Morgan et al., 2008; Vallory, 2012). However, the findings from this study suggest otherwise. While there is a heavy emphasis on collaboration in CoderDojo documents, the themes that emerged in this study suggest a lack of actual implementation of collaborative learning in Dojos. As Mentor 2 expressed, "It's [collaboration] real downside of what we do...it's so noticeable". Mentors' reasoning as to why there was a lack of collaboration varied, as highlighted in subsection 5.3.2.

One explanation can be the nature of CoderDojos as a non-formal learning environment. Within Dojos, the choice to team up rests with the Ninjas, who according to mentors tended to express an unwillingness to collaborate with other attendees on a shared project. As a result, according to participants, Ninjas working on their projects individually tend to be the norm except for particular situations where they had to collaborate due to a lack of resources.

The lack of collaboration in Dojos is consistent with the study of McKelvey (2017), who explored the learning experiences of young people attending CoderDojos from the Ninjas' perspectives. In this study, McKelvey (2017) noted that Ninjas did not appear to engage actively in teamwork and preferred to work individually. This observation aligns with the statements of mentors interviewed in this study who noted that young people expressed an unwillingness to collaborate with each other. As Mentor 2 stated, "A lot of them [Ninjas] don't want to do group projects".

Some mentors thought that the autonomy afforded to Ninjas negated the goal of encouraging them to collaborate with other learners who might have different learning interests and/or skill levels. As Mentor 19 stated, "It's very hard to create a collaborative environment when the whole ethos of it is, you know, you just come do your thing". Despite Mentor 19's perception that autonomy and collaboration were in opposition

to one another, numerous studies have shown that collaborative learning is an effective teaching technique to foster learners' autonomy (Danielewicz-Betz & Kawaguchi, 2014; Geary, 1998; Holliday, 2003; Kumaravadivelu, 2006). Kumaravadivelu (2006) went further to argue that full autonomy cannot be attained by learners working alone as they need the willing cooperation of all others to shape their learning outcomes.

This lack of collaboration can also be explained by the way mentors perceive their role as facilitators rather than instructors, and their perception of Dojos as a space for young people to express themselves and do what they want. Thus, when Ninjas did not initiate the desire to work with others, mentors would not instruct or advise them to do so. However, as Higgins et al. (2012) noted, learners may not collaborate without guidance from teachers and mentors. They claimed that learners may actually need to be introduced to collaboration and be guided through it in order for them to initiate the habit of collaboration.

Other challenges to promoting collaboration among CoderDojo attendees that mentors highlighted included classroom settings, young people not knowing each other, inconsistent attendance in Dojos, and the lack of structure associated with non-formal settings. In some instances, mentors did not think collaboration was that important and some had not considered promoting it in their Dojos. The different explanations that mentors provided might suggest an existing gap in communication between mentors within the CoderDojo community. In many cases during the interviews, participants seemed to only know what was taking place within their own Dojo but not anywhere else in the community. This suggests that there is space for better communication between CoderDojo mentors to talk through the difficulties they might face and draw support from each other. This finding confirms O'Keeffe et al.'s (2019) study on CoderDojos, suggesting that there is very little to no interaction between CoderDojos.

The CoderDojo Foundation offers monthly online meetings on their community page[1] for its global community to communicate and share ideas. However, none of the mentors in this study attended any of these online meetings, and in most cases, they did not even know they existed. This finding might suggest that a stronger emphasis on the importance of communication from the CoderDojo Foundation within the community can help to overcome this obstacle. Social learning theorists claim that communities offer a foundation for sharing knowledge (Li et al., 2009). Community concepts such as Community of Practice (COP) might help the CoderDojo community overcome the existing lack of collaboration. Wenger (1999) defines COP as "a group of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (p.73). O'Keeffe et al. (2019) conducted a study to measure the likelihood of COP being implemented effectively within the CoderDojos community. They concluded that COP would be suitable and effective to implement within CoderDojo communities where mentors often have computer science experience but no education background. Therefore, introducing such a concept to the CoderDojo community might help in facilitating better interaction between Dojos and consequently between mentors. This can also create a platform for mentors to share and discuss a wide variety of issues they might face, which are not necessarily related to collaboration.

Despite the challenges in encouraging collaboration among learners, encouraging peer learning was a common thread among mentors (see subsection 5.3.3). Peer learning is commonly perceived as an important element in the learning taking place in non-formal contexts and the findings of this study confirm this. Moreover, the interviews highlighted that even though Ninjas tended to work on their projects individually, mentors would encourage them to help each other when they had questions, rather than getting answers directly from mentors. As Mentor 4 explained, "So, at the beginning of the session, I always tell them the same thing, you know, that they have, before they

[1]https://coderdojo.com/en/community

ask a mentor, they have to do five things. So, ask the person on their right, then ask the person on the left, then the person in the front, and then the person in the back. And if they still haven't got an answer, then Google it. And if they still haven't got an answer, then call a mentor". Mentor 12 argued the importance of learners asking each other questions, as it would be "Like any project in real life". This facilitation of interaction between Ninjas is a practical demonstration of Vygotsky's concept of learning from a 'More Knowledgeable Other' (MKO) where the key is that a MKO must have more knowledge about the subject being learned than the learner does.

Yet, the observational data did not find clear evidence of peer learning actually taking place in Dojos. The observational data indicated that the non-formal and social environment Dojos offered contributed to better peer engagement and interaction as learners seemed to socialise and feel comfortable around each other. However, they did not necessarily ask each other questions or mentor one another.

Moreover, the data highlighted a conflict between what mentors thought regarding peer learning and what was actually happening in Dojos. So, while mentors expressed positive views towards peer learning, the observational data did not find clear evidence of peer learning actually taking place in Dojos. This finding can be linked to the fact that teaching beliefs do not always translate into actual teaching practices (An & Mindrila, 2020; An & Reigeluth, 2011; Becker, 2000). Looking at this issue through a social constructivist lens, Becker (2000) argues that educators are more constructivist in philosophy than in actual practice. According to An and Reigeluth (2011), a lack of knowledge about how to practically implement teaching beliefs in the classroom is one of the main challenges facing educators.

Given the voluntary nature of CoderDojos, expanding the learning circle to peers would lessen reliance on mentors for answers and would facilitate the possibility of mutual learning. This could also help solve the mentor shortage Dojos are commonly facing

and "make sure that CoderDojo would be somewhat self-sustaining and have mentors going into the future" (Mentor 18). Again, better communication and open discussions between mentors within the community regarding the issues facing mentors could also give them the opportunity to explore teaching practices that encourage more collaboration and better peer learning within Dojos.

6.4 Establishing a Social Learning Environment

In their documents, the CoderDojo movement describes itself as a 'social movement' (CoderDojo Community, 2017) where socialising, chatting, and making friends are encouraged. Its mission is "to give young people around the world the opportunity to learn to code in a social and safe environment" (CoderDojo Foundation, 2019, p. 7). This study's findings reflect that socialising is an essential factor in the CoderDojo movement. In Dojos, the goal is to avoid an atmosphere of control and policing, and instead create an atmosphere underlined by respect, trust, and personal responsibility, which can make young people feel comfortable and motivated to engage in activities. This result aligns with Roberts et al.'s (2018) argument that social interaction more commonly exists in less formal learning environments, which help create better opportunities for learners to obtain knowledge. As Mentor 9 put it: "Introducing kids to coding in a non-competitive, not kind of dead lamey way."

Even when Dojos take place in school classrooms (Dojos A and C), the social environment seems to help create a relaxed learning environment with less of the restraints and mores inherent in school settings. The absence of school uniforms, timetables, and curriculum, along with the mentors' perspectives toward Dojos and their role in them, might have contributed to creating such a social learning environment. In this study, it was also noted that Ninjas were addressing mentors by their first names, possibly indicating that they saw mentors as co-learners rather than authority figures. This

finding may explain research that suggested that less formal learning environments increase learner motivation and ability to learn compared to formal environments (Mohr-Schroeder et al., 2014; Roberts et al., 2018). Traditionally, in more formal learning settings, learners are expected to learn independently (Martin, 2004), while in less formal settings, they are given opportunities to mix and connect with peers (Denson et al., 2015).

During the interviews, mentors described Dojos using words like 'relaxed', 'friendly', and 'non-competitive', and viewed these characteristics as contributing factors to the social aspects of CoderDojos. As Mentor 5 noted, "It is very relaxed and laid back". A positive educational atmosphere is essential to facilitate optimally adaptive learner outcomes such as motivation, achievement, and learning (Eccles et al., 1998). The OECD (2013) argues that learning is enhanced when young people are inspired through a social learning atmosphere. The mentors who participated in this study appeared to agree. The social environment theme covered instances that showed mentors see they were mentoring in a social learning context that was positive for the Ninjas and different from their common experience with formal learning at school. For example, Mentor 8 noted, "A lot of it is about building their confidence in their own abilities and getting them used to that kind of social environment".

The social aspect of CoderDojo is important when young people of different ages are learning together in a social context. McKelvey and Cowan (2017b) argued that the social environment CoderDojos provide tends to bridge the age gap among its attendees. There is a good chance for young people to learn how to interact with each other in a more productive way and to learn empathy and understanding for others who might be encountering difficulty. These opportunities are not commonly present in a traditional school setting where a class is composed of students of the same age. Therefore, it can be argued that Dojos are providing attendees with learning autonomy as well as potential lifelong skills where importance is placed on the role of adults and capable

peers as the MKO in helping young people learn beyond their current capabilities.

In this study, creativity emerged as a sub-theme of the CoderDojo social environment theme. The CoderDojo Foundation features creativity as part of their movement's vision stating, "CoderDojo's vision is a world where every child has the opportunity to learn how to code and to be creative in a safe and social environment" (CoderDojo Foundation, 2012, p. 2). Paulus and Dzindolet (2008) claimed that the creativity of individuals appears to be strongly influenced by social context. The CoderDojo movement claims the non-formal and social atmosphere of its clubs nourishes creativity and that "too much structure and rigid organisation can stifle creativity" (CoderDojo Foundation, 2019, p. 9). Plucker et al. (2004) suggest that "creativity is the interaction between aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context" (p.90). Within CoderDojos' context, offering their attendees a creative learning environment aligns with numerous studies that have established a link between social environment and creativity (Hennessey, 1995; Patston et al., 2021; Semrád & Škrabal, 2017; Sternberg & Kaufman, 2010).

In the current formal education system where standardised tests are central, there might not be much space for promoting creativity (Sternberg & Kaufman, 2010). CoderDojo, with the learning flexibility it offers and its testing-free nature, could pose a good alternative to formal education. As Mentor 13 pointed out, "It's [CoderDojo] kind of bridging the gap which the school system isn't doing or hasn't been doing at least very well, how to use computers creatively".

CoderDojo's vision as a movement includes a world where young people have the opportunity to learn how to code and be creative within a social environment (CoderDojo Foundation, 2012). There is a frequent emphasis in their documents on the importance of creating a positive and creative atmosphere for Dojo attendees. In this study, the

mentors seemed to align with that view and showed a desire to build a creative learning environment for young people. However, there were very few explicit recommendations within CoderDojo documents that focused on how mentors might promote creativity-supporting practices in their Dojos. As Beghetto et al. (2017) emphasized, it is not enough to instruct educators to be creative; specific directions, ideas, and resources on how to implement it in classrooms is needed. As with the collaboration issue, more communication among the CoderDojo community could help mentors share ideas and resources in order to promote creativity within Dojos.

6.5 Supportive Project-based Learning Environment

Project-based learning (PBL) was a teaching approach used in all Dojos covered in this study (see subsection 5.3.4). PBL has roots in constructivist philosophy, mostly in the work of people like Piaget (1974) and Vygotsky (1978). As a non-formal learning context, CoderDojos are "not curriculum-based" (CoderDojo Foundation, 2019, p. 44) and therefore, use projects as an alternative learning tool and as a substitute for curriculum in formal classrooms. Adopting PBL as a teaching approach within Dojos can lead to deeper, more sustained learning that can be transferred to other situations and problems (Barron & Darling-Hammond, 2008; Bell, 2010).

The mentor role is essential when using a PBL approach. According to Dole et al. (2016), for the PBL approach to be successfully implemented in class, educators should adopt the role of facilitator or guide rather than position themselves as the source of knowledge. This study has shown that CoderDojo mentors have adopted the position of facilitator. Within Dojos, mentors appeared to support learners in finding authentic problems as projects, in conducting research, and in finding solutions for these problems. As Mentor 10 explained, "So, we kind of just let them work on their own, so they either pick [a] kind of a project off their heads so they just started making something

and you support them and give them ideas, or sometimes they use the Sushi cards, and we recommend the Sushi cards to the people who kind of are there for the first time". Mentors' role in promoting PBL as explored in this study aligned with the literature's recommendations, specifically adopting the role of facilitator rather than an instructor.

The findings from this study also indicated that autonomy was an important factor in CoderDojo classes, which backs up the process of adopting PBL as a teaching approach in Dojos. In the process of completing a project, learners are more likely to develop competence in different skills like researching and solving problems, collecting and evaluating information, working with different technologies, and developing new ideas and products (Kokotsaki et al., 2016; LaForce et al., 2017). PBL, when backed up with autonomous learning, can also lead to increased learner motivation by planning their learning and conducting their own research in solving real-world issues (Bell, 2010).

Developments in educational technologies have created new opportunities to design learning activities, which include learners taking more responsibility for their learning (Admiraal et al., 2017; Yurdakul, 2017). The *Coolest Projects* is one such example from the CoderDojo movement. One of the objectives of the *Coolest Projects*, an event carried out every year in the CoderDojo movement, is to encourage young people using technology to develop solutions to real-world problems. Participants seemed to embrace that as Mentor 16 stated, "When I see a good project or even a good idea, I would encourage that kid to think about applying for Coolest Projects". Working on their projects, learners can attain and retain knowledge when they are involved in their learning and when they can apply what they are learning to the real world (Dweck et al., 2014; LaForce et al., 2017).

One important factor of the PBL approach that seems to be missing in the CoderDojo context is collaboration. Bell (2010) suggested that adopting a PBL approach should encourage learners to engage in collaborative learning, leading them to develop the

ability to effectively collaborate with others. The lack of collaboration and the currently existing challenges to promoting it in Dojos (as discussed in section 6.3) could possibly limit the full implementation of PBL.

6.6 Sense of Fun and Enjoyment in the Learning

There are growing efforts among researchers and educators to promote fun and enjoyable learning spaces. In playful learning, learners try out ideas, test theories, take risks, explore social relations, and re-imagine the world. The findings of this study indicated that fun was a major theme among participants (see subsection 5.3.5). In a Dojo setting, there is a broad opportunity for young people to engage in fun activities either as part of their learning or completely separately. The unorthodox nature of the CoderDojo context contributes to a social and relaxed environment where learners can interact freely. These results corroborate the ideas of Vygotsky (1978), who claimed that "a child's greatest achievements are possible in play, achievements that will tomorrow become her basic level of real action" (p.100). Accordingly, efforts to evaluate whether learners enjoyed being in certain learning environments are an important aspect researchers need to focus on exploring.

In a fun learning context, young people are often more motivated to engage in activities for the experience of learning itself, which they perceive as enjoyable and valuable, rather than because they are looking for particular information (Packer, 2006). In this study, mentors seem to establish a correlation between fun and learner motivation, resulting in better learning. This connection was made by Mentor 1, who stated, "If you want to keep someone engaged in a process, it's good to keep them entertained". This finding aligns with Fink (2013), who stated that feelings of the learner are essential, rather than additional, to motivated learning. Learner motivation is considered central as it directly influences learner dedication and persistence towards accomplishing an

objective (Chandramouli et al., 2014).

This finding is particularly valid for teaching coding in school settings, where motivation to learn has been acknowledged as a learning barrier (Dorn et al., 2018). Moreover, the notion of a school being restrictive and applying limits is a cause for worry among some educators. Participants in this study were largely critical of school learning environments and viewed them as stressful and the opposite of fun. McKelvey and Cowan (2017b) explored young people's experiences at CoderDojos in Ireland and found that most attendees perceived Dojos as fun. This finding suggests that Ninjas and mentors share the view that CoderDojos are a fun learning space and that mentors were successful in promoting fun in their Dojos.

While fun in learning was found to be particularly beneficial in learning programming (Tisza & Markopoulos, 2023; Tisza et al., 2022), a vast majority of teaching approaches to programming in formal learning contexts use traditional learning methods depend on books, lab assignments, and quizzes (Zualkernan et al., 2006). Over time, these methods can have a negative and drastic impact on learners' attitudes towards learning programming (Chandramouli et al., 2014). Using such traditional approaches to teach programming might explain the alarming non-progression rates among computer science students in Ireland where difficulty in passing programming modules was identified as the main reason students' decided to drop out (Quille & Bergin, 2019). An approach that can increase learners' motivation needs to be developed to modify learners' mindsets and attitudes towards learning programming.

As attending Dojos is optional, creating a fun learning atmosphere that encourages young people to keep coming was of importance to mentors in this study. For example, Mentor 18 clearly emphasized the importance of fun, "I always want kids at Dojos to have fun...I would never want a kid leaving being like, 'Oh, I don't want to go back'...beyond just a standard, like, kid reaction of like, 'Ugh, I couldn't play' ". This

result aligns with Long's (2007) finding that having fun while learning leads to a higher learning commitment.

CoderDojos' pursuit of fun learning reflects a global growth of similar non-formal community initiatives that seek to increase young people's interest in computing by making learning fun (Long, 2007; Tisza & Markopoulos, 2023; Tisza et al., 2022). A recent study across nine European countries (Austria, Finland, Greece, Malta, Netherlands, Norway, Spain, Sweden, and the UK) of both informal and non-formal learning spaces related to STEM subject areas in general and coding in particular, reported that approximately two-thirds of the investigated activities were intended to encourage children in a playful way to become more interested and engaged in scientific topics in order to eventually improve their related skills (Tisza et al., 2019).

Griffin (2008) suggests that learners tend to enjoy learning more when they have some input into the selection of what and how they are learning. Since encouraging autonomous learning was also found as a common teaching approach among participants in this study, it also may have contributed to Ninjas enjoying their learning experience in Dojos. Offering learners opportunities to engage with a task in fun and relaxed spaces is certainly an aspect of CoderDojo that could make computing education more successful in formal learning environments.

6.7 CoderDojos Promoting a Learner-Centered Learning Environment

Learner-centered approaches stand in contrast to teacher-centered approaches. As the name suggests, in LCL environments learners assume increased autonomy and responsibility for their own learning. There is an emphasis on the learner as an individual as well as on the teaching approaches to support that particular learner. Based on the

results discussed in this chapter, this study argues that CoderDojos provide attendees with a learner-centered experience.

Research on the efficiency of learner-centered approaches continue to expand. Numerous studies have concluded that a learner-centered approach develops learners by focusing on real-world skills like decision-making, problem-solving, higher-order thinking, and collaboration skills (An & Mindrila, 2020; Bransford et al., 2000; Dole et al., 2016; McCombs & Whisler, 1997). According to An and Reigeluth (2011), LCL environments increase learner motivation to learn because learners feel ownership over their learning and also feel accepted and supported, which leads to more in-depth understanding. Therefore, learners are more likely to be involved and willing to learn. The autonomy, fun, and social environment CoderDojos provide to learners suggest young people are looking for motivation and atmosphere that is different from their usual classroom. In the four observed Dojos, which all had been active and running for more than three years at the time of observation, young people were attending voluntarily on a weekly basis and therefore, arguably already motivated and interested in learning.

Learner-centered teaching approaches include, but are not limited to, project-based learning, problem-based learning, and autonomous learning (An & Mindrila, 2020). According to Blumberg (2019), Learner-centered teaching can employ different teaching approaches. Hence, learner-centered teaching practices are not necessarily the same from one classroom to another (McCombs, 2008). Thus, even though teaching material and practices vary between different Dojos, mentors are still providing their learners with a good degree of LCL experience. Similarly, An and Reigeluth (2011) claim learner-centered teaching approaches do not take only one form but rather share the following common characteristics: learner autonomy, educators serving as facilitators, technology integration, and authentic and collaborative experiences, all within a social environment. In this study, all of these (except for collaboration) were found to commonly exist in Dojos to various extents, which again suggests that the CoderDojo

movement offers young people a LCL experience.

To implement teaching approaches that facilitate a more learner-centered approach an educator must believe that learners "make sense or make meaning out of information and experience in their own way" (Reigeluth et al., 2017, p. 12). Accordingly, it can be challenging to implement learner-centered teaching approaches in the current formal education system initially designed to reproduce knowers of information who learn to the test. Grant and Hill (2006) argue that teaching to the test plays a big role in the adoption of teacher-centered pedagogies in formal education, which meet the time and content demands of the tests. CoderDojos do not have similar pressures, which arguably plays a large role in their adopting teaching approaches that are more learner-centered. This study argues that new teaching approaches that support LCL environments in formal education demand changes in the relationships between teachers and students, teaching and learning practices, and how learning is assessed.

Epistemology is the study of knowledge and knowing (Strømsø & Bråten, 2011). In a traditional classroom setting, it is usually the case that the educator's personal epistemology is what is presented to the learners and learning is designed around that philosophy. In contrast, the CoderDojo philosophy is heuristic, which suggests there is no single approach considered, and therefore, there is an opportunity for the learner's personal epistemology to arise. In this study, mentors did not appear to influence the learner but rather were available in an unauthoritative manner encouraging learner autonomy. The rules within Dojos were not obvious, yet the children appeared focused and studious. The opportunity for the Ninjas to express their personal epistemology in Dojos likely has positive attributes and fosters learners to reach their personal goals.

The social environment CoderDojo provides to its attendees, where a diverse group of children are learning together in a social context, is important. CoderDojo strives to provide an inclusive environment for young people of all ages, genders, races, abilities,

etc. It provides Ninjas with an opportunity to learn how to interact with others in a more productive manner. Learning in a diverse environment can strengthen social bonds amongst learners, leading them to learn empathy and feel a sense of responsibility for each other (McKelvey & Cowan, 2017b; Tan et al., 2017). These opportunities do not usually exist in a school setting where a class is typically composed of learners of the same age. The different technologies used at CoderDojos, along with the flexibility made available to young people, enabled them to learn in a way that made them most comfortable and confident. McKelvey and Cowan (2017b) claimed that the fluid nature of CoderDojo offers private spaces for the learner to explore challenging issues and allows a studious approach to problem-solving.

The findings of this study revealed a system where young people appeared to have autonomy in their learning. Learners have freedom to learn, engage with peers, communicate with MKOs (like computing professionals and their peers) and use their creativity and imagination by developing projects that were personal to them, integrating different technologies. Considering the social environment available in CoderDojos and the mix of computing experts, parents, and young people from different ages and skill levels, the MKO may not necessarily be a mentor but rather another Ninja.

6.8 Answering the Research Questions

The research questions for this study are designed to explore current teaching approaches mentors implement within Dojos in Ireland and the alignment between these approaches and the CoderDojo teaching recommendations, as well as the extent to which the CoderDojo movement ethos is reflected. This section highlights the concise answers to the research questions that have been presented and discussed in Chapter 5 and Chapter 6.

6.8.1 Primary Research Question

The primary research question in this study was:

- What teaching approaches do mentors commonly implement within Dojos in Ireland?

The themes that emerged related to this question included autonomous learning, project-based learning, and fun learning. These were the most common teaching approaches mentors implemented while teaching in Dojos in Ireland. Mentors attempted to accommodate all these teaching approaches within a social environment. Each approach was thoroughly discussed in relation to literature (see section 6.2, section 6.5, section 6.6, section 6.4) and how they contribute to the LCL environment in Dojos (see section 6.7).

6.8.2 Research Sub-question 1

The first research sub-question was:

- To what extent do mentors' teaching approaches (discovered from the primary question) align with the recommended practices of the CoderDojo movement?

The 'CoderDojo Best Practice And Policy Recommendations Report' is a set of guiding principles composed by the CoderDojo movement that Dojo mentors can consult and choose to meet (CoderDojo Community, 2017). The non-formal nature of the movement and the prescribed absence of bureaucracy do not allow any compulsory processes to be obligatory for Dojos. The movement believes such requirements would detract

from the innovation and the spirit of CoderDojo. However, the movement provides advisory teaching recommendations that mentors can choose to meet.

After reviewing all the CoderDojo movement documents listed in subsubsection 3.4.3 and comparing those documents with the findings from this study regarding the teaching approaches mentors commonly use in Dojos (see section 5.3), the findings are well aligned with the recommended practices in CoderDojo documents. This alignment suggests that even though mentors seemed to be fairly disconnected from other Dojos, they were well aware of the CoderDojo movement recommendations and seemed to agree with them. The only exception was the common lack of collaboration. Even though collaborative learning is encouraged within the CoderDojo documents, the mentors found it a challenging approach to implement for a variety of reasons as highlighted in subsection 5.3.2. Introducing concepts like 'communities of practice' by the Foundation was suggested as a possible means of overcoming this issue (see section 6.3).

6.8.3 Research Sub-question 2

The second research sub-question was:

- To what extent is the CoderDojo ethos reflected in the teaching approaches used within Dojos in Ireland?

The CoderDojo ethos outlines the community approach to how its members (mentors in particular) are supposed to function in a Dojo and in the community, and how they can make an impact in the world. Figure 6.1 demonstrates the five essential CoderDojo ethos, which were thoroughly covered in section 1.2. The data set revealed the following regarding the actual implementation of the principles within Irish Dojos covered by this study:

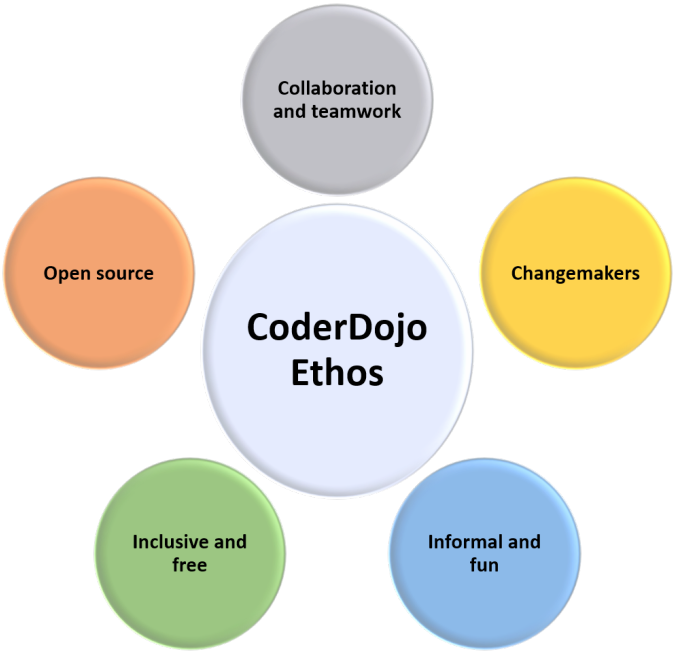


Figure 6.1: CoderDojo Ethos

- **Collaboration and teamwork**

  The findings of this study revealed that the majority of mentors did not implement collaboration in their Dojos and therefore this element was not well reflected within Dojos in Ireland. The causes for this lack of collaboration, as well as some recommendations on how to overcome this issue, were both covered in subsection 5.3.2 and section 6.3.

- **Informal and fun**

  In the CoderDojo handbook, the Foundation published five recommendations for mentors to implement in their Dojos in order to promote an informal and fun learning environment. The following list highlights these recommendations and how well they align with what was discovered in this study:

  - **Encourage self-led learning**: At Dojos young people are encouraged to explore coding, computer programming and technology by applying these to their interests. Autonomous learning was an emerging theme among all participants as noted in subsection 5.3.1. Hence, this result aligns with the

movement's recommendation to encourage independent learning.

- **Learning through project work**: According to the CoderDojo movement, mentors should encourage Ninjas to work on their own projects, which are shaped by their own abilities and interests. Project-based learning approaches based on learners' interests were an evolving theme from the data set (see subsection 5.3.4) and thus, aligned with this recommendation.
- **Not curriculum-based**: Dojos in general do not follow any curriculum and mentors are in charge of finding educational materials appropriate for their attendees based on their interests. Moreover, Ninjas are not obliged to follow a set learning path. They are encouraged to explore concepts in programming and to experiment further through their own individual projects. None of the mentors who participated in this study were using a syllabus. Instead, projects were used in place of a syllabus and thus, aligned with this recommendation.
- **CoderDojo is a club, not a classroom**: According to the Foundation, "The atmosphere in a Dojo is fun and social, and Ninjas have the opportunity to chat and work together" (CoderDojo Foundation, 2019, p. 42). In this study, fun was one of the emergent themes and 'Dojos not schools' was an evolving thread within that theme (see subsection 5.3.5). Thus, this movement recommendation is well aligned with the findings of this study.
- **Feedback should be constructive and positive**: This recommendation is mostly concerned with the mentor's role of supporting, guiding, and encouraging Ninjas rather than instructing them what to do. Mentors' awareness of their role as facilitators and supporters was an evolving thread amongst all participants as presented in subsection 5.3.1.

Based on the alignment between all the CoderDojo recommendations to promote an informal and fun learning environment and the findings from this study, the ethos of CoderDojo being informal and fun is well reflected within Dojos.

- **Changemakers**

  To implement this ethos, the movement recommends mentors encourage Ninjas to use technology to work on projects that are of direct interest to them. The movement believes that by doing so, mentors are giving young people the opportunity to positively influence the world around them. This ethos revolves around learning independently and encouraging kids to choose projects of interest to them. Since both autonomous learning and project-based learning were found as major themes in this study (see subsection 5.3.1, subsection 5.3.4), the findings aligned with this particular CoderDojo ethos.

- **Inclusive and free**

  There is no charge for attending any CoderDojo space worldwide. This enables Dojos to be open and inclusive for all members of society who wish to participate. This ethos relates to the technicalities of running Dojos and is not concerned with teaching or learning taking place within these Dojos and therefore, is out of the scope of this study.

- **Open source**

  Since its inception, CoderDojo has been based on an open-source model: "anyone anywhere can set up a Dojo as long as they operate according to the CoderDojo ethos and values" (CoderDojo Foundation, 2019, p. 46). Again, this ethos is more related to the technicalities of opening Dojos and is not concerned with the teaching or learning taking place within these Dojos.

In summary, the CoderDojo ethos (except for collaboration) is well reflected within Dojos in Ireland.

6.9 Conclusion

CoderDojos proposes a learning framework with scaffolding rooted in social constructivism that encompasses motivational, social, and fun aspects along with an opportunity to learn autonomously. This framework gives learners the opportunity to develop ownership over the process and accomplish personally meaningful learning goals to optimistically generate computing artefacts beyond the traditional assessment. The non-traditional learning environment offered by CoderDojos is arguably learner-centered as they are project-oriented and provide hands-on practical experience in a social and fun environment. The traditional teacher role is replaced by mainly computing-related professionals or computing-related graduate students who support and guide without a fixed structure and without facilitating a classroom hierarchy. The Dojo environment appeared to move away from the traditional student/teacher relationship as well as the usual boundaries that exist in traditional classrooms.

In this chapter, the themes resulting from analysing the data have been discussed. The use of social constructivism as a lens for discussion in this context produced a novel starting point within the framework for future studies of CoderDojo highlighting potential areas for further improvement. The discussion of findings presented in this chapter highlighted a system whereby young people appeared to have autonomy in their learning, projects were of personal interest, and young people were encouraged to achieve personal victories within a social environment supporting LCL. The research questions were restated for further discussion.

Chapter 7

Conclusion and Recommendations

7.1 Introduction

The concluding chapter of this thesis presents the significance of this study and highlights areas for further work. This chapter also acknowledges the limitations of this study. Finally, concluding remarks are recapped.

7.2 Significance of this Study

The research presented in this work constitutes a contribution to three different domains: computer science education research (CSED), the National Council for Curriculum and Assessment (NCCA), and the CoderDojo movement. The following sections discuss these key contributions in further detail.

7.2.1 Insight into Teaching Approaches

As presented in the literature review, there is limited research related on the teaching approaches used by educators who teach computing, especially, in non-formal learning environments like CoderDojo. The main contribution to computer science education and computer science education research made by this study is insight into the teaching approaches that evolve in non-formal contexts where in most cases, educationists are replaced with computing professionals. This research brought to light CoderDojo mentors' use of autonomous learning, collaboration, social learning environment, project-based learning, and fun as teaching approaches used while mentoring in Dojos and can be used as examples for other teachers, mentors, or facilitators seeking to teach computing in both formal and non-formal contexts.

7.2.2 Curriculum Reform at the National Level

The National Council for Curriculum and Assessment (NCCA) in Ireland has recently added a Leaving Certificate Computer Science and is currently working on reviewing and reforming the primary curriculum to include new competencies. Some of the key competencies they are aiming to develop include increasing learner independence, creativity, motivation, enjoyment, and use of technology across all curricula with a focus on the teacher's central role in successfully incorporating these competencies in schools. The CoderDojo mentors who participated in this study showed positive signs of incorporating these competencies in their Dojos. Thus, another contribution of this study is to help educators and policy makers at NCCA explore and understand different learning contexts to help implement the changes necessary in the formal education system.

7.2.3 Contribution of Research to CoderDojo Movement

The findings of this study should be of significant interest to the CoderDojo movement both locally and globally. The participants in this study were active CoderDojo mentors and so the findings of this study will provide the movement's community members with valuable insights into the mentors' experiences within the CoderDojo context. Moreover, being exposed to some of the CoderDojos' shortcomings and the misalignment between some of their ethos and mentors' actual practices could help the movement in searching for appropriate solutions to overcome these shortcomings.

7.3 Areas for Further Work

The recent trend towards computing education for young people in both formal and non-formal education offers an exciting opportunity for research. A number of promising lines for future research emerge from this study. This work sought to explore teaching approaches that are evolving in Irish CoderDojos with participants who experience their teaching in a culture and context particular to Ireland. CoderDojo is a global movement and it would be interesting to see what the findings would be in other national or cultural contexts. Also, it would be insightful to conduct a similar study involving other non-formal coding initiatives like Code Club, Girls Who Code, etc. in which the findings could be compared to this study to see how they might be similar or different from each other.

The findings of this study demonstrate a need for establishing and sustaining a Computer Science Community of Practice in Ireland. Communities of practice play a significant role in providing assistance and support to educators as well as facilitating the transfer of interpersonal knowledge (O'Keeffe et al., 2019). Delaney et al. (2017) claim that communities that share practices play a vital role in helping educators evaluate

outcomes. Educators' support of organisations such as the Computers in Education Society of Ireland (CESI) are important advocates for supporting educators involved in teaching computing-related subjects. These organisations should be supported.

7.4 Research Limitations

Patton (2002) states that "there are no perfect research designs. There are always trade-offs" (p.223). The researcher acknowledges that certain limitations exist in this research. There are some limitations associated with adopting a social constructivist paradigm. This study can be described as one based on "subjective, value-laden interpretations" (Lynch, 1996, p. 54). Some may question the lack of 'rigour' when validating study findings (Lincoln & Guba, 1985). However, the researcher aligned her views with the idea that "naturalistic investigation, with its preferences for direct apprehension of the social world, has somewhat fewer problems with validity than do research traditions that rely on indirect perception" (Lofland et al., 2022, p. 50). This means that in the context of this study, the researcher implemented this specific methodology to offer one of many interpretations. Furthermore, this study was based on the belief that there are no absolute truths, but rather truth claims that are evolving from a common understanding of what is real and meaningful.

The generalisation of a single case study approach to a wider context has also been questioned in the literature (Bell & Stephen, 2014). However, Dubois and Gadde (2002) argue that in certain studies interaction between a phenomenon and its context is best understood through an in-depth case study. Moreover, many researchers argue that the purpose of single case study research is not to generalise findings, but rather to offer a description and analysis of the case under investigation (Creswell, 2014; Greene & Caracelli, 1997; Marshall & Rossman, 2016). Accordingly, particularity rather than generalisability was the objective of this study.

This study focused on mentors who were actively volunteering in Dojos in Ireland, all of whom were over 18 at the time of the data collection. This means that not all mentors in Ireland are represented in the sample used. It should also be noted that no mentors over the age of 60 answered the call for participation in this study. As this research mostly relied on the responses supplied by the mentors, there is the possibility of disposition bias in the mentors' answers to questions during the interviews so that answers would be presented mostly positive rather than attaching negative aspects to an activity that they feel should be seen viewed positively.

In terms of the Ninjas' experience, the evidence included in this study is mostly taken from what the mentors said, including the mentors' reports on observations of Ninja's reactions to the teaching approaches they implemented. Where possible, these indirect reports were validated by triangulation with observational data collected by the researcher. While the mentors provided valuable insights into Ninja engagement and learning, further research is needed to explore the Ninja experience more directly. For example, to more fully appreciate the supports that Ninjas need to further engage in the learning of computing skills.

Due to the COVID-19 pandemic, the researcher only had the chance to observe four Dojos when on-site observations were still allowed. All the observed Dojos had been running for more than three years with mentors aged over 40 and with mentoring experience of at least three years at the time this research was carried out. While the observational data provided valuable insights allowing the researcher to take notes of teaching practices implemented in their original contexts, further research is needed to observe more recent Dojos and less experienced mentors.

7.5 Concluding Remarks

For a decade, the CoderDojo movement has been bridging the current gap in computing education for young people in Ireland. The purpose of this study is to conduct research within the context of CoderDojos in Ireland to explore the teaching approaches that are evolving in such non-traditional learning environments. This study reveals that CoderDojos arguably offer attendees a learner-centered learning experience. The absence of curriculum and assessment creates a flexible learning context. CoderDojos appear to embrace the utilisation of mentors with skills in computing. Traditional teacher-centered approaches do not seem to be common in Dojos where generally mentors are computing professionals/students with no prescribed theories of teaching and no pressure to assess learners. Mentors appear to support learners' autonomy, creativity, personal interests, social engagement, and sense of enjoyment. Their non-traditional approaches to teaching young people coding are possibly more similar to the real world of computing and therefore, are arguably more authentic for the learners.

The social environment available in CoderDojos and the mix of computing experts, parents, and young people from different ages and skill levels have the potential to better support Vygotsky's concepts of More Knowledgeable Other (MKO) as well as a Zone of Proximal Development (ZPD). The CoderDojo mentors appeared to place less emphasis on generating computing artefacts and focused primarily on promoting learners' autonomy and sense of enjoyment.

This study not only provides insights into the teaching approaches emergent in a non-formal learning environment like CoderDojo, but also sheds light on some of the issues that might obstruct learning. At a time when the NCCA is reviewing and re-developing the curriculum so computer literacy can become an essential part of the Irish education system, this study can provide educationalists and policymakers with insight and

understanding into how young people at CoderDojos are learning computing and help them decide which strategies and approaches have the potential to transfer to traditional educational classrooms. Moreover, this study offers insights into the CoderDojo movement itself as it highlights some areas for further development.

References

Ackermann, E. (2001). Piaget's Constructivism, Papert's Constructionism: What's the difference? *Future of learning group publication*, *5*(3), 438.

Admiraal, W., Louws, M., Lockhorst, D., Paas, T., Buynsters, M., Cviko, A., Janssen, C., de Jonge, M., Nouwens, S., Post, L., van der Ven, F., & Kester, L. (2017). Teachers in School-based Technology Innovations: A Typology of their Beliefs on Teaching and Technology. *Computers & Education*, *114*, 57–68. https://doi.org/10.1016/j.compedu.2017.06.013

Aivaloglou, E., & Hermans, F. (2019). How is Programming Taught in Code Clubs? Exploring the Experiences and Gender Perceptions of Code Club Teachers. *Proceedings of the 19th Koli Calling International Conference on Computing Education Research (Koli Calling '19)*, 1–10. https://doi.org/10.1145/3364510.3364514

Alharahsheh, H. H., & Pius, A. (2020). A review of key paradigms: Positivism VS interpretivism. *Global Academic Journal of Humanities and Social Sciences*, *2*(3), 39–43.

Alsheaibi, A., Huggard, M., & Strong, G. (2020). Teaching within the CoderDojo Movement: An Exploration of Mentors' Teaching Practices. *Proceedings of the Frontiers in Education Conference (FIE)*, 1–5. https://doi.org/10.1109/FIE44824.2020.9273998

Alsheaibi, A., Strong, G., & Millwood, R. (2018). The Need for a Learning Model in CoderDojo Mentoring Practice. *Proceedings of the 13th Workshop in Primary*

and Secondary Computing Education (WiPSCE '18), 1–2. https://doi.org/10.1145/3265757.3265785

Amineh, R. J., & Asl, H. D. (2015). Review of Constructivism and Social Constructivism. *Journal of Social Sciences, Literature and Languages*, *1*(1), 9–16.

An, Y., & Mindrila, D. (2020). Strategies and tools used for learner-centered instruction. *International Journal of Technology in Education and Science*, *4*(2), 133–143. https://files.eric.ed.gov/fulltext/EJ1255618.pdf

An, Y.-J., & Reigeluth, C. (2011). Creating Technology-Enhanced, Learner-Centered Classrooms: K–12 Teachers' Beliefs, Perceptions, Barriers, and Support Needs. *Journal of Digital Learning in Teacher Education*, *28*(2), 54–62. https://doi.org/10.1080/21532974.2011.10784681

Balanskat, A., & Engelhardt, K. (2015). Computing our Future: Computer Programming and Coding: Priorities, School Curricula and Initiatives Across Europe. http://www.eun.org/resources/detail?publicationID=661

Barron, B., Cayton-Hodges, G., Bofferding, L., Copple, C., Darling-Hammond, L., & Levine, M. (2011). Take a Giant Step: A Blueprint for Teaching Young Children in a Digital Age. https://joanganzcooneycenter.org/publication/take-a-giant-step-a-blueprint-for-teaching-young-children-in-a-digital-age/

Barron, B., & Darling-Hammond, L. (2008). Teaching for Meaningful Learning. *Powerful Learning: What We Know about Teaching for Understanding*, 11–70.

Baskerville, R. L. (1999). Investigating Information Systems with Action Research. *Communications of the association for information systems*, *2*(1), 19. https://doi.org/10.17705/1CAIS.00219

Batlle, I. C. (2019). Non-formal Education, Personhood and the Corrosive Power of Neoliberalism. *Cambridge Journal of Education*, *49*(4), 417–434. https://doi.org/10.1080/0305764X.2018.1552658

Bazeley, P. (2004). Issues in Mixing Qualitative and Quantitative Approaches to Research. In R. Buber, J. Gadner, & L. Richards (Eds.), *Applying qualitative methods to marketing management research* (pp. 141–156). Palgrave Macmillan.

Becker, H. J. (2000). Findings from the Teaching, Learning, and Computing Survey. *Education Policy Analysis Archives*, *8*, 51. https://doi.org/10.14507/epaa.v8n51.2000

Beecher, K. (2018). *Bad Programming Practices 101: Become a Better Coder by Learning How (Not) to Program*. Apress. https://doi.org/10.1007/978-1-4842-3411-2

Begel, A., & Ko, A. (2019). Learning Outside the Classroom. In S. A. Fincher & A. V. Robins (Eds.), *The cambridge handbook of computing education research* (pp. 749–772). Cambridge University Press. https://doi.org/10.1017/9781108654555.027

Beghetto, R. A., Baer, J., & Kaufman, J. C. (2017). *Teaching for Creativity in the Australian Curriculum Classroom*. Hawker Brownlow Education.

Bell, J., & Stephen, W. (2014). *Doing Your Research Project: A Guide for First-time Researchers*. McGraw-Hill Education.

Bell, S. (2010). Project-Based Learning for the 21st Century: Skills for the Future. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *83*(2), 39–43. https://doi.org/10.1080/00098650903505415

Bellanca, J. (2010). *21st Century Skills: Rethinking How Students Learn*. Solution Tree Press.

Ben-Ari, M. (2001). Constructivism in Computer Science Education. *Journal of Computers in Mathematics and Science Teaching*, *20*(1), 45–73. https://www.learntechlib.org/p/8505

Bheemaiah, A. K. (2020). Flipped Classroom: A coderdojo perspective. https://doi.org/10.31234/osf.io/pvysw

Bietenbeck, J. (2014). Teaching practices and cognitive skills. *Labour Economics*, *30*, 143–153. https://doi.org/10.1016/j.labeco.2014.03.002

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M. (2012). Defining Twenty-First Century Skills. In *Assessment and Teaching of 21st Century Skills* (pp. 17–66). Springer. https://doi.org/10.1007/978-94-007-2324-5_2

Blaikie, N. (2007). *Approaches to Social Enquiry: Advancing Knowledge*. Polity Press.

Blikstein, P. (2013). Digital Fabrication and 'Making' in Education: The Democratization of Invention. In J. Walter-Herrmann & C. Büching (Eds.), *FabLabs: Of Machines, Makers and Inventors* (pp. 203–222). Transcript Verlag. https://doi.org/10.14361/transcript.9783839423820.203

Blikstein, P., & Moghadam, S. H. (2019). Computing Education Literature Review and Voices from the Field. In S. A. Fincher & A. V. Robins (Eds.), *The Cambridge Handbook of Computing Education Research* (pp. 56–78). Cambridge University Press. https://doi.org/10.1017/9781108654555.004

Blumberg, P. (2019). Designing for Effective Group Process in PBL Using a Learner-Centered Teaching Approach. In M. Moallem, W. Hung, & N. Dabbagh (Eds.), *The Wiley Handbook of Problem-Based Learning* (pp. 343–365). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119173243.ch15

Bonk, C. J., & Cunningham, D. J. (2012). Searching for Learner-Centered, Constructivist, and Sociocultural Components of Collaborative Educational Learning Tools. In C. J. Bonk & K. S. King (Eds.), *Electronic Collaborators: Learner-centered Technologies for Literacy, Apprenticeship, and Discourse* (pp. 61–86). Routledge.

Boud, D. (1988). *Developing Student Autonomy in Learning*. Taylor & Francis.

Boud, D., Cohen, R., & Sampson, J. (1999). Peer Learning and Assessment. *Assessment & Evaluation in Higher Education*, *24*(4), 413–426. https://doi.org/10.1080/0260293990240405

Bransford, J., Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How People Learn: Brain, Mind, Experience, and School*. National Academies Press. https://doi.org/10.17226/9853

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, *11*(4), 589–597. https://doi.org/10.1080/2159676X.2019.1628806

Bresnihan, N., Millwood, R., Oldham, E., Strong, G., & Wilson, D. (2015). A Critique of the Current Trend to Implement Computing in Schools. *Pedagogika*, *65*(3), 292–300. https://pages.pedf.cuni.cz/pedagogika/files/2015/12/Ped_2015_3_anj_clanek_tisk.pdf

Bresnihan, N., Strong, G., Fisher, L., Millwood, R., & Lynch, Á. (2020). Increasing Parental Involvement in Computer Science Education Through the Design and Development of Family Creative Computing Workshops. In H. C. Lane, S. Zvacek, & J. Uhomoibhi (Eds.), *Computer Supported Education* (pp. 479–502). https://doi.org/10.1007/978-3-030-58459-7_23

Brinkmann, S., & Kvale, S. (2015). *Interviews: Learning the Craft of Qualitative Research Interviewing*. SAGE Publications Inc.

Broadbent, J., Panadero, E., & Boud, D. (2018). Implementing summative assessment with a formative flavour: A case study in a large class. *Assessment & Evaluation in Higher Education*, *43*(2), 307–322. https://doi.org/10.1080/02602938.2017.1343455

Brown, K. L. (2003). From Teacher-Centered to Learner-Centered Curriculum: Improving Learning in Diverse Classrooms. *Education*, *124*(1), 49–54.

Bryman, A. (2016). *Social Research Methods*. Oxford University Press.

Buckingham, D., & Willett, R. (2013). *Digital Generations: Children, Young People, and the New Media*. Routledge.

Bull, A., & Gilbert, J. (2012). Swimming out of our depth? Leading learning in 21st century schools. *New Zealand Council for Educational Research*, 1–23. https://www.nzcer.org.nz/research/publications/swimming-out-our-depth-leading-learning-21st-century-schools

Butler, N., Flood, C., & Power, A. (2018). What Motivates a Ninja?: An exploration of students' CoderDojo experience. In *Cyberpsychology and society* (pp. 47–62). Routledge. https://doi.org/10.4324/9781315160962-5

Byrne, J. R., Fisher, L., & Tangney, B. (2015). Empowering Teachers to Teach CS — Exploring a Social Constructivist Approach for CS CPD, Using the Bridge21 Model. *Proceedings of the Frontiers in Education Conference (FIE)*, 1–9. https://doi.org/10.1109/FIE.2015.7344030

Byrne, J. R., Kearney, S., & Sullivan, K. (2019). Technology-Mediated Collaborative Learning: The Bridge21 Activity Model in Theory and Practice. In L. Daniela (Ed.), *Didactics of Smart Pedagogy* (pp. 309–330). Springer International Publishing. https://doi.org/10.1007/978-3-030-01551-0_16

Chan, S. C., Wan, C. J., & Ko, S. (2019). Interactivity, active collaborative learning, and learning performance: The moderating role of perceived fun by using personal response systems. *The International Journal of Management Education*, *17*(1), 94–102. https://doi.org/10.1016/j.ijme.2018.12.004

Chandramouli, M., Zahraee, M., & Winer, C. (2014). A Fun-Learning Approach to Programming: An Adaptive Virtual Reality (VR) Platform to Teach Programming to Engineering Students. *Proceedings of the IEEE International Conference on Electro/Information Technology*, 581–586. https://doi.org/10.1109/EIT.2014.6871829

Chenail, R. (2011). Interviewing the Investigator: Strategies for Addressing Instrumentation and Researcher Bias Concerns in Qualitative Research. *The Qualitative Report*, *16*(1), 255–262. https://doi.org/10.46743/2160-3715/2011.1051

Chetty, R., Friedman, J. N., & Rockoff, J. E. (2014). Measuring the Impacts of Teachers II: Teacher Value-Added and Student Outcomes in Adulthood. *American Economic Review*, *104*(9), 2633–79. https://doi.org/10.1257/aer.104.9.2633

Claxton, G. (2013). *What's the Point of School?* Oneworld Publications.

CoderDojo Community. (2017). CoderDojo Best Practice And Policy Recommendations Report. https://wp-static.coderdojo.com/uploads/2017/01/Best-Practices-Policy.pdf

CoderDojo Foundation. (2012). CoderDojo ECHO (Ethos, Culture, Happiness and Outcomes). https://github.com/CoderDojo/kata-archive/blob/master/files/CoderDojo-ECHO.pdf

CoderDojo Foundation. (2017). CoderDojo Foundation Annual Report 2017. https://coderdojo.com/2018/05/12/coderdojo-foundation-annual-report-2017/

CoderDojo Foundation. (2019). CoderDojo Champions' Handbook. https://coderdojo.com/2019/02/21/the-champions-handbook-is-now-available-in-six-languages/

CoderDojo Foundation. (2020). CoderDojo annual survey 2019. https://coderdojo.com/2020/06/12/annual-survey-results-2019

CoderDojo Foundation. (2021). Annual Review and Accounts. https://www.globalgiving.org/projects/coderdojo/reports/

Colley, H., Hodkinson, P., & Malcolm, J. (2002). Non-formal learning: mapping the conceptual terrain: a consultation Report. http://www.infed.org/archives/e-texts/colley_informal_learning.htm

Conneely, C., Lawlor, J., & Tangney, B. (2013). Technology, Teamwork and 21st Century Skills in the Irish Classroom. In K. Marshall (Ed.), *Shaping our Future: How the lessons of the past can shape educational transformation* (pp. 20–27). Liffey Press. http://hdl.handle.net/2262/81988

Connolly, C., Byrne, J. R., & Oldham, E. (2022). The trajectory of computer science education policy in ireland: A document analysis narrative. *European Journal of Education*, *57*(3), 512–529. https://doi.org/10.1111/ejed.12507

Coombs, P. H., & Ahmed, M. (1974). *Attacking Rural Poverty: How Nonformal Education Can Help. A Research Report for the World Bank Prepared.* John Hopkins University Press.

Costa, J. M., Moro, S., Miranda, G., & Arnold, T. (2020). Empowered learning through microworlds and teaching methods: A text mining and meta-analysis-based sys-

tematic review. *Research in Learning Technology*, *28*. https://doi.org/10.25304/rlt.v28.2396

Cousin, G. (2008). *Researching Learning in Higher Education: An Introduction to Contemporary Methods and Approaches*. Routledge. https://doi.org/10.4324/9780203884584

Creswell, J. W. (2005). *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research*. Prentice Hall.

Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. SAGE Publications.

Creswell, J. W., & Poth, C. N. (2018). *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*. SAGE Publications Inc.

Crotty, M. (1998). *The Foundations of Social Research: Meaning and Perspective in the Research Process*. Routledge.

Culler, J. (2010). Introduction: Critical Paradigms. *PMLA*, *125*(4), 905–915. https://doi.org/10.1632/pmla.2010.125.4.905

Danielewicz-Betz, A., & Kawaguchi, T. (2014). Gaining Hands-on Experience via Collaborative Learning: Interactive Computer Science Courses. *2014 International Conference on Interactive Collaborative Learning (ICL)*, 403–409. https://doi.org/10.1109/ICL.2014.7017806

De Villiers, M. (2005). Interpretive research models for informatics: Action research, grounded theory, and the family of design-and development research. *Alternation*, *12*(2), 10–52. https://journals.co.za/doi/abs/10.10520/AJA10231757_388

Delaney, K., O'Keeffe, M., & Fragou, O. (2017). A Design Framework for Interdisciplinary Communities of Practice Towards STEM Learning in 2nd Level Education. In M. E. Auer, D. Guralnick, & I. Simonics (Eds.), *Teaching and Learning in a Digital World* (pp. 739–750). Springer International Publishing. https://doi.org/https://doi.org/10.1007/978-3-319-73210-7_86

Denson, C., Austin, C., Hailey, C., & Householder, D. (2015). Benefits of Informal Learning Environments: A Focused Examination of STEM-based Program En-

vironments. *Journal of STEM Education*, *16*(1). https://www.learntechlib.org/d/151634

Denzin, N. K., & Lincoln, Y. S. (2011). *The SAGE Handbook of Qualitative Research*. SAGE Publications Inc.

Department of Education. (2015). Digital Strategy for schools 2015–2020. https://www.gov.ie/en/publication/f8990-digital-strategy-for-schools-2015-2020/

Dib, C. Z. (1988). Formal, non-formal and informal education: Concepts/applicability. *AIP Conference Proceedings*, *173*(1), 300–315. https://doi.org/10.1063/1.37526

Dilekli, Y. (2020). Project-based learning. In *Paradigm shifts in 21st century teaching and learning* (pp. 53–68). IGI Global.

Dole, S., Bloom, L., & Kowalske, K. (2016). Transforming Pedagogy: Changing Perspectives from Teacher-Centered to Learner-Centered. *Interdisciplinary Journal of Problem-Based Learning*, *10*(1). https://doi.org/10.7771/1541-5015.1538

Dorn, N., Berges, M., Capovilla, D., & Hubwieser, P. (2018). Talking at cross purposes: Perceived learning barriers by students and teachers in programming education. *Proceedings of the 13th Workshop in Primary and Secondary Computing Education (WiPSCE '18)*, 1–4. https://doi.org/10.1145/3265757.3265769

Dubois, A., & Gadde, L.-E. (2002). Systematic combining: An abductive approach to case research. *Journal of Business Research*, *55*(7), 553–560. https://doi.org/10.1016/S0148-2963(00)00195-8

Duckworth, E. (2009). Helping Students Get to Where Ideas Can Find Them. *Journal of Business Research*, *5*(3), 185–188. https://doi.org/10.1080/1547688X.2009.10399573

Dugger, W. E. (2001). Standards for Technological Literacy. *Phi Delta Kappan*, *82*(7), 513–517. https://doi.org/10.1177/003172170108200707

Duncan, T., & Buskirk-Cohen, A. (2011). Exploring Learner-Centered Assessment: A Cross-Disciplinary Approach. *International Journal of Teaching and Learning in Higher Education*, *23*(2), 246–259.

Dweck, C. S., Walton, G. M., & Cohen, G. L. (2014). *Academic Tenacity: Mindsets and Skills that Promote Long-Term Learning*. Bill & Melinda Gates Foundation.

Eccles, J. S., Wigfield, A., & Schiefele, U. (1998). Motivation to Succeed. In W. Damon & N. Eisenberg (Eds.), *Handbook of child psychology: Social, emotional, and personality development* (pp. 1017–1095). John Wiley & Sons.

Edwards-Schachter, M., García-Granero, A., Sánchez-Barrioluengo, M., Quesada-Pineda, H., & Amara, N. (2015). Disentangling competences: Interrelationships on creativity, innovation and entrepreneurship. *Thinking Skills and Creativity*, *16*, 27–39. https://doi.org/10.1016/j.tsc.2014.11.006

Egan, A., & Gurhy, A. (2020). A sequential explanatory mixed methods study of pre-service teachers' experiences of and attitudes to coding in Ireland. In D. Schmidt-Crawford (Ed.), *Proceedings of society for information technology & teacher education international conference 2020* (pp. 625–630). Association for the Advancement of Computing in Education (AACE). https://www.learntechlib.org/p/215804

Eisner, E. W. (2017). *The Enlightened Eye: Qualitative Inquiry and the Enhancement of Educational Practice*. Teachers College Press.

Erlandson, D. A., Harris, E. L., Skipper, B. L., & Allen, S. D. (1993). *Doing Naturalistic Inquiry: A Guide to Methods*. SAGE Publications.

Ertmer, P. A., & Newby, T. J. (2013). Behaviorism, Cognitivism, Constructivism: Comparing Critical Features From an Instructional Design Perspective. *Performance Improvement Quarterly*, *26*(2), 43–71. https://doi.org/10.1002/piq.21143

Eshach, H. (2007). Bridging In-school and Out-of-school Learning: Formal, Non-Formal, and Informal Education. *Journal of Science Education and Technology*, *16*(2), 171–190. https://doi.org/10.1007/s10956-006-9027-1

European Commission. (2001). Making a European area of lifelong learning a reality. http://aei.pitt.edu/42878/

European Commission. (2021). Digital Education Action Plan (2021-2027). https://education.ec.europa.eu/focus-topics/digital/education-action-plan

Falchikov, N. (2003). *Learning Together: Peer Tutoring in Higher Education*. Routledge.

Fessakis, G., Gouli, E., & Mavroudi, E. (2013). Problem solving by 5–6 years old kindergarten children in a computer programming environment: A case study. *Computers & Education*, *63*, 87–97. https://doi.org/10.1016/j.compedu.2012.11.016

Fink, L. D. (2013). *Creating Significant Learning Experiences: An Integrated Approach to Designing College Courses*. John Wiley & Sons.

Fisher, L. (2019). *Exploring Use Of The Bridge21 Model As A 21St Century Method Of Continuing Professional Development (CPD) In Computer Science (CS) For Teachers In Ireland* [Doctoral dissertation, Trinity College Dublin]. http://hdl.handle.net/2262/89500

Fisher, L., Byrne, J. R., & Tangney, B. (2016). Teacher Experiences of Learning Computing using a 21st Century Model of Computer Science Continuing Professional Development. *Proceedings of the 8th International Conference on Computer Supported Education*, *2*, 273–280. https://doi.org/10.5220/0005906702730280

Fullan, M., & Langworthy, M. (2013). Towards a New End: New Pedagogies for Deep Learning. https://michaelfullan.ca/wp-content/uploads/2013/08/New-Pedagogies-for-Deep-Learning-An-Invitation-to-Partner-2013-6-201.pdf

Gartside, P., & Strachan, G. (2015). Do Good and Good Will Come to You. *ITNOW*, *57*(2), 34–35. https://doi.org/10.1093/itnow/bwv043

Geary, W. T. (1998). From Dependence toward Independence via Interdependence. https://files.eric.ed.gov/fulltext/ED422304.pdf

Ghadiri, M., Khanaposhtani, Liu, C. J., Gottesman, B. L., Shepardson, D., & Pijanowski, B. (2018). Evidence that an informal environmental summer camp can contribute to the construction of the conceptual understanding and situational interest of STEM in middle-school youth. *International Journal of Science Education*, *8*(3), 227–249. https://doi.org/10.1080/21548455.2018.1451665

Giannakos, M. (2020). An Introduction to Non-formal and Informal Science Learning in the ICT Era. In *Non-Formal and Informal Science Learning in the ICT Era* (pp. 3–13). Springer. https://doi.org/10.1007/978-981-15-6747-6_1

Golafshani, N. (2003). Understanding Reliability and Validity in Qualitative Research. *The Qualitative Report*, *8*(4), 597–607. https://doi.org/10.46743/2160-3715/2003.1870

Goldenson, D. (1996). Why Teach Computer Programming? Some Evidence about Generalization and Transfer. *Proceedings of the Annual National Educational Computing Conference*. https://files.eric.ed.gov/fulltext/ED398886.pdf

Grant, M., & Hill, J. (2006). Weighing the Risks with the Rewards: Implementing Student-centered Pedagogy within High Stakes Testing. In R. Lambert & C. McCarthy (Eds.), *Understanding Teacher Stress in the Age of Accountability* (pp. 19–42). Information Age.

Greene, J. C., & Caracelli, V. J. (1997). Advances in mixed-method evaluation: The challenges and benefits of integrating diverse paradigms. *New Directions for Evaluation*, *74*, 1–94.

Greeno, J., Collins, A., & Resnick, L. (1996). Cognition and Learning. In D. Berliner & R. Calfee (Eds.), *Handbook of educational psychology* (pp. 15–41, Vol. 77).

Griffin, J. (2008). Learning about Learning and Teaching: "You don't learn in there, you play". In P. Aubusson & S. Schuck (Eds.), *Teacher Learning and Development: The Mirror Maze* (pp. 145–161, Vol. 3). Springer. https://doi.org/10.1007/978-1-4020-4642-1_9

Gross, R. (2010). *Psychology: The Science of Mind and Behaviour*. Hodder Education.

Haapaniemi, J., Venäläinen, S., Malin, A., & Palojoki, P. (2021). Teacher autonomy and collaboration as part of integrative teaching–Reflections on the curriculum approach in Finland. *Journal of Curriculum Studies*, *53*(4), 546–562. https://doi.org/10.1080/00220272.2020.1759145

Haggard, D. L., Dougherty, T. W., Turban, D. B., & Wilbanks, J. E. (2011). Who Is a Mentor? A Review of Evolving Definitions and Implications for Research.

Journal of Management, *37*(1), 280–304. https://doi.org/10.1177/0149206310386227

Hains, B. J., & Smith, B. (2012). Student-Centered Course Design: Empowering Students to Become Self-Directed Learners. *Journal of Experiential Education*, *35*, 357–374.

Hamilton, L., & Corbett-Whittier, C. (2012). *Using Case Study in Education Research*. SAGE Publications Inc.

Harel, I., & Papert, S. (1991). *Constructionism*. Ablex Publishing.

Hazzan, O., Lapidot, T., & Ragonis, N. (2020). *Guide to Teaching Computer Science: An Activity-Based Approach*. Springer.

Heintz, F., Mannila, L., Nygårds, K., Parnes, P., & Regnell, B. (2015). Computing at School in Sweden – Experiences from Introducing Computer Science within Existing Subjects. In A. Brodnik & J. Vahrenhold (Eds.), *Informatics in Schools: Curricula, Competences, and Competitions* (pp. 118–130). https://doi.org/10.1007/978-3-319-25396-1_11

Hennessey, B. A. (1995). Social, environmental, and developmental issues and creativity. *Educational Psychology Review*, *7*(2), 163–183. https://doi.org/10.1007/BF02212492

Hensman, A. (2014). Setting Up and Mentoring in CoderDojo Dublin 15. *The ITB Journal*, *15*(2), 3. https://doi.org/10.21427/D77T79

Higgins, S., Xiao, Z., & Katsipataki, M. (2012). *The Impact of Digital Technology on Learning: A Summary for the Education Endowment Foundation* (tech. rep.). Education Endowment Foundation and Durham University. https://files.eric.ed.gov/fulltext/ED612174.pdf

Higher Education Authority. (2020). https://hea.ie/statistics/data-for-download-and-visualisations/students/progression/progression-introduction/non-progression-by-nfq-hei-isced/

Hirschman, K., & Wood, B. (2018). 21st Century Learners: Changing Conceptions of Knowledge, Learning and the Child. *New Zealand Annual Review of Education*, *23*, 20–35.

Hof, B., & Bürgi, R. (2021). The OECD as an arena for debate on the future uses of computers in schools. *Globalisation, Societies and Education*, *19*(2), 154–166. https://doi.org/10.1080/14767724.2021.1878015

Holec, H. (1981). *Autonomy and Foreign Language Learning*. Pergamon Press.

Holliday, A. (2003). Social Autonomy: Addressing the Dangers of Culturism in TESOL. In D. Palfreyman & R. C. Smith (Eds.), *Learner Autonomy Across Cultures* (pp. 110–126). Palgrave MacMillan. https://doi.org/10.1057/9780230504684_7

Holstein, J., & Gubrium, J. (2003). *Postmodern Interviewing*. SAGE Publications.

Hunter, D. (2009). *The Art of Facilitation: The Essentials for Leading Great Meetings and Creating Group Synergy*. John Wiley & Sons.

Iten, N., & Petko, D. (2016). Learning with serious games: Is fun playing the game a predictor of learning success? *British Journal of Educational Technology*, *47*(1), 151–163. https://doi.org/10.1111/bjet.12226

Jackson, K., & Bazeley, P. (2019). *Qualitative Data Analysis with NVivo*. SAGE Publications Inc.

Jackson, R., & Sorensen, G. (2006). *Introduction to International Relations Theories and Approaches*. Oxford University Press.

Johnson, D. W., & Johnson, R. T. (1999). Making cooperative learning work. *Theory Into Practice*, *38*(2), 67–73. https://doi.org/10.1080/00405849909543834

Johnson, M., & Majewska, D. (2022). *Formal, non-formal, and informal learning: What are they, and how can we research them? research report*. Cambridge University Press & Assessment. https://files.eric.ed.gov/fulltext/ED626005.pdf

Johnson, R. B., & Christensen, L. (2019). *Educational Research: Quantitative, Qualitative, and Mixed Approaches*. SAGE Publications Inc.

Kafai, Y. B., Baskin, J., Fields, D., Goode, J., Twarek, B., & Yadav, A. (2020). Looking Ahead: Professional Development Needs for Experienced CS Teachers. *Proceed-*

ings of the 51st ACM Technical Symposium on Computer Science Education, 1118–1119. https://doi.org/10.1145/3328778.3366977

Kalina, C., & Powell, K. (2009). Cognitive and Social Constructivism: Developing Tools for an Effective Classroom. *Education*, *130*(2), 241–250.

Kalyaniwala, C., & Ciekanski, M. (2021). Autonomy CALLing: A systematic review of 22 years of publications in learner autonomy and CALL. *25*(3), 106–131. http://hdl.handle.net/10125/73452

Katterfeldt, E.-S., Cukurova, M., Spikol, D., & Cuartielles, D. (2018). Physical computing with plug-and-play toolkits: Key recommendations for collaborative learning implementations. *International Journal of Child-Computer Interaction*, *17*, 72–82. https://doi.org/10.1016/j.ijcci.2018.03.002

Kawulich, B. B. (2005). Participant Observation as a Data Collection Method. *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, *6*(2). https://doi.org/10.17169/fqs-6.2.466

Keenan, J. (1999). A concept analysis of autonomy. *Journal of Advanced Nursing*, *29*(3), 556–562. https://doi.org/10.1046/j.1365-2648.1999.00948.x

Keiler, L. (2018). Teachers' roles and identities in student-centered classrooms. *International Journal of STEM Education*, *5*(1), 34. https://doi.org/10.1186/s40594-018-0131-6

Kennedy, B., & Thornburg, R. (2018). Deduction, Induction, and Abduction. In U. Flick (Ed.), *The SAGE Handbook of Qualitative Data Collection* (pp. 49–64). SAGE Publications Ltd.

Kennedy, J. (2011). Coding for Our Lives. https://www.siliconrepublic.com/discovery/coding-for-our-lives

Kiilakoski, T., & Kivijärvi, A. (2015). Youth clubs as spaces of non-formal learning: professional idealism meets the spatiality experienced by young people in Finland. *Studies in Continuing Education*, *37*(1), 47–61. https://doi.org/10.1080/0158037X.2014.967345

Kim, B. (2001). Social Constructivism. In M. Orey (Ed.), *Emerging Perspectives on Learning, Teaching and Technology*.

Kim, M. S., & Keyhani, N. (2019). Understanding STEM teacher learning in an informal setting: a case study of a novice STEM teacher. *Research and Practice in Technology Enhanced Learning*, *14*(1), 1–16. https://doi.org/10.1186/s41039-019-0103-6

King, A. (1993). From Sage on the Stage to Guide on the Side. *College Teaching*, *41*(1), 30–35. https://doi.org/10.1080/87567555.1993.9926781

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving schools*, *19*(3), 267–277. https://doi.org/10.1177/1365480216659733

Körber, N., Bailey, L., Greifenstein, L., Fraser, G., Sabitzer, B., & Rottenhofer, M. (2021). An Experience of Introducing Primary School Children to Programming Using Ozobots (Practical Report). *The 16th Workshop in Primary and Secondary Computing Education (WiPSCE '21)*. https://doi.org/10.1145/3481312.3481347

Kulavuz-Onal, D. (2011). Voicing the Less Heard: A Review of Focus Group Methodology: Principles and Practice. *Qualitative Report*, *16*(6), 1743–1748. https://doi.org/10.46743/2160-3715/2011.1326

Kumar, R. (2019). *Research Methodology: A Step-by-Step Guide for Beginners*. SAGE.

Kumaravadivelu, B. (2006). *Understanding Language Teaching: From Method to Postmethod*. Routledge. https://doi.org/10.4324/9781410615725

La Belle, T. (1982). Formal, nonformal and informal education: A holistic perspective on lifelong learning. *International Review of Education*, *28*(2), 159–175. https://doi.org/10.1007/BF00598444

LaForce, M., Noble, E., & Blackwell, C. (2017). Problem-Based Learning (PBL) and Student Interest in STEM Careers: The Roles of Motivation and Ability Beliefs. *Education Sciences*, *7*(4). https://doi.org/10.3390/educsci7040092

Lave, J., & Wenger, E. (1999). Learning and Pedagogy in Communities of Practice. In J. Leach & B. Moon (Eds.), *Learners and Pedagogy* (pp. 21–33).

Lawlor, G., Byrne, P., & Tangney, B. (2020). "CodePlus"-Measuring Short-Term Efficacy in a Non-Formal, All-Female CS Outreach Programme. *ACM Transactions on Computing Education*, *20*(4), 1–18. https://doi.org/10.1145/3411510

Lawlor, J., Conneely, C., Oldham, E., Marshall, K., & Tangney, B. (2018). Bridge21: Teamwork, technology and learning. a pragmatic model for effective twenty-first-century team-based learning. *Technology, Pedagogy and Education*, *27*(2), 211–232. https://doi.org/10.1080/1475939X.2017.1405066

Leat, D., & Lin, M. (2003). Developing a Pedagogy of Metacognition and Transfer: Some signposts for the generation and use of knowledge and the creation of research partnerships. *British Educational Research Journal*, *29*(3), 383–414. https://doi.org/10.1080/01411920301853

Lee, E. A. L., Black, M. H., Falkmer, M., Tan, T., Sheehy, L., Bölte, S., & Girdler, S. (2020). "We Can See a Bright Future": Parents' Perceptions of the Outcomes of Participating in a Strengths-Based Program for Adolescents with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, *50*(9), 3179–3194. https://doi.org/10.1007/s10803-020-04411-9

Lenjani, I. (2016). Constructivism and behaviorism methodologies on special needs education. *European Journal of Special Education Research*.

Leung, L. (2015). Validity, reliability, and generalizability in qualitative research. *Journal of Family Medicine and Primary Care*, *4*(3), 324–327. https://doi.org/10.4103/2249-4863.161306

Li, L. C., Grimshaw, J. M., Nielsen, C., Judd, M., Coyte, P. C., & Graham, I. D. (2009). Evolution of Wenger's concept of community of practice. *Implementation Science*, *4*(11), 1–8. https://doi.org/10.1186/1748-5908-4-11

Lian, E., Lin, J., & Zhang, J. (2022). Exploring the influence of favorite projects on programming skill improvement: Analyzing the longitudinal dataset of 5 years

of public activity on scratch social media. *Educational technology research and development*, 1–18. https://doi.org/10.1007/s11423-022-10157-1

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiries*. SAGE Publications Inc.

Lingard, R., & Barkataki, S. (2011). Teaching teamwork in engineering and computer science. *2011 Proceedings of the Frontiers in Education Conference (FIE)*, F1C-1–F1C-5. https://doi.org/10.1109/FIE.2011.6143000

Little, D. (1991). *Learner Autonomy: Definitions, Issues and Problems*. Authentik.

Littlewood, W. (1999). Defining and developing autonomy in East Asian contexts. *Applied Linguistics*, *20*(1), 71–94. https://doi.org/10.1093/applin/20.1.71

Lodico, M. G., Spaulding, D. T., & Voegtle, K. H. (2010). *Methods in Educational Research: From Theory to Practice*. John Wiley & Sons.

Lofland, J., Snow, D., Anderson, L., & Lofland, L. H. (2022). *Analyzing Social Settings: A Guide to Qualitative Observation and Analysis* (4th ed.). Waveland Press.

Long, J. (2007). Just For Fun: Using Programming Games in Software Programming Training and Education. *Journal of Information Technology Education*, *6*(1), 279–290. https://doi.org/10.28945/216

Lotto, L. S. (1986). Qualitative Data Analysis: A Sourcebook of New Methods. *Educational Evaluation and Policy Analysis*, *8*(3), 329–331. https://doi.org/10.3102/01623737008003329

Lunn, S., Marques Samary, M., & Peterfreund, A. (2021). Where is Computer Science Education Research Happening? *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education (SIGCSE '21)*, 288–294. https://doi.org/10.1145/3408877.3432375

Luo, F., Antonenko, P., & Davis, C. (2020). Exploring the evolution of two girls' conceptions and practices in computational thinking in science. *Computers & Education*, *146*, 103759. https://doi.org/10.1016/j.compedu.2019.103759

Lynch, B. K. (1996). *Language Program Evaluation: Theory and Practice* (1st ed.). Cambridge University Press.

MacSuga-Gage, A. S., Simonsen, B., & Briere, D. E. (2012). Effective teaching practices: Effective teaching practices that promote a positive classroom environment. *Beyond Behavior*, *22*(1), 14–22.

Madjar, N., & Cohen-Malayev, M. (2013). Youth movements as educational settings promoting personal development: Comparing motivation and identity formation in formal and non-formal education contexts. *International Journal of Educational Research*, *62*, 162–174. https://doi.org/10.1016/j.ijer.2013.09.002

Maguire, P., & Power, J. (2015). Ireland needs to switch on or be left behind in computer science. https://www.irishtimes.com/news/education/ireland-needs-to-switch-on-or-be-left-behind-in-computer-science-1.2067421

Malmi, L., Sheard, J., Bednarik, R., Helminen, J., Kinnunen, P., Korhonen, A., Myller, N., Sorva, J., & Taherkhani, A. (2014). Theoretical underpinnings of computing education research: What is the evidence? *Proceedings of the Tenth Annual Conference on International Computing Education Research (ICER '14)*, 27–34. https://doi.org/10.1145/2632320.2632358

Mardell, B., Wilson, D., Ryan, J., Ertel, K., Krechevsky, M., & Baker, M. (2016). Towards a Pedagogy of Play. http://pz.harvard.edu/resources/towards-a-pedagogy-of-play

Marshall, C., & Rossman, G. (2016). *Designing Qualitative Research* (6th ed.). SAGE.

Martin, L. M. (2004). An emerging research framework for studying informal learning and schools. *Science Education*, *88*(S1), S71–S82. https://doi.org/10.1002/sce.20020

Martín-Páez, T., Aguilera, D., Perales-Palacios, F. J., & Vílchez-González, J. M. (2019). What are we talking about when we talk about STEM education? A review of literature. *Science Education*, *103*(4), 799–822. https://doi.org/10.1002/sce.21522

Mason, S. (2020). Collaborative Learning in Computing Education: Faculty Perspectives and Practices. *Proceedings of the 2020 ACM Conference on International*

Computing Education Research, 136–146. https://doi.org/10.1145/3372782.3406254

Masouleh, N. S., & Jooneghani, R. B. (2012). Autonomous learning: A teacher-less learning! *Procedia - Social and Behavioral Sciences*, *55*, 835–842. https://doi.org/10.1016/j.sbspro.2012.09.570

Maxwell, J. A. (2013). *Qualitative Research Design: An Interactive Approach* (3rd ed.). SAGE Publications.

McCombs, B. L. (2008). From One-Size-Fits-All to Personalized Learner-Centered Learning: The Evidence. *The Duffy Reports*, *13*(2), 1–12.

McCombs, B. L., & Whisler, J. S. (1997). *The Learner-Centered Classroom and School: Strategies for Increasing Student Motivation and Achievement* (1st ed.). Jossey-Bass.

McGarr, O., & Johnston, K. (2020). Curricular responses to Computer Science provision in schools: current provision and alternative possibilities. *The Curriculum Journal*, *31*(4), 745–756. https://doi.org/10.1002/curj.40

McInerney, C., & Margaria, T. (2015). Software as a High-Tech Weapon in Ireland's Strategy. *Proceedings of the 39th Annual Computer Software and Applications Conference*, *3*, 658–663. https://doi.org/10.1109/COMPSAC.2015.137

McKelvey, N. (2017). *An Exploration of Children's Experience at CoderDojo in Ireland: An Activity Theory Perspective* [Doctoral dissertation, Queen's University Belfast].

McKelvey, N., & Cowan, P. (2017a). An Investigation into Tenacity Levels at CoderDojos1. *International Journal of Innovation in the Digital Economy*, *8*(3), 35–48. https://doi.org/10.4018/IJIDE.2017070103

McKelvey, N., & Cowan, P. (2017b). Valence at CoderDojos: An Exploration. *Literacy Information and Computer Education Journal (LICEJ)*, *8*, 2525–2533. https://doi.org/10.20533/licej.2040.2589.2017.0335

McKelvey, N., & Cowan, P. (2018). Challenging the Orthodoxies: A CoderDojo Perspective. *Proceedings of the Ireland International Conference on Education*, 103–

110. https://pureadmin.qub.ac.uk/ws/portalfiles/portal/156330585/IICE_2018_Paper_Submission_FINAL.pdf

Mercer, S. (2012). The Complexity of Learner Agency. *Journal of Applied Language Studies*, *6*(2), 41–59. https://jyx.jyu.fi/handle/123456789/40858

Merriam, S. B., & Tisdell, E. J. (2015). *Qualitative Research: A Guide to Design and Implementation* (4th ed.). John Wiley & Sons.

Mills, A., Durepos, G., & Wiebe, E. (2010). *Encyclopedia of Case Study Research*. SAGE Publications Inc.

Mingers, J. (1992). Criticizing the Phenomenological Critique-Autopoiesis and Critical Realism. *Systems Practice*, *5*(2), 173–180. https://doi.org/10.1007/BF01059939

Mishra, P., & Henriksen, D. (2018). *Creativity, Technology & Education: Exploring their Convergence*. Springer. https://doi.org/10.1007/978-3-319-70275-9

Mohr-Schroeder, M. J., Jackson, C., Miller, M., Walcott, B., Little, D. L., Speler, L., Schooler, W., & Schroeder, D. C. (2014). Developing Middle School Students' Interests in STEM via Summer Learning Experiences: See Blue STEM Camp. *School Science and Mathematics*, *114*(6), 291–301. https://doi.org/10.1111/ssm.12079

Molly, M. (2011). Irish schoolboy tells Dublin web summit about first hacking of iPod Nano. https://www.irishcentral.com/news/irish-schoolboy-tells-dublin-web-summit-about-first-hacking-of-ipod-nano-117729048-237374631

Morgan, T., Morgan, P., & O'Kelly, B. (2008). *Youth Work in Schools: an Investigation of Youth Work, as a Process of Informal Learning, in Formal Settings*. Department of Education, Northern Ireland. https://dera.ioe.ac.uk/7821/7/no_48-3_Redacted.pdf

Moynihan, M. D. (1986). *Computer Education: Ireland: a Case Study* [Doctoral dissertation, Loughborough University]. https://repository.lboro.ac.uk/articles/thesis/Computer_education_Ireland_a_case_study/9384668

Mufti, E., & Peace, M. (2012). *Teaching and Learning and the Curriculum: A Critical Introduction*. Continuum International Publishing.

Mulisa, F. (2022). When Does a Researcher Choose a Quantitative, Qualitative, or Mixed Research Approach? *Interchange*, *53*(1), 113–131. https://doi.org/10.1007/s10780-021-09447-z

Murphy, L. (2011). Autonomy and Context: A Tale of Two Learners. In D. Gardner (Ed.), *Fostering Autonomy in Language Learning* (pp. 17–26). Zirve University.

Murphy, S. (2018). The History of Computer Science in Irish Education. https://educationmatters.ie/the-history-of-computer-science-in-irish-education/

Musaeus, L. H., & Musaeus, P. (2019). Computational Thinking in the Danish High School: Learning Coding, Modeling, and Content Knowledge with NetLogo. *Proceedings of the 50th ACM Technical Symposium on Computer Science Education*, 913–919. https://doi.org/10.1145/3287324.3287452

Myers, M. (1999). Investigating Information Systems with Ethnographic Research. *Communications of the Association for Information Systems*, *2*(1), 23. https://doi.org/10.17705/1CAIS.00223

Nandi, A., & Mandernach, M. (2016). Hackathons as an Informal Learning Platform, 346–351. https://doi.org/10.1145/2839509.2844590

National Research Council. (2000). *Being Fluent with Information Technology*. The National Academies Press. https://doi.org/10.17226/6482

National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. The National Academies Press. https://doi.org/10.17226/13165

NCCA. (2018a). Computer Science Curriculum Specification - Leaving Certificate Ordinary and Higher Level. https://ncca.ie/media/3369/computer-science-final-specification.pdf

NCCA. (2018b). LCCS 2018 Information - Leaving Certificate Computer Science. https://ncca.ie/media/3261/lccs-information-brochure.pdf

NCCA. (2019). Primary Developments: Final Report on the Coding in Primary Schools Initiative. https://ncca.ie/media/4155/primary-coding_final-report-on-the-coding-in-primary-schools-initiative.pdf

NCCA. (2020). Draft Primary Curriculum Framework. https://ncca.ie/media/4456/ncca-primary-curriculum-framework-2020.pdf

NCCA. (2022). Report on the Consultation on the Draft Primary Curriculum Framework. https://ncca.ie/media/5902/consultation-on-the-draft-primary-curriculum-framework_december-2022.pdf

Nouri, J., Zhang, L., Mannila, L., & Norén, E. (2020). Development of computational thinking, digital competence and 21st century skills when learning programming in K-9. *Education Inquiry*, *11*(1), 1–17. https://doi.org/10.1080/20004508.2019.1627844

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic Analysis: Striving to Meet the Trustworthiness Criteria. *International Journal of Qualitative Methods*, *16*(1). https://doi.org/10.1177/1609406917733847

O'Briain, D. (2014). Protecting the Future of ICT-is Ireland being Left Behind? https://www.engineersireland.ie/Engineers-Journal/Technology/protecting-the-future-of-ict-is-ireland-being-left-behind

OECD. (2013). Innovative Learning Environments. https://www.oecd.org/education/ceri/innovativelearningenvironments.htm

O'Keeffe, M., Hogan, T., & Delaney, K. (2019). Revisiting and Rethinking the Structural Elements of Communities of Practice. *Proceedings of 17th European Conference on Computer-Supported Cooperative Work*, *3*(1). https://doi.org/10.18420/ecscw2019_ep11

Okudan, G. E., & Rzasa, S. E. (2006). A project-based approach to entrepreneurial leadership education. *Technovation*, *26*(2), 195–210.

Oldham, E. (2015). Setting the Context: Developments in the Republic of Ireland to Schools IT 2000. In E. Oldham, D. Butler, K. Marshall, & L. Margaret (Eds.), *Shaping the Future: How Technology Can Lead to Educational Transformation* (pp. 19–45). The Liffey Press.

Opper, I. M. (2019). *Teachers Matter: Understanding Teachers' Impact on Student Achievement*. RAND Corporation. https://doi.org/10.7249/RR4312

Ormston, R., Spencer, L., Barnard, M., & Snape, D. (2014). The Foundations of Qualitative Research. In J. Ritchie, J. Lewis, C. M. Nicholls, & R. Ormston (Eds.), *Qualitative Research Practice: A Guide for Social Science Students and Researchers* (2nd ed., pp. 1–26). SAGE Publications.

Packer, J. (2006). Learning for Fun: The Unique Contribution of Educational Leisure Experiences. *Curator: The Museum Journal*, *49*(3), 329–344. https://doi.org/10.1111/j.2151-6952.2006.tb00227.x

Papert, S. (1980). *Mindstorms: Children, Computers, And Powerful Ideas*. Harvester.

Parsons, S. A., Vaughn, M., Scales, R. Q., Gallagher, M. A., Parsons, A. W., Davis, S. G., Pierczynski, M., & Allen, M. (2018). Teachers' Instructional Adaptations: A Research Synthesis. *Review of Educational Research*, *88*(2), 205–242. https://doi.org/10.3102/0034654317743198

Patston, T. J., Kaufman, J. C., Cropley, A. J., & Marrone, R. (2021). What Is Creativity in Education? A Qualitative Study of International Curricula. *Journal of Advanced Academics*, *32*(2), 207–230. https://doi.org/10.1177/1932202X20978356

Patton, M. Q. (2002). *Qualitative Research & Evaluation Methods* (3rd ed.). SAGE Publications.

Paulus, P. B., & Dzindolet, M. (2008). Social influence, creativity and innovation. *Social Influence*, *3*(4), 228–247. https://doi.org/10.1080/15534510802341082

Pea, R., & Kurland, M. (1984). On the cognitive prerequisites of learning computer programming. *New Ideas in Psychology*, *2*(2), 137–168. https://doi.org/10.1016/0732-118X(84)90018-7

Pereles, L., Lockyer, J., & Fidler, H. (2005). Permanent small groups: Group dynamics, learning, and change. *Journal of Continuing Education in the Health Professions*, *22*(4), 205–213. https://doi.org/10.1002/chp.1340220404

Piaget, J. (1950). *The Psychology of Intelligence*. Routledge & Paul.

Piaget, J. (1974). *The Child and Reality: Problems of Genetic Psychology. (Trans. Arnold Rosin)*. Muller.

Pierce, V., Cheesebrow, D., & Braun, L. M. (2000). Facilitator competencies. *Group Facilitation*, (2), 24. https://www.proquest.com/scholarly-journals/facilitator-competencies/docview/205837525/se-2

Plucker, J. A., Beghetto, R. A., & Dow, G. T. (2004). Why Isn't Creativity More Important to Educational Psychologists? Potentials, Pitfalls, and Future Directions in Creativity Research. *Educational Psychologist*, *39*(2), 83–96. https://doi.org/10.1207/s15326985ep3902_1

Poggenpoel, M., & Myburgh, C. (2003). The Researcher as Research Instrument in Educational Research: A Possible Threat to Trustworthiness? *Education*, *124*(2), 418–423.

Ponton, M., & Rhea, N. (2006). Autonomous Learning from a Social Cognitive Perspective. *New Horizons in Adult Education and Human Resource Development*, *20*(2), 38–49. https://doi.org/10.1002/NHA3.10250

Quigley, C. (2017). Working Towards a Better Gender Balance in CoderDojo Scotland Clubs. https://coderdojoscotland.com/reports/scotgov-gender-balance-2017/Gender-Balance-Analysis-V1.0-Final.pdf

Quille, K., & Bergin, S. (2019). CS1: how will they do? How can we help? A decade of research and practice. *Computer Science Education*, *29*(2-3), 254–282. https://doi.org/10.1080/08993408.2019.1612679

Randolph, J. (2007). *Computer Science Education Research at the Crossroads: a Methodological Review of Computer Science Education Research: 2000–2005* [Doctoral dissertation, Utah State University].

Reigeluth, C. M., Beatty, B. J., & Myers, R. D. (2017). *Instructional-Design Theories and Models: The Learner-Centered Paradigm of Education* (1st ed.). Routledge. https://doi.org/10.4324/9781315795478

Reigeluth, C. M., & Garfinkle, R. J. (1992). Envisioning a New System of Education. *Educational Technology*, *32*(11), 17–23. http://www.jstor.org/stable/44425486

Resnick, M. (2002). *Rethinking Learning in the Digital Age* (tech. rep.). Massachusetts Institute of Technology. https://www.media.mit.edu/~mres/papers/wef.pdf

Resnick, M., & Robinson, K. (2017). *Lifelong Kindergarten: Cultivating Creativity Through Projects, Passion, Peers, and Play*. MIT Press.

Ridgway, J., & Passey, D. (1991). A constructivist approach to educational computing. *Australian Educational Computing*, *6*(2), 4–9. https://search.informit.org/doi/10.3316/aeipt.86018

Roberts, T., Jackson, C., Mohr-Schroeder, M., Bush, S., Maiorca, C., Cavalcanti, M., Schroeder, D. C., Delaney, A., Putnam, L., & Cremeans, C. (2018). Students' Perceptions of STEM Learning After Participating in a Summer Informal Learning Experience. *International Journal of STEM Education*, *5*(1), 1–14. https://doi.org/10.1186/s40594-018-0133-4

Robins, A., Rountree, J., & Rountree, N. (2003). Learning and Teaching Programming: A Review and Discussion. *Computer Science Education*, *13*(2), 137–172. https://doi.org/10.1076/csed.13.2.137.14200

Robinson, K. (2010). Changing Education Paradigms. https://www.ted.com/talks/sir_ken_robinson_changing_education_paradigms

Robson, C. (2002). *Real World Research: A Resource for Social Scientists and Practitioner-researchers*. John Wiley & Sons.

Rogers, A. (2005). *Non-formal Education: Flexible Schooling or Participatory Education?* Springer Science & Business Media. https://doi.org/10.1007/0-387-28693-4

Romi, S., & Schmida, M. (2009). Non-formal education: A major educational force in the postmodern era. *Cambridge Journal of Education*, *39*(2), 257–273. https://doi.org/10.1080/03057640902904472

Sáez-López, J.-M., Román-González, M., & Vázquez-Cano, E. (2016). Visual programming languages integrated across the curriculum in elementary school: A two year case study using "Scratch" in five schools. *Computers & Education*, *97*, 129–141. https://doi.org/10.1016/j.compedu.2016.03.003

Saks, K., & Leijen, Ä. (2014). Distinguishing Self-directed and Self-regulated Learning and Measuring them in the E-learning Context. *Procedia - Social and Behavioral Sciences*, *112*, 190–198. https://doi.org/10.1016/j.sbspro.2014.01.1155

Saldaña, J. (2016). *The Coding Manual for Qualitative Researchers* (3rd ed.). SAGE Publications Ltd.

Savage, J. (2000). Participative Observation: Standing in the Shoes of Others? *Qualitative Health Research*, *10*(3), 324–339. https://doi.org/10.1177/104973200129118471

Scarbrough, H., Bresnen, M., Edelman, L. F., Laurent, S., Newell, S., & Swan, J. (2004). The Processes of Project-based Learning: An Exploratory Study. *Management learning*, *35*(4), 491–506. https://doi.org/10.1177/1350507604048275

Schensul, S. L., Schensul, J. J., & LeCompte, M. D. (1999). *Essential Ethnographic Methods: Observations, Interviews, and Questionnaires*. AltaMira Press.

Scherer, R., Siddiq, F., & Viveros, B. S. (2020). A meta-analysis of teaching and learning computer programming: Effective instructional approaches and conditions. *Computers in Human Behavior*, *109*, 106349. https://doi.org/10.1016/j.chb.2020.106349

Scheurs, J., & Dumbraveanu, R. (2014). A shift from teacher centered to learner centered approach. *International Journal of Engineering Pedagogy (iJEP)*, *4*(3), 31–37.

Schmuck, R. A. (2006). *Practical Action Research for Change* (2nd ed.). Corwin Press.

Scott, C. L. (2015). The Futures of Learning 3: What Kind of Pedagogies for the 21st Century? http://repositorio.minedu.gob.pe/handle/20.500.12799/3747

Scott, J., & Marshall, G. (1998). *A Dictionary of Sociology* (3rd ed.). Oxford University Press.

Semrád, J., & Škrabal, M. (2017). The Influence of the Social Environment on the Creative Activities of Secondary School Students. *Littera Scripta*, *10*(1), 117–130.

Sentance, S., & Csizmadia, A. (2017). Professional Recognition Matters: Certification for In-service Computer Science Teachers. *Proceedings of the 2017 ACM SIGCSE Technical Symposium on Computer Science Education*, 537–542. https://doi.org/10.1145/3017680.3017752

Sentance, S., Waite, J., & Kallia, M. (2019). Teaching computer programming with PRIMM: a sociocultural perspective. *Computer Science Education*, *29*(2-3), 136–176. https://doi.org/10.1080/08993408.2019.1608781

Sheridan, I., Goggin, D., & O'Sullivan, L. (2016). Exploration of Learning Gained Through CoderDojo Coding Activities. *Proceedings of the 10th International Technology, Education and Development Conference*, 6541–6548. https://doi.org/10.21125/inted.2016.0545

Silver, C., & Lewins, A. (2014). *Using Software in Qualitative Research: A Step-by-Step Guide*. SAGE Publications Inc.

Silverman, D. (2019). *Interpreting Qualitative Data* (6th ed.). SAGE Publications Inc.

Sim, G., MacFarlane, S., & Read, J. (2006). All work and no play: Measuring fun, usability, and learning in software for children. *Computers & Education*, *46*(3), 235–248. https://doi.org/10.1016/j.compedu.2005.11.021

Sırakaya, M., & Alsancak Sırakaya, D. (2022). Augmented reality in STEM education: a systematic review. *Interactive Learning Environments*, *30*(8), 1556–1569. https://doi.org/10.1080/10494820.2020.1722713

Slack, F., & Rowley, J. (2001). Observation: Perspectives on research methodologies for leisure managers. *Management Research News*, *24*(1), 35–42. https://doi.org/10.1108/01409170010781984

Steele, M. M. (2005). Teaching Students with Learning Disabilities: Constructivism or Behaviorism? *Current Issues in Education*, *8*(10).

Stephan, M. (2020). Teacher-Centered Teaching in Mathematics Education. In S. Lerman (Ed.), *Encyclopedia of Mathematics Education* (pp. 836–840). Springer International Publishing. https://doi.org/10.1007/978-3-030-15789-0_150

Sternberg, R. J., & Kaufman, J. C. (2010). Constraints on Creativity: Obvious and Not So Obvious. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge Handbook of Creativity* (pp. 467–482). Cambridge University Press. https://doi.org/10.1017/CBO9780511763205.029

Strømsø, H. I., & Bråten, I. (2011). Personal Epistemology in Higher Education. In J. Brownlee, G. Schraw, & D. Berthelsen (Eds.), *Personal Epistemology and Teacher Education* (pp. 52–58). Routledge. https://doi.org/10.4324/9780203806616

Strong, G., Higgins, C., Bresnihan, N., & Millwood, R. (2017). A Survey of the Prior Programming Experience of Undergraduate Computing and Engineering Students in Ireland. In A. Tatnall & M. Webb (Eds.), *Tomorrow's Learning: Involving Everyone. Learning with and about Technologies and Computing* (pp. 473–483). Springer International Publishing. https://doi.org/10.1007/978-3-319-74310-3_48

Szymkowiak, A., Melović, B., Dabić, M., Jeganathan, K., & Kundi, G. S. (2021). Information technology and Gen Z: The role of teachers, the internet, and technology in the education of young people. *Technology in Society*, *65*, 101565. https://doi.org/10.1016/j.techsoc.2021.101565

Tan, J. P.-L., Choo, S. S., Kang, T., & Liem, G. A. D. (2017). Educating for twenty-first century competencies and future-ready learners: research perspectives from Singapore. *Asia Pacific Journal of Education*, *37*(4), 425–436. https://doi.org/10.1080/02188791.2017.1405475

Taylor, E. W. (2006). Making Meaning of Local Nonformal Education: Practitioner's Perspective. *Adult Education Quarterly*, *56*(4), 291–307. https://doi.org/10.1177/0741713606289122

Taylor, G. W., & Ussher, J. M. (2001). Making Sense of S&M: A Discourse Analytic Account. *Sexualities*, *4*(3), 293–314. https://doi.org/10.1177/136346001004003002

Terrazas-Marín, R. A. (2018). Developing non-formal education competences as a complement of formal education for STEM lecturers. *Journal of Education for Teaching*, *44*(1), 118–123. https://doi.org/10.1080/02607476.2018.1422613

Thabane, L., Ma, J., Chu, R., Cheng, J., Ismaila, A., Rios, L. P., Robson, R., Thabane, M., Giangregorio, L., & Goldsmith, C. H. (2010). A tutorial on pilot studies: The what, why and how. *BMC Medical Research Methodology*, *10*(1). https://doi.org/https://doi.org/10.1186/1471-2288-10-1

Tisza, G., & Markopoulos, P. (2023). FunQ: Measuring the fun experience of a learning activity with adolescents. *Current Psychology*, *42*, 1936–1956. https://doi.org/10.1007/s12144-021-01484-2

Tisza, G., Papavlasopoulou, S., Christidou, D., Iivari, N., Kinnula, M., & Voulgari, I. (2020). Patterns in informal and non-formal science learning activities for children–A Europe-wide survey study. *International Journal of Child-Computer Interaction*, *25*, 100184. https://doi.org/10.1016/j.ijcci.2020.100184

Tisza, G., Papavlasopoulou, S., Christidou, D., Voulgari, I., Iivari, N., Giannakos, M. G., Kinnula, M., & Markopoulos, P. (2019). The role of age and gender on implementing informal and non-formal science learning activities for children. *Proceedings of the FabLearn Europe Conference*, 1–9. https://doi.org/10.1145/3335055.3335065

Tisza, G., Sharma, K., Papavlasopoulou, S., Markopoulos, P., & Giannakos, M. (2022). Understanding Fun in Learning to Code: A Multi-Modal Data Approach. *Interaction Design and Children*, 274–287. https://doi.org/10.1145/3501712.3529716

Topalli, D., & Cagiltay, N. E. (2018). Improving programming skills in engineering education through problem-based game projects with Scratch. *Computers & Education*, *120*, 64–74. https://doi.org/10.1016/j.compedu.2018.01.011

UCD Teaching and Learning. (2020). Education theory: Constructivism and social constructivism. https://www.ucd.ie/t4cms/ucdtlt0019.pdf

UNESCO. (2000). The Dakar Framework for Action: Education for All: meeting our collective commitments. https://unesdoc.unesco.org/ark:/48223/pf0000121147

Vaismoradi, M., Turunen, H., & Bondas, T. (2013). Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nursing & Health Sciences*, *15*(3), 398–405. https://doi.org/10.1111/nhs.12048

Vallory, E. (2012). *World Scouting: Educating for Global Citizenship*. Palgrave Macmillan. https://doi.org/10.1057/9781137012067

Vannini, W., & Ferri, M. (2015). Code Is Poetry, But Poets Starve: First Steps Along The Way Of The Coder. https://www.academia.edu/29073508/Code_Is_Poetry_But_Poets_Starve_First_Steps_Along_The_Way_Of_The_Coder

Vee, A. (2013). Understanding Computer Programming as a Literacy. *Literacy in Composition Studies*, *1*(2), 42–64. https://doi.org/10.21623/1.1.2.4

Verger, A., Fontdevila, C., & Parcerisa, L. (2019). Reforming governance through policy instruments: How and to what extent standards, tests and accountability in education spread worldwide. *Discourse: Studies in the Cultural Politics of Education*, *40*(2), 248–270. https://doi.org/10.1080/01596306.2019.1569882

Vivian, R., Falkner, K., & Szabo, C. (2014). Can everybody learn to code? computer science community perceptions about learning the fundamentals of programming. *Proceedings of the 14th Koli Calling International Conference on Computing Education Research*, 41–50. https://doi.org/10.1145/2674683.2674695

Voskamp, A., Kuiper, E., & Volman, M. (2020). Teaching practices for self-directed and self-regulated learning: case studies in Dutch innovative secondary schools. *Educational Studies*, *48*(6), 772–789. https://doi.org/10.1080/03055698.2020.1814699

Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Harvard University Press.

Wagner, T. (2012). *Creating Innovators: The Making of Young People Who Will Change the World*. Simon; Schuster.

Wagner, T. (2014). *The Global Achievement Gap*. Basic Books.

Wang, L. (2007). Sociocultural Learning Theories and Information Literacy Teaching Activities in Higher Education. *Reference & User Services Quarterly*, *47*(2), 149–158. http://www.jstor.org/stable/20864842

Ward, M. (2016). CoderDojo and Libraries: Why Your Library Should Get Involved and How to Start Your Own. http://hdl.handle.net/2262/79709

Warner, J., & Guo, P. (2017). Hack.Edu: Examining How College Hackathons Are Perceived By Student Attendees and Non-Attendees. *Proceedings of the 2017 ACM Conference on International Computing Education Research*, 254–262. https://doi.org/10.1145/3105726.3106174

Wei, X., Lin, L., Meng, N., Tan, W., & Kong, S.-C. (2021). The effectiveness of partial pair programming on elementary school students' Computational Thinking skills and self-efficacy. *Computers & Education*, *160*, 104023. https://doi.org/10.1016/j.compedu.2020.104023

Weimer, M. (2013). *Learner-Centered Teaching: Five Key Changes to Practice* (2nd ed.). John Wiley & Sons.

Wenger, E. (1999). *Communities of Practice: Learning, Meaning, and Identity*. Cambridge University Press.

Werquin, P. (2010). *Recognising Non-Formal and Informal Learning: Outcomes, Policies and Practices*. OECD Publishing. https://doi.org/10.1787/9789264063853-en

Willems, J. (2015). Individual perceptions on the participant and societal functionality of non-formal education for youth: Explaining differences across countries based on the human development index. *International Journal of Educational Development*, *44*, 11–20. https://doi.org/10.1016/j.ijedudev.2015.07.003

William, G. (1998). *Choice Theory: A New Psychology Of Personal Freedom*. Harper; Row.

Wood, D., Bruner, J. S., & Ross, G. (1976). The Role of Tutoring in Problem Solving. *Journal of Child Psychology and Psychiatry*, *17*(2), 89–100. https://doi.org/10.1111/j.1469-7610.1976.tb00381.x

Wyffels, F., Martens, B., & Lemmens, S. (2014). Starting from scratch: experimenting with computer science in Flemish secondary education. *Proceedings of the 9th Workshop in Primary and Secondary Computing Education*, 12–15. https://doi.org/10.1145/2670757.2670763

Yan, S. (2012). Teachers' Roles in Autonomous Learning. *Journal of Sociological Research*, *3*(2), 557–562. https://doi.org/10.5296/jsr.v3i2.2860

Yin, R. K. (2009). *Case Study Research: Design and Methods* (4th ed.). SAGE Publications.

Yin, R. K. (2017). *Case Study Research: Design and Methods* (5th ed.). SAGE Publications.

Yurdakul, C. (2017). An Investigation of the Relationship between Autonomous Learning and Lifelong Learning. *International Journal of Educational Research Review*, *2*(1), 15–20. https://doi.org/10.24331/ijere.309968

Zendler, A. (2018). Instructional methods in computing education judged by computer science teachers and educational experts. *it - Information Technology*, *60*(2), 79–90. https://doi.org/10.1515/itit-2017-0015

Zualkernan, I. A., Allert, J., & Qadah, G. Z. (2006). Learning Styles of Computer Programming Students: A Middle Eastern and American Comparison. *IEEE Transactions on Education*, *49*(4), 443–450. https://doi.org/10.1109/TE.2006.882366

Appendices

Appendix A Online Form

Page 1

Survey of CoderDojo Mentors' Mentoring Experience

Thank you for your interest in this research! This survey is to the first step into exploring CoderDojo mentors personal beliefs on teaching and learning based on their mentoring experience in Dojo(s) around Ireland. This study aims to understand CoderDojo mentors needs and the challenges facing them in order to find the appropriate solutions and make Dojos more contributing to the community.

Next stage of this study will include interviewing mentors to get an in-depth insight about their mentoring practice. I really appreciate your willingness to be part of these interviews.

This study is conducted by Abeer Alsheaibi https://abeersulaimancs.wixsite.com/website

You have to be over 18 to participate in this study. The survey is completely anonymous and should only take less than 10 minutes to complete.

Each question is optional. Feel free to omit a response to any question; however we would be grateful if all questions are responded to.

You can withdraw from the survey at any time.

Please do not identify yourself, your Dojo or any third parties in open text responses to the questionnaire, any such replies will be anonymised.

CONTACT
Abeer Alsheaibi <alsheaia@tcd.ie>
Trinity College Dublin
School of Computer Science and Statistics

CONSENT
• I have read, or had read to me, the information about this research and this consent form. I have had the opportunity to ask questions and all my questions have been answered to my satisfaction and I understand the description of the research that is being provided to me.
• I agree that any data I provide will be used for scientific purposes and I have no objection if this data is published in scientific publications in a way that does not reveal my identity.
• I understand that if I make illicit activities known, these will be reported to appropriate authorities.
• I freely and voluntarily agree to be part of this research study, though without prejudice to my legal and ethical rights.
• I understand that I may refuse to answer any question and that I may withdraw at any time without penalty.
• I understand that my participation is fully anonymous and that no personal details about me will be recorded.
• I understand that if I have a history of epilepsy then I agree to proceed at my own risk.
• I agree to Trinity College, University of Dublin storing and using the information I provide for this project.
* Required

*Required

Participation Consent

If you wish to participate in this survey, please give your consent here to participate

1. I have read, or had read to me, information about the project and know how information will be collected and stored. I understand that I can choose not to take part in this study at any time and for any reason I choose. *

Mark only one oval.

- ◯ Yes, I understand and would like to continue
- ◯ No, I would not like to continue

Before you start

You have to be over 18 and based in Ireland to participate in this survey

2. Are you over 18 and living in Ireland? *

Mark only one oval.

- ◯ Yes
- ◯ No

About you

Each question is optional. Feel free to omit a response to any question; however we would be
grateful if all questions are responded to.

3. Gender

Mark only one oval.

- ◯ Male
- ◯ Female

4. Age

Mark only one oval.

- ◯ 18-25
- ◯ 25-29
- ◯ 30-39
- ◯ 40-49
- ◯ 50-59
- ◯ 60+

5. Current job

_____

6. The highest level of education you have completed? (if other please specify)

Mark only one oval.

- ◯ Junior Certificate (or equivalent)
- ◯ Leaving Certificate (or equivalent)
- ◯ Bachelor Degree
- ◯ Masters Degree
- ◯ PhD Degree
- ◯ Other: _____

About You As a Mentor

Please tell us about yourself as a mentor

7. Do you mentor in Dojos regularly?

Mark only one oval.

- ◯ Yes
- ◯ No

8. What Dojo you mentor in?

_____

9. How long is your session?

_____

10. How many Ninjas (roughly) are in your class?

_____

11. How long have you been mentoring in CoderDojo?

Mark only one oval.

- ◯ This is my first year
- ◯ 1-2 years
- ◯ 3-5 years
- ◯ More than 6 years

12. Have you received any mentoring preparation/training before you join Dojo?

Mark only one oval.

- ◯ Yes
- ◯ No

13. Aside from CoderDojo, have you got experience of teaching in a formal educational context (e.g. teaching a class in school or college, delivering training sessions)?

Mark only one oval.

- ◯ Yes
- ◯ No *Skip to question 15*

Teaching Experience

Based on your previous answer; In this section we are interested in knowing more about your previous teaching experience

14. What was the nature of that experience?

Mentoring Experience

15. Aside from CoderDojo, have you got experience with mentoring in any informal/non-formal educational context?

Mark only one oval.

- ◯ Yes
- ◯ No *Skip to question 17*

Mentoring Experience

Based on your previous answer; In this section we are interested in knowing more about your previous mentoring experience

16. What was the nature of that experience?

Upcoming Interviews

I'm Abeer Alsheaibi, the researcher conducting this study and would really like to hear more about your experience as a CoderDojo mentor. Thus, if you are happy for me to contact you regarding upcoming interviews, could you enter your email address below, please?

Your participation in this study is completely voluntary and you may withdraw at any time without penalty. Don't hesitate to contact me at <alsheaia@tcd.ie> with any questions or concerns that you may have.

17. Email

Confirm Answers

18. If you are happy with your answers, please confirm your consent for them to be recorded. You may instead wish to exit without submitting your answers. *

Mark only one oval.

- ◯ I am content with my answers and wish them to be recorded.
- ◯ I am not happy with my answers and would like them to be disregarded.
  Skip to section 11 (Exit Without Completing)

Exit Without Completing

Your responses have not been recorded and you may exit without submitting by closing this window, however it would be appreciated if you would consider having your answers recorded. Thanks for your time.

Appendix B Interview Questions

Page 1

Interview Questions (First Session)

At the beginning of each interview, the researcher will introduce herself to the interviewee. Indicate it is confidential and will be anonymised. Ask permission to start recording. Then do the recording.

Interview main question:

What teaching practices do mentors employ when mentoring in Dojos?

Interview Guide for Semi-Structured Interviews

Themes	Questions
Background	• Tell me a little bit about yourself. • Why did you become a mentor? • Follow up on the survey questions.
Teaching beliefs	• What do you think mentoring is? • What are the characteristics of a good mentor?
Teaching practices	• Describe to me a regular Dojo class from start to end.
Session planning	• Do you usually plan your sessions ahead? ▪ If Yes, tell me how and why? ▪ If No, why not? • Where do you get your teaching content/materials from? • What learning outcomes do you expect of your teaching?
Teaching strategies	• Any strategies you follow to ensure the active participation of all ninjas in your Dojo? • Any strategies you follow to ensure the social development of your ninjas? • How do you handle Ninjas questions? • Do you give regular feedback on Ninja's performance?

Evaluation	• Any strategies you follow to evaluate your Ninjas learning?
End of session	• Do you ask your Ninjas to do any tasks/assignments at the end of session?
Finishing the interview session	• Based on our conversation, is there anything we have talked about, you want to go back to? • Is there anything else you think it would be useful for me to know or things I should be considering?

Interview Questions (Second Session)

At the beginning of each interview, the researcher will introduce herself to the interviewee. Indicate it is confidential and will be anonymised. Ask permission to start recording. Then do the recording.

Interview main question:

What teaching practices do mentors employ when mentoring in Dojos?

Interview Guide for Semi-Structured Interviews

Themes	Questions
CoderDojo philosophy	• What do you think it means to be a CoderDojo mentor? • What do you think are the characteristics of a good CoderDojo mentor?
Motivation	• What was your motivation to become a mentor? • Has your motivation changed over time?
Parents/guardians	• Do parents/guardians attend Dojo sessions with their children? • What influence parents/guardians have on the learning process? • How is their involvement in the learning process?
Relationship with other mentors	• How many mentors (roughly) you work with? • Describe your relationship with them.
Finishing the interview session	• Based on our conversation, is there anything we have talked about, you want to go back to? • Is there anything else you think it would be useful for me to know or things I should be considering?

Appendix C Ethical Approval

Page 1

School of Computer Science & Statistics
Research Ethics Application

Part A

Project Title: Exploring CoderDojo Mentors" Teaching Philosophies, Pedagogical Approaches and Mentoring Practices in Dojos

Name of Lead Researcher (student in case of project work): Abeer Alsheaibi

Name of Supervisor: Glenn Strong

TCD E-mail: alsheaia@tcd.ie Contact Tel No.: +353 83 832 7101

Course Name and Code (if applicable): …….....……...……

Estimated start date of survey/research: 09/09/19

I confirm that I will (where relevant):

- Familiarize myself with the Data Protection Act and the College Good Research Practice guidelines http://www.tcd.ie/info_compliance/dp/legislation.php;
- Tell participants that any recordings, e.g. audio/video/photographs, will not be identifiable unless prior written permission has been given. I will obtain permission for specific reuse (in papers, talks, etc.)
- Provide participants with an information sheet (or web-page for web-based experiments) that describes the main procedures (a copy of the information sheet must be included with this application)
- Obtain informed consent for participation (a copy of the informed consent form must be included with this application)
- Should the research be observational, ask participants for their consent to be observed
- Tell participants that their participation is voluntary
- Tell participants that they may withdraw at any time and for any reason without penalty
- Give participants the option of omitting questions they do not wish to answer if a questionnaire is used
- Tell participants that their data will be treated with full confidentiality and that, if published, it will not be identified as theirs
- On request, debrief participants at the end of their participation (i.e. give them a brief explanation of the study)
- Verify that participants are 18 years or older and competent to supply consent.
- If the study involves participants viewing video displays then I will verify that they understand that if they or anyone in their family has a history of epilepsy then the participant is proceeding at their own risk
- Declare any potential conflict of interest to participants.
- Inform participants that in the extremely unlikely event that illicit activity is reported to me during the study I will be obliged to report it to appropriate authorities.
- Act in accordance with the information provided (i.e. if I tell participants I will not do something, then I will not do it).

Signed: Abeer Alsheaibi Date: 15/11/19

Lead Researcher/student in case of project work

Ethics Application Guidelines – 2016

Part B

Please answer the following questions.		*Yes/No*
Has this research application or any application of a similar nature connected to this research project been refused ethical approval by another review committee of the College (or at the institutions of any collaborators)?		No
Will your project involve photographing participants or electronic audio or video recordings?		Yes
Will your project deliberately involve misleading participants in any way?		No
Does this study contain commercially sensitive material?		No
Is there a risk of participants experiencing either physical or psychological distress or discomfort? If yes, give details on a separate sheet and state what you will tell them to do if they should experience any such problems (e.g. who they can contact for help).		No
Does your study involve any of the following?	Children (under 18 years of age)	No
	People with intellectual or communication difficulties	No
	Patients	No

School of Computer Science and Statistics
Research Ethical Application Form

Details of the Research Project Proposal must be submitted as a separate document to include the following information:

1. Title of project
2. Purpose of project including academic rationale
3. Brief description of methods and measurements to be used
4. Participants - recruitment methods, number, age, gender, exclusion/inclusion criteria, including statistical justification for numbers ofparticipants
5. Briefing arrangements
6. A clear concise statement of the ethical considerations raised by the project and how you intend to deal with them
7. Cite any relevant legislation relevant to the project with the method of compliance e.g. Data Protection Act etc.

Part C

I confirm that the materials I have submitted provided a complete and accurate account of the research I propose to conduct in this context, including my assessment of the ethical ramifications.

Signed: Abeer Alsheuibi Date: 15/11/19

Lead Researcher/student in case of project work

There is an obligation on the lead researcher to bring to the attention of the SCSS Research Ethics Committee any issues with ethical implications not clearly covered above.

Part D

If external or other TCD Ethics Committee approval has been received, please complete below.

External/TCD ethical approval has been received and no further ethical approval is required from the School's Research Ethical Committee. I have attached a copy of the external ethical approval for the School's Research Unit.

Signed: ..... Date:.....
Lead Researcher/student in case of project work

Part E

If the research is proposed by an undergraduate or postgraduate student, please have the below section completed.

I confirm, as an academic supervisor of this proposed research that the documents at hand are complete (i.e. each item on the submission checklist is accounted for) and are in a form that is suitable for review by the SCSS Research Ethics Committ

Signed: ..... Date: 15/11/19
Supervisor

Completed application forms together with supporting documentation should be submitted electronically to the online ethics system - https://webhost.tchpc.tcd.ie/research_ethics/ When your application has been reviewed and approved by the Ethics committee, hardcopies with original signatures should be submitted to the School of Computer Science & Statistics, Room 104, Lloyd Building, Trinity College, Dublin 2.

CHECKLIST

Please ensure that you have submitted the following documents with your application:

1.	• SCSS Ethical **Application Form**	
2.	• **Participant's Information Sheet** must include the following: a) Declarations from Part A of the application form; b) Details provided to participants about how they were selected to participate; c) Declaration of all conflicts of interest.	
3.	• **Participant's Consent Form** must include the following: a) Declarations from Part A of the application form; b) Researchers contact details provided for counter-signature (your participant will keep one copy of the signed consent form and return a copy to you).	
4.	• **Research Project Proposal** must include the following: a) You must inform the Ethics Committee **who** your intended participants are i.e. are they your work colleagues, class mates etc. b) How will you recruit the participants i.e. **how** do you intend asking people to take part in your research? For example, will you stand on Pearse Street asking passers-by? c) If your participants are under the age of 18, you must seek both parental/guardian AND child consent.	
5.	• Intended **questionnaire**/survey/interview protocol/screen shots/representative materials (as appropriate)	
6.	• **URL** to intended on-line survey (as appropriate)	

Notes on Conflict of Interest

1. If your intended participants are work colleagues, you must declare a potential conflict of interest: you are taking advantage of your existing relationships in order to make progress in your research. It is best to acknowledge this in your invitation to participants.
2. If your research is also intended to direct commercial or other exploitation, this must be declared. For example, *"Please be advised that this research is being conducted by an employee of the company that supplies the product or service which form an object of studywithin the research."*

Notes for questionnaires and interviews

1. If your questionnaire is **paper based**, you must have the following **opt-out** clause on the top of each page of the questionnaire: *"Each question is optional. Feel free to omit a response to any question; however the researcher would be grateful if all questions are responded to."*
2. If you questionnaire is **on-line**, the first page of your questionnaire must repeat the content of the information sheet. This must be followed by the consent form. If the participant does not agree to the consent, they must automatically be exited from the questionnaire.
3. Each question must be **optional**.
4. The participant must have the option to „**not submit, exit without submitting'** at the final submission point on your questionnaire.

5. If you have open-ended questions on your questionnaire you must warn the participant against naming **third parties**: "*Please do not name third parties in any open text field of the questionnaire. Any such replies will be anonymised."*
6. You must inform your participants regarding **illicit activity**: "*In the extremely unlikely event that illicit activity is reported I will be obliged to report it to appropriate authorities."*

Contents

Research Proposal

Title of project

Exploring CoderDojo Mentors' Teaching Philosophies, Pedagogical Approaches and Mentoring Practices in Dojos

Purpose of project including academic rationale

Dojos are informal coding clubs for young people between 6 to 16 years to learn coding. Dojos are run by volunteering individuals called mentors responsible about running these Dojos. Mentors are free to choose and apply any teaching style they feel comfortable with. Thus, the purpose of this study is to explore CoderDojo mentors teaching philosophies, the different pedagogies and current mentoring practices in different Dojos around Ireland. This project aims to see how well do these correlate with the expectations of the CoderDojo Movement and with best practice in teaching and learning. This research is part of ongoing PhD research carried out by the lead researcher. This project is an extension to a previous approved project named *Learning Model for Informal Learning in CoderDojo* and the approval was received one and half years back.

This research will be in the format of semi-structured interviews aiming to explore CoderDojo mentors thoughts, preferences, feelings and attitude towards their own learning and mentoring experience and the influence of this on their pedagogical practice in Dojos.

The **objectives** of the project are:

1. Explore CoderDojo mentors teaching philosophies and pedagogical approaches and mentoring practices taking place in Dojos around Ireland.
2. Explore CoderDojo mentors adoption of 21st learning skills.
3. Compare the current mentoring practices with the recommend mentoring practices in the literature.
4. Compare the current mentoring practices with the CoderDojo foundation recommend practices.

Brief description of methods and measurements to be used

This study designed as a series of semi-structured interviews (a set of 4 to 6) with number of CoderDojo mentors (15 to 20 mentors). The same group of mentors is to be interviewed in these set of interviews with one to two months in between. Each interview session will be between 40

to 60 minutes and audio recorder will be used to record all interview sessions.

Participants:

Profile:

Participants are CoderDojo mentors from Dojos within the Republic of Ireland. Mixed gender. All participants will be over 18.

Recruitment methods:

Participants will be contacted through emails sent into the CoderDojo coding clubs they are attending (the contact details of these clubs are all available online at https://coderdojo.com/) inviting them to participate in these interviews along with all information about the research. These emails will be used as the recruitment method for these interviews. These emails are all published online for any contacting purposes.

Also, an online survey in the following link https://bit.ly/2nLgbXp is to be published on the CoderDojo web page (https://forums.coderdojo.com/) (ethics approval for the online survey already received). The survey was originally created to explore CoderDojo mentors perceptions of teaching and learning. As the research is now putting more emphasis on mentors perceptions of teaching and learning, another run of the survey is taken place with optional section been added to the survey to ask mentors if they are willing to participate in upcoming interviews. This optional section will only appear to participants over 18. The information and consent sheet for the survey are distributed to people who are participating in the survey. As part of the survey they are invited to participate in a further interview process, which has its own separate information and consent sheets which they receive should they participate (See Appendix B, C).

Briefing arrangements:

Mentors wishing to participate in this study are to contact the lead researcher through emails expressing their wish to participate (as explained in the recruitment methods section) or to express their willingness to participate in the online survey. After that, the contact will be made with each participant to set a date and time that suits both the participant and the researcher. The interview is to take place on the decided date/time.

This study consists of a series of semi-structured interviews (a set of 4 to 6) with number of CoderDojo mentors. The same group of mentors is to be interviewed individually every one to two months until sufficient data is collected (the total number of sessions not to exceed 6). Each interview will be between 40 to 60 minutes and audio recorder will be used to record all interview sessions.

Depending on the participant location, the interview is to be conducted either face to face or via a video call (through Skype) and following are the arrangements for both situations:

- **When interview is face to face:** At the beginning of each interview, participants will be briefed about the research and given time to ask questions or raise concerns (See Appendix A-Interview Protocol). They will be made aware that the findings of the research will be communicated to them upon request. This will be repeated at the end. Participants will be issued with information sheets and consent forms to sign. Participants may opt out the interview at any time. It will be made clear that they may contact the researcher with questions and concerns, or regarding the findings of the research upon completion. The contacts details of the lead researcher are written on the information sheet and consent sheet and hardcopy of both sheets will be hand into all participants. Participants will be asked to read the information sheet and sign the consent sheet prior to the first interview session.

- **When interview is on video call (through Skype):** At the beginning of each interview, participants will be briefed about the research and given time to ask questions or raise concerns. They will be made aware that the findings of the research will be communicated to them upon request. This will be repeated at the end. Participants may opt out the interview at any time. The call will not record the video signal. It will be made clear that they may contact the researcher with questions and concerns, or regarding the findings ofthe research upon completion. The contacts details of the principal researcher are written on the information sheet and consent sheet and soft copy of both sheets will be sent to all participants email. A soft copy of the information sheets and consent forms is to be sent to their emails. Participants will be asked to read the information sheet and to print out the consent sheet, sign it, scan it and then send it back to the lead researcher prior to the first interview session.

Ethical Considerations:

1. While the participants will be asked to provide their names during the first interview so that all interview sessions can be correlated, names will be anonymised once individual interviews are correlated. These data will also be anonymised for any reports of the findings.
2. Gender is requested as research has shown it to be a factor in computing self-efficacy.
3. All interviews questions are optional.
4. The audio recording of the interviews will not be replayed in any public venue and are constructed solely for transcription purposes for review by the lead researcher. The audio recordings will be stored in a password protected account on TCD servers.
5. Participants will be informed that they may withdraw from the research at any time and without penalty.
6. Participant identities will be kept anonymous.

Relevant Legislation:

1. Trinity College Dublin Data Retention Policy
https://www.tcd.ie/about/policies/data_protection.php

In accordance with the principles of the General Data Protection Regulation (GDPR) (2018):

- **Obtain and process information fairly** - All participants will be issued with ethics information and consent forms, which they will be required to read and agree to prior to data collection
- **Keep it only for one or more specified, explicit and lawful purposes** - data collected by the lead researcher will only be processed for research under the terms and research aims and objectives of this research.
- **Use and disclose it only in ways compatible with these purposes** - reported data sets be anonymised and published in accordance with the aims and objectives of the research publication plan
- **Keep it safe and secure** - electronic data will be stored on a password protected directory system located on Trinity servers. Hardcopy data will be stored in a locked filing cabinet in the principle investigators office (on trinity campus).
- **Withdraw without penalty** - Participants may withdraw from the research at any time and without penalty. Participants may withdraw before/during the interviews and may choose not to proceed to the next interview(s). Participants are under no obligation to participate in interviews, and can opt out of at any stage of the process. Participating in all or any of the interviews is voluntary and participants can choose to stop at any time. In case any of the participants want to opt out after the interview has started, he/she can do so by informing the interviewer and all data related to this participant will be discarded accordingly. Participants may also choose not to answer an individual question in the interview at any time and skip without penalty.

2. Interviews Data Retention Strategy
https://www.tcd.ie/about/policies/data_protection.php

In accordance with good practice and principles of GDPR data protection:

- **Ensure that it is adequate, relevant and not excessive** - the lead researcher will review and maintain retained data sets, with redundant or non-essential data deleted from databases.
- **Retain it for no longer than is necessary for the purpose or purposes** - the project team commit to reviewing and maintaining the data set on a yearly basis in line with college guidelines.

Appendix A – Interview Protocol

To aim of these interviews is answer the research questions:

- What teaching philosophies and pedagogical approaches underpin current practice within Dojos?
- How well do these correlate with the expectations of the CoderDojo Movement and with best practice in teaching and learning?
- How well does the broad knowledge base of teaching and learning skills within the CoderDojo mentor groups align with best practice for the teaching of 21st century skills?

Each interview session will commence with the following statement:

The goal of this study is to explore the various teaching philosophies and pedagogical approaches that are currently practiced within Dojos. Prior to the interview you were sent an information sheet and two consent forms (one to sign and return and one to keep).

To facilitate our note-taking, we would like to audio tape our conversations today. We have planned this interview to last no longer than one hour. During this time, we have several questions that we would like to cover.

Main question:

- What teaching philosophies and pedagogical approaches you are currently practicing when mentoring in Dojos?

These are semi-structured interviews and in each session different themes with different questions will be asked. The following table contains some of the main themes with open exploratory questions that will be used as prompts, with participants encouraged to share their experiences which will feed into the following interview sessions. Following is a sample of the themes and questions to be discussed:

Getting to Know You as a Mentor:

• Tell me a little bit about yourself.

• Describe your teaching style.

• What did you find to be the most difficult aspect of your ninjas teaching?

• How would your ninjas describe you?

• Define a superior mentor?

Teaching/Classroom/Learning Environment:

• How would you prepare your Dojo?

• What is your classroom management plan?

• What routines and procedures did you use to keep the class organized?

Mentor thoughts while preparing the lesson

• What you wanted the pupils to learn?

• How you expected use of the technology to help pupil learning

Assessment and Evaluation:

• What ways do you assess and evaluate ninjas?

Teaching Skills:

• How do you differentiate your teaching? Please provide an example.

• Describe a sample lesson plan that guides your teaching.

Teaching Dispositions:

• Are you a flexible mentor? If so, explain how.

Student Centered Focus:

• How would you create a student-centered environment in your Dojo?

• How would you utilize students‟ “voice” in your teaching?

• What will you do to modify your teaching to meet the needs of ninjas?

• How would you engage a reluctant student?

Teaching theories and philosophies:

• Describe your teaching/discipline philosophy.

• What do you see as the current trends in education today?

• What are some of the trends, issues and methodologies in education that relate to coding?

• What is the role of homework?

• What is the broad purpose of informal coding clubs in your opinion?

Building community for learning:

• How would you motivate parents to become involved in the Dojo and in their child‟s learning?

Appendix B - Participants Information Sheet

An email will be sent to each participant prior to the first interview session which includes a copy of the information sheet and consent form sheet. Participants will get either hard or soft copies based on the interview circumstances (See Briefing arrangements).

Information Sheet - Exploring CoderDojo Mentors' Pedagogical and Mentoring Practices in Dojos

You are invited to participate in the *Exploring CoderDojo Mentors' Pedagogical and Mentoring Practices in Dojos* research study. You are selected to participate in this interview because of your role as a mentor in the CoderDojo community. Your contact details have been acquired through the online survey you submitted previously and agreed to be contacted using the email address you provided.

The project is part of PhD research based in the School of Computer Science and Statistics, Trinity College Dublin, conducted by Abeer Alsheaibi (a.alsheaia@tcd.ie) with the supervision of Dr. Meriel Huggard (huggardm@scss.tcd.ie) and Glenn Strong (Glenn.Strong@scss.tcd.ie)

Research Overview

The overall aim of this research is to explore your experience, thoughts, preferences, feelings and attitude as a CoderDojo mentor towards your own learning and mentoring experience. Hearing your experience as a mentor could help us know more about CoderDojo movement and correlate that with recommend mentoring practice in the literature.

This research is formed as set of interviews (4 to 6 sessions) with one to two months in between; wherein each interview we go through a series of questions related to your own learning/mentoring experience. Time allocated for every interview is between 40 to 60 minutes. Participating in all or any of these interviews is voluntary and you may change your mind and stop at any time before/during the interview.

This research, which you are participating in, will either take place in the Dojo you are attending or through a video call (Skype).

Research Participation

By agreeing to participate in the interview process, you will be invited to (1) sign a consent sheet for the research team to participate in the interview conducted at the Dojo you are attending (copy of the consent sheet and information sheet will be given for you to keep); (2) provide consent for the research team to record your voice contribution made within the context of answering the researcher questions; (3) recording is essential in this study and thus if you choose not to be recorded, that will end the interview accordingly; (4) If the interview is taking place over Skype, the call will not record the video signal; (5) All personal data related to you including names, email and audio recording will only be available to the research team and will be anonymised once individual set of interviews are finished and recordings are transcribed so you are no longer identified; (6) In case you want to opt out after the interview has started, you can do so by informing the interviewer and your recording will be discarded accordingly; (7) If you wish to withdraw your recording data subsequent to the interview ending you may do so by contacting the lead researcher within six weeks after the last interview. If you have provided a name or email address by which they can be identified then they will be discarded. After six weeks all recording data will be transcribed and anonymised, and it

will no longer be possible to withdraw.

All information that is collected by the researchers will be anonymised and stored in accordance with the Data Protection Act at Trinity College, Dublin. In the extremely unlikely event that illicit activity is reported during the study, the research team will be obliged to report it to appropriate authorities.

Voluntary nature

Participating in this project is voluntary. You may change your mind and stop at any time during the interview without penalty. You may choose not to participate in all interviews set. You may also choose to not answer a question for any reason.

Benefits

We hope that this project will result in better understanding of the different pedagogies, teaching philosophy and mentoring practices within Dojos in Ireland.

Risks and discomforts

Answering questions about one's experiences may be uncomfortable. You can choose not to answer a question at any time. You may withdraw from the study atany time without penalty.

Confidentiality

There may be lectures, Ph.D. theses, conference presentations and peer-reviewed journal articles written as a result of this project, however the participants will not be identified.

We anticipate the project will be completed in two years. In accordance with TCD recommended research practice, following the completion of the project your data will be retained for a period of five years following the completion of the project and then deleted.

Please do not hesitate to contact us with any further questions. You can email Abeer Alsheaibi directly at alsheaia@tcd.ie.

Finally, thank you for taking part in this research.

Kind regards,

Abeer Alsheaibi (Lead Researcher)
School of Computer Science & Statistics
Trinity College Dublin
Dublin 2
+353 (0)8 383 27101
a.alsheaia@tcd.ie

Appendix C - Participants Consent Sheet

Mentors showing interest at the recruitment stage in participating will receive an email includes a copy of the information sheet, consent form sheet. During the interviews, participants will get either hard or soft copies of the information sheet and consent forms before the interview started.

Consent Sheet - Exploring CoderDojo Mentors' Pedagogical and Mentoring Practices in Dojos

Please read, and then sign the following if you wish to participate in the interviews research process. You are under no obligation to participate in the interviews research process, and can opt in / out of at any stage of the process.

Data Protection: I agree to Trinity College, University of Dublin anonymising and storing all information that is collected by the researchers in accordance with the General Data Protection Regulation (GDPR) (2018). I agree to the processing of such data for purposes connected with the research project as outlined on the *Exploring CoderDojo Mentors' Pedagogical and Mentoring Practices in Dojos* Information Sheet.

My participation is voluntary, and I may withdraw at any time before/during the interview and for any reason without penalty.

- If I want to opt out after the interview has started, I can do so by informing interviewer and the audio recording will be discarded accordingly.
- I can choose not to be recorded and that will end the interview accordingly.
- If the interview is taking place over Skype, the call will not record the video signal.
- All my data (audio recording) will be treated with full confidentiality and stored securelyso that, in the event that any data is published or used for promotional purposes (e.g media reports), my data will not be identified as mine, nor identify my Dojo or ninjas.
- Only researchers on the project will be privy to the tapes which will be eventually destroyed after they are transcribed.
- At the start of the interview, I may provide my name so the data I give can be correlated. I have six weeks from the last interview date to email the lead researcher if I wish to withdraw my data. After six weeks my data will be anonymised and thus it is no longer possible to withdraw.
- When conducting interview through a video call (use video displays). If you or anyone in your family has a history of epilepsy, please be aware you are proceeding at your own risk.
- There may be media reporting, lectures, college projects including PhD theses, conference presentations and journal articles written as a result of this research.
- In the extremely unlikely event that illicit activity is reported during the study, the research team will be obliged to report it to appropriate authorities.

Consent: I have been provided with an information and consent sheet detailing how my data will be processed and how I can contact the research team. The research team will also provide a debrief at the end of this interview. By signing this consent form I confirm that I am over 18, have read and understood the contents of the information and consent forms, ***and give permission to be contacted by the team.***

PRINTED NAME: _____ ***Signature:*** _____

Signature of Researcher (TCD): _____ ***Date:*** _____

Ethics Application Guidelines – 2016

Statement of investigator's responsibility: I have explained the nature and purpose of this research study, the procedures to be undertaken and any risks that may be involved. I have offered to answer any questions and fully answered such questions. I believe that the participant understands my explanation and has freely given informed consent.

Researcher Name (Print):_____
Researcher Signature:_____

Date:

Abeer Alsheaibi

Abeer can be contacted directly at alsheaia@tcd.ie

Appendix D - Audio/Visual Recording Protocol

2. Summary:

This protocol details the process for managing audio and visual recordings and consent procedures aspart of the management of personal information procedures for the CoderDojo mentoring workshops.

2. Purpose:

The purpose of this document is to set out guidelines on the appropriate use of audio and visual equipment and the management of any resultant data by anyone connected to the delivery and/or evaluation of CoderDojo mentoring Workshops, ensuring compliance with the requirements of the General Data Protection Regulation (GDPR) (2018), professional codes of conduct and Trinity College Dublin research ethics requirements. All members involved in delivering these workshops are required to comply with this policy.

It covers:

- Consent relating to visual and/or audio recordings
- Confidentiality of visual and/or audio recordings
- Copyright of visual and/or audio recordings
- Anonymising visual and/or audio recordings as appropriate
- The need to adopt a systematic and secure approach to shooting, and archiving photography
- Using visual and/or audio recordings on the internet and across social media sites

All photography/audio recording taken at any CoderDojo mentoring workshop by any individual member of the research team remains the property of the research and copyright of the images are retained by Trinity College Dublin[15] (no film recording to be taken).

3. Duties and responsibilities:

Any person involved in delivering or evaluating a CoderDojo mentoring workshop (a) using image and audio equipment or (b) using the resultant image or audio files for research or promotional purposes (e.g media reports and showcase events) are subject to the terms and conditions of this procedure. This procedure applies to both permanent and temporary staff (e.g. those onsecondment on honorary contracts, and volunteers). It also applies to anyone contracted to the research or covered by an information sharing agreement that, in the course of their work, are required to access information normally restricted to the lead research.

4. Consent:

Consent must be sought for audio recording undertaken on behalf of the research. In addition to the provision of an Information Sheet, the requester should explain to the individual and/or all participants present:

- The purpose of the photography and/or audio recording.
- How photography and/or audio recording will be used, for example, Publications, Social Media.
- It should be made clear that refusal for the audio recording and/or photography to be used for research or publication will not affect their participation in the workshops.

When requestors have gained informed written consent for photography and/or visual recordings from a participant the appropriate consent form/s must be completed and filed correctly with the research records in a password protected and encrypted file on servers located in Trinity College Dublin, Ireland. All hard copies of the data will be stored in a locked filing cabinet on the Trinity College campus.

Withdrawal of consent

Participants who have consented to photography/audio recording have the right to withdraw that consent at any time without penalty. If this happens, the lead researcher should be contacted immediately and the photography/film will no longer be available for future use. In the case of electronic publications, it should be made clear to the service user that once the photograph is in the public domain there is no opportunity for effective withdrawal of consent.

5. Storage

The data will be stored in a password protected and encrypted file on servers located in Trinity College Dublin, Ireland. Any hard copies of the data (such as transcripts) will be stored in a locked filing cabinet on the Trinity College campus. Only the research team will have access to the data.

In accordance with good practice and principles of GDPR data protection https://www.tcd.ie/about/policies/data_protection.php , the lead researcher commit to review and maintain retained data sets, with redundant or non-essential data deleted from databases. The lead researcher commit also commit to reviewing and maintaining the data set on a yearly basis in line with college guidelines [16].

In the unlikely event that information about illegal activities should emerge during data collection, the researchers will be required to inform the relevant authorities.

6. Anonymising images

The lead researcher will endeavour to omit any identifiable features from photos when taking them, focusing on the products and processes of the workshops and excluding faces. If a participant's face or any other distinguishing mark (such as a tattoo) is included inadvertently they will be edited using an image processing application to render them unrecognisable. The original images will then be deleted.

7. Usage

Audio recordings will not be replayed in any public venue e.g. media reports, showcase events and academicpresentations.

Lead researcher: Abeer Alsheaibi
Abeer may be contacted directly at alsheaia@tcd.ie

Appendix D Interviews Consent

Page 1

Information Sheet - Exploring CoderDojo Mentors' Pedagogical and Mentoring Practices in Dojos

You are invited to participate in the *Exploring CoderDojo Mentors' Pedagogical and Mentoring Practices in Dojos* research study. You are selected to participate in this interview because of your role as a mentor in the CoderDojo community. Your contact details have been acquired through the online survey you submitted previously and agreed to be contacted using the email address you provided.

The project is part of PhD research based in the School of Computer Science and Statistics, Trinity College Dublin, conducted by Abeer Alsheaibi (a.alsheaia@tcd.ie) with the supervision of Dr. Meriel Huggard (huggardm@scss.tcd.ie) and Glenn Strong (Glenn.Strong@scss.tcd.ie)

Research Overview

The overall aim of this research is to explore your experience, thoughts, preferences, feelings and attitude as a CoderDojo mentor towards your own learning and mentoring experience. Hearing your experience as a mentor could help us know more about CoderDojo movement and correlate that with recommend mentoring practice in the literature.

This research is formed as set of interviews (2 to 4 sessions); wherein each interview we go through a series of questions related to your own learning/mentoring experience. Time allocated for every interview is between 30 to 40 minutes. Participating in all or any of these interviews is voluntary and you may change your mind and stop at any time before/during the interview.

This research, which you are participating in, will either take place in the Dojo you are attending or through a video call (Skype/Zoom).

Research Participation

By agreeing to participate in the interview process, you will be invited to (1) sign a consent sheet for the researcher to participate in the interview conducted at the Dojo you are attending (copy of the consent sheet and information sheet will be given for you to keep); (2) provide consent for the researcher to record your voice contribution made within the context of answering the researcher questions; (3) recording is essential in this study and thus if you choose not to be recorded, that will end the interview accordingly; (4) If the interview is taking place over Skype/Zoom, the call will not record the video signal; (5) All personal data related to you including names, email and audio recording will only be available to the researcher and will be anonymised once individual set of interviews are finished and recordings are transcribed so you are no longer identified; (6) In case you

want to opt out after the interview has started, you can do so by informing the interviewer and your recording will be discarded accordingly; (7) If you wish to withdraw your recording data subsequent to the interview ending you may do so by contacting the lead researcher within six weeks after the last interview. If you have provided a name or email address by which they can be identified then they will be discarded. After six weeks all recording data will be transcribed and anonymised, and it will no longer be possible to withdraw.

All information that is collected by the researchers will be anonymised and stored in accordance with the Data Protection Act at Trinity College, Dublin. In the extremely unlikely event that illicit activity is reported during the study, the research team will be obliged to report it to appropriate authorities.

Voluntary nature

Participating in this project is voluntary. You may change your mind and stop at any time during the interview without penalty. You may choose not to participate in all interviews set. You may also choose to not answer a question for any reason.

Benefits

We hope that this project will result in better understanding of the different pedagogies, teaching philosophy and mentoring practices within Dojos in Ireland.

Risks and discomforts

Answering questions about one's experiences may be uncomfortable. You can choose not to answer a question at any time. You may withdraw from the study at any time without penalty.

Confidentiality

There may be lectures, Ph.D. theses, conference presentations and peer-reviewed journal articles written as a result of this project, however the participants will not be identified.

We anticipate the project will be completed in two years. In accordance with TCD recommended research practice, following the completion of the project your data will be retained for aperiod of five years following the completion of the project andthen deleted.

Please do not hesitate to contact us with any further questions. You can email Abeer Alsheaibi directly at alsheaia@tcd.ie.

Finally, thank you for taking part in this research.

Kind regards,

Abeer Alsheaibi (Lead Researcher)
School of Computer Science & Statistics
Trinity College Dublin
Dublin 2
+353 (0)8 383 27101
alsheaia@tcd.ie

Consent Sheet - Exploring CoderDojo Mentors' Pedagogical and Mentoring Practices in Dojos

Please read, and then sign the following if you wish to participate in the interviews research process. You are under no obligation to participate in the interviews research process and can opt in/out of at any stage of the process.

Data Protection: I agree to Trinity College, University of Dublin anonymising and storing all information that is collected by the researchers in accordance with the General Data Protection Regulation (GDPR) (2018). I agree to the processing of such data for purposes connected with the research project as outlined on the *Exploring CoderDojo Mentors' Pedagogical and Mentoring Practices in Dojos* Information Sheet.

My participation is voluntary, and I may withdraw at any time before/during the interview and for any reason without penalty.

- If I want to opt out after the interview has started, I can do so by informing interviewer and the audio recording will be discarded accordingly.
- I can choose not to be recorded and that will end the interview accordingly.
- If the interview is taking place over Skype/Zoom, the call will not record the video signal.
- All my data (audio recording) will be treated with full confidentiality and stored securely so that, in the event that any data is published or used for promotional purposes (e.g. media reports), my data will not be identified as mine, nor identify my Dojo or ninjas.
- Only researchers on the project will be privy to the tapes which will be eventually destroyed after they are transcribed.
- At the start of the interview, I may provide my name so the data I give can be correlated. I have six weeks from the last interview date to email the lead researcher if I wish to withdraw my data. After six weeks my data will be anonymised and thus it is no longer possible to withdraw.
- When conducting interview through a video call (use video displays). If you or anyone in your family has a history of epilepsy, please be aware you are proceeding at your own risk.
- There may be media reporting, lectures, college projects including PhD theses, conference presentations and journal articles written as a result of this research.
- In the extremely unlikely event that illicit activity is reported during the study, the research team will be obliged to report it to appropriate authorities.

Consent: I have been provided with an information and consent sheet detailing how my data will be processed and how I can contact the research team. The research team will also provide a debrief at the end of this interview. By signing this consent form, I confirm that I am over 18, have read and understood the contents of the information and consent forms, ***and give permission to be contacted by the team.***

PRINTED NAME: _____ ***Signature:*** _____

Signature of Researcher (TCD): _____ ***Date:*** _____

Statement of investigator's responsibility: I have explained the nature and purpose of this research study, the procedures to be undertaken and any risks that may be involved. I have offered to answer any questions and fully answered such questions. I believe that the participant understands my explanation and has freely given informed consent.

Researcher Name (Print):_____

Researcher Signature:_____

Date:

Abeer Alsheaibi

Abeer can be contacted directly at alsheaia@tcd.ie

Appendix E Observation Consent (Mentors)

Page 1

Information Sheet - Exploring CoderDojo Mentors' Pedagogical and Mentoring Practices in Dojos

You are invited to participate in the *Exploring CoderDojo Mentors' Pedagogical and Mentoring Practices in Dojos* research study. Your Dojo is selected to be part of an observation session to assist the researcher exploring current mentoring practices in Dojos. This study is part of PhD research based in the School of Computer Science and Statistics, Trinity College Dublin, conducted by Abeer Alsheaibi (a.alsheaia@tcd.ie) with the supervision of Glenn Strong (Glenn.Strong@scss.tcd.ie) and Dr. Meriel Huggard (huggardm@scss.tcd.ie).

Research Overview

The overall aim of this research is to explore the mentoring practices underpin current mentoring practice within Dojos. Observing you as a mentor could help us know more about current mentoring practices and correlate that with CoderDojo philosophy and recommend mentoring practice in the literature.

This research is formed as a single observation session. The researcher will set somewhere back in the class observing and taking notes and will not interfere or interact in any part of the teaching and will have no direct contact with any child in the class. The researcher will only start observing after you signed the consent sheet. Participating in this observed session is voluntary and you may change your mind at any time before/during the session.

In case and for any reason you don't want to participate in this study, the researcher will not attend the Dojo you are mentoring in and no observation is taking place. In case you change your mind after the session has started, the researcher will stop observing and leave the class and any notes taken will be discarded accordingly.

Research Participation

By agreeing to participate in this observed Dojo session, you will be invited to (1) sign a consent sheet for the researcher to start observing at the Dojo you are attending (copy of the consent sheet and information sheet will be given for you to keep); (2) No personal data are taken in this study; (3) In case you want to opt out after the observation has started, you can do so by informing the researcher attending the class and she will stop observing, leave the class and any notes that were taken will be discarded accordingly; (4) After the researcher leaves the class, it will no longer be possible to withdraw as no personal information were taken and thus it is not possible to identify you.

All information that is collected by the researchers will be anonymised and stored in accordance with the Data Protection Act at Trinity College, Dublin. In the extremely unlikely event that illicit activity is reported during the study, the research team will be obliged to report it to appropriate authorities.

Voluntary nature

Participating in this sudy is voluntary. You may choose not to participate in the observation session. You may change your mind and withdraw at any time during the observation session without penalty.

Benefits

We hope that this project will result in better understanding of the different pedagogies, teaching philosophy and mentoring practices within Dojos.

Risks and discomforts

Being observed may be uncomfortable. You can choose not to be observed at any time. You may withdraw from the study at any time without penalty.

Confidentiality

There may be lectures, Ph.D. theses, conference presentations and peer-reviewed journal articles written as a result of this project, however the participants will not be identified.

We anticipate the project will be completed in two to three years. In accordance with TCD recommended research practice, following the completion of the project your data will be retained for a period of five years following the completion of the project and then deleted.

Please do not hesitate to contact us with any further questions. You can email Abeer Alsheaibi directly at alsheaia@tcd.ie.

Finally, thank you for taking part in this research.

Abeer Alsheaibi (Lead Researcher)
School of Computer Science & Statistics
Trinity College Dublin
Dublin 2
+353 (0)8 383 27101

Consent Sheet - Exploring CoderDojo Mentors' Pedagogical and Mentoring Practices in Dojos

Please read, and then sign the following if you agree to participate in the observation process. You are under no obligation to participate in the class observation research process and can withdraw at any stage of the process.

Data Protection: I agree to Trinity College, University of Dublin anonymising and storing all information that is collected by the researchers in accordance with the General Data Protection Regulation (GDPR) (2018). I agree to the processing of such data for purposes connected with the research study as outlined on the Exploring CoderDojo Mentors' Pedagogical and Mentoring Practices in Dojos Information Sheet.

- No personal data are taken in this study.
- My participation is voluntary, and I may withdraw at any time before/during the class observation session and for any reason without penalty.
- If I want to opt out after the researcher has started observing, I can do so by informing her (the researcher) and she will stop observing, leave the class and any notes that were taken will be discarded accordingly.
- All the notes that are taken by researcher during class will be treated with full confidentiality and stored securely so that, in the event that any data is published or used for promotional purposes (e.g media, reports), my data will not be identified as mine, nor identify my Dojo or ninjas.
- There may be media reporting, lectures, college projects including PhD theses, conference presentations and journal articles written as a result of this research.
- In the extremely unlikely event that illicit activity is reported during the study, the researcher will be obliged to report it to appropriate authorities.

Consent: I have been provided with an information and consent sheet detailing how my data will be processed and how I can contact the researcher. By signing this consent form I confirm that I am over 18, have read and understood the contents of the information and consent forms.

PRINTED NAME: _____**Signature:** _____
Signature of Researcher (TCD): _____**Date:**_____

Statement of investigator's responsibility: I have explained the nature and purpose of this research study, the procedures to be undertaken and any risks that may be involved. I have offered to answer any questions and fully answered such questions. I believe that the participant understands my explanation and has freely given informed consent.

Researcher Name (Print): _____
Researcher Signature: _____
Date:
Abeer Alsheaibi
Abeer can be contacted directly at alsheaia@tcd.ie

Appendix F Observation Consent (Parents)

Page 1

Information Sheet - Exploring CoderDojo Mentors' Pedagogical and Mentoring Practices in Dojos

Dear Parent/Guardian,

Your Dojo is participating in a study called *Exploring CoderDojo Mentors' Teaching Philosophies, Pedagogical Approaches and Mentoring Practices in Dojos*. This study is part of PhD research based in the School of Computer Science and Statistics, Trinity College Dublin, conducted by Abeer Alsheaibi (a.alsheaia@tcd.ie) with the supervision of Glenn Strong (Glenn.Strong@scss.tcd.ie) and Dr. Meriel Huggard (huggardm@scss.tcd.ie)

Research Overview

The overall aim of this research is to explore the mentoring practices underpin current mentoring practice within Dojos. Observing your child could help us know more about current mentoring practices and correlate that with CoderDojo philosophy and recommend mentoring practice in the literature. You as Parent/Guardian and your child are important part of this learning process and so it is essential for the purpose of this study to observe your attitude and reaction during the class.

This research is formed as a single observation session. The researcher will set somewhere back in the class to observe and take notes and will not interfere or interact in any part of the teaching\learning and will have no contact with any child in the class. The researcher will only start observing after you signed the consent sheet. Participating in this observed session is voluntary and you may change your mind at any time before/during the session.

In case and for any reason you don't want your child to participate in this study, the researcher will not attend the session you and your child are attending, and no observation is taking place. In case you change your mind after the session has started, you can inform the researcher and she will stop observing, leave the class and any notes that were taken will be discarded accordingly.

Research Participation

By agreeing to participate in this observed class session, you will be invited to (1) Sign a consent sheet for the researcher to start observing at the Dojo you and your child are attending (copy of the consent sheet and information sheet will be given for you to keep); (2) No photos, video or audio recording to be used during the class ; (3) No personal data are taken in this study; (4) In case you want to opt yourself or your child out after the observation has started,

you can do so by informing the researcher or the Dojo champion attending the class and she (the researcher) will stop observing, leave the class and any notes that were taken will be discarded accordingly.

All information that is collected by the researchers will be anonymised and stored in accordance with the Data Protection Act at Trinity College, Dublin. In the extremely unlikely event that illicit activity is reported during the study, the research team will be obliged to report it to appropriate authorities.

Voluntary nature

Participating in this project is voluntary. You may choose not to participate in the observation session. You may change your mind and withdraw yourself and/or your child at any time during the observation session without penalty.

Benefits

We hope that this project will result in better understanding of the different pedagogies, teaching philosophy and mentoring practices within Dojos in Ireland.

Risks and discomforts

Being observed may be uncomfortable. You can choose not to be observed at any time. You may withdraw from the study at any time without penalty.

Confidentiality

There may be lectures, Ph.D. theses, conference presentations and peer-reviewed journal articles written as a result of this project, however the participants will not be identified.

We anticipate the project will be completed in two to three years. In accordance with TCD recommended research practice, following the completion of the project your data will be retained for a period of five years following the completion of the project and then deleted.
Please do not hesitate to contact us with any further questions. You can email Abeer Alsheaibi directly at alsheaia@tcd.ie.

Finally, thank you for taking part in this research.

Abeer Alsheaibi (Lead Researcher)
School of Computer Science & Statistics
Trinity College Dublin
+353 (0)8 383 27101

Consent Sheet - Exploring CoderDojo Mentors' Pedagogical and Mentoring Practices in Dojos

I _____ (name of parent/guardian) have been provided with an information letter that outlines the class observation session details that _____ (name of child) will take part in a one-time observation session, how research data will be collected and stored and how I can contact the researcher conducting this study.

Data Protection: I agree to Trinity College, University of Dublin anonymising and storing all information that is collected by the researchers in accordance with the General Data Protection Regulation (GDPR) (2018). I agree to the processing of such data for purposes connected with the research study as outlined on the *Exploring CoderDojo Mentors' Pedagogical and Mentoring Practices in Dojos* Information Sheet. I'm aware that:

- No personal data are taken in this study
- My participation is voluntary, and I may withdraw at any time before/during the class observation session and for any reason without penalty.
- If I want to opt my child out after the researcher has started observing, I can do so by informing her (the researcher) and she will stop observing, leave the class and any notes that were taken will be discarded accordingly.
- All the notes that are taken by researcher during class will be treated with full confidentiality and stored securely so that, in the event that any data is published or used for promotional purposes (e.g media, reports), my data will not be identified as mine, nor identify my Dojo or ninjas.
- There may be media reporting, lectures, college projects including PhD theses, conference presentations and journal articles written as a result of this research.

- In the extremely unlikely event that illicit activity is reported during the study, the researcher will be obliged to report it to appropriate authorities.

Consent: I have been provided with an information and consent sheet detailing how my data will be processed and how I can contact the researcher. By signing this consent form I confirm that I am over 18, have read and understood the contents of the information and consent forms.

Parent/guardian Name (Print):_____ Signature: _____
Signature of Researcher (TCD):_____Date:_____

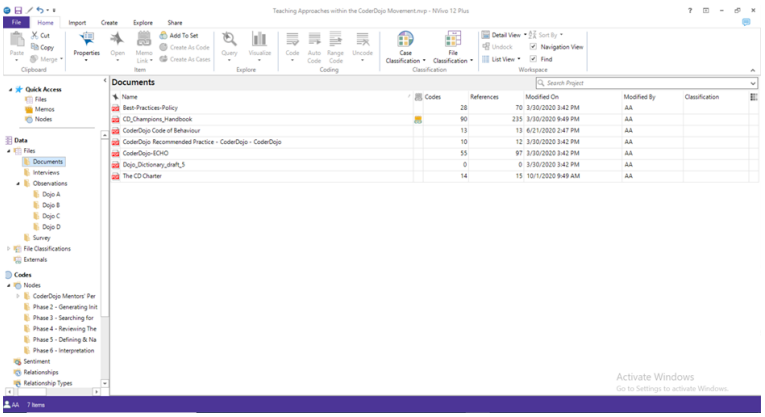
Statement of investigator's responsibility: I have explained the nature and purpose of this research study, the procedures to be undertaken and any risks that may be involved. I have offered to answer any questions and fully answered such questions. I believe that the participant understands my explanation and has freely given informed consent.

Researcher Name (Print): _____
Researcher Signature: _____
Date:
Abeer Alsheaibi
Abeer can be contacted directly at alsheaia@tcd.ie

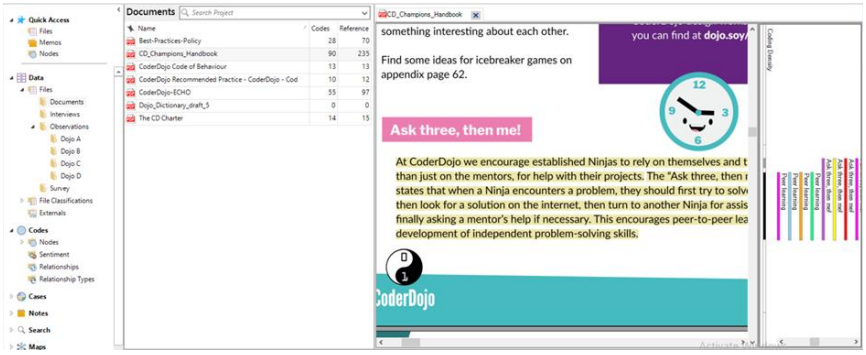
Appendix G NVivo 12 Plus

Page 1

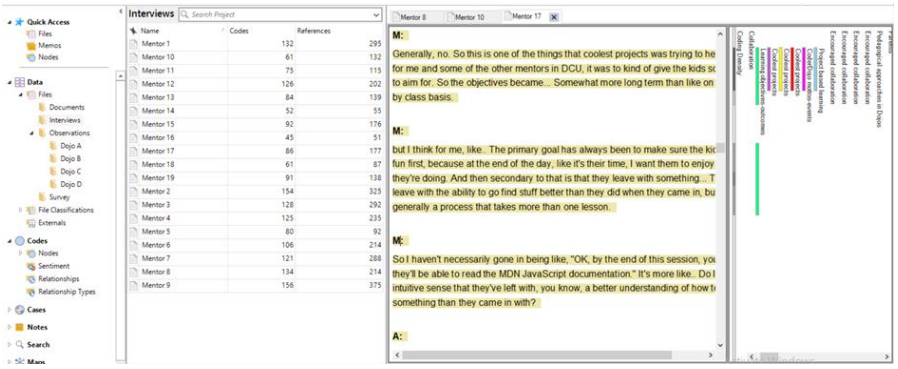
Overall data look in Nvivo 12 Plus software



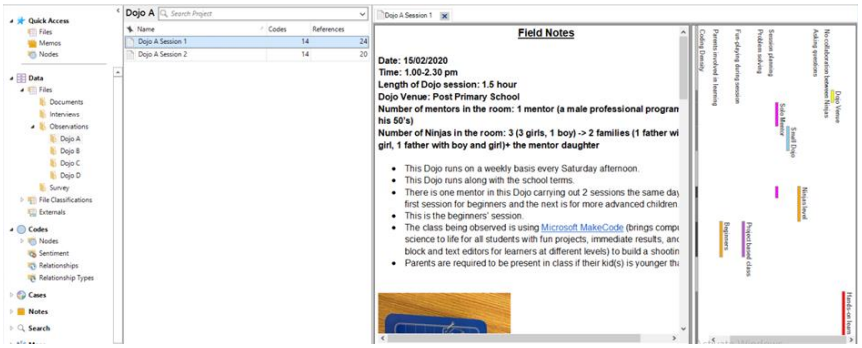
Example of document coding



Example of interview coding

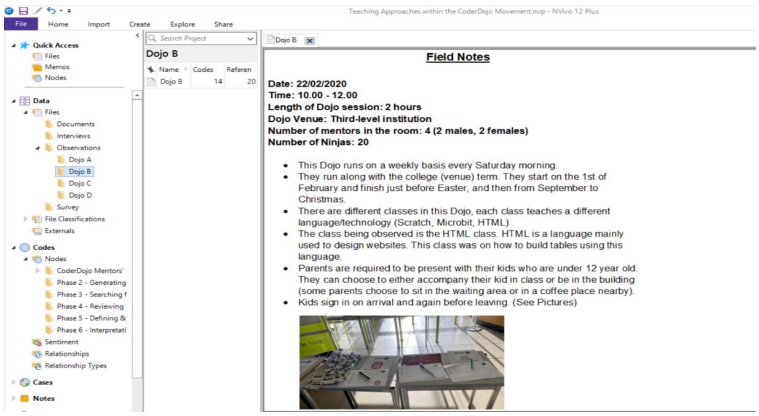


Example of observational session coding



Appendix H Observation Notes

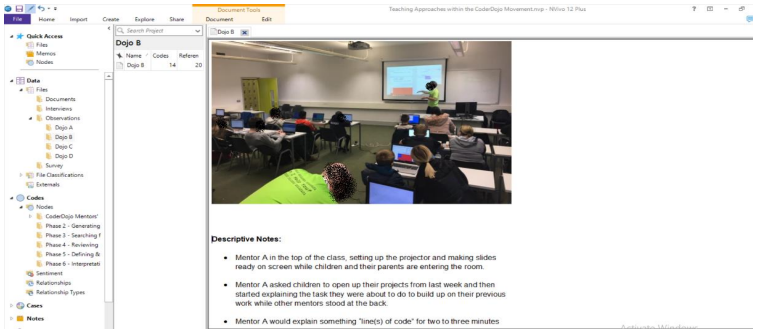
Page 1



Field Notes

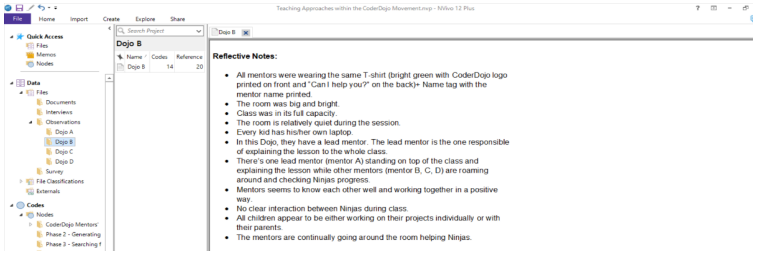
Date: 22/02/2020
Time: 10.00 - 12.00
Length of Dojo session: 2 hours
Dojo Venue: Third-level institution
Number of mentors in the room: 4 (2 males, 2 females)
Number of Ninjas: 20

- This Dojo runs on a weekly basis every Saturday morning.
- They run along with the college (venue) term. They start on the 1st of February and finish just before Easter, and then from September to Christmas.
- There are different classes in this Dojo, each class teaches a different language/technology (Scratch, Microbit, HTML)
- The class being observed is the HTML class. HTML is a language mainly used to design websites. This class was on how to build tables using this language.
- Parents are required to be present with their kids who are under 12 year old. They can choose to either accompany their kid in class or be in the building (some parents choose to sit in the waiting area or in a coffee place nearby).
- Kids sign in on arrival and again before leaving. (See Pictures)



Descriptive Notes:

- Mentor A in the top of the class, setting up the projector and making slides ready on screen while children and their parents are entering the room.
- Mentor A asked children to open up their projects from last week and then started explaining the task they were about to do to build up on their previous work while other mentors stood at the back.
- Mentor A would explain something "line(s) of code" for two to three minutes



Reflective Notes:

- All mentors were wearing the same T-shirt (bright green with CoderDojo logo printed on front and "Can I help you?" on the back)+ Name tag with the mentor name printed.
- The room was big and bright.
- Class was in its full capacity.
- The room is relatively quiet during the session.
- Every kid has his/her own laptop.
- In this Dojo, they have a lead mentor. The lead mentor is the one responsible of explaining the lesson to the whole class.
- There's one lead mentor (mentor A) standing on top of the class and explaining the lesson while other mentors (mentor B, C, D) are roaming around and checking Ninjas progress.
- Mentors seems to know each other well and working together in a positive way.
- No clear interaction between Ninjas during class.
- All children appear to be either working on their projects individually or with their parents.
- The mentors are continually going around the room helping Ninjas.