Is Teacher Knowledge Affecting Students' Transition from Primary to Second Level Mathematics Education?

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Similar to counties such as the U.K. and the U.S.A, the Irish education system is divided into four key stages; pre-school education, primary level education, second level education and tertiary education. Transition between each of these phases has its own set of challenges but many believe the most challenging of all is the transition from primary to second level education. This quantitative, national study investigates the transition from primary to second level mathematics education from the perspective of teachers. It investigates sixth class teachers' knowledge of the mathematics curriculum and teaching strategies employed at second level and first year mathematics teachers' knowledge of the mathematics curriculum and teaching strategies favored in primary school. The results of the study highlight low levels of knowledge in these domains amongst both sixth class and first year mathematics teachers. The ramifications of this gap in teacher knowledge are also discussed in detail.

Keywords: Primary school mathematics education, Second level mathematics education, Transition, Teacher knowledge, Continuity.

Background to the Study

As is the case in Australia, the United States and the United Kingdom, Ireland's education system is divided into four phases; pre-school education, primary level education, second level education and tertiary education. The transition from primary mathematics education to second level mathematics education is one of the greatest challenges that young people experience during their school years. According to Bicknell, Burgess and Hunter (2009) the challenge presented by this transition is multifaceted and involves challenges from social, academic and systematic perspectives. As such this is a pertinent research area and one which has been looked at in depth in recent years.

The overarching finding to emerge from the research carried out to date was that the transition from primary to second level mathematics education resulted in a decline in students' attitudes, academic performance and confidence (Attard, 2010; Economic and Social Research Institute [ESRI], 2007). Furthermore, Bicknell et al. (2009) found that the gap between high achieving and low achieving students widened significantly during this transition period. Due to the serious nature of these consequences, researchers, such as Green (1997) and Attard (2010), have sought to investigate what constitutes effective transition and what are the main factors that contribute to a poor transition for students.

In her study on students' experiences of the transition from primary to second level mathematics education in Australia, Attard (2010) listed curriculum, pedagogy, assessment strategies, social

interactions and students' relationships with others, as key factors that dictate the success of transition. Likewise Barber (1999) describes the transition as a set of five hurdles which all must be overcome at once. The hurdles which must be overcome to ensure a smooth transition, as listed in this study, are bureaucratic, social and emotional, curriculum, pedagogy, and management of learning. In addition to this, Evangelou et al. (2008, p. 2) stated that a successful transition for children entailed:

> …developing new friendships and improving their self-esteem and confidence; having settled so well in school life that they caused no concerns to their parents; showing an increasing interest in school and school work; getting used to their new routines and school organisation with great ease [and] experiencing curriculum continuity.

All research conducted into what constitutes effective transition make some reference to curriculum and pedagogical continuity. Likewise, research conducted in the area of problematic transitions all point to a lack of continuity in this regard. For example, Elkins (1989), Green (1997) and Tilleczek (2007) all found that the attainment and motivational losses that students often experience when moving from primary to second level mathematics education can, in no small way, be attributed to a lack of continuity in terms of both curriculum and pedagogical approaches.

However, in order to ensure continuity between both curriculum and pedagogical approaches it is critical that teachers who are teaching students that are about to enter or have just completed the transition process have an in-depth Mathematical Knowledge for Teaching (MKT) encompassing knowledge of the mathematical content previously studied and that which they will study in subsequent years (Ball, Thames & Phelps, 2008). Ernest (1989) reiterates that a teacher's MKT is not limited to knowledge of curriculum, but also knowledge of students, in order to enable them to teach mathematics effectively. The authors further ascertain that teachers, especially those involved in the transition process, must have a comprehensive MKT comprising of the curricula, students and teaching methodologies utilised before and after the transition process. It is this belief, in conjunction with existing research, which led the authors to investigate the following research questions.

> 1. How familiar are sixth class primary school teachers with the second level mathematics syllabus and the teaching methodologies being promoted at second level and vice versa?
>
> 2. What are the consequences of these levels of MKT in terms of (a) the fluidity of the transition between primary and secondary mathematics education and (b) the teaching approach adopted by second level teachers when teaching mathematics to first year students?

Methodology

The research design for this quantitative study involved the distribution of questionnaires to a representative sample of two groups of stakeholders involved in the transition process; namely sixth class teachers in primary schools and first year mathematics teachers in second level schools. For the purpose of this study two advisory groups, one involving primary teachers and another involving second level mathematics teachers, were established. Their role was to help with the development and piloting of the questionnaires and to help the authors in relation to sampling issues. To allow for comparison of responses from primary and second level teachers the questionnaires were of a similar

nature and were both based on the framework for transition developed by the authors from the work of Anderson, Jacobs, Schramm and Splittgerber (2000) and the models of knowledge proposed for primary teachers by Ball (2008) and for second level teachers by Ernest (1989). This theoretical framework is provided in Figure 1.

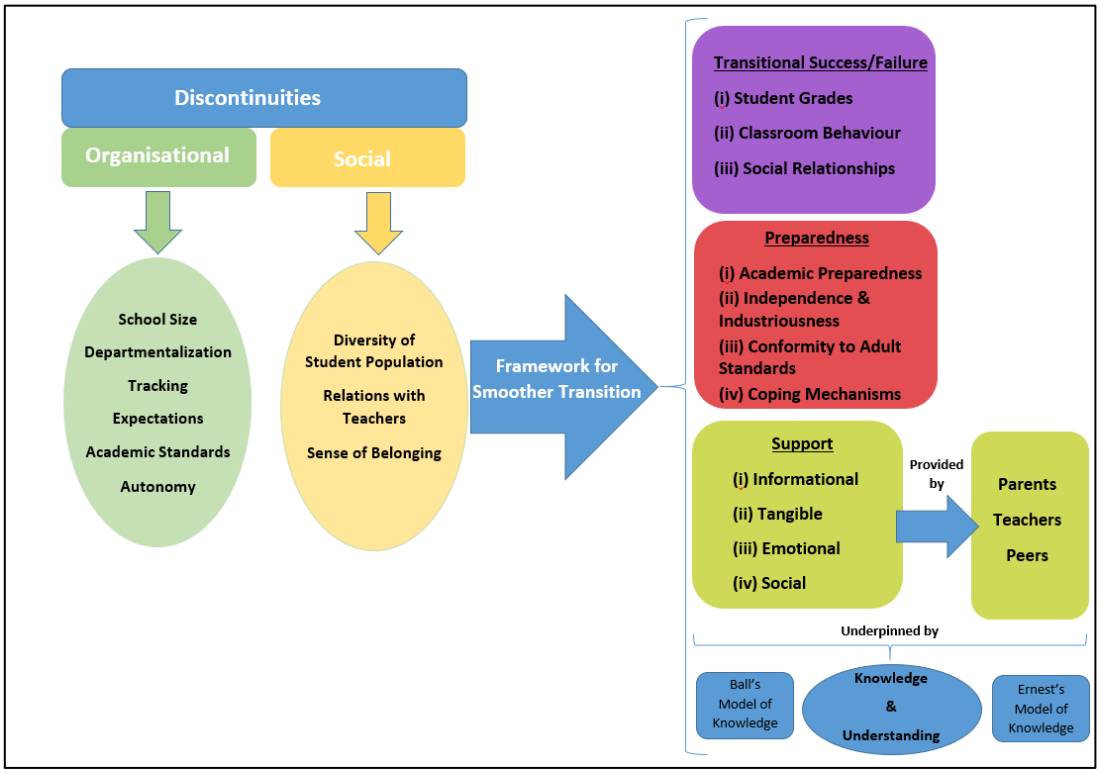


Figure 1: Theoretical Framework

This study was unique in that it looked solely at the issue from the perspective of teachers. As such, only some dimensions of this model were relevant to this study namely the discontinuity pillar, the support pillar and the teacher knowledge pillar. This particular paper has an even narrower focus and looks solely at the pillar of teacher knowledge.

The sampling frame for this study was a list of all 3,300 primary schools and 723 second level schools in Ireland (DES website February 2016). The targeted sample was 700 sixth class teachers and 400 first year mathematics teachers. By consulting the primary school advisory groups, the authors established that on average, there is one sixth class teacher in each primary school in Ireland. As a result, a simple random sample of 700 primary schools was selected. Overall the sample included 21.2% of all primary schools. Having consulted with the second level advisory group it was established that on average, there are two mathematics teachers teaching first year mathematics in each school in Ireland. Hence using this estimate, a stratified random sample of 200 second level schools around Ireland was selected. This sampling technique ensured that an accurate representation of each type of school (secondary, vocational, community and comprehensive) in Ireland was included in the sample. Overall the sample included 27.7% of all second level schools in Ireland.

The questionnaires were distributed to the 700 primary schools and 200 second level schools in early April 2015. The advisory groups felt that this was the optimum time to increase response rate as it

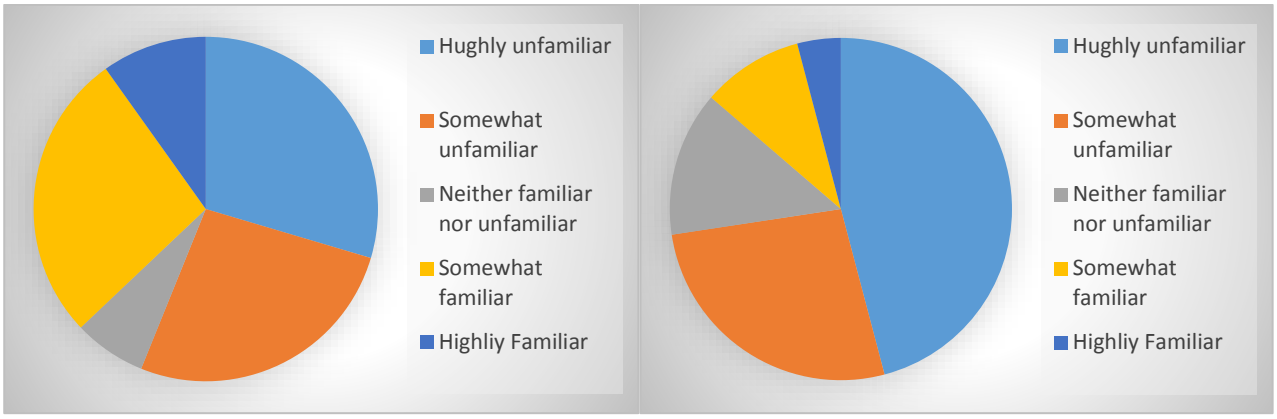
was immediately after Easter break and it was hoped that teachers would be rejuvenated upon their return and be more likely to respond. The primary school questionnaires were sent to the principal of each school and they were asked to distribute these questionnaires to the sixth class teacher. The pack sent to each of the 700 principals included an information sheet for the principal, a teacher information sheet along with the questionnaire and a stamped address enveloped for the questionnaire to be returned in. The second level questionnaires were sent to the Head of Mathematics in each of the 200 second level schools and they were asked to distribute the questionnaires to the first year mathematics teachers in their school. The pack sent to each department head included an information sheet for their perusal, an information sheet for first year mathematics teachers along with two questionnaires and two stamped address envelopes in which the questionnaires could be returned. At both primary and second level, each stamped addressed envelope included was given a number corresponding to the school selected so the researchers could identify the schools that had not returned the completed questionnaires. Two weeks after sending the questionnaires, follow-up telephone calls to each of these schools were undertaken so as to increase the response rate.

Upon receipt of the completed questionnaires the quantitative data was inputted and saved into the computer programme SPSS. Descriptive analysis examined primary teachers' knowledge of the mathematics curriculum and teaching strategies employed in secondary school and second level mathematics teachers' knowledge of the mathematics curriculum and teaching strategies employed at primary level. Descriptive analysis also allowed the authors to determine how these levels of knowledge affected the approach adopted by second level teachers when teaching first year students and also to determine if the transition from primary to secondary was smooth from the teachers' perspective. The authors will now present the results of this analysis in an attempt to address the aforementioned research questions.

Findings

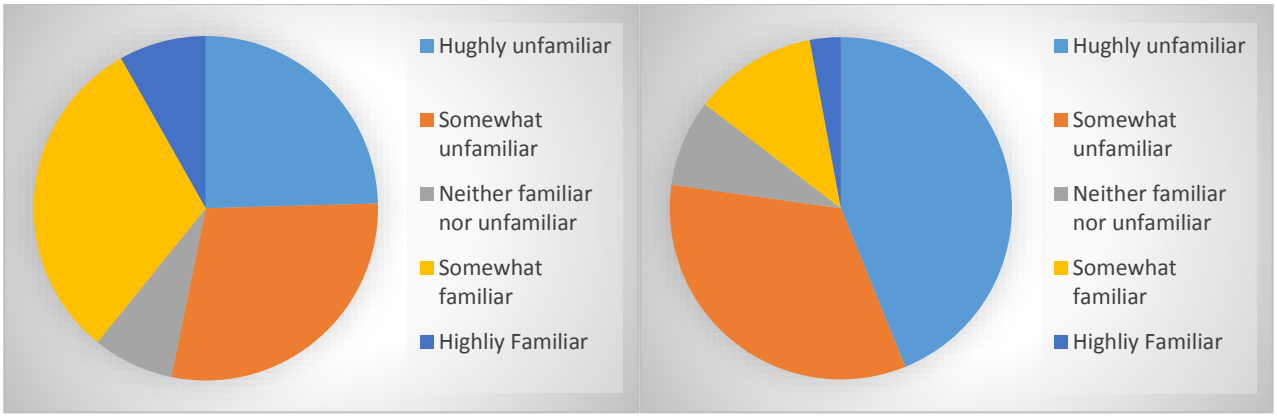
Based on the population size it was determined that, to allow for a 5% margin of error, the study would require 263 responses from sixth class teachers and 133 responses from first year mathematics teachers. The actual response rate was 296 primary school teachers (approx. 42%) and 171 second level teachers (approx. 43%). The primary teachers who responded were distributed across 271 schools (38.7% of schools surveyed) while the second level teachers who responded were distributed across 101 schools (50.5% of schools surveyed).

The first research question sought to ascertain sixth class teachers' knowledge of the first year mathematics curricula and the teaching strategies employed by first year mathematics teachers as well as first year teachers' knowledge of the sixth class curriculum and the teaching strategies adopted by sixth class teachers. The findings related to this research question are presented in Figure 2 and Figure 3 overleaf.



(a) **(b)**

Figure 2: Primary teachers' responses when asked (a) *How familiar are you with the first year mathematics syllabus?* and (b) *How familiar are you with the recommended teaching methods for first year mathematics?*



(a) **(b)**

Figure 3: Second Level teachers' responses when asked (a) *How familiar are you with the sixth class mathematics syllabus?* and (b) *How familiar are you with the recommended teaching methods for sixth class mathematics?*

These findings demonstrate that teachers, at both levels, have a deficient understanding of the syllabus and teaching strategies that their students were/will be exposed to in their previous/next year of schooling. Over half of sixth class teachers (56%) reported that the first year mathematics syllabus was either highly unfamiliar or slightly unfamiliar to them. The corresponding figure for second level teachers was 49%. The responses in relation to knowledge of teaching strategies were even more pronounced. Almost three-quarters of sixth class teachers (73%) stated that they were highly unfamiliar or slightly unfamiliar with the teaching approaches used in mathematics classrooms at second level. Likewise, 77% of first year mathematics teachers stated that they were highly unfamiliar or slightly unfamiliar with the pedagogical approaches employed by sixth class teachers. Furthermore, only 13% of sixth class teachers claimed to be in any way familiar with the teaching approaches used by first year mathematics teachers while the corresponding figure for the first year teachers who responded was 15%.

The second research question was two-folded and sought to analyse the knock on effect of the gaps in teacher knowledge discussed previously. In order to address this research question both groups of

teachers were first asked to rate their agreement with the statement *"There is a fluid transition between primary and secondary mathematics"*. The second level teachers were then further probed on these knock on effects when they were asked to describe the approach they adopt when teaching first year mathematics students upon their entry to second level. For this, they were asked to pick from a pre-determined list of four options which included "Other". The responses received are provided in Figure 4 and Figure 5.

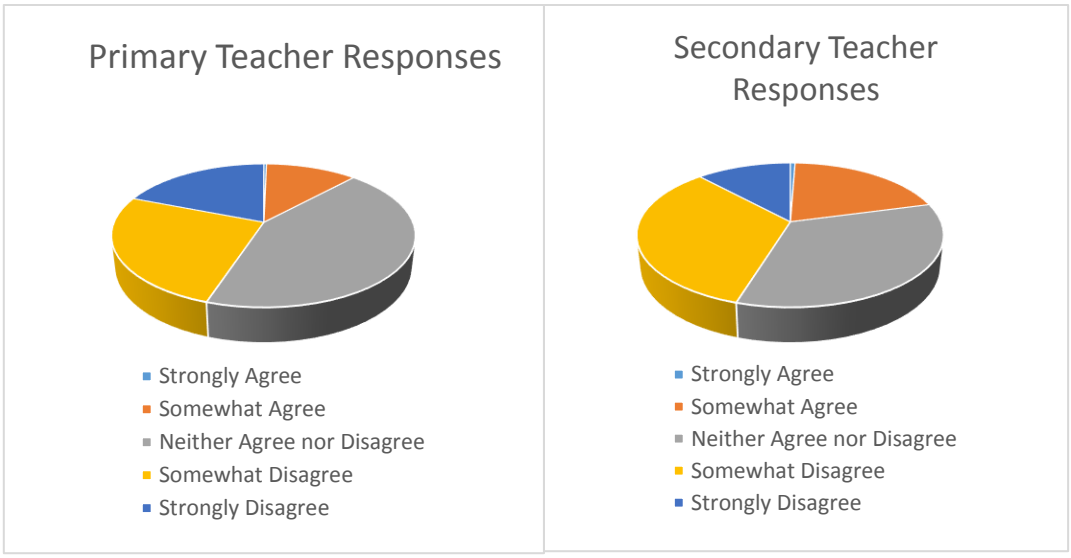


Figure 4: Teachers' responses when asked their level of agreement with the statement *"There is a fluid transition between the primary and secondary school mathematics curricula."*

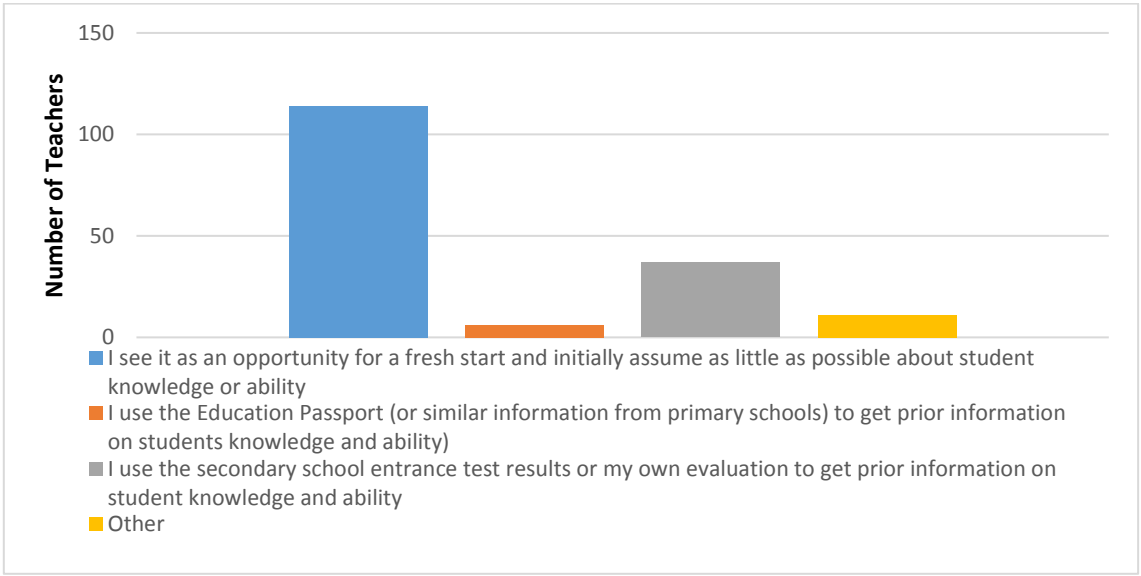


Figure 5: Second level teachers' responses when asked which of the 4 strategies outlined best describe their approach to teaching first year mathematics

Figure 4 shows that a large proportion of both groups of teachers believe that the transition from primary school mathematics to second level mathematics is not smooth. For example, 44.6% of sixth class teachers believe this to be the case compared with 44.4% of first year mathematics teachers. Only one teacher in both groups strongly agreed that there was a fluid transition between primary

school mathematics and second level mathematics with a further 34 in each group agreeing with the sentiment. The lack of fluidity or continuity is further elaborated upon when secondary teachers were asked to describe the approach that they adopt when teaching first year mathematics students. Of the 168 teachers who responded to this question 67.9% stated that they "See it as an opportunity for a fresh start and initially assume as little as possible about student knowledge or ability". Despite mechanisms, such as the Education Passport[1] being introduced in recent years, this study shows that teachers, most probably due to their own lack of knowledge of the primary school curriculum, continue to adopt a "fresh start" approach. This will undoubtedly lead to a disjointed and fractured transition from primary to secondary mathematics education.

Discussion and Conclusion

> "If a teacher is largely ignorant or uninformed he can do much harm" (Conant, 1963: 93)

This research study has demonstrated that sixth class teachers have gaps in their knowledge in relation to the syllabus and pedagogical approaches being adopted at second level while the same can also be said about second level mathematics teachers in relation to the primary school mathematics syllabus and favoured pedagogical approaches. As Conant (1963) points out, such gaps can be detrimental to students' progress and prove a hindrance in their academic progression. This gap in teacher knowledge can prevent teachers from adequately preparing students for the transition process or providing them with a sense of continuity when they make the transition. For example, in a study carried out by Bicknell et al. (2009) teachers expressed concerns that gaps in their own knowledge meant that they were not equipped to prepare students for the mathematics they would face at second level. Likewise, students in a study carried out by Green (1997) reported that the lack of continuity between primary and second level mathematics education, which stemmed from the lack of understanding of the mathematics syllabi and teaching strategies being employed in the years either side of the transition on the part of teachers, meant that they did not face new challenges on entry to second level and as a result their motivation and attitudes declined. Hence, internationally it has been shown that these gaps in teacher knowledge can play a role in the declining attainment levels and attitudes of students during the transition. As a result, it is critical that steps are taken to improve teachers' knowledge in this regard in order to improve students' experience of transition.

In addition to the ramifications already discussed in international literature, this study found that the knowledge levels reported by teachers had other consequences, namely the lack of fluidity in transition and the approach adopted by teachers when students enter first year. The lack of fluidity in transition reported by teachers in this study is unsurprising, as without an in-depth understanding of the previous or subsequent syllabi and teaching approaches it is difficult for teachers to ensure curriculum or pedagogical continuity. Such continuity is critical in order to allow for a smooth or fluid transition from primary to second level mathematics education (Evangelou et al., 2008). The

[1] The Education Passport was an initiative introduced in 2014. It requires primary schools to pass documentation onto second level schools which details a rounded picture of the child's progress and achievement at primary school as well as signalling to second level schools what support a child may need. The overall purpose of the Education Passport is to help the child progress and experience continuity as they move from primary education to second level education.

gaps in teacher knowledge which inhibit them from providing curriculum and pedagogical continuity also force them to adopt a "fresh approach" with their first year students. This is the only option available to teachers who are not informed about the syllabus and/or pedagogical practices that students were exposed to in their previous year of schooling. It is not surprising that this lack of teachers' MKT of incoming students has resulted in pedagogical approaches that are not well received by students, and thus lead to boredom, lack of motivation and a consequential decline in students' attainment levels (Bicknell et al, 2009). As a result of such concerns, the authors believe it is of paramount importance that teachers are given the opportunity to develop knowledge of the sixth class and first year mathematics syllabi; of students in both these years; and of the teaching strategies in place across both levels. Only when such opportunities are available will the hurdle of discontinuity be overcome and students' experience of transition be addressed and enhanced.

Bibliography

Anderson, L.W., Jacobs, J. Schramm, S. & Splittgerber, F. (2000). School Transitions: Beginning of the End or a New Beginning? *International Journal of Educational Research, 33,* 325 – 329.

Attard, C. (2010). Students Experiences of Mathematics During the Transition from Primary to Secondary School. In Sparrow, L., Kissane, B. & Hurst C. (Eds.) *Proceedings of the 33rd Annual Conference of the Mathematics Education Research Group of Australasia* (pp. 67 - 74). Freemantle, Australia: MERGA Inc.

Ball, D., Thames, M. & Phelps, G. (2008). Content Knowledge for Teaching: What makes it Special? *Journal of Teacher Education, 59(5), 389 – 407.*

Barber, M. (1999). Bridges to Assist a Difficult Crossing. *Times Educational Supplement, 4315.*

Bicknell, B., Burgess, T. & Hunter, R. (2009). Explorations of Year 8 to Year 9 Transition in Mathematics. In *Findings from the Numeracy Development Projects 2008* (pp. 145 – 157). Wellington, New Zealand: Ministry of Education.

Conant, J. (1963). *The Education of American Teachers.* New York, USA: Mc Graw – Hill.

Elkins, J. (1989). Literacy and the Transition to Secondary School. *Australian Journal of Reading, 12(4),* 300 – 305.

Ernest, P. (1989) The Knowledge, Beliefs and Attitudes of the Mathematics Teacher: A Model. *Journal of Education for Teaching, 15(1),* 12 – 33. DOI: 10.1080/0260747890150102.

Evangelou, M., Taggart, B., Sylva, K., Melhuish, E., Sammons, P. & Siraj – Blatcford, I. (2008). *What Makes a Successful Transition from Primary to Secondary School: Findings from Effective Pre – School, Primary and Secondary Education 3 – 14 (EPPSE) Project* (DCSF Publication Ref: RB019).

Green, P. (1997). Moving from the World of the Known to the Unknown: The Transition from Primary to Secondary School. *Melbourne Studies in Education, 38(2),* 67 – 83.

Tilleczek, K. (2008). Building Bridges: Transitions from Elementary to Secondary School. *Education Canada, 48(1),*68 – 71.