Junior Secondary Mathematics Teachers' Perspectives on the Transition of Year 7 into Secondary Schooling in Queensland

Author

Strang, Rebekah, Larkin, Kevin

Published

2017

Conference Title

Annual Conference of the Mathematics Education Research Group of Australasia (MERGA)

Version

Version of Record (VoR)

Junior Secondary Mathematics Teachers' Perspectives on the Transition of Year 7 into Secondary Schooling in Queensland.

Rebekah Strang
Griffith University
r.strang@griffith.edu.au

Kevin Larkin
Griffith University
k.larkin@griffith.edu.au

This paper explores the experiences of Junior Secondary teachers in two Queensland schools following the 2015 transition of Year 7 students from primary school to secondary school. There is a well-documented shortage of suitably qualified mathematics teachers in secondary schools in Queensland. A significant concern is that this potential shortage will be worsened with the new cohort of Year 7 students entering secondary schooling, as the demand for qualified mathematics teachers will increase. We use a Teacher Identify Framework to identify whether Junior Secondary mathematics teachers felt their self-reported level of mathematical knowledge was sufficient for this task.

In 2015, Queensland Government moved Year 7 from the last year of Primary School to the first year of Secondary School to align with all other Australian states and territories, with the exception of South Australia. Although this relocation occurred for a number of reasons; it was primarily argued that students would (and will in future) benefit from the additional year of education they will receive from teachers who have trained in a specific discipline(s) rather than primary trained teachers who are considered 'all-rounders' (Mannix, 2014). With the addition of Year 7 to secondary schooling, schools will likely need to modify their educational delivery to effectively address changes of infrastructure and staffing. In addition, they will need to use the Year 7 Australian Curriculum: Mathematics, which is unlikely to have been taught by many existing Queensland secondary school mathematics teachers. The transition in Queensland also took place in the context of an ongoing shortage of highly skilled mathematics teachers in secondary schooling, which has led to the use of "out of field" teachers to teach mathematics (Donnelly, 2012). Out of field teachers are generally considered to be registered teachers, teaching outside the boundaries of their primary discipline. This paper presents a case study of a sample of Junior Secondary Mathematics teachers from two Queensland schools to identify whether the self-reported level of mathematical content knowledge (MCK) and pedagogical content knowledge (PCK) is sufficient to effectively teach this new cohort.

Three underlining facets of mathematical knowledge are commonly identified in relation to the teaching of mathematics education: MCK; PCK; and technological pedagogical content knowledge (TPACK) (Mishra & Koehler, 2006). Schoenfeld and Kilpatrick (2008) highlight the importance of content knowledge in mathematics maintaining that mathematical knowledge is the backbone of proficiency in teaching mathematics and comprises three types of content knowledge: common content knowledge, specialised content knowledge, and knowledge at the mathematical horizon. Ma (1999) identified the positive relationship between teachers' mathematical knowledge and student performance, highlighting that it is imperative for mathematics teachers to possess a strong comprehension and understanding of mathematics subject matter.

While effective mathematics teachers need a "broad and deep" knowledge of mathematical content, of more importance is the consideration of how this knowledge is communicated to students (Schoenfeld & Kilpatrick, 2008). Shulman (1986) first developed

2017. In xxxx (Eds.). 40 years on: We are still learning! *(Proceedings of the 40th annual conference of the Mathematics Education Research Group of Australasia)* pp. xxxx. Melbourne: MERGA.

the notion of PCK, where a combination of content knowledge and pedagogical knowledge was recognised. According to Schulman, pedagogical content knowledge is the method of enacting content knowledge so that others understand it. This can be achieved by adopting many forms of representations such as illustrations, examples, explanations, and analogies. MCK and PCK are of most benefit when employed in unison. This is supported by Campbell et al. (2014) who conducted a large scale, quantitative study comprising 259 upper elementary (years 4–5) and 184 middle grade teachers (years 6-8) to determine whether there was a correlation between teachers' mathematical content and pedagogical knowledge, teachers' perceptions, and student achievement. They found that students taught by teachers with strong MCK and PCK demonstrated a higher mathematical achievement on average. Campbell et al., (2014) further argue that these findings imply that in order to improve student achievement, a strategic approach to professional development should be implemented.

Underpinning MCK and PCK is TPACK. Mishra and Koehler (2005) conducted substantial research on incorporating digital technologies into teaching practices, in order to effectively teach content to students in more engaging and differentiated ways. This framework is important for all teaching, and is relevant due to the need for teachers to utilise digital technologies in the teaching of mathematics as mandated by ACARA (2015). Incorporating technologies within the mathematics discipline increases the scope for new challenges and possibilities in teaching, as well as new issues to contend with e.g. electronic modes of assessment (Handal, et al., 2012). Polly and Barbour (2009) further argue that it is the integration of this technology with teachers' knowledge of pedagogy and content that is beneficial. Larkin and Calder (2016) suggest that mobile technologies provide renewed opportunities in many areas of mathematics education, and can improve student engagement and mathematical learning. With the increasing use of 'Bring Your Own Device' (BYOD) programs in schools, as adopted by both schools in this study, mobile technologies provide more flexible opportunities for students as transport and usage of their device between their home and school environment is more efficient.

Bhagat, Chang and Chang (2016) discuss another effective means of utilising technology in the classroom, known as the *flipped classroom*. This approach involves a model in which learners can access and review online teaching material prior to the classroom lesson, and therefore utilise class time to participate in meaningful learning activities involving problem solving and discussion. The benefits of such an approach are that students are able to learn the content at home and have time to think and process the information before attending school classes. This can be very useful in supporting authentic mathematics activities in school classrooms. However, for the flipped classroom approach to be successful, teachers must be fluent in technology and have the time available to devise and upload such content in advance. Furthermore, students must have access to an online platform in their home environment and be prepared to undertake the work involved prior to class for this approach to succeed. The majority of the reviewed literature predominately focused on MCK, PCK and TPACK from a holistic perspective i.e. across many year levels. While this is valid, the current literature does not specifically consider the knowledge of Year 7 mathematics teachers. This is an important omission requiring further investigation.

Theoretical Framework

Teacher identity, also known in the literature as *professional identity,* focuses upon a range of teacher characteristics and encompasses their knowledge, values, beliefs about themselves as educators and their pedagogies relating to teaching (Grootenboer, Smith & Lowrie, 2006). As a theoretical lens, teacher identity is particularly useful, as the information that is being sought from mathematics teachers and other key stakeholders derives from their opinions and viewpoints of themselves as teaching professionals. Graham and Phelps (2003) state that it is vital that teachers come to realise their identity as a lifelong learner and understand their own values, attitudes and beliefs as learners. Hobbs (2012) suggests that teacher identity can work in unison with self-efficacy to reflect an individual's belief in their capacity to influence their environment in relation to motivation, behaviour and particular performance accomplishments. Furthermore, teachers' awareness of their own teacher identity affects their professional development, their ability and inclination to manage educational change, and how they innovate in their teaching practice (Beijaard, Verloop & Vermund, 2000). Beijaard et al. further suggest that specific attention be given to the relationship between relevant topics such as 'self' and 'identity'; the role of the context in the professional identity formation; and what is perceived as 'professional' in professional identity. Given the twin influence of teacher knowledge and teacher identity on the teaching of mathematics; we intend to addresses the following research question in this paper - How prepared were the teachers to teach Year 7 students in terms of content knowledge and pedagogical practices, including the use of digital technologies?

Method

Data was collected from teachers in two secondary schools, and a case study approach was utilised to develop a deep and holistic understanding of a single phenomenon. In this instance the "case" consists of ten teachers or School Heads of Department (HODs) at two Queensland school sites. Case studies also provide an effective platform for an in-depth investigation encompassing the viewpoints of the participants and identifying the relationships, patterns, and themes that occur.

Participants

The qualitative data was gathered from a combination of classroom teachers and HODs. There were six participants from School 1 and four participants from School 2 and these provide a "valid, workable and manageable" data set (Kumar, 2014, p. 39). Table 1 outlines the demographics and experience of each participant. The specific details and credentials of each participant were not known prior to the commencement of this research, thus the lead author had no influence in determining the expertise or current teaching relevance of the participants. Therefore, some of the participants were not currently teaching Year 7 students, however, they had done so in the past. Each participant was interviewed using a consistent set of questions with the aim of encapsulating an emergent pattern to improve the quality of the data collected.

Table 1.
Demographics and Qualifications of Participants

Participant	**Age Range (years)**	**Gender**	**Time at School Site**	**Current Teaching Position**	**Qualifications**
School 1					
Peter	40-50	Male	6 years	Mathematics HOD	B.Ed. Grad Dip Ed (Math)
James	20-30	Male	2 years	Y8 Maths Co-Ord	B.Eng (Civil). Grad Dip Ed (Math/Phys)
Rose	30-40	Female	11 years	Y9 Maths Co-Ord	B.Sc. Grad Dip Ed

Violet	50-60	Female	22 years	Y8-12 Maths Teacher	Dip Teach, then upgraded to B. Ed
Leigh	50-60	Male	2 years	Y7 Maths Co-Ord	B. Ed (Primary P-10). Flying Start.
Dylan	30-40	Male	2 years	Y7 Maths Teacher	B. Ed (Primary). Flying Start.
School 2					
Mary	40-50	Female	9 years	Y7 Echo Facilitator	Dip Teach, then upgraded to B. Ed
Caroline	20-30	Female	4 years	Y7-9 Maths Teacher	BPsySc. Grad Dip Ed. Studying Masters
Dougal	40-50	Male	3 weeks	Y11/12 Maths Teacher Dir of Academic Perf	B.Ed (Math/Science)
Carly	50-60	Female	1 year	Y7-9 Maths Teacher	B.Sc/B.IT. Grad Dip Ed.

Note. Flying Start denotes a Flying Start teacher who is primary trained brought in from state primary schools to teach Year 7 students in the secondary setting; Echo denotes a special program which aims to enhance gifted students.

The participants in this study were interviewed individually in order to identify their beliefs and attitudes towards teaching mathematics to Year 7 students. They were invited to self-evaluate their strengths and weaknesses pertaining to their MCK, PCK and TPACK knowledge. This process involved a critical self-analysis of their identity as a teacher. This self-reflection task can be difficult and daunting for some, as teachers may have difficulty acknowledging the discomfort and challenge that reflection of their teacher identity entails; however, it is a very useful method for collecting authentic data.

Data Instruments

Interviews are understood here as an interaction between individuals with a specific purpose in mind. Each teacher or HOD attended a semi-structured interview of approximately thirty minutes. While there were set questions; additional questions were asked, based upon responses given, thus providing a more flexible interview structure further tailored to each individual participant (Wiersma & Jurs, 2005). In addition, interviewees were given the option to discuss any issues that were not raised by the researcher. Freebody (2006) suggests that semi-structured interviews are the “best of both worlds” by determining central issues at the hub of the study, whilst also allowing the interviewee a level of spontaneous control over the structure and the significance of the discussion. To ensure that the interviews were valid, each question was carefully examined to confirm that it was relevant to the study, and thus provided reliable data, to ascertain the various beliefs, attitudes and mathematical understandings of the participants. To further improve the credibility of the interviews, the questions were trialled with two experienced mathematics educators.

Methods of Data Analysis

The interviews were transcribed by the lead author as the additional exposure to the vocalisation of each interview helped to enrich an understanding of each participant and the significant opinions they portrayed. The Six Phases of Analysis approach – i.e. familiarizing yourself with your idea; generating initial codes; searching for themes; reviewing themes; defining and naming themes; and producing the report (Braun & Clarke, 2006), formed the basis of the analytical process. Key themes were progressively identified in the transcription process via a thematic coding approach. Once the data was coded, the practice of repeat reading was used to confirm or challenge previously noted patterns (Braun & Clarke, 2006).

Findings and Results

The findings and results are discussed according to three main themes: MCK, PCK and TPACK.

Mathematical Content Knowledge (MCK)

Five of the most senior teachers felt they possessed the strongest MCK responding with 'very confident' and 'very good' when asked about their MCK. The five remaining participants self-identified as having weaker MCK and each mentioned specific areas of deficiencies. These deficiencies were identified in areas such as statistics and probability, spatial reasoning, and the analytical skills associated with problem solving. James (pseudonym) identified a difficulty in simplifying content to students and often overestimated their ability. While two of the participating teachers endeavoured to relearn the content, the findings support other claims (See Brodbelt, 1990) that many Junior Secondary mathematics teachers are not confident enough in their mathematical ability to effectively teach Year 7 students. Furthermore, only four of the participants in this study possessed a thorough knowledge of the Year 7 component of the Australian Curriculum: Mathematics. Thus six of the Junior Secondary teachers lacked familiarity with the Australian Curriculum and were uncertain as to the specific content that is to be taught. There are two underlying causes of this shortfall in this study: the "lack of time" to review the Australian Curriculum; and the overreliance on using textbooks.

Two teachers specifically identified the issue of time to explain their insufficient knowledge of the Australian Curriculum. It is a common theme in the research that teachers are time poor (Leong & Chick, 2011). However, this may have become more of an issue due to the more content driven, standardised Australian curriculum. The lack of time teachers face is therefore a circular paradox: their preparation and teaching time is consumed with teaching content, so that teachers have limited time to engage more fully with the curriculum, and instead rely on unit or term planning provided to them. To encourage ownership and personalisation of the content, and to enhance both teacher and student understanding, teachers should be encouraged to, at a minimum, adapt school based programs in light of the curriculum intent of the Australian Curriculum.

Secondly, teachers from both schools sites admitted to relying on textbooks instead of the Australian Curriculum. Teachers from School 1 were particularly reliant on the use of the school textbook (MathsWorld). This may save preparation time but presented other difficulties as it was deemed by the teachers to be too difficult for the majority of students. School 2 also used MathsWorld; however, this text is only utilised by the advanced "echo students" – i.e. advanced students. The textbook used by the majority of mainstream students at School 2 was Maths Quest, which uses simpler, remedial style questions.

It therefore is the case that nearly half of the participating teachers were not confident in their MCK and that over half were not fully aware of the content to be taught to students; hence the use of textbooks at both schools. As outlined by Schoenfield and Kilpatrick (2008), a proficient teacher possesses a profoundly entrenched and varied knowledge of mathematical practices; therefore to become more proficient in the teaching of mathematics, the participants need to develop their MCK with flow on benefits for the students.

Pedagogical Content Knowledge (PCK)

The two schools adopted different approaches to improve PCK. School 1 adopted aspects of the Marzano pedagogical approach to teaching with an emphasis on "Tactical Teaching" incorporating word problem comprehension (Marzano, 2007). School 1 also supported students via separate remedial classes (in lieu of specialist classes) for those experiencing difficult with mathematics. School 2 employed a part time pedagogical coach to help educate and improve current mathematical teaching pedagogical practices. School 2 also incorporated the use of theme park excursions to relate mathematics to real world contexts. A significant difference between the schools is that School 2 focuses specifically on higher performing students. Rather than remedial classes, School 2 has "Echo" classes for extension students focussing on more complex topics whist still remaining within the Year level content boundaries for each particular year. While it is evident that most teachers have altered their teaching approach by incorporating strategies such as the use of reflection, group work, or the use of games to help engage students; not all teachers have evolved in their teaching methods and in their understanding of Year 7 students. Teachers predominantly realised that Year 7 students were different in their needs, wants and learning styles; however, their changes were limited in catering for this younger, more vulnerable year level. Beswick (2010) suggests that effective mathematics teachers engage students in diversified mathematical processes, and vary their pedagogical approaches, to achieve this. Such varying was not evident to any significant degree in this project. Therefore, further improvement to the PCK of Year 7 mathematics teachers is recommended. This will maximise the opportunities for their Year 7 mathematics students to be effectively exposed to a variety of teaching methods, which will likely enhance understanding, and increase their engagement with, and motivation towards, mathematics.

Technological Pedagogical Content Knowledge (TPACK)

It is evident that School 1 utilises technology in a more rudimentary sense with a higher concentration of similar types of usage. School 1 predominately uses Kahootz (Software), the IWB, and MyMaths online (which aligns with the school's textbook). Technology at this school is primarily used for revision and homework tasks and could be used more effectively to engage the students and enhance the learning of mathematics. While these teachers and HODS felt that technology could be useful overall; three teachers at School 1 disliked and discouraged the use of technology in their mathematics lessons. This is concerning given Beswick's (2010) suggestion that effective mathematics teachers portray positive attitudes to the use of technology in mathematics. This aversion is perhaps driven by a deficiency of technological understanding and confidence, and may be due to lack of PD in the use of digital technologies in mathematics. Furthermore, School 1 is a government school; reductions to the school budget may have resulted in the cut of at least one school online mathematics program (Mathletics). Putting aside our views on the veracity of Mathletics, the loss of this program was seen as a negative by the teachers. This school is also required to adhere to access to the internet conditions set out by the Queensland Government where cloud storage was not available. These limitations likely contribute to why technology usage at School 1 is limited.

In contrast, the results suggested that School 2 incorporated a broader approach to technology use by utilising software such as OneNote, Mathletics, and Quizlets. The results indicated that School 2 was more open to the use of technology and the teachers who participated in the study were aware of the enhanced engagement if technologies are appropriately incorporated in the classroom. However, this could be due to that fact that School 2 is an independent school, with a substantial school budget derived from school fees, thus enabling the mathematics department to utilise and pay subscriptions to online programs, such as Mathletics. Overall, while there were hindrances at both schools; e.g. internet and / or server connectivity, and battery complications; teachers at both participating schools would benefit from further training in the use of technology in mathematics.

Conclusion

While some teachers involved in the study felt they were proficient and knowledgeable in MCK and PCK, approximately half indicated a lack of confidence in their MCK and thus would benefit, as would their students, from professional development to improve their existing level of mathematics understanding. Teachers were also not fluent with the Australian Curriculum: Mathematics and instead relied heavily on textbook use. Both schools incorporated varying approaches to improve their mathematical pedagogy with the use of the group work and games to engage students; incorporation of the Marzano Framework (School 1); and the use of school excursions to provide authentic mathematics context (School 2). Whilst schools have made improvements, and recognise that Year 7 students are different, the changes noted in the study did not occur directly as a consequence of the incorporation of Year 7 into the high school setting. Therefore, further consideration of the specific needs of Year 7 students would be useful. While both schools incorporated technology within their pedagogy, it was mainly rudimentary. Additionally, there were three teachers who were overtly hostile towards the use of technology, with likely negative outcomes for students. If the findings here are reflective of broader practice, Junior Secondary teachers would benefit from further exposure to, and training in, the use of technology within the mathematics classroom.

Limitations

While the literature suggests that, due to a shortage of mathematics teachers in secondary schooling (Brodbelt, 1990; Donnelly, 2012), there are teachers teaching out of field in mathematics; this was not the case within these educational settings; therefore, we are unable to contribute to this particular aspect of Junior Secondary Mathematics teaching. As Teacher Identity was the underlying framework of focus in this study, teacher perceptions and beliefs about themselves as teachers were the primary data source. The findings are therefore limited, in that teacher's self-perceptions may be markedly different to the reality experienced by the students.

Implications of the Research

This research sought to explore the self reported MCK, PCK and TPACK of Junior Secondary teachers and HODs in relation to their teaching of mathematics to Year 7 students. The findings indicated that many of the teachers were not confident in specific areas of their mathematical content knowledge and at times had to relearn content, as teachers were often placed in year levels that they were not proficient in teaching. This lack of knowledge typically impacts negatively on student outcomes, as the teachers were less aware of differing pedagogical approaches and teaching strategies for students resulting in a narrow view of mathematical practices. It is evident that technology is a medium to engage students in mathematics education; however, many teachers in this study were not confident or fluent in the use of technology in their classrooms. While some technology was used in the classroom, further PD in this area would be further useful. Also requiring further investigation, and only touched on briefly in this paper, is the impact of the structure of the mathematics department in each school given that both departments operate where decision-making and curriculum design seems to be formulated by a "top down" approach. While having some benefits in terms of the time poor nature of teaching, it may be the case that this is inadvertently minimising the teachers' MCK, PCK and TPACK in relation to the Year 7 Australian Curriculum: Mathematics.

References

Australian Curriculum and Reporting Authority (2015). *Shape of the Australian curriculum: Mathematics.* Retrieved from: http://www.acara.edu.au/verve/_resources/australian_curriculum_-_maths.pdf

Beijaard, D., Verloop, N., & Vermunt, J. D. (2000). Teachers perceptions of professional identity: an exploratory study from a personal knowledge perspective. *Teacher and Teacher Education, 16*, 749-764. doi: 10.1016/S0742-051X(00)00023-8

Beswick, K. (2010). Changes in preservice teachers' attitudes and beliefs: The new impact of two mathematics education units and intervening experiences. *School Sciences and Mathematics, 106*(1), 36-47.

Bhagat, K. K., Chang, C. N., & Chang, C. Y. (2016). The Impact of the Flipped Classroom on Mathematics Concept Learning in High School. *Educational Technology & Society, 19* (3), 134–142.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77-101. doi:10.1191/1478088706qp063oa

Brodbelt, S. (1990).Out-of-field teaching. *The Clearing House*, *63*(6), 282-285.

Campbell, P., Nishio, M., Smith, T., Clark, L., Conant, D., Rust, A., . . . Choi, Y. (2014). The relationship between teachers' mathematical content and pedagogical knowledge, teachers' perceptions and student achievement. *Journal for Research in Mathematics Education, 45*(4), 419-459. doi: 10.5951/jresematheduc.45.4.0419

Donnelly, K. (2012). The shortage of properly trained maths teachers in schools is finally being tackled, with a new university level course for those teaching the subject without a qualification. Retrieved from http://search.proquest.com.libraryproxy.griffith.edu.au/docview/1016332263?accountid=14543

Freebody, P. (2006). *Qualitative Research in Education*. London, GBR: SAGE Publications.

Graham, A., & Phelps, R. (2003). Being a teacher: developing teacher identity and enhancing practice through metacognitive and reflective learning processes. *Australian Journal of Teacher Education*, *27*(2), 11-24.

Grootenboer, P., Smith, T., & Lowrie, T. (2006). *Researching Identity in Mathematics Education: The Lay of the Land.* Paper presented at the Proceedings of the 29th annual conference of Mathematics Education Research Group of Australasia, Canberra, Australia.

Handal, B., Campbell, C., Cavanagh, M., Petocz, P., & Kelly, N. (2012). Integrating technology, pedagogy and content in mathematics education. *Journal of Computers in Mathematics and Science Teaching, 31*(4), 387-413.

Hobbs, L. (2012). Examining the aesthetic dimensions of teaching: Relationships between teacher knowledge, identity and passion. *Teaching and Teacher Education, 28*(5), 718-727. doi: 10.1016/j.tate.2012.01.010

Kumar, R. (2014). *Research Methodology: A step-by-step guide for beginners.* (4thed). London: Sage International.

Larkin, K., & Calder, N. (2016). Mathematics education and mobile technologies. *Mathematics Education Research Journal*, *28*(1), 1-7. doi:10.1007/s13394-015-01676

Leong, Y. H., & Chick, H. L. (2011). Time pressure and instructional choices when teaching mathematics. *Mathematics Education Research Journal, 23*(3), 347-362. doi:I0.I007/s13394-011-0019-y

Ma, L. (1999). *Knowing and teaching elementary mathematics*. Mahwah, NJ:

Mannix, L. (2014, January 21). Principals support extra high school year. *In Daily*. Retrieved from http://indaily.com.au/

Marzano, R. J. (2007). Art and Science of Teaching: A Comprehensive Framework for Effective Instruction. Alexandria, US: Association for Supervision & Curriculum Development (ASCD).

Mishra, P., & Koehler, M. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017-1054. doi: 10.1111/j.1467-9620.2006.00684.x

Polly, D., & Barbour, M. (2009). Developing Teachers' Technological, Pedagogical, and Content Knowledge in Mathematics. Paper presented at the *Society for Information Technology &Teacher Education International Conference*, Charleston, SC, USA.

Schoenfeld, A. H., & Kilpatrick, J. (2008). Toward a theory of proficiency in teaching mathematics. In D. Tirosh & T. Wood (Eds.), *The international handbook of mathematics teacher education: Tools and processes in mathematics teacher education,*2,321-354. Rotterdam: Sense Publishers.

Shulman, L. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, *15*(2),

Wiersma, W., & Jurs, S. G. (2005). *Research Methods in Education: An introduction.*(8thed). Boston: Pearson Education, Inc.