EXPLORING PRIMARY TEACHER EDUCATION STUDENTS' SELF-PERCEPTIONS OF READINESS TO TEACH PRIMARY MATHEMATICS

Thuan Thai[a] and Gregory Hine[b]

Presenting Authors: Thuan Thai (thuan.thai@nd.edu.au) & Gregory Hine (gregory.hine@nd.edu.au)
[a]School of Education, University of Notre Dame Australia, Sydney Campus, NSW 2007, Australia
[b]School of Education, University of Notre Dame Australia, Fremantle Campus, WA 6959, Australia

ABSTRACT
In all primary initial teacher education programs, there is an underlying assumption that teacher education students (TES) who successfully complete all the requisite coursework and practicums should be ready to teach all subject areas in the primary school curriculum, including mathematics. However, it is becoming increasingly apparent that performance or course achievement during the teacher education program is not directly correlated with classroom readiness. Therefore, it is important to determine TES' self-perceptions of readiness to teach primary school mathematics, which is currently lacking in the research literature. A summary of current research literature in primary mathematics education is provided in this article, together with an argument for further research on TES' self-perceptions of readiness. Such literature is presented through the lens of and intersection between content knowledge, pedagogical knowledge, and overall knowledge and readiness to teach.

Proceedings of the Australian Conference on Science and Mathematics Education, The University of Sydney and University of Technology Sydney, 2 - 4 October 2019, pages 169-174, ISBN Number 978-0-9871834-8-4

KEYWORDS: Primary Mathematics Education, Teacher Education, Readiness, Self-Perceptions

AIM
The aim of this article is to present an argument for the need to investigate the self-perceptions of primary teacher education students' (TES) readiness to teach primary school mathematics throughout their tertiary education and training. This argument is presented through an examination of key themes evidenced within the literature base, namely: the training experienced by TES during initial teacher education (ITE) programs, research conducted on secondary mathematics TES' readiness to teach, and research conducted on primary TES' readiness to teach mathematics. While there is a general paucity of literature published on the latter theme, a majority of empirical research is offered on primary TES' confidence levels in relation to various types of specialised teacher knowledge. In light of the reviewed literature, it is the authors' contention that a better understanding of TES' needs during their studies will help providers to prepare TES to become confident and competent graduate primary school teachers.

SUMMARY OF RESEARCH

INITIAL TEACHER EDUCATION PROGRAMS
The tertiary education of TES is pivotal in their professional preparation and formation as qualified educators. In Australia, the Australian Institute for Teaching and School Leadership (AITSL) mandates at least half of all ITE programs be comprised of subject content and subject-specific curriculum and pedagogical studies, which is typically two years full-time equivalent study. Within this, mathematics/numeracy curriculum and pedagogy make up at least one quarter of a year of equivalent full-time study load or two courses of study (AITSL, 2016). The rest of the program is made up of specialist studies in priority areas including Aboriginal and Torres Strait Islander education, classroom management, information and communication technologies, literacy and numeracy, students with special needs, and teaching students with English as an additional language or dialect (New South Wales Education Standards Authority [NESA], 2018).

Although NESA have suggested the types of mathematical content knowledge (MCK) and mathematical pedagogical knowledge (MPK) to include in primary education programs, the actual content and structure of courses is largely the prerogative of individual ITE providers (NESA, 2018). Whilst this freedom allows providers to tailor mathematics courses to suit their individual context, it

has also meant that there is little consistency in content, structure, and the number of courses offered between providers (Board of Studies, Teaching and Educations Standards [BOSTES], 2016). However, amongst all ITE program providers, there is a common assumption that TES who successfully complete all the requisite coursework (content, curriculum and pedagogy courses) and practicums should be adequately equipped to teach all subject areas in the primary school curriculum, including mathematics. This assumption is at odds with research that has reported that program success varies widely and that ITE programs sometimes have little to no influence on graduate teacher practices (Anderson & Stillman, 2013; Kennedy, 1999; Korthagen, 2010). It has also been suggested that course performance during the ITE program does not correlate with classroom readiness (Burghes & Geach, 2011; Monk, 1994; Tatto et al., 2008).

As such, there is ongoing debate amongst scholars about the most appropriate models of teacher education, including strategies to develop TES' MCK and MPK, and overall mathematical knowledge for teaching (MKT) (Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2009; Cavanagh, 2009). In addition, Norton (2010, p. 66) pointed out that there has been little research conducted on the "level of mathematics understanding that graduates typically bring to teacher preparation and the effect of teacher education courses upon that knowledge base". Miller and Davidson (2006) asserted that prospective teachers require coursework that focuses on the foundations of the disciplines rather than on studying them to greater depths, whereas others have posited that teachers require a development of pedagogical content knowledge, or knowing a variety of ways to present mathematical content and to assist students to deepen their understanding (Chick, 2012; Shulman, 1987). Furthermore, Emerick, Hirsch and Berry (2003) argued that effective teachers must possess appropriate content knowledge and must also possess considerable background in communicating this knowledge effectively to students.

Given the disparity between the content and overall degree requirements amongst ITE programs, the majority of research into teacher classroom readiness has been small-scale and focused within individual researchers' own institutions (Blomeke, Felbrich, Muller, Kaiser, & Lehmann, 2008). Also, research has often focussed on three main areas: TES' MCK, MPK, and MKT in association with TES' effectiveness in the classroom (Ball, Hill, & Bass, 2005; Beswick & Goos, 2012; Norton, 2010). However, these approaches have not taken into account the student voice, which constitutes TES' own perceptions of readiness against these three areas.

SECONDARY MATHEMATICS TES' READINESS TO TEACH

Attempts have been made to evaluate secondary TES' self-perceptions of their readiness to teach secondary mathematics (Hine, 2018; Hine & Thai, in press). These researchers found that despite participants communicating a general readiness to teach mathematics, many of the participants self-reported a need for their MCK and MKT to be strengthened. Similar findings were reported by Hine (2015) who explored the self-perceptions of middle school TES before and after they undertook a mathematics course. While all participants expressed feeling more confident and ready to teach mathematics concepts following the course, approximately half of the participants reported a need to further strengthen their MCK, particularly in the Number and Algebra strand. In addition, Norton's (2019) study of 108 middle school TES as to what they felt was the most important feature of quality mathematics teaching and what they wanted most out of a mathematics education course, found that the most frequently cited responses to both questions was a specific need to improve both their MCK and MPK.

It is worth noting that AITSL (2016) has mandated that secondary TES complete at least six courses of mathematics content to form a first teaching area (major) or four courses of content for a second teaching area (minor), plus two additional curriculum and pedagogy courses in both instances, compared with only two courses of mathematics content, curriculum and pedagogy for primary TES. Whilst it could be argued that primary school teachers require a breadth of subject content knowledge rather than specialist content knowledge, in an interconnected subject such as mathematics where concepts build onto others, a deep understanding of MCK, MPK, and MKT is required at all levels of teaching. Therefore, an understanding of primary TES' self-perceptions of readiness to teach primary school mathematics in terms of these three areas is not only useful to providers but can have implications for future ITE policies.

In addition to the coursework requirements, ITE programs must also have at least 80 days of in-school professional experience (i.e., practicum) in undergraduate programs and at least 60 days in

postgraduate programs (AITSL, 2016). According to the literature base, it is undisputable that the practicum component of an ITE program plays a pivotal role in developing TES' perceptions, confidence and overall teaching craft. In fact, many scholars have reported that TES consider the practicum as having a major influence on their education and training (Allen & Wright, 2014; Goos, 2006; Smith & Lev-Ari, 2005). However, the great variability between practicum experiences (e.g., the school philosophy and culture, student cohort and ability, and the supervising teacher's teaching practices) means not all TES will be exposed to the same experience and/or training. Furthermore, TES' learning during practicums might conflict with what was taught in their coursework, including pedagogical approaches and best practice in teaching mathematics (Cavanagh & Garvey, 2012; Shane, 2002).

Interestingly, Hine and Thai (in press) have recently reported that following the completion of a 10-week practicum, secondary mathematics TES were more likely to rate their own MCK and MPK lower than how they had rated themselves before the practicum. The reasons for this shift in self-perceptions included awareness of TES' own MCK and MPK made apparent during the practicum, limited exposure to senior classes where higher level or depth of mathematics is taught, or not being able to see a direct link between what was taught in university and the school curriculum (Hine & Thai, in press). Given the importance of ITE on developing future teachers, more research is required to better understand the needs of TES during their tertiary training by seeking the student voice. Specifically, and in light of recent scholarly efforts, such research should evaluate the impact of both the coursework and practicum in ITE programs on TES' self-perceptions of readiness to teach primary school mathematics.

PRIMARY TES' READINESS TO TEACH MATHEMATICS

The preparation of primary school teachers in mathematics is an increasingly critical topic for ITE programs (Matthews, Rech, & Grandgenett, 2010). Preparing teachers to teach mathematics effectively is one of the most urgent problems facing those who wish to improve students' learning (Morris, Hiebert, & Spitzer 2009). However, it cannot be assumed that primary TES entering Australian universities will be competent in mathematics (Hamlett, 2009). Hutchinson (1997) extended this notion, reporting how graduate teachers faced many problems which were largely due to their inadequate preparation in primary school mathematics content knowledge. Decades ago, Glennon (1949) reported "those preparing to teach mathematics in the elementary grades understand approximately 50% of the computational processes taught in grades one to six" (cited in Rech, Hatzell & Stephens, 1993). Many years later, Hungerford (1994) noted that the Mathematical Association of America registered a similar sentiment: "the mathematical preparation of elementary school teachers is perhaps the weakest link in our nation's entire system of mathematics education". While Hiebert et al. (2007) acknowledged that it is unrealistic to expect graduates of ITE programs to enter the classroom as expert teachers, these authors suggested that TES should acquire knowledge, skills, and dispositions that would enable them to study their teaching and gradually improve over time. After the Australian Academy of Science identified mathematics as a critical skill for Australia's future, it was recommended that "all mathematics teachers in Australian schools have appropriate testing in the disciplines of mathematics and statistics" with "national accreditation standards for teachers of mathematics at all levels of schooling… and… appropriate programs to ensure that future teachers meet those standards" (Rubinstein, 2006, p. 15). More recently, the Teacher Education Ministerial Advisory Group (TEMAG) (2014) unanimously agreed that the Australian Professional Standards for Teachers (Professional Standards) were not being effectively applied by ITE providers. Consequently the TEMAG (2014) suggested providers will be required to select carefully entrants possessing requisite academic skills. Furthermore, TES must collect evidence that they demonstrate skills and capabilities for both graduation and employment, in particular, a thorough knowledge of content they will go on to teach.

MATHEMATICAL CONTENT KNOWLEDGE

There is clear evidence on the relationship between teachers' MCK and their ability to teach well in classrooms (Ball et al., 2005; Chapman 2005). According to Matthews, Rech and Grandgenett (2010), mathematical content courses are an effective way of enhancing the mathematical knowledge that primary teachers might require for their own classroom instruction of mathematics. Moreover, such content courses can help new teachers to become more prepared to teach and represent the increasingly important discipline of mathematics to their students. Additionally, research in the United States has shown that the quality and the rigour of the mathematics curriculum are strongly correlated to the MCK of the teachers (Schmidt, 2002). A number of studies suggest that TES' necessary MCK

is a cause for widespread concern, namely Australian TES' difficulties with fractions (Chinnappan, Forrester, & Thurtell-Hoare, 2012; Marshman & Porter, 2013), as well as struggles with proportional reasoning and number sense in England and New Zealand (Burghes & Geach, 2011; Livy & Herbert, 2013). While the issue of determining what constitutes adequate competency, or comprehensive understanding in primary teaching is not simple, commentators have indicated that the relationship between confidence and capacity is not well researched (Grootenboer, 2008; Norton, 2019). As indicated earlier, scholars have established that knowing the content (i.e. MCK) and knowing how to teach that content (i.e. MKT) is not the same thing (e.g., Ball & Bass, 2000; Hill, Rowan, & Ball, 2005). Nevertheless, researchers have indicated that these knowledge types are strongly related, and linked to teachers' perceived self-efficacy (Bleicher, 2004; Ross, 2013).

Instead of taking into account the multiple facets of TES' knowledge and beliefs, there appears to be a tendency among teacher educators to view TES as simply lacking particular knowledge (Delaney et al., 2008). Furthermore, although some TES are able to successfully solve mathematical problems, many are unable to explain the concepts and procedures they perform (Mewborn, 2001). Significantly, Ball, Hill and Bass (2005) determined a correlation between teacher mathematical knowledge and student achievement. However, these researchers concluded that teaching TES more content knowledge is not the best way to prepare teachers; rather, teaching for understanding is required. In addition to the content (i.e. the 'what' of mathematics), Delaney et al. (2008) asserted that teachers also need to know 'how' to teach mathematics, and at the same time coined the term MKT. Following research into MKT, certain scholars believe that implications for translating the content matter of mathematics into effective pedagogical practice are paramount in raising the profile of mathematics (Butterfield & Chinnappan, 2010). Others have asserted that MKT provides the most promising current answer to the longstanding question of what kind of content knowledge is needed to teach mathematics well (Morris, Hiebert, & Spitzer, 2009). Various studies at the primary school level provide initial data linking teachers' MKT with the mathematical quality of instruction (Hill et al., 2008) and the level of students' achievement (Hill et al., 2005). In support of developing MCK in TES, Ball et al. (2009) contended that teachers must be able to understand why particular content is taught and how the content should be developed. Additionally, teachers must be able to use their mathematical knowledge in teaching for identifying a range of solutions and mathematical connections when they are teaching students, planning lessons and evaluating students' work (Ball et al., 2009). To use MKT effectively, teachers must be able to access a wider range of knowledge types such as procedural knowledge and fluency, concepts and connections (Ball el al., 2005).

TEACHER CONFIDENCE

There is an abundance of literature indicating that TES at all stages possess low levels of confidence in mathematical knowledge (Battisa, 1986; Bursal & Paznokas, 2006; Cornell, 1999; Grootenboer, 2008; Henderson & Rodrigues, 2008; Schackow, 2005). While teacher confidence has the potential to induce positive or negative affect within students, it also has been linked to the quality of pedagogy (Stipek, Givvin, Salmon, & MacGyvers, 2001). To illustrate, teachers who lack confidence may manifest this disposition through various behaviours including: an avoidance of teaching aspects of mathematics, a lack of variation in pedagogy, and relying either upon tightly scripted or very unscripted lessons where teacher input is minimal (Ross, 2013; Stipek et al., 2001; Wilkins & Ma, 2003). Henderson and Rodrigues (2008) investigated the mathematical confidence of 80 primary school teachers in Scotland. These researchers determined that 68% of their sample averred having little or no confidence in their own mathematical skills, despite all participants having graduated from secondary school and having completed the necessary qualifications to enrol in primary teacher education. A case study of Australian TES revealed that they possessed attitudes of avoidance and non-engagement attitudes towards mathematics and mathematics teaching, as well as having feelings of incompetency and anxiety as future teachers. Overall, while the models of mathematics education for TES have undergone considerable change in the past few decades, concerns about the depth of teachers' MCK have remained a prominent theme in Western education research literature (Norton, 2019).

CONCLUSIONS

In order to better understand the needs of primary TES in their preparation to teach primary school mathematics, it is important to determine their self-perceptions of readiness in terms of MCK, MPK, MKT and overall readiness to teach, which is currently lacking in the research literature. Through a targeted review of mathematics education ITE, and the confidence levels of TES regarding those types of mathematical knowledge, the authors have identified a current gap in the literature. While

scholars have focused considerable effort on researching the importance of teacher confidence and self-efficacy, there has been very little done to explore TES' self-perceptions of readiness as they progress through their degree program. Ascertaining these self-perceived needs will not only assist teacher educators in providing adequate support for TES but to strengthen ITE programs for future cohorts.

REFERENCES

Allen, J. M., & Wright, S. E. (2014). Integrating theory and practice in the pre-service teacher education practicum. *Teachers and Teaching, 20*(2), 136-151.

Anderson, L., & Stillman, J. (2013). Student teaching's contribution to preservice teacher development: A review of research focused on the preparation of teachers for urban and high-needs contexts. *Review of Educational Research, 83*(1), 3–69.

Australian Institute for Teaching and School Leadership (AITSL) (2016). Guidelines for the accreditation of initial teacher education programs in Australia. Retrieved from https://www.aitsl.edu.au/tools-resources/resource/guidelines-for-the-accreditation-of-initial-teacher-education-programs-in-australia.

Ball, D., & Bass, H. (2000). Interweaving content and pedagogy in teaching and learning how to teach. Knowing and using mathematics. In J. Boaler (Ed.), *Multiple perspectives on the teaching and learning of mathematics* (pp. 83-104). Westport, CT: Ablex.

Ball, D., Hill, H., & Bass, H. (2005). Knowing mathematics for teaching: Who knows mathematics well enough to teach third grade, and how can we decide? *American Educator* (Fall). Retrieved from www.aft.org/pubs-reports/americian_educator/fall05

Ball, D. L., Thames, M. H., Bass, H., Sleep, L., Lewis, J., & Phelps, G. (2009). A practice-based theory of mathematical knowledge for teaching. In M. Tzekaki, M. Kaldrimidou & H. Sakonidis (Eds.), *Proceedings of the 33rd Conference of the International Group for the Psychology of Mathematics Education* (Vol. 1, pp. 95-98). Thessaloniki, Greece.

Battista, M. (1986). The relationship of mathematics anxiety and mathematical knowledge to the learning of mathematical pedagogy by preservice elementary teachers. *School Science and Mathematics*, *86*(1), 10-19.

Bleicher, R. (2004). Revisiting the STEBI-B: Measuring self-efficacy in preservice elementary teachers. *School Science and Mathematics*, *104*(8), 383-392.

Blomeke, S., Felbrich, A., Müller, C., Kaiser, G., & Lehmann, R. (2008). Effectiveness of teacher education: state of research, measurement issues and consequences for future teachers. *ZDM Mathematics Education, 40*(5), 719-734.

Board of Studies, Teaching and Educational Standards (BOSTES) (2016). Quality of initial teacher education in NSW: Learning to teach primary mathematics. Retrieved from https://educationstandards.nsw.edu.au/wps/portal/nesa/about/news/news-stories/news-stories-detail/learning-to-teach-primary-mathematics.

Boyd, D., Grossman, P., Lankford, H., Loeb, S., & Wyckoff, J. (2009). Teacher preparation and student achievement. *Educational Evaluation and Policy Analysis, 31*(4), 416-441.

Burghes, D., Geach, R. (2011). International comparative study in Mathematics training: Recommendations for initial teacher training in England. CfBT Education Trust. Retrieved from https://www.cimt.org.uk/papers/icsmtt.pdf.

Bursal, M., & Paznokas, L. (2006). Mathematics anxiety and preservice elementary teachers' confidence to teach mathematics and science. *School Science and Mathematics*, *104*(6), 173-179

Butterfield, B., & Chinnappan, M. (2010). Walking the talk: Translation of mathematical content knowledge to practice. In L. Sparrow, B. Kissane & C. Hurst (Eds), Proceedings of the 33rd annual conference of the Mathematical Education Research Group of Australasia (pp.109-116). Fremantle, WA: MERGA.

Cavanagh, M. S. & Garvey, T. (2012). A professional experience learning community for pre-service secondary mathematics teachers. *Australian Journal of Teacher Education, 37*(12), 57-74.

Cavanagh, S. (2009). Majoring in math not always a classroom plus. *Education Week, 29*(13), 14-15.

Chapman, O. (2005). Constructing pedagogical knowledge of problem solving: Preservice mathematics teachers. In H. L. Chick & J. L. Vincent (Eds.), *Proceedings of the 29th Conference of the International Group for the Psychology of Mathematics Education*, 225-232.

Chick, H. (2012). Pedagogical content knowledge. Paper presented at CEMENT Conference. The University of Tasmania: Launceston.

Chinnappan, M., Forreser, T., & Thurtell-Hoare, E. (2012). Developments in pre-service teachers' mathematics for teaching of fractions. In J. Dindyal, L. P. Cheng & S. F. Ng (Eds.), *Mathematics education: Expanding horizons* (Proceedings of the 35th annual conference of the Mathematics Education Research Group of Australasia). Singapore: MERGA.

Cornell, C. (1999). "I hate Math! I could not learn it, and I can't teach it!" *Childhood Education*, *75*(4), 225-230.

Delaney, S., Ball, D., Hill, H. C., Schilling, S. G., & Zopf, D. (2008). Mathematical knowledge for teaching: Adapting U.S. measures for use in Ireland. *Journal of Mathematics Teacher Education*, *11*(3), 171-197.

Emerick, S., Hirsch, E., & Berry, B. (2003). Unfulfilled promise: Ensuring high quality teachers for our nation's students. Retrieved from http://www.teachingquality.org.

Goos, M. E. (2006). License to thrill or live and let die? *Principal Matters*, Spring, 6-8.

Grootenboer, P. (2008). Mathematical belief change in prospective primary teachers. *Journal of Mathematics Teacher Education, 11*, 479-497.

Hamlett, B. (2009). Supporting pre-service primary teachers to improve their mathematics content knowledge. *eCulture*, *2*(1), 76-82.

Henderson, S., & Rodrigues, S. (2008). Scottish student primary teachers' levels of mathematical competence and confidence for teaching mathematics: some implications for national qualifications and initial teacher education. *Journal of Education for Teaching*, *34*(2), 93-107.

Hiebert, J., Morris, A. K., Berk, D., & Jansen, A. (2007). Preparing teachers to learn from teaching. *Journal of Teacher Education*, *58*, 47-61.

Hill, H., Rowan, B., & Ball, D. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal*, *42*(2), 371-406.

Hill, H. C., Blunk, M. L., Charalambous, C. Y., Lewis, J. M., Phelps, G. C., Sleep, L., & Ball, D. L. (2008). Mathematical knowledge for teaching and the mathematical quality of instruction: An exploratory study. *Cognition and instruction, 26*(4), 430-511.

Hine, G.S.C. (2015). Strengthening pre-service teachers' mathematical content knowledge. *Journal of University Teaching and Learning Practice, 12*(4), 1-16.
Hine, G.S.C. (2018). Exploring pre-service teachers' self-perceptions of readiness to teach secondary mathematics. In M.E. Strutchins, R. Huang, D. Potari & L. Losano (Eds.), *Educating prospective secondary mathematics teachers: Knowledge, identity and pedagogical practices* (pp. 287-306). International Congress of Mathematics Education (ICME) 13 Monographs. Cham, Switzerland: Springer.
Hine, G., & Thai, T. (in press). Pre-service mathematics teachers' self-perceptions of readiness to teach secondary school mathematics. *Mathematics Teacher Education and Development.*
Hungerford, T. W. (1994). Future elementary teachers: The neglected constituency. *The American Mathematical Monthly*, *101*(1),15-21.
Hutchinson, L. (1997). *Learning for teaching: A case of constructing the bridge between subject matter knowledge and pedagogical content knowledge*. Wyoming: The University of Wyoming. Retrieved from https://files.eric.ed.gov/fulltext/ED413332.pdf.
Kennedy, M. (1999). The role of preservice teacher education. In L. Darling-Hammond & G. Sykes (Eds.), *Teaching as the learning profession* (pp. 59–85). San Francisco, CA: Jossey Bass.
Korthagen, F. (2010). How teacher education can make a difference. *Journal of Education for Teaching, 36*(4), 407–423.
Livy, S., & Herbert, S. (2013). Pre-service teachers' responses for ratio and proportion items. In V. Steinle, L. Ball & C. Bardini (Eds.), Proceedings of the 36th annual conference of the Mathematics Education Research Group of Australasia (pp. 450-457). Melbourne: MERGA.
Marshman, M., & Porter, G. (2013). Pre-service teachers' pedagogical content knowledge: Implications for teaching. In V. Steinle, L. Ball, & C. Bardini (Eds.), Proceedings of the 36th annual conference of the Mathematics Education Research Group of Australasia (pp. 474-481). Melbourne: MERGA.
Matthews, M., Rech, J., & Grandgenett, N. (2010). The impact of content courses on pre-service elementary teachers' mathematical content knowledge. *Issues in the Undergraduate Mathematics of School Teachers: The Journal, 1*, 1-11.
Mewborn, D. (2001). Teachers content knowledge, teacher education, and their effects on the preparation of elementary teachers. *United States Mathematics Education Research Journal*, *3*, 28-36.
Miller, K.W., & Davidson, D.M. (2006). What makes a secondary school science and/or mathematics teacher "highly qualified"? *Science Educator, 15*(1), 56-59.
Monk, D. H. (1994). Subject area preparation of secondary mathematics and science teachers and student achievement. *Economics of education review, 13*(2), 125-145.
Morris, A, K., Hiebert, J., & Spitzer, S. M. (2009). Mathematical knowledge for teaching in planning and evaluating instruction: What can pre-service teachers learn? *Journal for Research in Mathematics Education*, *40*(5), 491-529.
New South Wales Education Standards Authority (NESA). (2018). Program accreditation requirements. Retrieved from https://educationstandards.nsw.edu.au/wps/portal/nesa/teacher-accreditation/how-accreditation-works/higher-ed-providers-ite/program-accreditation-requirements.
Norton, S. (2010). How deeply and how well? How ready to teach mathematics after a one-year program? *Mathematics Education and Special Education, 12*(1), 65-84.
Norton, S. J. (2019). Middle school mathematics pre-service teacher's responses to a mathematics content and specific mathematics pedagogy intervention. *Australian Journal of Teacher Education*, *44*(5), 1-23.
Rech, J., Hartzell, J., & Stephens, L. (1993). Comparisons of mathematical competencies and attitudes of elementary mathematics majors with established norms of a general college population. *School Science and Mathematics*, *93*(3), 141-144.
Ross, J. (2013). Teacher efficacy. In J. Hattie, & E. Anderman (Eds.), *International guide to student achievement (*pp, 266-267). Routledge: NY.
Rubinstein, H. (2006). *Mathematics and statistics: Critical skills for Australia's future. Key findings and recommendations of the National Strategic Review of Mathematical Sciences Research in Australia.* Melbourne: Australian Academy of Science.
Schackow, J. (2005). Examining the attitudes towards mathematics of preservice elementary school teachers enrolled in an introductory mathematics methods course and the experiences that have influenced the development of these attitudes. Graduation Theses and Dissertations. Retrieved from http://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=1852&context=etd.
Schmidt, W. (2002). The benefit to subject-matter knowledge. *American Educator*, *26*(2), 8.
Shane, R. (2002). Context and content: What are pre-service teachers learning about teaching mathematics? In S. Goodchild & L. English (Eds.), *Researching mathematics classrooms: A critical examination of methodology* (pp. 119-154). Westport, Connecticut: Praeger.
Shulman, L.S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*(1), 1-22.
Smith, K., & Lev-Ari, L. (2005). The place of the practicum in pre-service teacher education: The voice of the students. *Asia-Pacific Journal of Teacher Education, 33*(3), 289-302.
Stipek, D., Givvin, K., Salmon, J., & MacGyvers, V. (2001). Teachers' beliefs and practices related to mathematics instruction. *Teacher and Teaching Education*, *17*, 213-226.
Tatto, M., Ingvarson, L Schwille, J., Peck, R., Senk, S., & Rowley, G. (2008). *Teacher education and development study in Mathematics (TEDS-M): Policy, practice, and readiness to teach primary and secondary mathematics. Conceptual framework.* East Lansing, MI: Teacher Education and Development International Study Center, College of Education, Michigan University.
Teacher Education Ministerial Advisory Group [TEMAG] (2014). Action now! Classroom ready teachers. Retrieved from http://docs.education.gov.au/system/files/doc/other/action_now_classroom_ready_tea chers_print.pdf
Wilkins, J., & Ma, X. (2003). Modeling change in student attitude toward and beliefs about mathematics. *Journal of Educational Research*, *97*(1), 52-63.