

Queensland Pre-service Teachers' Beliefs on the Integration of Children's Literature in Mathematics Teaching: A Pilot Case Study

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This paper reports the findings from a pilot qualitative study that set out to investigate pre-service primary school teachers' beliefs concerning the integration of children's literature in their mathematics learning and teaching. The thematic and content analyses were drawn from self-reported beliefs of 33, third- and fourth-year pre-service teachers in Queensland. Findings from this pilot study reveal several gaps in knowledge, as well as misconceptions held by them, concerning the use of children's literature in mathematics learning and teaching. These findings suggest the need for mathematics teacher educators to do more to address these gaps and misconceptions, also possibly held by the pre-service teachers they teach, in order for this future generation of teachers to become more knowledgeable in their approach to the use of children's literature.

Recognising connections between mathematics and other curriculum areas, as well as appreciating mathematics as an accessible and enjoyable discipline to study, are highlighted as significant aims of the Australian Curriculum (Queensland Studies Authority, 2018). Such aims can be met by using children's literature as suggested by a wealth of empirical studies spanning the past 20 years. However, research into beliefs, "a personal subjective worldview which can be individually or socially held" (Trakulphadetkrai, 2012, p. 25), of pre-service teachers (PSTs) about the value of children's literature in mathematics teaching is limited, particularly in the Australian context. Investigating PSTs' beliefs is important as beliefs formed during their professional formative years have a lasting impact on their professional practice. In addition, as beliefs about the use of various pedagogical tools (children's literature included) impact upon their use, and given that children's literature is considered a valuable pedagogical tool in the literature (see Bragg, Attard, Muir, & Livy, 2018), our research into the perceptions regarding the future use of children's literature is timely and important. This pilot study thus sought to determine the beliefs held by a cohort of Queensland PSTs regarding the integration of children's literature in mathematics teaching and learning. Children's literature is defined here as "all books that are centred and focused on the child while also appropriately reflecting the emotions and experiences of the child" (Huck & Kieferas cited in Nesmith & Cooper, 2010, p. 280).

Beliefs concerning the use of resources, such as children's literature, to teach mathematics can be viewed alongside Pedagogical Content Knowledge (PCK). PCK is a term coined by Shulman (1987) who suggests that PCK bridges the gap between content and pedagogy as it is "the blending of content and pedagogy into an understanding of how particular [subject] topics, problems, or issues are organised, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (Shulman, 1987, p. 8). In the context of teacher education, being aware of PSTs' PCK is important. As well, eliciting their self-reported beliefs about the role of children's literature in mathematics education, it can be useful for teacher educators to address any misconceptions in these beliefs during the PSTs formative years.

Literature Review

Much of the research regarding the use of children's literature in mathematics teaching tends to report on the pedagogical benefits of this approach. Primarily, a wealth of relevant literature focuses on how students' mathematical thinking can be developed using children's literature. To a large extent, such development can be explained by the affordance of rich mathematical discussion opportunities, generated by meaningful contexts, found in children's mathematical literature (Bragg et al., 2018). Similarly, van den Heuvel-Panhuizen, van den Boogaard and Doig (2009) argue how children's mathematical literature provides "an informal basis of experience with mathematical ideas that can be developed into more formal levels of understanding" (p. 37). This is particularly relevant when stories can be 'mathematised' (Fosnot & Dolk as cited in Hintz & Smith, 2013) or read with a 'mathematical lens' (Trakulphadetkrai, 2018). Moreover, visualisation of mathematical concepts, often presented in children's literature in the form of page illustrations, can also help to foster students' mathematical thinking by making mathematical concepts less abstract (Trakulphadetkrai, 2018). Finally, Clarke (as cited in Shatzer, 2008) reported that the use of literature resulted in improvements in students' mathematical reasoning, strategy use and persistence with difficult tasks.

Another documented benefit of using children's literature in mathematics teaching is how it can help to develop students' language abilities, particularly their vocabulary knowledge (Hassinger-Das, Jordan, & Dyson, 2015; Purpura, Napoli, Wehrspann, & Gold, 2017). This is significant given that students' language abilities have been empirically linked to their mathematical abilities (Trakulphadetkrai, Courtney, Clenton, Treffers-Daller, & Tsakalaki, 2017). In terms of affect, research also highlights a positive impact of literature use on fostering students' positive attitudes towards mathematics (McAndrew, Morris, & Fennell, 2017). Specifically, children's literature connects mathematics to emotions and promotes interest and engagement. In addition, when used in group contexts, it supports social and emotional growth, persistence and goal-oriented behaviours (Flevaris & Schiff, 2014).

As with any pedagogical strategy, there are a number of cautions regarding the use of literature in mathematics classrooms. Firstly, Bintz, Moore, Wright and Dempsey (2011) make the observation that, just because a piece of literature is recommended to teachers as a good teaching resource, this is no guarantee that mathematical concepts are accurately or appropriately developed. Secondly, teachers are time poor (Larkin, 2016) and may not have the opportunity to read a variety of children's literature to determine which books are appropriate for which particular mathematics concepts (Perger, 2011). Finally, mathematics misconceptions can be fostered where picture books, in particular, offer a mismatch between illustrations and text e.g. two-dimensional shape names are used but represented as 3D objects or vice-versa. Flevaris and Schiff (2014) warn that such mismatches may appear trivial; however, "the reality is that students retain these misconceptions as truths and experience confusion when trying to connect this knowledge to future learning" (p. 8). This is also a very real concern for language use and representations of geometric shapes and objects in electronic forms of literature (see Larkin, 2016).

It is worth noting that much of what has been written on teaching mathematics using children's literature tends to focus on using them with children in the early years. However, the use of children's literature can extend into upper primary school classes where an important part of the teacher's role is connecting children's informal mathematics with formal school mathematics (van den Heuvel-Panhuizen et al., 2009), and also into junior secondary classrooms where some students have "difficulty thinking about,

understanding, and applying mathematics correctly to real world situations” (Franz & Pope, 2005, p. 21).

The Current Study

As previously noted, teachers’ beliefs on the use of children’s literature in mathematics teaching has been largely under-researched. One of the more closely related studies to this study is that of Prendergast, Harbison, Miller and Trakulphadetkrai (2018), which examined the aforementioned beliefs as espoused by primary school pre- and in-service teachers in Ireland. The Irish study focuses on only two particular beliefs, namely teachers’ perceived enablers for, and perceived barriers to, the integration of children’s literature in mathematics teaching. While Prendergast et al. (2018) provides a useful starting point for the current study, its limitation lies in its narrow focus on the two aforementioned beliefs. The current study instead chooses to adopt a very different approach whereby no particular themes or beliefs are pre-determined. Instead, this exploratory pilot study attempts to reveal an underlying cluster of beliefs concerning the integration of children’s literature mathematics teaching as espoused by pre-service teachers in Queensland. This approach is also being utilised in on-going research of the same nature and focus, but with teachers in England (Trakulphadetkrai, 2015).

Methodology

Information about the beliefs of the PSTs was gathered qualitatively via an open-ended questionnaire. Participants were asked to list their first five thoughts to the prompt ‘integrating children’s literature in mathematics teaching and learning’. They then had the opportunity to explain more fully these five thoughts. For example, a pre-service teacher indicated that their first thought was “*multimodal*” and then in the clarification section explained that “*students can view literature in many ways and can make meaning from these texts*”. This method of eliciting initial thoughts, and then developing these thoughts further, belongs to a class of “projective techniques” (Cooper & Schindler, 2006) whereby stimuli (in this case in the form of word association) are provided to participants in an attempt to elicit conscious or subconscious thoughts about the topic under question. The use of the elaborations minimises a drawback of word association tests – namely, the high level of interpretation required by the researcher. By allowing participants to write a brief elaboration, a more accurate account of their thoughts is accessed.

Sample

After ethical clearance was obtained, the survey was distributed electronically to 140 3rd and 4th year students enrolled in a Bachelor of Primary Education degree at three campuses in Queensland. Thirty-three students responded, representing a 24% response rate. Nineteen were 25 years or younger; 10 were between 26 and 35; and seven were over 35 years of age. The majority of respondents were in the final year of their degree, and all had completed two or three compulsory mathematics pedagogy courses (most had completed three). This exploratory study adopted convenience sampling; therefore, the generalisability is limited. Information sheets and consent forms were distributed electronically and PSTs were informed that their participation was voluntary and that they could withdraw from the study at any time.

Data analysis

Thematic analysis was employed to identify and code emerging themes from the data. Trakulphadetkrai's (2015) *Pre-Service Primary Teachers' Beliefs concerning the Integration of Children's Literature in Mathematics Learning and Teaching* (PPTB-ICLMLT) framework. The framework, originally developed with data from English PSTs, comprises nine themes and 93 sub-themes (or categories), covers a wide range of potential beliefs concerning the integration approach (see Findings and Discussion).

To maximise the reliability of the coding, the researchers went through a number of stages of coding moderation. Early moderation yielded an 86.55% agreement (calculated by dividing the number of times the two raters agreed by the number of possible opportunities to agree, then expressing this as a % (Cohen et al., 2011). Further moderation resulted in 100% agreement. Content analysis, defined as "an analysis of the frequency and patterns of use of terms and phrases" (Savin-Baden & Major, 2013, p. 438), was conducted with the implied understanding that the frequency and pattern of use provide evidence of the importance of the words or phrases to the target population.

Findings and Discussion

We anticipated that we would have a data set of 165 written responses (33 students x 5 responses each) regarding children's literature in mathematics teaching and learning; however, some survey participants gave fewer than five thoughts and both researchers agreed that eight of the remaining thoughts were too ambiguous (e.g., "Educational - is of educational benefit to children, both from a literacy and numeracy perspective") and were therefore discarded. Of the 147 thoughts remaining for content analysis, 204 coding occurrences were made. These occurrences are broadly grouped under nine broad themes, retaining the overall structure of Trakulphadetkrai's (2015) original belief framework.

Beliefs Concerning Pedagogical Benefits

This theme represents the largest proportion (39.71%) of all the coding occurrences (81 out of 204). It consists of 14 categories concerning the perceived pedagogical benefits of literature integration. Due to space limitations, only certain categories are highlighted here. Most of the common perceived benefits of the approach by these PSTs are very similar to the findings of a similar pilot study with PSTs in England (Trakulphadetkrai, 2015); namely children's literature can *increase children's engagement in mathematics learning* (13.79%); *provide a meaningful and relevant context and application* (7.88%), and *promote cross-curricular links* (6.40%). While it is encouraging to see that the PSTs in both pilot studies collectively recognised these key pedagogical benefits as highlighted by, for example, Capraro and Capraro (2006) and Shatzer (2008); other pedagogical benefits, such as how the use of children's literature in mathematics learning can introduce or reinforce mathematical language (Hassinger-Das et al., 2015; Purpura et al., 2017) were not identified.

Two of the categories generated in the Queensland context, namely *Saves planning and lesson time* and *Helps calm students*, are not found in the original framework generated by English PSTs. More specifically, a number of Queensland PSTs appreciated that the integration approach could actually save their planning and lesson time (1.97%) for example: "*By incorporating literature into maths you would be covering the two core curriculum subjects which is beneficial in such a tight curriculum*". Concerning the second new category (0.49%), one PST highlighted how children's literature in mathematics lessons helps to calm children: "*I find using stories as a great way to calm students and create an effective learning environment for all students*".

Beliefs Concerning Key Barriers

This theme represents the second highest proportion (21.08%) of all the coding occurrences (43 out of 204). It consists of 15 categories that are concerned with perceived key barriers inhibiting PSTs from integrating children's literature. As with the previous category, close similarity occurred between both pilot study cohorts in relation to barriers. The key barrier in both studies, and one that resonates with the finding of Prendergast et al.'s (2018) study, was their *limited or lack of awareness of children's literature books that have explicit mathematical elements in them* (4.93%). As one PST wrote: "I can't think of any examples [books] off the top of my head that could be used within a mathematical context. Are many available, and if not, why?" Although children's literature is used as a prompting artefact in two of the three courses the PSTs undertake, this finding indicates that the use of literature in the mathematics courses is limited to the role of a prompt for concept development rather than being used as an integral part of a more holistic approach to the use of children's literature in their teaching.

It is interesting to note that many PSTs felt that they could only use specific books with explicit mathematical contents when, as has been argued in the literature, teachers can easily mathematise a range of books not specifically targeted for mathematics (Hintz & Smith, 2013) and integrate them as part of their mathematics instruction. The second most common key barrier is PSTs *limited or lack of experience in the integration approach* (2.96%), which to a large extent creates a further key barrier concerning PSTs *low confidence level in adopting the approach* (2.96%). One respondent illustrates this by self-describing as "Incompetent. I myself do not feel comfortable or confident using children's literature for mathematical teaching and learning as I have very little experience with it and have not observed it". This is concerning as these PSTs are indicating that children's literature is not widely used in the two or three mathematics classrooms visited in their placement experiences.

Two new barrier categories in this data are not found in the original framework. The first concerns *limited or lack of emphasis by the school on the importance of reading and Literacy* (0.49%), illustrated by the following remark: "Reading in general under-utilised. Literacy and being read to appear under-utilised at this school". This highlights the role of broader contextual factors (e.g., a school's ethos) that can limit or prevent the integration of literature and mathematics. The second new category under this theme concerns *the range of children's ability being too wide to be catered for by a book* (0.49%), and identifies a concern of some PSTs that children's literature may not accommodate the needs of children with varying levels of reading or mathematical abilities.

Beliefs Concerning Enabling Factors

This theme represents the third largest proportion (16.18%) of all the coding occurrences (33 out of 204). It consists of five categories concerning those factors that enable and encourage PSTs to integrate children's literature. In this theme, there was great similarity to the findings of the pilot study in England. The two common enabling factors in both studies were *positive attitudes towards the integration approach* (8.37%) for example: "Exciting. I believe it is an exciting and interesting way to teach the two, and will help students to learn well in both areas", and an expression of interest in learning more about integration in that - *they intend to further explore the approach further* (6.40%) for example: "Interesting. I would like to learn more about how I can integrate children's literature into mathematics teaching and learning in my classroom". These findings suggest that some PSTs, despite their recent classroom placement experiences, recognise

the potential of children's literature and demonstrate a willingness to further investigate its use once they commence their careers.

Beliefs Concerning Ways of Integration

This theme represents 10.78% (22 out of 204) of all the coding occurrences and consists of seven categories related to the mechanics of how children's literature can be integrated in mathematics teaching. The most commonly held beliefs among PSTs, in both pilot studies, relate to using children's literature to *introduce new mathematical topics and skills* (3.45%), to *generate mathematical problems and context for mathematical problem solving* (2.46%) and to *generate discussions about mathematics* (2.46%). Again, while it is important to note that the PSTs collectively recognised a number of ways to integrate literature and mathematics; other integrating strategies, such as how children's literature can be used in collaboration with *role play and games* (0.99%), with *hands-on investigative activities* (0.49%), with *outdoor learning* (0.49%), and to *encourage children to write their own mathematics-related story* (2.11%) are much less emphasised, and may indicate areas for additional focus in their mathematics pedagogy courses at university.

Beliefs Concerning Cautions

This theme represents 2.94% (6 out of 204) of all the coding occurrences and consists of two categories of cautions regarding the use of children's literature. Two particular categories inferred from the data are worth noting. The first is how *the integration could confuse children* (2.46%): "*Having the last prac class I am not sure that this would work well as many still could not add efficiently at year 5 level, so would this just confuse them further*". The second caution expressed was a concern that some literature might *not be suitable for all children* (0.49%): "*Students that already struggle with reading will feel as if they have another barrier to overcome and their confidence will be threatened in another core subject area*". So, whilst generally positive, teacher educators need to be aware that some PSTs require additional scaffolding in relation to the appropriate use of children's literature in catering for a range of student learning needs.

Beliefs Concerning Selection Criteria

This theme represents 2.45% (5 out of 204) of all the coding occurrences and consists of four categories relating to the selection of appropriate literature. Again, whilst only a minor concern for the Queensland PSTs, greater clarity was recognised as necessary in relation to choosing children's literature books that are: *appropriate for the age of the children* (0.99%); *visually attractive* (0.49%); *accessible to children of different reading abilities* (0.49%), and *show or allow for real world application of mathematical knowledge and skills* (0.49%). This observation may relate to the fact that literature used in the two of the three mathematics courses in their teacher training program was to support early concept development and thus were mainly appropriate for young learners given that most conceptual development occurs in the early years, for example, basic operations, counting, and place value.

Beliefs Concerning Associated Mathematical Topics, Literary Genres and Formats

The final cluster of beliefs, although separate themes in the original survey are, for the purpose of brevity, presented together here. It is apparent that PSTs did not initially identify, as uppermost in their thoughts, different mathematical topics and skills, literary genres, or formats associated with using children's literature for mathematics instruction. In percentage terms, 3.92% (8 out of 204) of all the coding occurrences were related to

mathematical topics that the PSTs associated with using children's literature to teach. These topics include basic mathematical concepts such as shapes, counting, number and number operations, money, time, and patterns. It can be argued, that for these PSTs (when mentioned at all), children's literature appears to be useful only for introducing number or shapes to young children. This misconception needs to be addressed given, as highlighted by Bintz et al. (2011) and Franz and Pope (2005), that children's literature is an appropriate vehicle for teaching a broad range of concepts including probability, data analysis and spatial reasoning. 1.96% of all the coding occurrences (4 out of 204) related to literary genres associated with children's literature and mathematics instruction - poems, rhymes and songs - with more PSTs mentioning these genres rather than nominating fiction, for example. Finally, 0.98% of all the coding occurrences (2 out of 204) were related to literary formats and primarily this format was *picture books*. This highlights a further a gap in their knowledge of other formats of children's literature that could be used for mathematics instruction, for example longer form story books such as Powley and Weiskopf's (2009) *Parting is such sweet sorrow: Fractions and decimals* or Thielbar's (2010) *The lost key: A mystery with whole numbers*.

Conclusions

This study set out to explore the beliefs of one cohort of Queensland primary PSTs concerning the integration of children's literature in mathematics teaching and learning. The findings highlight several gaps in knowledge and limitations in their thoughts about the role of children's literature held by them. More specifically, the analysis shows that many of the respondents thought they could rely only on stories with explicit mathematical contents (rather than adapting ones with a more implicit to no mathematical focus and content) and that children's literature can only be used to introduce simple mathematical concepts. Although only one cohort, it is likely that these PSTs are similar to PSTs at many universities; therefore, teacher educators might do more to address these misconceptions, by utilising a wide range of children's literature. This is vital to enhance mathematics teaching and learning with children's literature beyond those uses commonly associated with the early years of schooling. Despite well-documented positive outcomes regarding the use of children's literature in primary school classrooms, the findings of this pilot study reveals a concerning prospect, at least for this cohort, that the use of children's literature is not something that our future teachers are actively and comprehensively thinking about, and could likely result in this teaching strategy becoming a minor component (if at all) in their future teaching of mathematics.

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