Relationship Between Pre-Service Teachers' Early Mathematics Experiences and Their Current Self-Perception on Mathematics

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This study explores the relationship between pre-service teachers' (PSTs) early experiences and their current views on mathematics. The data were collected through an online survey from 107 PSTs and were analysed using descriptive statistics and Pearson's Chi-square test. Study results suggest that PSTs' early mathematics experiences relate to their current self-perception of mathematics. The majority of participants who loved mathematics as children are confident in using mathematics, whereas those who dreaded it at school lack current mathematical confidence. This highlights the importance of early mathematics education in shaping future perceptions.

In education, the influence of early experiences cannot be overstated. For future educators, pre-service teachers (PSTs), these early experiences are not only connected with their views of education but also their future teaching practices in the classroom (e.g., Sayers, 2013; Yang et al., 2020). This study investigates the relationship between PSTs' early mathematics learning experiences and their current view of mathematics in the Australian context. As guided by the Australian Curriculum, Assessment, and Reporting Authority (ACARA, 2019), mathematics education in Australia emphasises the importance of early numeracy skills as the foundation for later mathematical proficiency. The pivotal role of mathematics in students' academic development and the nation's future workforce underscores the significance understanding of how early mathematics experiences influence those prepared to become mathematics educators. While the literature on mathematics education is vast, with research on both early mathematics education (Björklund et al., 2020) and teacher beliefs and practices, there is a noticeable gap in exploring the relationship between early mathematics experiences during one's own schooling years and current view and future teaching in the Australian context. As a result, this study seeks to address the following research question: How did PST's early personal mathematics experiences relate to their current view of mathematics?

Understanding how early mathematics experiences connect with the beliefs and views of PSTs has the potential to inform teacher education programs, curriculum development, and classroom teaching strategies. It can provide valuable insights into how to nurture confident and capable mathematics educators who, in turn, inspire the next generation of mathematics learners in Australian schools.

Background

Early mathematics education plays a pivotal role in influencing the beliefs and practices of future teachers. In Australian schools and elsewhere, the significance of mathematics education in the early years cannot be understated, as it lays the foundation for not only students' mathematical proficiency but also informs the pedagogical approaches employed by teachers (Björklund et al., 2020). This literature review explores the intricate relationship between early mathematics experiences and the development of PSTs' beliefs and views of mathematics.

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Early Mathematics Experiences and Beliefs

Bandura's Social Cognitive Theory (1986) highlights the concept of self-efficacy as the belief or personal judgement about one's competence in a subject matter relative to a specified standard. This concept leads to individuals' perceptions and behaviour and connects with prior experiences, in this case, early mathematics experience. Bandura emphasised the central role of self-efficacy in human agency and its influence on the choices of activities, persistence and efforts, and flexibility to adversity. For example, heightened self-perception or self-efficacy guides individual choices in making decisions, especially in effort expenditure and persistence, which may influence PSTs' beliefs, teaching strategy, and confidence. In contrast, low self-efficacy could result in unstable behaviour, discourages endurance and effort, and may cause total disengagement from learning. Hence, there is a need for continuing research on self-efficacy, self-perception and early mathematics experiences.

Early mathematics experiences are the impressions created by individuals about mathematics after engaging in learning mathematics during primary education levels. In mathematics education, early mathematics experiences can influence individuals' views about the subject. Various studies indicate that the quality and nature of early mathematics experiences significantly influence individuals' beliefs about mathematics (e.g., Sayers, 2013; Yang et al., 2020). For example, early positive experiences profoundly reinforce individuals' self-efficacy beliefs, leading to more confident and enthusiastic mathematics learners (Yang et al., 2020). Another study by Claessens and Engel (2013) found that early mathematics experiences, including exposure to engaging and interactive learning environments or traditional pedagogical approaches (Güler et al., 2023), are linked to changes in attitudes towards mathematics. Furthermore, Sayers (2013), through multiple case studies, revealed that these beliefs, seeded in early mathematical encounters, continue, and reappear in later beliefs and practices. Similarly, Ngan et al. (2003), in their study within early year centres, discovered that such experiences engender consistent beliefs and practices among kindergarten and primary grade teachers, illustrating the enduring influence of these formative encounters. An earlier study by Raymond (1993) explored the role of prior school experiences and teacher education programs, highlighting the relationship between these early factors and serving teachers' beliefs. Collectively, these studies underline the pivotal role of early mathematics experiences in laying the foundation for individuals' beliefs about mathematics.

Early Mathematics Experiences and Beliefs on the Current View/Practice

Relating the early mathematics experience of individuals to their current perception of mathematics, various studies consistently showed that the influence of early mathematics experiences and beliefs extends into one's current view and practice (e.g., Philipp et al., 2007; Yang et al., 2020). A study conducted by Philipp et al. (2007) demonstrated that individuals who actively engaged with children's mathematical thinking while learning mathematics developed more sophisticated beliefs about teaching and learning the subject. This underscores how early experiences influence not only beliefs but also teaching approaches. Also, Ampadu (2014) showed that teachers' beliefs and practices are not static but are continually shaped by background knowledge, professional development, and school culture, with early experiences serving as foundational elements. Moreover, Yang et al. (2020) provided empirical evidence of the enduring impact of early beliefs. They revealed that teachers' knowledge and beliefs, which often originate from early experiences, directly and indirectly, influence their current views and practices, demonstrating that early experiences continue to influence teaching throughout one's career. On the contrary, Purnomo et al. (2016) found that inconsistencies can emerge between beliefs formed in early experiences and actual classroom practices, suggesting that these beliefs do not always translate directly into current views or teaching actions.

While there is a substantial body of research exploring the relationship between early mathematics experiences and teacher beliefs and practices, there is a need for more specific investigation within the Australian context. The existing literature predominantly focuses on broader international perspectives, with limited attention paid to the unique challenges and opportunities the Australian education system presents. Recognising and understanding this relationship is crucial for the continuous improvement of mathematics education in the country. This study aims to contribute to the existing body of knowledge by exploring this relationship in the Australian context.

Method

Participants

This study involved 107 PSTs enrolled in a teacher education program at a regional university in Australia. These PSTs were in their third-year initial teacher education program to become primary school teachers in Australia. Data for this research was collected from two distinct cohorts of PSTs, comprising 68 PSTs from the 2021 cohort and 39 from the 2022 cohort, representing 59.8% of the total 179 enrolled students. The authors did not collect demographic information from the participants.

Data Collection

Data were collected through an anonymous online survey comprising three closed-ended questions. The three questions were: (1) How did you view mathematics in primary school; (2) How do you remember being taught mathematics when you were at school? Select the most common ways you were taught; and (3) How do you view yourself as a mathematician/educator today?

Data Analysis

The initial analysis stage focused on descriptive statistics, including frequency and percentage, offering an overview of PSTs' early experiences and views of mathematics. We used cross-tabulation techniques to explore relationships within the data and presented the findings using stacked bar charts. These techniques examined the relationships between various aspects, such as their current self-view of mathematics and their early mathematics experiences and views. Pearson's Chi-squared test was conducted to discern significant associations between primary school and current views and teaching methods across cohorts.

Results

Early and Current View of Mathematics

Analysis of the survey responses revealed several key themes related to the connection between early mathematics learning experiences and PSTs' current mathematics beliefs. Table 1 shows the early views of PSTs toward mathematics.

Table 1

PST's View of Mathematics in Primary School

Item	Frequency	Percent
Loved it	40	37.4
Could do it but I did not look forward to mathematics lessons	37	34.6
Just dreaded it!	30	28.0
Total	107	100

As shown in Table 1, many PSTs (37.4%) expressed positive views, indicating that they loved mathematics during their primary school years. On the other hand, 34.6% of the PSTs

had the ability but did not particularly look forward to mathematics lessons, reflecting a neutral stance. Notably, 28.0% of the PSTs admitted having dreaded mathematics in primary school. These results underscore a range of perceptions among the PSTs, with a substantial portion having positive views about mathematics in their early education. In contrast, others held mixed or negative views.

The other theme investigated in this study was the PSTs' current view of themselves as a mathematician/educator. Table 2 summarises how the PSTs perceive themselves as mathematicians today.

Table 2

PSTs Self-View as a Mathematician Today

Item	Frequency	Percent
Love using mathematics to work out problems and enjoy learning about new mathematical ideas	21	19.6
Confident to apply mathematics in my everyday life	33	30.8
Ok, but I often feel like I need to double-check my calculations.	42	39.3
Not confident. I often avoid having to work things out if mathematics is involved.	11	10.3
Total	107	100

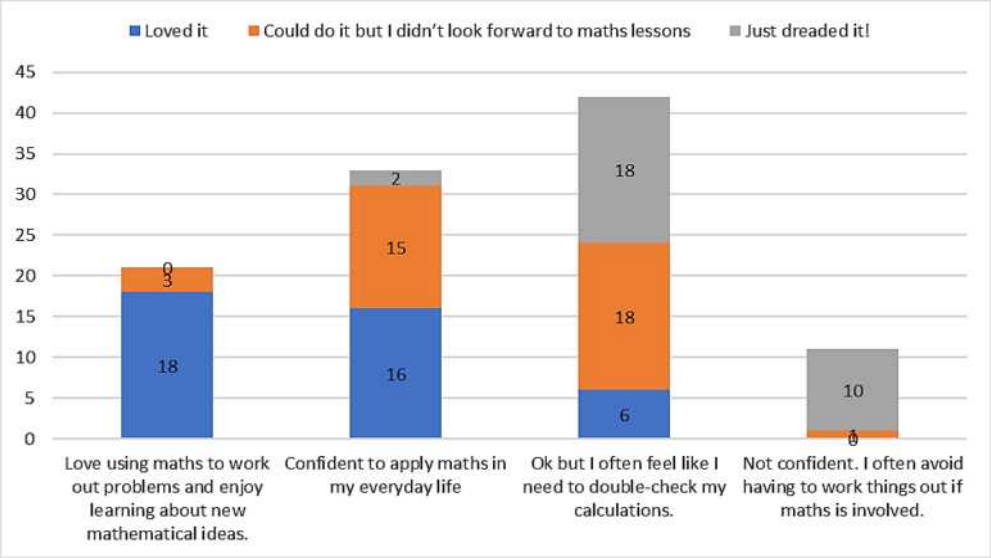
As shown in Table 2, 30.8% of the PSTs notably expressed confidence in applying mathematics in their daily lives. About 39.3% valued precision, often double-checking calculations. Additionally, 19.6% of the PSTs exhibited a strong love for mathematics, enjoying problem-solving and exploring new concepts. However, 10.3% of the PSTs lacked confidence and often avoided mathematics-related tasks.

Relationship Between PSTs' Early View of Mathematics and Their Current View as a Mathematician

Figure 2 reveals the relationship between how PSTs viewed mathematics in primary school and their current self-perception as mathematicians.

Figure 2

Link Between PSTs' Early View of Mathematics and Their Current View as a Mathematician



PSTs who loved mathematics during their primary school years predominantly fall into the category of "Love using mathematics to work out problems and enjoy learning about new

mathematical ideas" today, with 18 out of 21 respondents falling into this group. On the other hand, those PSTs who dreaded mathematics in primary school tend to fall into the "Not confident, I often avoid having to work things out if mathematics is involved" category today, comprising 10 out of 11 the PSTs in this group. Interestingly, there is a relatively even distribution among the PSTs who could do mathematics but did not look forward to lessons in primary school, as they are spread across various categories of self-perception as mathematicians today. In addition, the Pearson Chi-Square value is statistically significant, $\chi^2(6, 107) = 61.21$, $p<0.001$. These findings illustrate a connection between early perceptions of mathematics and current self-identifications as mathematicians among PSTs, highlighting the importance of primary school experiences.

PSTs Early Mathematics Learning Experiences

Table 3 provides insights into how PSTs remember being taught mathematics during their own school years.

Table 3

PSTs Taught Mathematics at Primary School

Early learning/teaching strategies	Responses		Percent of cases
	n	**Percent**	
Copying sums from the board to complete after a demonstration of how to work an example by the teacher	103	30.0	96.3
Using real life materials and situations to learn a mathematical concept or apply understanding	20	5.8	18.7
Using concrete materials or other manipulatives to understand or work through math ideas	33	9.6%	30.8
Working on exercises in a textbook	96	28.0	89.7
Working in groups with other students to learn new math concepts	24	7.0	22.4
Using a calculator to work out answers	55	16.0	51.4
Going on math excursions to see real life examples of mathematical learning	2	0.6	1.9
Visits from experts to demonstrate how they use mathematics	2	0.6	1.9
Using computer software to make learning more interactive	8	2.3	7.5
Total	343	100	320.6

As shown in Table 3, the most prevalent teaching method recalled by the PSTs is "Copying sums from the board to complete after a demonstration of how to work an example by the teacher," representing 96.3% of responses. This traditional approach seems deeply deep-seated in their memory. Additionally, 89.7% of the PSTs reported "Working on exercises in a textbook," indicating a substantial reliance on textbook-based learning. Interestingly, only a smaller percentage, 30.8% of the PSTs, recall using "concrete materials or other manipulatives" to understand math concepts. In comparison, 51.4% of the PSTs recall using calculators, suggesting a shift toward technology in teaching methods. These findings underscore the dominance of traditional teaching approaches in the PSTs' memories of their own mathematics education, with some indications of evolving methods involving technology and hands-on learning experiences.

PSTs Early Mathematics Experience and Their Current View as Mathematician

Table 4 shows the connection between the PSTs' memories of their primary school mathematics education and their current self-perception as mathematicians.

Table 4

How PSTs Remember Being Taught Mathematics When They Were at School and how They View Themselves as a Mathematician Today

Early learning/teaching strategies	Self-view as a mathematician/educator today				Total
	1^{α}	2^{β}	3^{γ}	4^{δ}	
Copying sums from the board to complete after a demonstration of how to work an example by the teacher	19 (17.8%)	33 (30.8%)	40 (37.4%)	11 (10.3%)	103 (96.3%)
Using real life materials and situations to learn a mathematical concept or apply understanding	7 (6.5%)	3 (2.8%)	9 (8.4%)	1 (0.9%)	20 (18.7%)
Using concrete materials or other manipulatives to understand or work through math ideas	9 (8.4%)	9 (8.4%)	15 (14.0%)	0 (0.0%)	33 (30.8%)
Working on exercises in a textbook	16 (15.0%)	32 (29.9%)	38 (35.5%)	10 (9.3%)	96 (89.7%)
Working in groups with other students to learn new math concepts	4 (3.7%)	6 (5.6%)	13 (12.1%)	1 (0.9%)	24 (22.4%)
Using a calculator to work out answers	11 (10.3%)	19 (17.8%)	20 (18.7%)	5 (4.7%)	55 (51.4%)
Going on math excursions to see real-life examples of mathematical learning	1 (0.9%)	0 (0.0%)	1 (0.9%)	0 (0.0%)	2 (1.9%)
Visits from experts to demonstrate how they use mathematics	0 (0.0%)	2 (1.9%)	0 (0.0%)	0 (0.0%)	2 (1.9%)
Using computer software to make learning more interactive	1 (0.9%)	4 (3.7%)	2 (1.9%)	1 (0.9%)	8 (7.5%)
Total	21 (19.6%)	33 (30.8%)	42 (39.3%)	11 (10.3%)	107 (100%)

$^{\alpha}$Love using mathematics to work out problems and enjoy learning about new mathematical ideas; $^{\beta}$Confident to apply mathematics in my everyday life; $^{\gamma}$OK, but I often feel like I need to double-check my calculations; and $^{\delta}$Not confident. I often avoid having to work things out if mathematics is involved.

The PSTs who recall being taught through traditional methods, such as "Copying sums from the board to complete after a demonstration by the teacher" (96.3%), related with two self-perception categories, "Confident to apply mathematics in my everyday life" (30.8%) and "Ok but I often feel like I need to double-check my calculations" (37.4%). This underscores the association between traditional teaching techniques and confidence. Similarly, "Working on exercises in a textbook" (89.7%) is linked with varied self-perception categories, including "Not confident". I often avoid having to work things out if mathematics is involved" (35.5%). Mainly, those taught with calculators for answers (51.4%) display mixed self-perception, but a significant portion lean toward "Confident to apply mathematics in my everyday life". On the other hand, hands-on approaches like "Using concrete materials or other manipulatives" and "Working in groups with other students" yield more balanced distributions among self-perception categories of the PSTs. However, the Pearson Chi-Square value between their early teaching and learning mathematics experience and their current view as a mathematician is not statistically significant, $\chi^2(24, 107) = 35.14$, $p > 0.001$. These findings illustrate the lasting

influence of primary school teaching methods on the PSTs' current self-perception as mathematicians, with traditional methods influencing confidence levels but not significant.

Discussion

This study investigates the relationship between PSTs' early mathematics experiences and their current self-perceptions as mathematicians/educators. By addressing our research question, we have uncovered findings that provide valuable insights into how early mathematics experiences connect with future mathematics educators.

The dominance of traditional teaching methods, as indicated by the substantial recall of "Copying sums from the board" and "Working on exercises in a textbook," underscores the deeply in-built nature of these methods in the PSTs' memories. This alignment with the existing literature suggests that traditional approaches have been a consistent feature of mathematics education (Güler et al., 2023). This emphasises how early exposure to teaching methods influences the self-perceptions of future educators.

The diverse range of perceptions expressed by the PSTs toward mathematics during their primary school years echoes previous research findings (Leder & Forgasz, 2002). While a considerable portion recalled "loving" mathematics, a significant percentage exhibited neutrality or even disliked the subject. This heterogeneity of perception aligns with the established understanding that students' experiences and views about mathematics during their formative years vary widely (Elçi, 2017). Moreover, the study emphasises a distinct link between pre-service teachers' (PSTs') early experiences in mathematics and their present self-view as mathematicians. This finding aligns with Bandura's Social Cognitive Theory (1986), which suggests that early experiences influence one's current self-perception, with a significant relationship from the Pearson Chi-Square value, $\chi^2(6, 107) = 61.21$, $p < 0.001$. Those who remembered positive primary school mathematics experiences, such as "loving" math, often exhibited confident and enthusiastic self-perceptions as mathematicians today, which resonates with the notion that early positive experiences can contribute to a stronger identity as a mathematics educator or learner (Sayers, 2013).

The indication of a shift toward technology in teaching methods, as evidenced by the recall of using calculators, reflects the evolving landscape of mathematics education. This suggests that technology is increasingly integrated into mathematics classroom teaching, influencing PSTs' perceptions and self-identifications as mathematicians in contemporary contexts.

This study emphasises the continuing influence of early mathematics experiences on PSTs' attitudes and self-perceptions as mathematicians. Traditional teaching methods play a significant role in influencing these perceptions, with some indication of evolving methods involving technology. Recognising these associations is vital for designing effective mathematics education programs that cater to the diverse needs and attitudes of future educators. Moreover, fostering positive early mathematics experiences is crucial for cultivating confident and passionate mathematicians among PSTs, thus contributing to improving mathematics education in schools.

Conclusion

The study reveals critical insights into mathematics education and teacher preparation, highlighting the need for customised support in teacher education programs for PSTs with varied perceptions of mathematics. Many PSTs recall either loving or dreading mathematics in primary school, which connects with their current self-perceptions as mathematicians. Those with positive early experiences tend to enjoy mathematical problem-solving, while those with negative experiences often lack confidence. The study emphasises the lasting relationship between primary school experiences and PSTs' perceptions and identities in mathematics.

Limitations

While this study provides valuable insights into the connection between early mathematics experiences and the current views of the PSTs, it has certain limitations. Self-reported data collected through surveys are subject to response and retrospective recall biases, potentially impacting data accuracy. In addition, the study results provide a snapshot rather than a longitudinal view of beliefs' evolution over time. The fixed-response survey format may not capture the full complexity of the PSTs' views and experiences, and the study does not explore contextual factors or causality. Additionally, the study's scope focuses primarily on views and experiences without a deep investigation of the specific teaching strategy effectiveness or interventions. Addressing these limitations in future research would contribute to a more comprehensive understanding of this intricate relationship and generalisations.

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