

# Critical Moments in Learning Mathematics: First Year Pre-service Primary Teachers' Perspectives

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Pre-service primary teachers have been identified in several research studies as having poor self-conceptions of themselves as mathematics teachers. Many express feelings of anxiety when faced with mathematics tasks resulting in poor dispositions and understandings. This paper reports on beginning pre-service primary teachers' (N=106) recollections of critical moments in their mathematics education at school. Interestingly, their graphical ratings of their dispositions suggest a slightly positive recollection of their mathematical experiences. In contrast their justifications and recount was generally negative.

Many pre-service primary teachers have demonstrated negative feelings and attitudes to learning mathematics. These attitudes have been extensively researched (Beswick & Dole, 2008; Wilson & Thornton, 2006). Generally, for mathematics teacher educators, the task has been to counter prior negative experiences with affirming activities that engage and enable learners to re-evaluate their dispositions to learning mathematics and address personal misconceptions and understandings in light of how they might teach the subject. In this respect, mathematics teacher education is viewed as intertwining the teaching and learning of mathematics to gain an in-depth conceptual and procedural understanding. Clearly, to achieve this, a sequential understanding of mathematics concepts and processes is required to gain a self-fulfilling and robust vision of teaching and assessing mathematics. However, for learning mathematics, essentially the task is contextual and likely to be non-linear, requiring a productive disposition, perseverance, and a willingness to analyse tasks as a teacher. Subsequently, the role for the mathematics teacher educator is complex and much more than teaching content and skills. As highlighted by Owens (2007), it is to help pre-service teachers develop their "identity as mathematical thinkers" (p.36). Further, it is to develop a professional demeanour as a mathematics teacher and therefore learner.

Pre-service teachers' attitudes and feelings about learning mathematics has been an area of concern. It is argued (Tobias & Itter, 2007) that in order to address conceptual and procedural understanding, a learner's willingness to engage in the process is critical. Given that many pre-service primary teachers have had poor prior experiences as learners, there is a concern that this will affect their willingness to engage at a mastery level in mathematics education units while at university and adopt a performance view (Dweck, 2000) as classroom teachers.

The recent Group of Eight's (Go8) *Review of Education in Mathematics, Data Science and Quantitative Disciplines* (Brown, 2009) found that "the state of the mathematical sciences and related quantitative disciplines has deteriorated to a dangerous level" (p.3). This has been widely reported and acknowledged over many years. Interestingly, the Go8 review emphasised "student attitudes", "appreciation" and "fun" along with "application" to "make mathematics interesting and relevant" (p.4) and then suggested a model for pre-service primary teachers based on undertaking first year mathematics discipline units of

study. As a conclusion the Go8 review acknowledged, “It is difficult to find sharp evidence of how these issues affect attainment in primary schools but it seems dangerous to ignore the first links of the supply chain” (p.4). However contentious this may seem, it does raise an interesting juxtaposition.

## Background

This study reports on the attempts of mathematics educators to dislodge negative dispositions and improve first-year pre-service primary teachers’ abilities. This has been a long-term fundamental issue. Ball (1990) identified the problem that beginning teachers of mathematics teach in a manner that reverts back to their prior experiences as a student at school. The experiences that frame teaching practices adopted by beginning teachers is based on their personal memories and belief systems that have developed as a result of their educational experiences. Beswick (2008, p.68) defined a “belief as anything that an individual regards as true” and suggested that what they regard to be true is shaped by personal interconnected experiences both in and out of school.

Essentially, knowledge that becomes central in the sense of having many connections with other beliefs, and particularly to those about self, is most likely to be retained. This includes knowledge that has an emotional meaning to the individual concerned and that constitutes part of his/her identity. (Beswick, 2008, p.73)

Subsequently, the role of the mathematics teacher educator is critical in identifying and dislodging negative beliefs and helping students master concepts and processes, by understanding how children develop conceptually and what the implications for pedagogy might be.

In this study, as an initial measure, students were asked to complete the ‘Critical Moments Survey - Feelings about Learning Mathematics’ (Figure 1) task. The survey responses provided an insight into the prior learning experiences of the cohort to gain a general understanding of their dispositions to learning mathematics. It was hoped that this base line data maybe useful in two ways; (a) for gauging the extent of any attitude or confidence issues that may prevail, and (b) as a basis for addressing deeply entrenched views of both teaching and learning mathematics.

This study was designed to investigate the following research question: What were the first year primary education students’ recollections of their critical moments when learning mathematics at primary and secondary school?

## Methodology

The ‘Critical Moments Survey - Feelings about Learning Mathematics’ was undertaken in the initial stages of Semester Two 2009 with 106 (88 female, 18 male) first-year primary pre-service teachers undertaking the BEd course at The University of New England in Armidale, NSW. The pre-service teachers were enrolled in a first year, semester-length mathematics education unit of study. All participants are described as continuing students who arrive at university immediately or within a few years of completing secondary school education.

In an effort to understand the prior learning experiences of the cohort, they were surveyed to gain a glimpse of the extent of their perceived concerns. Participants were asked to complete the survey to identify the critical moments in their mathematics education. This paper reports on the findings and implications for mathematics education that can be generalised beyond the host institution. The survey, shown in Figure 1, was

designed to provide pre-service primary mathematics education students with an opportunity to reflect on their prior mathematics learning experiences as a graphical representation.

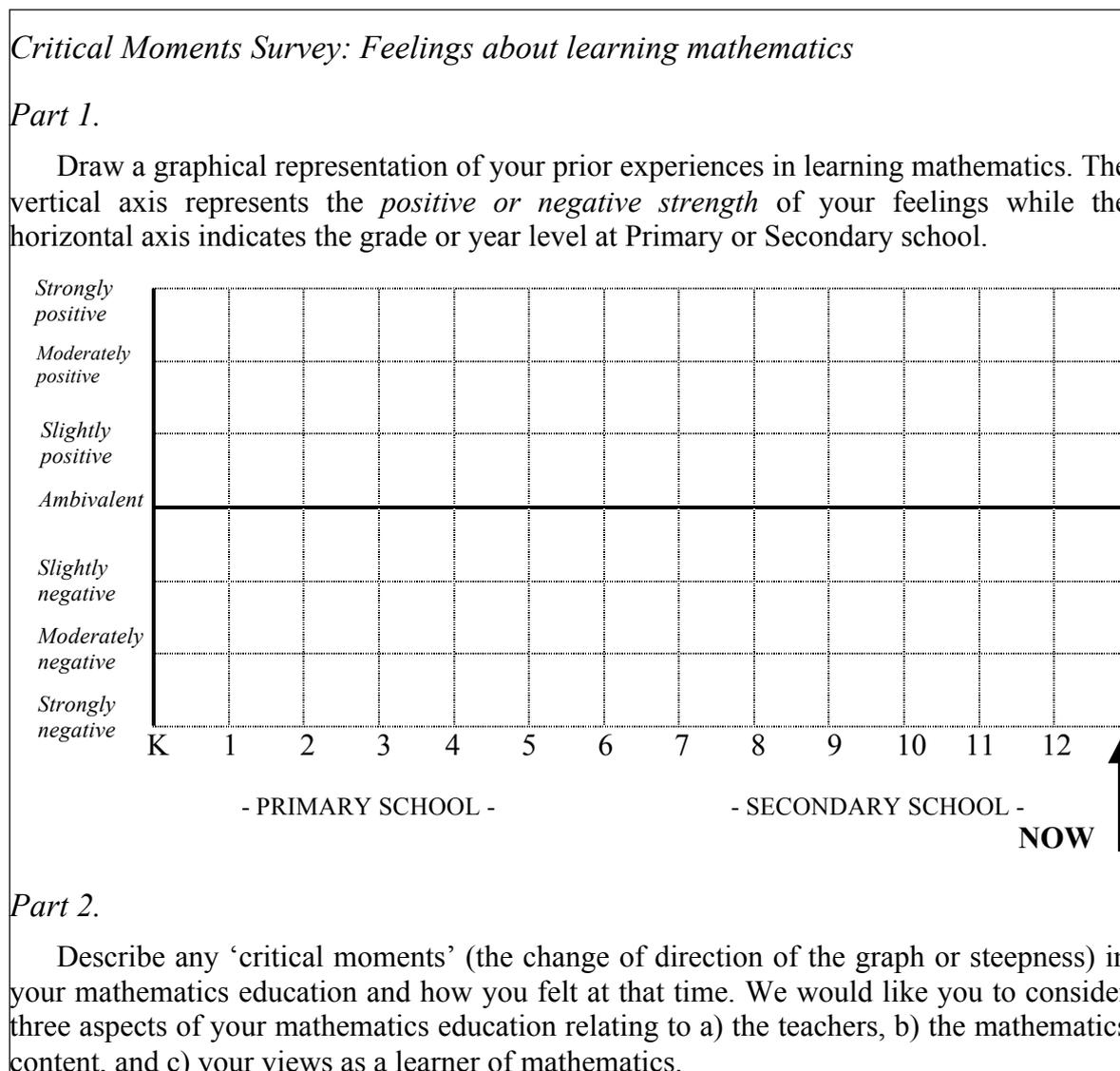


Figure 1. Mean rating of disposition of the cohort of first-year pre-service primary teachers.

Additionally, the beginning pre-service teachers were asked to explain any critical moments (defined as: a change in direction, or an increasing or decreasing gradient of the graph) in their mathematics education and how they felt at that time. The pre-service teachers were able to justify their perceived critical moments openly as a personal reflection. The justifications were analysed qualitatively (Miles & Huberman, 1994) to identify emerging themes.

## Results

The results presented below highlight some interesting trends in this cohort of first-year pre-service primary teachers' perceptions of critical moments when asked to reflect upon their mathematical learning journey. These are presented in graphical form which portray the mean disposition rating for each year of schooling and their present disposition

rating. The standard deviations were calculated for each school year and are included in the form of error bars that illustrate the variance evident in the participants' responses. Due to the extent of variation, a summary of themes arising from the content analysis of the student justifications is included in the results section and expanded on in the discussion. Figure 2 presents the mean ratings of disposition across the years and provides some insight into where the critical moments of mathematical learning were expressed. Overall, the mean ratings remained on the positive side. However, there is a marked decrease in ratings after entering secondary school, with a more positive rating in the final year.

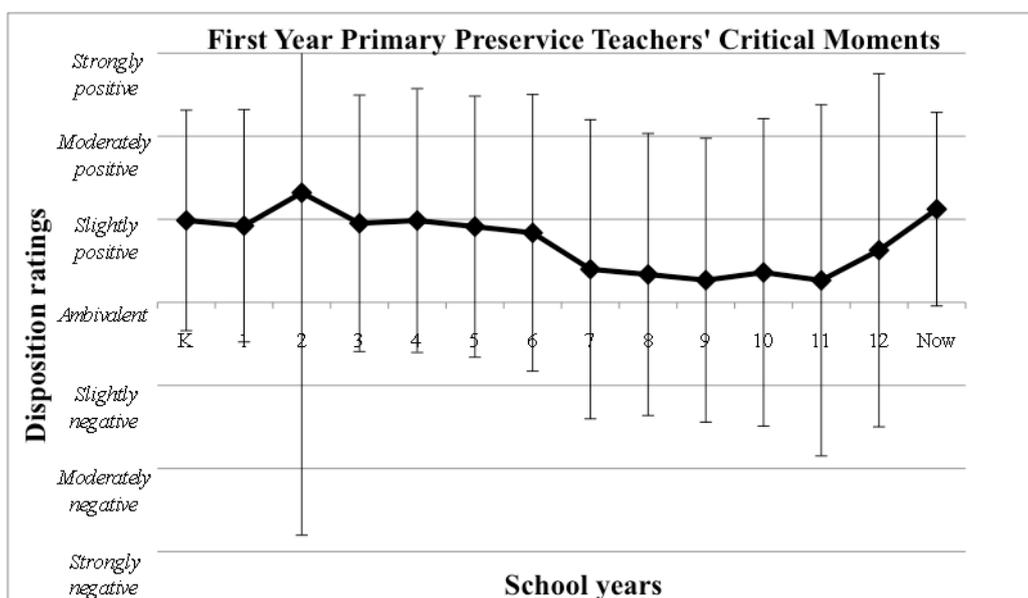


Figure 2. Mean rating of disposition of the cohort of first-year pre-service primary teachers.

When separating the cohort by gender and considering the mean ratings, as presented in Figures 3 and 4 below, the males (less than 20% of participants) and females followed a similar pattern of low points. However, the males were more negative in their disposition rating of lower secondary. The means suggest a marked negative critical moment when reflecting upon their experiences as a Year 8 student and an ambivalence during Year 9. There is a gradual improvement in overall disposition over the remaining years of secondary education. The females recorded the highest mean rating of their disposition during Year 2, the mean is consistently slightly positive during primary school. The mean rating decreases for females over five years from Years 7 to 11. Disposition was not rated as negatively as the males over this period of schooling. Figures 3 and 4 show the variance of the ratings for females and males respectively. This variance highlights the need to consider the themes in the light of justifications offered by the students.

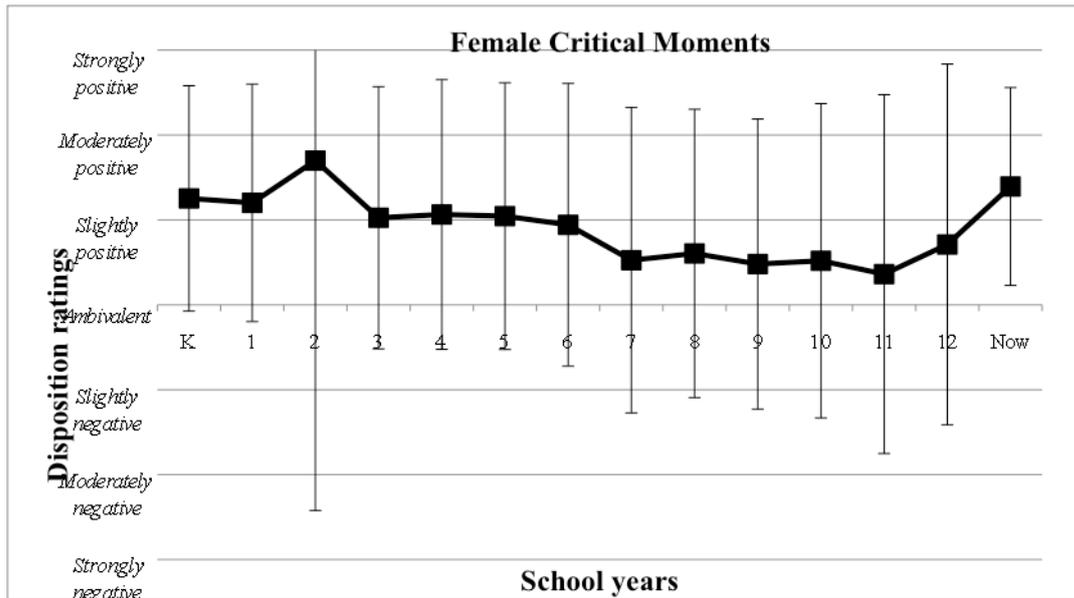


Figure 3. Female first-year pre-service primary teachers mean disposition ratings

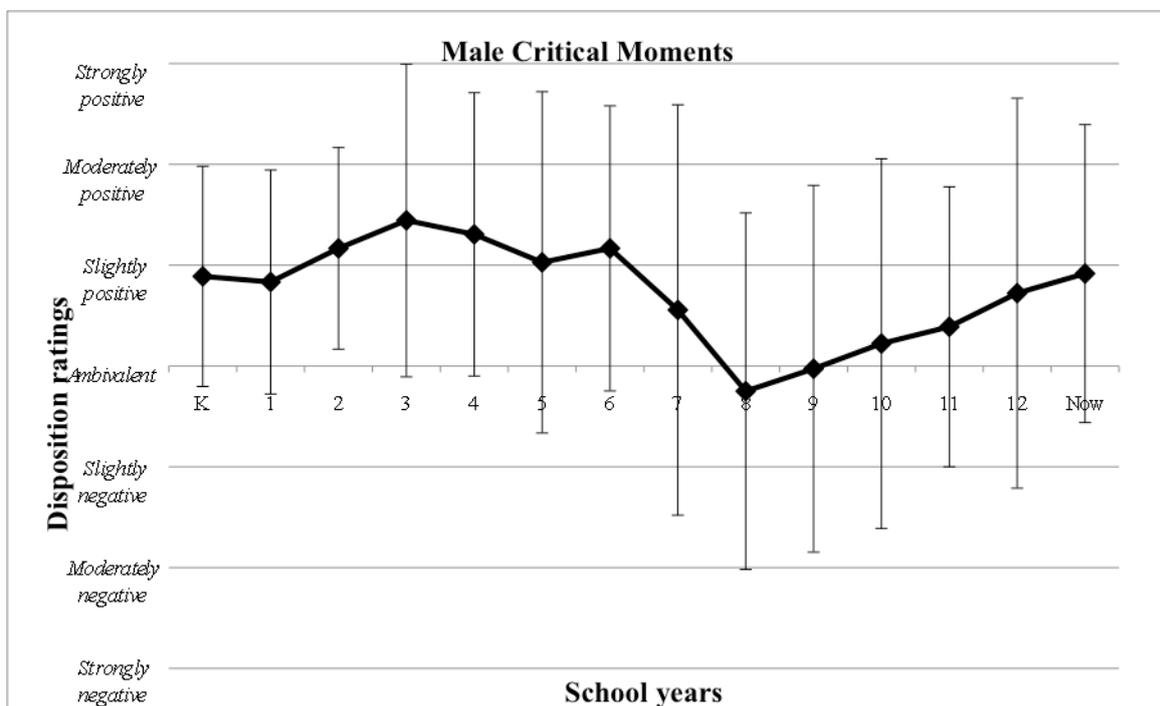


Figure 4. Male first-year pre-service primary teachers mean disposition ratings

The themes arising from the provided explanations of perceived critical moments are summarised below in Table 1. The area of each square depicts the relative frequency of each theme arising in the justifications. Hence, the numerical value was not used in Table 1 with the frequency patterns assisting in identifying trends in disposition over the school years. The discussion to follow considers the patterns arising from these themes in the light of the mean ratings. The positive and negative signs added to each theme description in

Table 1 indicate an increase or decrease in rating respectively when providing the justification.

Table 1  
*Themes Arising From the Content Analysis of the Critical Moment Justification*

Themes	K	1	2	3	4	5	6	7	8	9	10	11	12
Maths was fun and involved games (+)	■	■	■	■	■			■		■	■		
Change in teacher (-)		■	■	■	■	■		■	■		■	■	■
Content was difficult (-)	■	■	■	■	■	■	■	■	■	■	■	■	■
Placed in an inappropriate level or class grouping (-)					■	■	■	■	■	■	■		
Content was irrelevant and dull (-)				■	■			■	■	■	■	■	■
Stagnating time in my learning (-)								■	■	■	■	■	■
Teacher was not helpful, boring, and couldn't relate to students (-)		■	■	■	■	■	■	■	■	■	■	■	■
Teacher was helpful, enthusiastic, and positive (+)	■	■	■	■	■	■	■	■	■	■	■	■	■
Parental support (+)	■												
Maths was integrated across the curriculum (+)	■	■	■	■									
Hands-on activities (+)	■	■	■	■	■	■	■	■		■			
Content easily understood/enjoyable (+)	■	■	■	■	■	■	■	■	■	■	■	■	■
Social issues impacted on my learning (-)				■	■	■	■	■	■	■	■	■	■

## Discussion

When interpreting the mean disposition ratings and self-selected justifications of perceived critical moments, it was evident that teacher's level of enthusiasm, interaction with students, and ability to engage the students actively was a prevalent justification

across the thirteen years of schooling. An example of positive critical moments included “influential teacher, built up my confidence, I began enjoying maths again” (Yr 12) and:

Throughout these final years, I had a fantastic and most inspiring mathematics teacher. He had great teaching strategies that allowed me to understand concepts such as percentages and money easily. This resulted in my feeling towards mathematics to be moderately positive. This period of time in my schooling was my most positive in regards to mathematics (Year 11-12).

Another participant stated that an “excellent teacher guided me to explore different ways of solving problems” (Yr 3). In contrast to these statements, low points were frequently contributed to a teacher being unhelpful, dull and unable to relate to students, and the teacher having poor content knowledge. Sample responses included “passive, boring teacher” (Yr 7), “poor grasp of content, ineffective teacher” (Yr 8), and:

My teacher held no passion for teaching and this influenced my attitude dramatically as a learner. Pedagogy was repetitive and not engaging, as a learner I failed to meet the requirements of the syllabus. At this point I was achieving at a low standard” (Yr 8).

Similarly, justifications offered that there was “no guidance from my teacher and inadequate teacher knowledge” (Yr 8) and that “learning out of textbooks” (Yr 8) was a predominant teaching style.

The perceived level of content difficulty featured across many students’ journeys. Interestingly, whilst Year 8 and Year 9 were identified as relatively low critical moments, the emphasis on content difficulty declined, and was replaced with issues such as relevancy of content, social issues, and class streaming. The impact of relevancy of content was depicted in responses such as “maths became more irrelevant and abstract” (Yr 9). Of particular interest was the raised focus on social issues during Years 5, 6, 7, 8 and 9 that corresponds to lower disposition points, and hence, a critical time in students’ mathematical learning. This is illustrated in the following comment; “my social life became more important” (Yr 9). This focus on social aspects was further compounded by class structures where one participant expressed that “I felt like I was in the dumb class” (Yr 8). The placing of students in ability groupings was provided as a justification for low points in their journey for two reasons. Some participants identified the impact of being placed in a class that was perceived as “lower level” when they were capable of completing more difficult content. Other comments related to the difficulties associated with being placed in a class that targeted harder concepts than their level of understanding. The influence of a change in teaching staff in Years 11 and 12 increased as a justification for low points in their mathematical learning. A minor emphasis was placed on stagnation in mathematical learning without elaboration as to why this occurred.

Recollections of the first two years of schooling showed an emphasis on playing games and having fun during mathematics lessons. Whilst recollections of one’s early years could be considered a limitation of the study, Beswick (2008, p.68) suggested that a recollection or a belief of a prior experience is regarded as true and has a direct impact upon their current behaviour. One participant provided the following justification for a high critical moment, “maths in the early years was very hands-on and concrete” (K-Yr 4). This declined during the primary years and was highlighted by some students as important to them in Years 7, 9, and 10. Similarly, students described that it was the ‘hands-on’ approach to the teaching of mathematics that assisted their learning in the primary years with few comments of this nature in Years 7 and 9. It is interesting to note that the integration of mathematics across the curriculum as a positive element appeared minimally and in the lower primary years in particular. Parental support featured minimally in the first year of schooling and was provided to explain a positive disposition rating.

## Conclusion

The results of the study indicate that pre-service teachers' dispositions vary for several main reasons. The predominant positive influence was the teacher's enthusiasm and consideration of the individual learner. However, many experiences were recalled in a negative light and were described as boring and unrelated, particularly in junior secondary education.

Pre-service teachers' attitude is influenced by their prior learning experiences, in turn this may influence their views as a future classroom teacher. Either way, teacher education provides a critical opportunity for influencing a student's mathematics education learning cycle and enhancing attitudes and confidence through conceptual and pedagogical understanding. Alternatively, the concern that falling attainment levels can be addressed with a 'more of the same' approach will potentially inflame poor self-concepts that pre-service teachers tend to display if conceptual and procedural understanding are not contextually achieved in light of pedagogical and cognitive classroom realities. Therefore, mathematics education units at the tertiary level should encourage a renewed view of learning and teaching beyond a procedural understanding of mathematics. This raises questions as to the appropriateness of including mathematics content units that are void of contextual links to the mathematics classroom.

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