Exploring the relationship between teacher enjoyment of mathematics, their attitudes towards student struggle and instructional time amongst early years primary teachers

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HIGHLIGHTS

• Enjoyment of teaching mathematics was strongly related to teacher attitudes towards student struggle ($r = 0.52$).
• Enjoyment of teaching mathematics was related to instructional time spent on mathematics ($r = 0.25$).
• A reliable measure of teacher attitudes towards student struggle in mathematics was developed ($\alpha = 0.74$).

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ABSTRACT

In this study we explored the relationship between teacher enjoyment of teaching mathematics, their attitudes towards student struggle, and the amount of time teachers spent teaching mathematics. Ninety-eight primary educators were surveyed regarding their attitudes and behaviors towards mathematics instruction. Hierarchical regression analyses revealed that teacher enjoyment of teaching mathematics explained variance in both teacher attitudes towards student struggle and instructional time spent on mathematics, even after relevant educator characteristics were accounted for. Findings suggest that teacher enjoyment of teaching mathematics in the early primary years has important implications for both the quality and quantity of mathematics instruction students receive.

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1. Introduction and literature review

1.1. Introduction

Emotion is pervasive in educational contexts for both students and teachers (Hargreaves, 1998). Most teachers acknowledge the positive charge from emotions such as enjoyment and pride when learners actively respond to their teaching or demonstrate progress in understanding. Most would also have experienced negative emotions such as disappointment associated with student disengagement or perceived lack of learning. Recognition of the critical role emotions play in educational settings has given rise to a growing research interest in emotions, with the majority concentrating on the student perspective (Jacob, Frenzel, & Stephens, 2017; Sutton & Wheatley, 2003). However, there is now an emerging body of research that focuses on teacher emotions, particularly exploring the reciprocal links between teacher and student enjoyment (Frenzel, Becker-Kurz, Pekrun, Goetz, & Lüdtke, 2018; Russo & Russo, 2019), teacher enjoyment and teaching quality (Frenzel et al., 2016) and how emotions shape teacher instructional approaches (Jacob et al., 2017; Trigwell, 2012).

Both teaching and learning quality in mathematics are acknowledged as greatest in classrooms where teachers’ instructional approaches consistently incorporate cognitively challenging tasks that encourage high-level thinking in their students (National
Council of Teachers of Mathematics, 2014). Unfortunately, teachers are reluctant to routinely implement such tasks (Cheeseman, Clarke, Roche, & Wilson, 2013). Researchers have suggested several reasons for this limited uptake, including teachers’ beliefs about and attitudes towards the teaching of mathematics, their acceptance of student struggle (Chapman, 2013), and constraints surrounding instructional time required to effectively support students who are struggling (Warshauer, 2015). Prompted by evidence linking teacher enjoyment of teaching to their positive attitudes towards and willingness to adopt instructional approaches involving student-focused pedagogy needed to effectively implement challenging tasks (Stipek, Givvin, Salmon, & MacGyvers, 2001; Trigwell, 2012), we sought to explore teacher enjoyment of teaching mathematics, and its relationship with important teacher attitudes and instructional behaviours associated with the effective implementation of challenging tasks.

Prior research in the domain of mathematics has predominantly focused on the impact of teachers’ negative attitudes and emotions (namely, the negative attitudes and mathematics anxiety of primary teachers) on student outcomes (e.g., Bellock, Gunderson, Ramirez, & Levine, 2010; Ma, 1999). In this study, our central aim was to explore the relationship between early primary year teachers’ enjoyment of teaching mathematics, teachers’ attitudes towards student struggle in mathematics, and the amount of time teachers spend teaching mathematics in their classrooms. Given the absence of a suitable instrument to measure teacher attitudes towards student struggle in the primary mathematics classroom, a secondary aim of the study was to develop a purposeful, preliminary measure for measuring this aspect of teacher attitude.

## 1.2. Emotions and teacher enjoyment of teaching mathematics

Emotions are defined as mental states (Hargreaves, 1998) and generally conceived as multicomponential (Sutton & Wheatley, 2003), involving systematic changes in a range of cognitive, psychological and expressive components. They are inherently linked to and influenced by attitudes (Philipp, 2007). Like emotions, attitudes are observable via actions but are better at revealing one’s thinking, opinions or disposition. On the other hand, emotions change more rapidly, are felt more intensely and considered to be “less cognitive than attitudes” (Philipp, 2007, p. 259).

As a positive emotion, enjoyment is the subjective feeling of pleasure associated with a particular activity or event. It is considered to arise from feelings of being in control over a situation that is also sufficiently valued and interesting (Pekrun, 2006). Teachers’ enjoyment of teaching has many positive consequences for their classroom instruction and environment. To explore the reciprocal benefits of teacher and student enjoyment, Frenzel et al. (2018) studied 69 grade 5 to 10 teachers and their students in a range of disciplines including mathematics across six months of the school year. Findings indicated that teachers’ enjoyment at the start of the school year was positively related to student perceptions of their teachers’ enthusiasm for teaching and to student enjoyment at midterm. Teacher enjoyment at the start of the year as measured by their level of enthusiasm was also positively related to their reported feelings of enjoyment for teaching later in the year. Frenzel et al.’s findings add to those of previous studies indicating that enjoyment of teaching, can positively impact student enjoyment of learning, energise teachers in their desire to improve the quality of their instruction, and protect teachers against burn-out and attrition (Frenzel et al., 2016). In the context of the current study, these findings suggest that teachers who enjoy teaching mathematics for instance, are more likely to seek out professional learning opportunities in that discipline than in other disciplines or than other teachers and are more likely to stay longer in the profession. Trigwell (2012) suggested that the confidence teachers gain from feeling positive about teaching may encourage more risk-taking in the teaching approaches they adopt. In a study investigating the relationships between tertiary teachers’ emotions and their approaches to teaching, Trigwell (2012) found that teachers who described higher levels of enjoyment towards and about their teaching also described their teaching in terms of a student-focused approach. Conversely, teachers who described negative emotions towards their teaching tended to be teacher-focused in their teaching approaches, selecting transmissive strategies that were perceived as ‘safe’ and that would ensure content was delivered.

Teachers who adopt student-focused approaches view their role as facilitators of student learning rather than simply transmitters of knowledge. They also view student learning as a process of conceptual change whereby learners are encouraged to construct their own knowledge (Trigwell, 2012) and apply assessment strategies that focus on deep understanding of mathematics concepts and processes rather than just right answers (Stipek et al., 2001). According to Stipek and her colleagues, student-focused teaching approaches in mathematics are associated with ‘high-risk’ strategies involving cognitive challenge, open class discussions, and increased interaction among students and between teachers and their students. While Trigwell (2012) made a clear case for linking instructional practices of teachers to their enjoyment of teaching, he cautioned that it was unclear if the link was unidirectional. It could be that teachers who are more student focused in their approaches experience more enjoyment in teaching. His findings with tertiary teachers working in a range of disciplines have not as yet been tested with teachers of other levels of education or with teachers of specific disciplines such as mathematics.

The same teaching strategies employed by teachers reporting high levels of enjoyment described by Trigwell (2012) also feature in research surrounding quality teaching (Jacobs et al., 2017). Quality teaching in mathematics is characterised by increased student autonomy in the learning process, cognitive activation, adaptive teaching and a valuing of effort and persistence in the face of challenge (Stipek et al., 2001). Such teaching approaches require teachers to have substantive mathematical content knowledge to elicit and respond to high-level student thinking, a disposition to accept student struggle and a degree of self-confidence in their capacity to support students who are struggling with appropriate pedagogy.

Teacher self-confidence in mathematics has also been linked to higher levels of enjoyment in teachers (Stipek, 1998). In a classroom observation and self-report study, Stipek et al. (2001) found that primary teachers who held student-focused beliefs also claimed to enjoy teaching mathematics more than teachers who held more teacher-focused beliefs and were observed displaying relatively more enthusiasm when teaching. These findings parallel the characteristics of, and emotions expressed by, teachers identified in the quality teaching literature, including feelings of enjoyment, enthusiasm, confidence and passion for teaching (Trigwell, 2012).

Finally, there is some preliminary evidence that, at least in educational contexts where teachers are granted sufficient autonomy over how they allocate instructional time, teachers holding more positive attitudes towards mathematics tend to spend more time teaching mathematics (Lee, 2005). For example, Trice and Ogden (1987) assessed the lesson planning and lesson content of 40 first year primary school teachers. They found that more mathematics anxious teachers allocated less planned time to mathematics instruction and spent less of their specifically allocated time actually teaching mathematics. Moreover, Schmidt and Buchmann (1983) interviewed six primary school teachers (from different year levels) to explore how their relative enjoyment of teaching different subjects impacted on how much instructional time they allocated to each subject. Using a diary log methodology
and teacher questionnaire, it was revealed that the four teachers who stated that they “thoroughly enjoyed teaching mathematics” allocated more instructional time to mathematics than the other two teachers who reported enjoying mathematics less (p. 168).

Interestingly, despite many reviews of relevant literature citing one or both of the Trice and Ogden (1987) and Schmidt and Buchmann (1983) studies, and treating the apparent link between feelings towards teaching mathematics and instructional time as a robust research finding (e.g., Good & Lavigne, 2018; Haciomeroglu, 2013; Lee, 2005; Sloan, 2010; Wilkins, 2008, 2009), we could not identify any research from the past three decades specifically examining this issue. Coupled with the relatively low sample sizes of these studies, and the fact that they both took place in a US educational setting, re-examining this issue in a different time and cultural context with a larger sample of teachers is of great value.

### 1.3. Teacher enjoyment and attitudes towards student struggle

To summarise, high levels of enjoyment in teaching mathematics appears to be associated with the adoption of particular instructional strategies (Stipek et al., 2001), a student-centred stance (Trigwell, 2012), and particular teacher attitudes, beliefs and practices, including teachers’ own self-confidence to teach mathematics (Stipek et al., 2001) and willingness for greater risk-taking (Trigwell, 2012). Together, such pedagogies, beliefs and teachers’ enjoyment are considered vital for quality teaching in mathematics (Stipek et al., 2001). Given this evidence, it can be postulated that enjoyment of teaching mathematics will be associated with another pivotal aspect of effective pedagogy, that is; the willingness of the teacher to employ more cognitively demanding tasks and, critically, to maintain a high level of cognitive demand as work on the task unfolds during the lesson (Stein, Grover, & Henningsen, 1996).

Stein et al. (1996) argue not only for the need for teachers to incorporate mathematical tasks that are meaningful, worthwhile and “truly problematic for students” (p. 456), but the importance of sustaining a high level of cognitive demand throughout student engagement with the task. This speaks to not only the structure of the task, but the manner in which it is set-up and implemented by the teacher in the classroom. The willingness of a teacher to maintain a high level of cognitive demand suggests that such a teacher is able to accept and support students struggling without resorting to telling students what to do, leading students towards a particular solution or simplifying the task (Sullivan, Clarke, Clarke & O’Shea, 2010; Stein et al., 1996; Wilkie, 2016).

The notion that struggle is a necessary aspect of learning has a long history in education, including in mathematics (Warshauer, 2015). Basically, struggle involves students in some confusion and doubt while attempting to resolve problematic situations where the solution strategy and/or answer is not obvious (Hiebert & Grouws, 2007). While ‘struggle’ is mostly internal, it is also observable. In a study aimed to depict what student struggle looks like in mathematics classrooms, Warshauer (2015) observed 327 middle school students in 39 mathematics lessons of six different US teachers. He categorized four different kinds of struggles ranging from students’ uncertainties about how to start solving a task, to errors or misconceptions that interfered with their capacity to correctly find a solution. Each kind of struggle was accompanied by observable behaviours, such as gestures indicating uncertainty, blank pages and students voicing their struggles (“I’m confused”, “I’m stuck”, “I need help”). Warshauer found that teacher responses to student struggles were critical in determining opportunities for learning. Responses required teachers to constantly balance the level of challenge with the nature and degree of support provided as the task unfurled. Teachers’ mathematical knowledge for teaching, and in particular, their pedagogical content knowledge (Hill, Ball, & Schilling, 2008), was paramount in achieving this balance. For example, most teachers began responding to student struggles by assessing their progress on the task. Teachers utilized an array of questions to elicit students’ mathematical reasoning, being careful not to overwhelm, embarrass or ‘tell’ them answers. They were then noted to interpret students’ responses ‘in the moment’, initiate discussion to further probe for understanding, determine if and what mathematical misconceptions or procedural errors were hindering progress and formulate a strategy to support each student’s progress and all the time keeping “the intellectual work of the tasks with the students” (Warshauer, 2015, p. 393). The most successful teachers were able to balance support for individual students while maintaining whole class engagement.

However, time was identified by Warshauer (2015) as a constraint to teachers’ capacities to effectively respond to students’ struggles. Pre- and post-observation interviews revealed that teachers experienced conflict when attempting to address student struggles when also needing to close-off a lesson. Such conflict can arise when teachers hold positive attitudes towards student struggle but are required to compromise their opinions and values when facing structural constraints such as insufficient lesson time-frames. Early primary-years teachers are not normally as constrained by rigid time-frames for their lessons as are teachers of middle and high school. It is therefore possible that early years teachers with positive attitudes towards struggle will not need to compromise the high value they place on student struggle by closing-off lessons when students still need their support and time.

Hiebert and Grouws (2007) suggest that student struggle is often viewed as an essential aspect of mathematics learning, particularly in relation to providing opportunities for students to develop conceptual understanding. They argue that the centrality of student struggle stems from the fact that “students expend effort in order to make sense of mathematics, to figure something out that is not immediately apparent” (p. 387). Importantly, it has been suggested that providing all students with opportunities to engage in struggle is an essential aspect of effective pedagogy and equality in the mathematics classroom, despite the inclination of many teachers to provide immediate support to those students who have difficulty learning mathematics (Lynch, Hunt, & Lewis, 2018).

Following from the above points, it can be postulated that teachers who enjoy teaching mathematics will also hold positive attitudes towards student struggle. There are at least two specific explanations as to why we might expect these two constructs to be related.

First, Pekrun’s (2006) control-value theory of emotions in an achievement setting, originally developed for understanding the interaction between learning contexts and students’ affective states, can be repurposed for making sense of teachers’ emotional reactions. Pekrun’s theory suggests that learning activities experienced as high-value and high-control will generate enjoyment, whilst other combinations will generate negative emotions such as anxiety, frustration, anger and boredom. The argument would be that high-enjoyment teachers experience both a high degree of valuing of their craft (i.e., the act of teaching mathematics) whilst being able to maintain a sense of self-perceived control, even in relatively chaotic and uncomfortable scenarios, such as when the majority of students are struggling with a task and perhaps expressing negative emotions associated with this struggle. By

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2 It is important to note that high-control does not mean teachers employ controlling-type instructional practices. Control in this context is associated with teachers’ confidence or self-belief in their capacity to effectively facilitate student learning of mathematics.
In contrast, lower-enjoyment teachers may have experienced the same level of student struggle as a threat to their sense of control, which in turn generates anxiety, particularly if mathematics teaching remains a highly valued activity. Thus, self-perceived control may moderate the relationship between valuing of mathematics and enjoyment of teaching mathematics. It might be further postulated that this sense of control is supported by a high level of pedagogical content knowledge, self-belief and confidence in one’s capacity as a mathematics educator, and experience and comfort with student-centred pedagogies; with these latter two constructs having already been demonstrated to be associated with teacher enjoyment of mathematics teaching (Stipek et al., 2001; Trigwell, 2012).

Second, there is some indirect evidence that negative emotional states on behalf of the teacher appear to be correlated with a lack of willingness to allow students to struggle with mathematical problems. This might imply that positive emotional states, such as enjoyment, lead to greater acceptance of student struggle. In his case-study contrasting the extent to which two teachers adopted reformist-oriented pedagogies, Clarke (1997) found that tolerance for student struggle differed between teachers. Although by no means definitive, there is a lens through which to interpret Clarke’s contrasting case-studies which might imply that the apparent negative affect experienced by one of the teacher-participants (Bartlett) for the duration of the professional learning project resulted in her being less tolerant of student struggle. It is interesting to note that her negative affect was tied in part to the particular cohort of students she was teaching, perhaps suggesting that both acceptance of student struggle and enjoyment of teaching mathematics are malleable, and sensitive to school and classroom environment factors.

Taken together, these explanations imply a reciprocal relationship between teacher enjoyment and their attitude towards student struggle. The dynamics described in this section are represented visually in the diagram displayed at Fig. 1.

The lack of more substantial evidence linking teacher emotions to their attitudes towards student struggle is arguably further limited by the lack of quantifiable measures of the latter construct. Although a reliable measure has been developed for assessing teacher enjoyment of teaching mathematics (Frenzel, Goetz, Lüdtke, Pekrun, & Sutton, 2009), our review of the literature did not reveal an explicitly purposed measure of teacher attitudes towards student struggle. It should be noted, however, that the belief that teachers should allow students to struggle has emerged from an exploratory factor analysis of a survey of teachers’ beliefs and awareness about mathematics teaching. Specifically, Campbell et al. (2014) analysed the responses of 459 teachers (Grades 4–8) to their 40-item Beliefs and Awareness survey to reveal three factors: teacher allowance for student struggle with problems, teacher modelling for incremental mastery, and teachers’ claimed awareness of their students’ mathematical dispositions. The Cronbach alpha for the struggle factor was 0.66. It is promising that teacher beliefs about student struggle emerged from a relatively large, broad-based survey, suggesting that it is a meaningful, coherent and central aspect of teacher beliefs and attitudes that warrants more explicit focus. However, the relatively low Cronbach alpha associated with the factor suggests that there is utility in developing a more purposed measure of this construct.

1.4. The current study

The primary aim of this study was to investigate whether teacher enjoyment of teaching mathematics amongst early primary-years teachers was related to their attitudes towards student struggle in the mathematics classroom, and the amount of time spent on mathematics instruction. In terms of the conceptual framework depicted in Fig. 1, teachers who implement cognitively demanding tasks will also be exposed to high degrees of student struggle. Their tolerance for sustaining struggle will be linked to a number of teacher characteristics and attitudes, including the value they place on struggle, their self-confidence to effectively respond to student struggles, and the repertoire of pedagogies they can comfortably draw upon to support the various struggles students might experience. The more highly teachers value struggle and feel in control of the learning experience, the more they will enjoy teaching mathematics and embrace student struggle in the future. Consequently, the two central propositions to be examined that emerged from the literature were:

1. Teacher enjoyment of teaching mathematics is related to their attitudes towards student struggle in the mathematics classroom, such that higher enjoyment teachers will possess more positive attitudes towards student struggle.
2. Teacher enjoyment of teaching mathematics is related to instructional time, such that higher enjoyment teachers will spend more time engaged in mathematics instruction.

A secondary aim of the study was to develop a purposeful, preliminary measure for measuring teacher attitude towards student struggle in the primary mathematics classroom.

2. Method

2.1. Participants

Participants included 98 Foundation to Year 2 (5–8 years of age)
teaching mathematics. The majority of participants were female (n = 85; 87%). Of the 98 teacher-participants, 80 (82%) were solely in a classroom teaching role, whilst 18 (18%) had at least some additional leadership responsibilities, usually in relation to numeracy or mathematics (e.g., numeracy coordinator). The role of numeracy coordinator varies considerably, and is contingent on school contextual factors (e.g., school size) and the specific skill-set of the individual in question. It might encompass, amongst other things, resource management (e.g., purchasing of supplies), pedagogical leadership (e.g., teaching demonstration lessons and observing/supporting the practice of colleagues), and consulting within and outside the school community (e.g., acting as a conduit between the principal team and teaching staff in matters relating to numeracy) (Cheeseman & Clarke, 2005).

2.2. Procedure

Participants attended a professional learning day in relation to a project focused on sequencing lessons involving challenging tasks in the early years of schooling (Foundation, Year 1 and Year 2; corresponding to 5- to 8-year olds). This project, and its associated professional learning, was conceptualized, developed and administered by the study authors. We targeted the early years of schooling (Foundation, Year 1 and Year 2; project focused on sequencing lessons involving challenging tasks that necessarily included a numeracy and/or mathematics aspect.

2.3. Survey

The survey consisted of four main sections. The first section collected teacher background data, including their teaching or administrative role at the school, the year level they currently taught and years of teaching experience. The next three sections were designed to measure teacher enjoyment, their attitudes towards student struggle and amount of instructional time spent teaching mathematics respectively.

2.4. Teacher enjoyment

A 5-item measure of teacher enjoyment of teaching mathematics, originally developed by Frenzel et al. (2009), was employed in the current study. The items were measured on 5-point Likert scales, as per the Frenzel et al. (2009) study, ranging from strongly disagree (1) to strongly agree (5).

- I really enjoy teaching mathematics
- I look forward to mathematics lessons
- Teaching mathematics is so enjoyable that I like preparing and planning my lessons.
- When teaching mathematics, I am good-humoured
- Teaching mathematics gives me many reasons to be pleased

The maximum score on this measure is 25 and the minimum score is 5. The measure has been shown to have high reliability (Frenzel et al., 2009: \( \alpha = 0.90 \)), and this was also the case in the current study (\( \alpha = 0.90 \)).

2.5. Attitudes towards struggle

Given the lack of measures of teacher attitudes towards student struggle in the mathematics classroom, a 7-item measure was developed for the current study. The items were developed through the first author consulting extensively with four other expert primary mathematics educators, including two educational consultants, one school numeracy leader, and one pre-service teacher educator. These individuals were identified through established networks based on the criterion that they regularly ran demonstration lessons in primary classrooms where encouraging student struggle was a central instructional focus. Following several face-to-face conversations and virtual exchanges, the group developed and refined a list of statements that they believed captured a teacher’s attitude towards struggle in the classroom, drawing on their own classroom experiences in both teacher and observer roles. These draft items were then shared with the other study authors, who made further refinements and additions (e.g., adding the last item “I allow students to struggle before I intervene with a prompt”).

The items were measured on 5-point Likert scales, ranging from strongly disagree (1) to strongly agree (5). Three of the items were reverse scored (denoted by *).

- Most students can’t begin a challenging task without the teacher first explaining the maths.*
- There is value in ‘throwing them in the deep end’, and having students tackle a task before the teacher explains the maths.
- Experiencing struggle is an important part of students doing mathematics.
- If a student doesn’t get it, it is the teachers responsibility to ‘set them right’ straight away.*
- Student confusion in the mathematics classroom amounts to a waste of instructional time.*
- Getting stuck but not giving up is key to students learning mathematics.
- I allow students to struggle before I intervene with a prompt.4

Cronbach alpha for the measure was acceptable with all seven items included (\( \alpha = 0.73 \)), however would have been marginally improved by deleting the sixth item “Getting stuck but not giving up is key to students learning” (\( \alpha = 0.74 \)). Following this deletion, there were six items included in the measure. The maximum score on this measure is 30 and the minimum score is 6.

2.6. Instructional time

Participants were asked to indicate how many times per week, on average, they taught mathematics, as well as the average length of a mathematics lesson. These two responses were used to derive a measure of instructional time, which equated to minutes of mathematical instruction per week.

2.7. Approach to data analysis

Data were analysed quantitatively, using SPSS Statistics, Version 25, using a combination of correlational analysis and hierarchical multiple regression. Results of data screening suggest that the

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3 In the majority of cases (72%), these leadership responsibilities were indicated to relate specifically to mathematics or numeracy (e.g., numeracy coordinator). In the remainder of cases, the precise nature of these leadership responsibilities were not adequately specified to make a determination whether the leadership role necessarily included a numeracy and/or mathematics aspect.

4 In retrospect, the wording for this item should have been in the third person to be consistent with the other items in the measure: “Teachers should allow students to struggle before they intervene with a prompt.”
overall scores on the teacher enjoyment measure (skewness = -0.340; SE = 0.244) and the attitude towards struggle measure (skewness = 0.11; SE = 0.244) approximated a normal distribution. By contrast, initial data screening suggested that the instructional time measure was positively skewed (skewness = 0.858; SE = 0.250); however, further exploration revealed this was due to an extreme outlier. As this outlier was a valid observation (600 min of instruction per week; involving a teacher choosing to undertake six 100 min mathematics sessions with her class), it was decided to Winsorize the outlier, rather than delete it (Hawkins, 1980). This process of Winsorization involved replacing the outlier with the next most extreme value (455 min of instruction per week). Following this treatment of the outlier, instructional time became approximately normally distributed (skewness = -0.013; SE = 0.251). Furthermore, following the Winsorization of this outlier, all assumptions of multiple regression were met for both regression analyses.

Five participants did not provide information regarding either the average length of a typical mathematics session, or the number of times they taught mathematics per week. Given that instructional time could not be calculated for these participants, they were excluded pairwise from the analysis. In addition, two participants did not complete one of the seven items on the attitude towards struggle questionnaire. Given that this constituted less than 20% of the relevant data for these two participants on this measure, these missing values were replaced by the person mean score across the remaining six items (Downey & King, 1998).

3. Results

3.1. Descriptive statistics

Table 1 presents the means and standard deviations for the three study variables of interest. It can be inferred from this data that, on average, participants agreed that student struggle was necessary to mathematics learning, and enjoyed teaching mathematics. Moreover, typically participants spent just under 5 h per week on mathematics instruction.

### Table 1
<table>
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<th>Variable</th>
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<th>Mean</th>
<th>SD</th>
<th>Min</th>
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<td>Attitude Towards Struggle</td>
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<td>Instructional Time</td>
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<td>60.7</td>
<td>120</td>
<td>455</td>
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</table>

3.2. Correlational analysis

A correlation matrix was created to provide a preliminary exploration of the relationships amongst the key variables of interest in our study; that is, teacher enjoyment of teaching primary mathematics (teacher enjoyment), teacher attitudes towards student struggle (attitudes towards struggle) and time spent teaching mathematics per week (instructional time). In addition, three educator characteristics were included in the matrix: leadership role, year level taught and teaching experience (see Table 2).

The purpose of including these three educator characteristic variables was in part to identify any important, additional variables that we needed to include in our subsequent regression analyses. Leadership role was operationalised dichotomously, and related to whether or not the educator had any leadership responsibilities, or was solely employed as a classroom teacher. Year level taught was also operationalised dichotomously. Although there was relatively little variability in year level taught amongst study participants (given the focus of the professional learning day was on the first three years of schooling), it was decided to compare teachers instructing students in their first year of schooling with the results for all other participants. Finally, teaching experience was operationalised ordinally, with the three experience categories being less than three years’ experience, between three and ten years’ experience, and more than ten years’ experience.

With regards to our educator characteristic variables, it is notable when viewing Table 2 that being in a (mathematics-related) leadership role was moderately positively correlated with both teacher enjoyment (r = 0.37) and attitude towards struggle (r = 0.43). Moreover, more experienced teachers tended to enjoy teaching mathematics more than less experienced teachers (r = 0.23), and were, perhaps not surprisingly, more likely to be in a leadership role (r = 0.33). Given the significant correlations between being in a leadership role and two of our study variables of interest, it was decided to include this variable in our regression analyses.

### Table 2
<table>
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*Significant at the .05 level (2-tailed).
+ Significant at the .01 level (2-tailed).
struggle) beyond which could be attributed to being in a leadership role (leadership role). Table 3 displays the results of the regression, including unstandardized regression coefficients (B) and standardized regression coefficients (β) for each variable, and \( R^2 \), adjusted \( R^2 \) and change in \( R^2 \) for each of the models. After Step 2, with both Leadership Role and Teacher Enjoyment included in the model, \( R^2 = 0.33, F(2, 95) = 23.46, p < 0.01 \). The adjusted \( R^2 \) value of 0.32 indicates that approximately one-third of the variability in teacher attitudes towards student struggle is predicted by being in a leadership role and teacher enjoyment of teaching mathematics. Importantly, adding Teacher Enjoyment to the equation significantly improved the predictive power of our model, explaining an additional 15% of the variance, \( F(1, 95) = 21.27, p < 0.01 \).

### 3.3.2. Regression analysis 2: instructional time

A second hierarchical regression was employed to determine if enjoyment of teaching mathematics (Teacher Enjoyment) contributed to time spent teaching mathematics per week (Instructional Time) beyond that which could be attributed to being in a leadership role (Leadership Role). Table 4 shows the results of the regression. After Step 2, with Leadership Role and Teacher Enjoyment included, \( R^2 = 0.06, F(2, 90) = 3.09, p = 0.05 \), suggesting that the model was only borderline statistically significant. However, it is noteworthy that adding Teacher Enjoyment to the equation significantly improved the predictive power of the model, contributing an additional 4% of the variance, \( F(1, 90) = 4.05, p < 0.05 \).

### 4. Discussion

In this study we investigated relationships among early primary-years teachers’ enjoyment of teaching mathematics, their attitudes towards student struggle in the mathematics classroom and the amount of time spent on mathematics instruction. Based on prior research indicating that enjoyment of teaching is associated with the adoption of inquiry-based and student-centred teaching approaches (Stipek et al., 2001), and to higher levels of teacher self-confidence and risk-taking instructional practices (Trigwell, 2012), we postulated that enjoyment of teaching mathematics is associated with teachers’ willingness to employ cognitively demanding tasks in their mathematics classrooms. Based on Pekrun’s (2006) control-value theory of emotions, which assumes that high-enjoyment teachers will highly value teaching mathematics and perceive a sense of control even when students are struggling, we proposed that teacher enjoyment of teaching mathematics is linked to their preparedness to accept student struggle. Furthermore, we suggested that teachers who enjoy teaching mathematics are more likely to spend more time engaged in mathematics instruction than teachers who do not enjoy teaching it.

#### 4.1. Teacher enjoyment and attitude towards struggle

Findings of the current study supported each of our propositions. First, teacher-reported enjoyment of teaching mathematics was strongly positively related to teachers’ attitudes towards struggle in the mathematics classroom. Additionally, experienced teachers were more likely to enjoy teaching mathematics than less experienced teachers and were more likely to be in leadership roles. Moreover, leadership role and enjoyment were found to be predictive of teacher attitude towards student struggle. It is likely that primary teachers who enjoy teaching in general (including teaching mathematics), stay in the profession longer and seek out leadership roles more than those who do not enjoy teaching. We are assuming that teachers who stay in the profession also value teaching. However, longevity in the teaching profession does not by itself explain acceptance of student struggle while teaching mathematics.

We know that teacher enjoyment is associated with the adoption of student-centred instructional approaches (Trigwell, 2012). Such approaches include a preference for inquiry-based instruction that is typically characterised by autonomous learning, challenging tasks and student struggle (Sherin, 2002; Stein et al., 1996). Stipek et al. (2001) also make the point that teaching approaches that value persistence in the face of challenge require substantive knowledge of content and content-specific pedagogy (Hill et al., 2008) as well as a high degree of teacher self-confidence to facilitate student learning.

Warshauer’s (2015) investigation of middle school student struggles and the kinds of teacher responses revealed that an extensive and complex interplay of teacher knowledge of mathematics content and pedagogical content knowledge was critical to enable teachers to maintain high cognitive demand of tasks, and sustain student struggle while supporting individual and whole class engagement. While teachers ranged in experience from two to 18 years, Warshauer did not specify if teachers with greater years of experience were also the ones observed to have greater success in terms of the support they provided to students, their attitude towards struggle or their enjoyment of teaching mathematics. The current study’s findings link teacher experience and, in particular, (Moss, Bruce, & Bobis, 2015; Russo & Russo, 2019; Sullivan, Clarke, Clarke, & O’Shea, 2010) teacher expertise (i.e., being in a mathematics leadership role) to both attitude towards student struggle and enjoyment of teaching therefore builds on the Warshauer’s findings. It is probable that teachers with greater experience and expertise possess extensive pedagogical content knowledge such as that described by Warshauer, have experience with both the content being taught and student-centred approaches (Trigwell, 2012), and therefore possess the self-confidence with their mathematics teaching that lead to a high sense of control even in classrooms where students are voicing their struggle.

In accordance with Pekrun’s (2006) control-value theory, teachers who value mathematics teaching and perceive a sense of control while teaching it will experience a high degree of enjoyment. A high degree of enjoyment means that these teachers will in turn be accepting of student struggle in the future (see Fig. 1). This allows them to confidently facilitate high-struggle learning environments through the adoption of cognitively demanding tasks and maintain high levels of cognitive demand on such tasks. By contrast, a teacher with a low sense of control might experience anxiety when teaching mathematics and therefore avoid student struggle in the future. These teachers are likely to adopt teacher-centred instructional practices that rarely involve high-challenge tasks and will experience little enjoyment of teaching.

#### 4.2. Instructional time

Enjoyment of teaching mathematics was found to be positively related to instructional time. This means that teachers who enjoy teaching mathematics are more likely to spend additional time engaged in mathematics instruction than teachers who do not enjoy
teaching mathematics. While a seemingly unsurprising finding, it importantly confirms little-explored research findings from the 1980’s (Schmidt & Buchmann, 1983; Trice & Ogden, 1987) demonstrating links between feelings towards teaching mathematics and instructional time. More concerning is the fact that some students are receiving as little as 2 h of mathematics instruction per week while others are receiving around 7.5 h (10 h in the case of one teacher; the average was just under 5 h) per week in Foundation to Year 2 classrooms. Over a full academic year, this difference would amount to a major gap in mathematics instructional time for many students. Without classroom observations we cannot confirm that the self-reported times accurately reflect reality or the nature and quality of instruction that took place in any of these classrooms. However, considering prior research findings by Jacob et al. (2017) and Trigwell (2012), it is possible that high enjoyment teachers estimated more time for mathematics instruction in order to support them in pursuing such pedagogies. Instruction involving challenging tasks often necessitates extended timeframes because it involves prolonged periods of problem solving, reasoning and discussing—essential mathematical processes highlighted in the current Australian Curriculum — Mathematics (ACARA, 2015).

This proposition is supported by Warshauer’s (2015) revelation that time was considered a constraint by teachers when supporting students who were struggling with challenging mathematics tasks. When teachers were able to allocate sufficient time to support students’ struggle, the cognitive challenge of tasks was not compromised. However, Warshauer did not clarify whether more or less experienced teachers gave way to time constraints and compromised the learning opportunity afforded by struggle. Once again, the findings of the current study extend Warshauer’s findings and add important new information to the study of student struggle in mathematics education.

Either way, it is likely that students in the classrooms of high enjoyment teachers will experience more time engaged in mathematics instruction and that the nature of the instruction will involve more cognitively challenging tasks and student struggle than students in the classrooms of low enjoyment teachers. To add our support to Frenzel and colleagues’ proclamations (2016; 2018), it seems that teachers’ enjoyment of teaching mathematics can indeed have many positive consequences for their classroom instruction and learning environment.

4.3. Measuring teacher attitude towards struggle

A secondary aim of the study was to develop a purposeful, preliminary measure for measuring teacher attitude towards student struggle in the primary mathematics classroom. Although teacher attitude towards struggle in the mathematics classroom is a highly salient aspect of teachers’ overall attitudes and beliefs towards mathematics teaching (Campbell et al., 2014), we could not identify a specifically designed measure of attitudes towards struggle in the existing mathematics education research literature. The current study developed and piloted a 7-item attitudes towards struggle measure to capture this construct. The Cronbach alpha for the measure was acceptable, and was marginally improved by deleting one item.

Beyond its promising psychometric properties, we note two particular strengths of the measure. First, it includes a balance of positively and negatively worded items, which is considered good practice if one is considering including any negative items in a questionnaire (Rozkowski & Soven, 2010). Second, although we primarily anticipated the measure being used with teachers, the items were deliberately developed in the third-person so that the measure could be administered to non-teachers. In particular, in future research, it would be interesting to use the measure to examine, for example, principals’ attitudes towards struggle, and whether the attitudes of a given principal predicted corresponding teacher attitudes. The measure might even be used with other mathematics education stakeholder groups, such as parent communities, education support workers, or even teacher-educators. For example, one might anticipate that teacher-educators would have very positive attitudes towards student struggle, however it would be interesting to see whether this finding varied by cultural context and educational system.

4.4. Limitations, conclusions and future directions

There are several limitations of the current study worth noting. First, our findings are specific to teachers in the early years of schooling. It would be important to see whether the relationships uncovered in the current study generalized to other groups of teachers. Second, the aforementioned reliance on retrospective, self-report data might limit the validity of some of the measures employed in the current study, particularly in relation to instructional time and teachers’ attitudes towards struggle. It would be important to replicate the current findings with real-time data collection methods (e.g., diaries) and/or classroom observations. Third, the correlational design employed does not allow us to determine cause and effect; longitudinal study designs would begin to allow causal relationships to be teased out. As discussed below, this is a particularly interesting area to examine in future research, given the relationship between teacher enjoyment of teaching mathematics and attitude towards student struggle is likely to be reciprocal.

We would encourage educational researchers to examine whether attitude towards struggle relates to other important phenomena known to impact the student learning experience in mathematics, such as teachers’ mathematics content knowledge, their pedagogical content knowledge, and their propensity to use cognitively demanding tasks. Although many of these relationships have previously been examined qualitatively (e.g., Sullivan et al., 2010), the development of a purposeful measure of teacher attitude towards struggle allows these relationships to be analysed quantitatively, and therefore systematically explored at a larger scale. In the context of building on the current study, it is suggested that future research should also consider examining whether factors such as pedagogical content knowledge do in fact mediate the relationship between teachers’ attitudes towards student struggle and their enjoyment of teaching mathematics, in order to fully examine the model proposed in Fig. 1.

The belief that it is desirable to maintain a high level of cognitive demand for students as work on a mathematics task unfolds is central to quality mathematics pedagogies (Sherin, 2002; Stein et al., 1996). This belief involves accepting that struggle is an integral aspect of learning (Hiebert & Grouws, 2007), and implies that teachers’ positive attitudes towards student struggle is fundamental to effective mathematics teaching. The strong relationship between attitude towards student struggle and teacher enjoyment revealed in the current study is therefore consistent with the maxim “good teaching feels good” (Jacob et al., 2017, p. 461). It implies that teacher educators and educational researchers should continue to explore the phenomenon of teacher enjoyment of teaching mathematics, given its apparent reciprocal relationship with good practice.

Finally, although the model of teacher enjoyment and attitude towards student struggle presented in Fig. 1 attempts to capture the interplay between teacher characteristics and the classroom environment, one important dynamic not specifically modelled is student emotional responses, particularly student enjoyment. Research has demonstrated teacher and student enjoyment to be reciprocally related over time (Frenzel et al., 2009; 2018); high levels of student enjoyment tend to foster high levels of teacher
enjoyment and vice versa. In this context, it is interesting to consider whether levels of student enjoyment might have a causal influence on the apparent connection between teacher enjoyment and their capacity to embrace student struggle. During professional learning with teachers, we have at times asked them to indicate what gives them joy when teaching mathematics. Anecdotally, a common response is when a student has a “lightbulb” or “Ahah!” moment. It seems possible that a teacher who values such student experiences in their classroom might embrace student struggle. The suggestion is that a student’s experience of overcoming a challenge and discovering a solution – having a “lightbulb moment” – is likely to generate an expression of joy within the student which in turn might give the teacher enjoyment. Consequently, future research into teacher enjoyment and their pedagogical actions and attitudes should also consider the emotional responses of students, and, in particular, teachers’ sensitivity to these emotional responses.

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