Pre-Service Teachers' Gender Beliefs in Relation to their Beliefs about Children's Mistakes

by

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Abstract

Mistakes made in the process of learning are critical opportunities for acquiring knowledge. Nonetheless, children often feel anxious about making mistakes. It is important that teachers are able to alleviate this anxiety in order to maximize the learning potential of errors. However, teachers' adaptive or maladaptive responses to students' mistakes in the classroom can influence their students' attitudes toward learning from mistakes. Moreover, observational research has shown that teachers provide work-related feedback to students differently depending on their gender. There is a lack of research that addresses how pre-service teachers' gender beliefs might be related to their beliefs and attitudes towards children's mistakes. Part of the challenge is the absence of measurement tools for measuring teachers' beliefs about children's errors. The objectives of the present study were (1) to explore the internal consistency of a psychometric instrument, the Error Orientation Questionnaire (EOQ), adapted for the present study to measure pre-service teachers' beliefs about children's mistakes in a school setting, and (2) to examine pre-service teachers' gender beliefs and attitudes towards their own mistakes in relation to their views towards children's mistakes in the classroom. Two groups of pre-service teachers studying at the University of Alberta were surveyed: (a) 80 pre-service teachers who were enrolled in a child development course (EDPY 302), and (b) 50 pre-service teachers who were enrolled in an adolescent development course (EDPY 304). Results indicated that the adaptation of the EOQ led to a mixed profile of internal consistency values, which informed subsequent analyses. Four out of eight EOQ subscales were retained for regression analyses. Regression analyses showed different results between both groups of pre-service teachers. Nonetheless, important patterns among pre-service teachers' gender beliefs, attitudes towards their own mistakes, and views towards children's mistakes were revealed. Pre-

service teachers' gender beliefs in part predicted their beliefs about children's mistakes, and, pre-service teachers' attitudes towards their own mistakes in part predicted their beliefs about children's mistakes. Potential implications are discussed, including that pre-service teachers' own beliefs and attitudes can be projected onto children, and, that this may have an influence on how pre-service teachers eventually handle children's mistakes in the classroom. As well, pre-service teachers' gender bias may unintentionally impact how they promote and encourage boys versus girls learning from their mistakes. Overall, the results from this study contribute to addressing persistent issues surrounding gender beliefs in relation to children and may help to understand girls' disengagement and underrepresentation in science, technology, engineering and mathematics (STEM) careers.

Preface

This thesis is an original work by Alicia Orr. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board, "Pre-service Teachers' Gender Attitudes and Beliefs in Relation to Children's Mistakes in the Classroom", No. Pro00092066, August 19, 2019.

Dedication

I dedicate this research to my parents, Douglas and Pamela, who have inspired and fostered my passion for education and research, and who always show unwavering support in everything that I do.

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Introduction

Making mistakes in the learning process provides a critical opportunity for acquiring knowledge (Metcalfe, 1996; Ohlsson, 1996). Indeed, mistakes are a natural part of the learning process. Even though making mistakes are common and important learning opportunities, children are commonly observed to feel nervous or anxious about making mistakes and perceive them as shameful or something to be hidden (Covington, 1992). This may be because mistakes are often attributed to ability level, an uncontrollable trait, and is thus an unfavourable reflection of one's self-worth (Covington, 1992; Dweck, 1986). Since teachers serve as secondary attachment figures and role models in the classroom (Koomen & Hoeksma, 2003; Pianta, 1999), it is crucial that teachers learn how to alleviate children's anxiety about making mistakes during the learning process.

Depending on how teachers respond to children's mistakes in the classroom, children will observe and learn whether mistakes are useful opportunities for feedback or events that should be covered up or minimized. For example, teachers may respond adaptively to children's errors by starting a class discussion to find other solutions. Alternatively, teachers may respond maladaptively by ignoring the mistake, which can lead students to adopt unproductive error-related attitudes towards their mistakes such as avoiding the discussion of errors based on how they see teachers manage mistakes (Tulis, 2012). Research has shown that students' attitudes towards their mistakes is predictive of their academic achievement, such that positive attitudes towards making mistakes predicts higher academic achievement (Leighton, Tang, & Guo, 2018). Therefore, the way teachers handle mistakes in the classroom may affect how comfortable children feel about making mistakes, and in turn, may affect how students' value and learn from their mistakes. However, teachers' error-handling strategies may be influenced

by their beliefs about their own mistakes, and teachers' beliefs about children's mistakes may be influenced by their own views of errors.

Academic mistakes may also be a useful platform in which to study gender bias in the classroom. Observational research has shown that teachers provide differential work-related feedback to boys versus girls (Dweck, Davidson, Nelson, & Enna, 1978). For example, boys tend to receive feedback from teachers that refers to their motivation, such as praising their effort, a non-intellectual attribute that can be changed; and, girls tend to receive feedback from teachers that refers to their ability, such as acknowledging that they obtained a correct answer, an intellectual attribute that cannot be changed. Teachers are likely unaware of the different ways in which they provide feedback to students. However, if teachers act on their implicit gender biases, the differential teacher-student feedback interactions may influence how boys and girls learn to perceive their mistakes and, in turn, could affect boys' and girls' perceptions of their controllability in dealing with their mistakes. There is surprisingly little large-scale empirical research investigating how pre-service teachers' implicit gender beliefs and attitudes may be associated with their beliefs about children's mistakes. In addition, a major challenge for this type of research is the lack of measurement tools for specifically investigating teachers' beliefs about children's mistakes. Thus, the objective of the present study is to (1) adapt instrumentation to assess teachers' beliefs about children's mistakes and (2) assess how teachers' beliefs about gender and their own mistakes may predict their views on children's mistakes.

Literature Review

Making Mistakes and Learning

Mistakes are a natural and expected part of acquiring knowledge (Metcalfe, 2017; Ohlsson, 1996). Identifying mistakes creates critical opportunities for improvement and is an important aspect of the learning process (e.g., Tulis, Steuer, & Dresel, 2018). In fact, some researchers argue that it is sometimes "better to be wrong," as mistakes promote learning, motivation, and self-regulation (McMillan & Moore, 2020, p. 85). According to Metcalfe (2017), this is because focusing on errors empowers students to think critically, evaluate, criticize and reconsider their own thought processes while attempting to correct their mistake (p. 468). Consequently, corrective feedback – especially elaborative or scaffolded – from the teacher is crucial following students' mistakes in order to maximize the learning potential of students' errors (Metcalfe, 2017). Students who make mistakes and who are provided evaluative feedback from their teachers – for example, the teacher asks the student to explain the reasoning behind the correct answer – are likely to see greater learning benefits because they are encouraged to deeply reflect and analyze the underlying thinking processes leading to the correct answer (Metcalfe, 2017).

Moreover, Ohlsson's (1996) model of learning from performance errors demonstrates the underlying cognitive processes required for learning new skills and transferring knowledge, which is largely dependent on identifying and correcting errors. In essence, when confronted with a new task, the learner will depend on his or her previous general knowledge to apply it to the novel task (Ohlsson, 1996). This previous knowledge is composed of certain *knowledge structures,* or *production rules*, which guide the learner to the best action for completing the task (Ohlsson, 1996). These knowledge structures comprise three main components: (1) a goal,

(2) a situation, and (3) an action (Ohlsson, 1996). For example, a driver may have the desire to turn left (the goal) but is driving in the right lane (the situation) and will likely consider changing to the left lane to make the turn (the action). Thus, these knowledge structures represent a disposition to act a particular way given a certain situation (Ohlsson, 1996). However, knowledge structures may be overly generalized and not specific enough to function appropriately for a new task because they were based on past usage (Ohlsson, 1996; Schunk, 2012). Errors naturally occur when general knowledge structures are applied to novel tasks because the knowledge structure has not been specialized to the current task (Ohlsson, 1996). Applying previous knowledge structures to new situations or tasks prepares the learner to anticipate whether or not he or she has committed an error because prior knowledge has been incorrectly applied; thus, helping the learner to recognize whether the current outcome failed to conform to what they believed ought to be true (Ohlsson, 1996; Schunk, 2012).

The correction of errors is how new learning occurs because the previous general knowledge structures will be become specialized or tailored to the new task or skill, which comes with practice (Ohlsson, 1996; Schunk, 2012). Correspondingly, the learning process requires a change in knowledge structures, which occurs from detecting and correcting one's mistakes (Ohlsson, 1996). Therefore, errors can facilitate new learning, and it may even be argued that errors are required in the learning process (McMillan & Moore, 2020).

It is, therefore, important that students value learning from their mistakes as errors are valuable and unavoidable during the learning process. However, many children are often reluctant to make mistakes and have negative reactions when they happen, which may be explained by causal attributions of academic mistakes to innate intelligence. Attributions of academic mistakes to intelligence can affect one's self-worth (Covington, 1992; Dweck et al.,

1978). Since teachers provide a "safe haven" for children in the classroom as secondary attachment figures and are role models to their students (Koomen & Hoeksma, 2003; Pianta, 1999; Verschueren & Koomen, 2012), it is important that teachers are able to alleviate anxiety and stress surrounding making mistakes in order to maximize the learning potential of errors.

Reluctance to Make Mistakes at School

A driving force behind the fear of making mistakes may be explained by a combination of Covington's (1992) self-worth theory of achievement motivation, as well as Dweck and colleagues' (1973, 1978, 1986) work on causal attributions of achievement. Self-worth theory proposes that students' motivation to achieve is largely guided by how students perceive their ability; and in turn, self-perceptions of ability are a significant part of an individual's *academic self-concept* (Covington, 1984). In general, *self-concept* has been defined as "a person's self-perceptions that are formed through experience with and interpretations of one's environment … [and] is influenced especially by evaluations by significant others, reinforcements, and attributions for one's own behaviour" (Marsh, Xu, & Martin, 2012, p. 429). The *academic self-concept* is one dimension of a person's general self-concept, and it reflects individuals' beliefs and perceptions about their own abilities within certain academic domains, such as math, science, and English (Marsh et al., 2012; Steuer, Rosentritt-Brunn, & Dresel, 2013). Notably, self-worth theory is based upon two main assumptions: (a) Western societies tend to view the "ability to achieve" as equating to human value – or self-worth as the theory is aptly named – and (b) *self-aggrandizement,* the process of promoting and increasing one's own importance, is a main motivational force of human behaviour, such that humans will attempt to maximize success (i.e., a reflection of high ability) and minimize failure (i.e., a reflection of low ability) whenever possible (Covington, 1979).

Based upon these assumptions, Covington and colleagues (1984, 1992) have argued that academic achievement may be considered a student's attempt at demonstrating and maintaining a positive self-image of competency. In terms of achievement, failure is perceived as a reflection of inability and thus diminishes a student's sense of self-worth, especially with the need to achieve competitively. However, an important addition to considering students' self-worth is to consider their causal attributions of academic outcomes, such as ability versus effort (Dweck & Reppucci, 1973).

Dweck and colleagues' work (1973, 1978, 1986), suggested that failure with low levels of effort may be preferred for many students because effort is an attribute that is modifiable and can be controlled by the student, and thus is able to be changed by the student if he or she fails. For example, the student is able to attribute negative outcomes to low effort, such as not studying, which can be improved upon for the next test. On the other hand, high levels of effort in combination with failure is often attributed by students to a lack of intelligence because intelligence is tied to innate or genetic ability level in Western societies, which is a stable attribute that cannot be controlled or changed (Dweck, 1986). For example, the student is unable to attribute a negative outcome to low effort if he or she studied hard for the test, leaving the student to potentially question his or her ability which cannot be changed. Accordingly, students may learn to feel helpless when they believe that failure is insurmountable due to uncontrollable factors, such as ability, and these children tend to display negative affect (e.g., anxiety) in the face of errors (Dweck et al., 1978, 1986). In fact, a study by Dweck and Reppucci (1973) found that children who tend to attribute failure to external factors (e.g., ability) also tend to lack motivation to try hard because they believe they are powerless in *controlling* their academic outcomes. Interestingly, Covington and colleagues (1979, 1981)

have found students tend to prefer explanations of failure to pertain to low effort than low ability, and explanations of success to a combination of intelligence and low effort. Covington and colleagues' (1979, 1981) contended that students prefer explanations pertaining to low effort when they fail because this avoids any inference that they lack ability, and also when they succeed because this enhances their reputation of intelligence, which ultimately protects one's self-worth. Importantly, though, this is likely because, in Western cultures, ability is believed to reflect a stable, uncontrollable and unchangeable trait; whereas, effort reflects an unstable, controllable and changeable factor (Dweck et al., 1973, 1978, 1986). Therefore, errors can be threatening to a student's self-worth precisely because failure may elicit a sense of worthlessness and social disapproval as it is closely tied to one's intelligence and can be perceived as being beyond one's control (Covington, 1992; Dweck & Reppucci, 1973). Thus, if students attribute errors and failure to their lack of ability, this can be perceived as lacking control over increasing their self-worth, which may contribute to anxiety and stress surrounding academic mistakes.

Overall, Covington and colleagues' work (1979, 1981, 1984, 1992) has shown that the need to preserve one's self-image of competency necessarily contributes to school achievement behaviour. As a result, failure is feared and avoided by students because it is connected to their feelings of self-worth. Importantly, however, Dweck and colleagues' work (1973, 1978, 1986) has demonstrated that one's ability is closely tied to the perceived controllability of handling failure since ability is perceived as an uncontrollable attribute, which may help explain why the expenditure of effort is often avoided: in order to conceal one's true ability in light of failure so that it can be attributed to low effort, or to enhance the appearance of one's intelligence in light of success. Although failure is an extreme scenario in comparison to making a few mistakes,

making mistakes are nonetheless a reflection of a student's performance, which is connected to the controllability of being able to increase self-worth (Leighton et al., 2018). Therefore, making mistakes can be perceived as a negative and threatening experience to one's self-worth, and may lead students to fear and avoid them.

Error Climate in the Classroom

Many variables or attributes undoubtedly contribute to how students perceive and deal with making mistakes. Some of the attributes that have been extensively researched are personal goal-orientations (i.e., mastery goals or performance goals) and academic self-concept (Dweck, 1986; Marsh et al., 2012; Steuer et al., 2013). Although these individual attributes and orientations have been shown to influence how students deal with and learn from mistakes (e.g., Dweck, 1986; Senko, 2016; Skinner, 2016), there is a growing body of research that demonstrates how the classroom environment can also affect students' attitudes towards mistakes, and in turn, can influence individual learning processes (Steuer et al., 2013). For example, a major construct proposed and researched in the area of learning from mistakes is the *error climate* (Steuer et al., 2013). *Error climate* is defined as characteristics that are inherent to the learning environment, such as the handling of errors within the environment that either promotes or prohibits learning from errors (Steuer et al., 2013). In an educational context, error climate has been characterized by the quality of everyday error-handling practices by teachers within the classroom (Tulis, 2012). A positive error climate in the classroom is one that promotes open communication about mistakes, whereby students are encouraged to consider, evaluate, and discuss their misconceptions (Tulis, 2012). When the error climate in the classroom is positive, it fosters adaptive reactions to errors that are the most conducive to learning from mistakes – particularly by using errors as a fundamental part of the learning

process (Steuer et al., 2013). In contrast, a negative error climate is one where open communication about errors and learning from mistakes is not emphasized or encouraged, whereby students feel negatively evaluated for their mistakes and anticipate that their mistakes will be attributed by the teacher to their lack of ability (Tulis, 2012). Positive versus negative error climates can influence students' affective, cognitive, and behavioural attitudes and reactions towards mistakes, beyond individual characteristics such as personal goal orientations or academic self-concepts. Indeed, a study by Steuer and colleagues (2013) investigated students' perceptions of their classroom error climate in relation to their affective and behavioural reactions towards making mistakes, while controlling for students' individual achievement motivation, such as goal orientation and academic self-concept. Results demonstrated that students' perceived error climate in the classroom positively predicted their adaptive affective-motivational and adaptive-action responses to mistakes, meaning that students who perceived the classroom error climate as more adaptive also demonstrated more adaptive emotional, motivational, and behavioural reactions to errors (Steuer et al., 2013). For example, when students perceived the error climate as positive, they were more likely to endorse reactions to errors that were emotionally positive (e.g., curiosity) while maintaining the motivation to learn, and demonstrated behavioural attitudes aimed at overcoming the error (Steuer et al., 2013).

Markedly, error climate in the classroom is primarily determined by the teacher's error-handling practices and attitudes towards learning from mistakes (McMillan & Moore, 2020; Steuer & Dresel, 2015; Steuer et al., 2013; Tulis, 2012). The way teachers handle and deal with students' mistakes contributes to fostering a positive or negative error climate in the classroom as perceived by students, and in turn, can influence students' attitudes towards mistakes and

subsequent academic achievement (Tulis, 2012). For example, Tulis (2012) investigated how teachers' maladaptive and adaptive error management in the classroom would affect students' attitudes towards mistakes. Maladaptive responses to students' mistakes were coded as: (a) ignoring the mistake, (b) criticizing the student, (c) redirecting the question to another student, (d) humiliating or laughing, and (e) expressions of disappointment, hopelessness, or annoyance. Adaptive responses were coded as: (a) a discussion with the whole class, (b) correction by the student – for example, the teacher repeats the question or gives a hint to the student who made the mistake, (c) patiently waiting, (d) emphasizing the learning potential of the mistake, and (e) impeding negative reactions from classmates – for example, the teacher stops classmates from laughing.

According to Tulis (2012), the way teachers handle mistakes in the classroom may influence how comfortable students feel in making mistakes. This may be because research has shown that the student-teacher relationship is an important predictive factor of students' attitudinal affective experience at school (e.g., enjoyment), academic self-consciousness (e.g., the fear of making mistakes in front of others), academic self-efficacy (e.g., the belief in one's ability to master the material and skills taught at school), and feelings of belonging at school (Roeser, Midgley, & Urdan, 1996). Given that teachers spend substantial amounts of time with their students daily, making teachers secondary attachment figures as well as role models, it is not overly surprising that they may have the potential to influence students' individual attitudes, affect, and orientations towards learning (Pianta, 1999; Roeser et al., 1999; Tulis, 2012). Consequently, if teachers exhibit maladaptive responses to students' mistakes, students may interpret errors as undesirable and avoid mistakes out of fear of failure, which could negatively impact students' motivation towards learning (Tulis, 2012). Using questionnaires and

observational data, Tulis' results indicated teachers' error handling strategies in the classroom lead to students adopting error-related attitudes based on how their teachers responded to mistakes (Tulis, 2012). Specifically, students whose teachers used maladaptive responses to mistakes – for example, the teacher picked another student to correct the first student's mistake – had more negative attitudes towards mistakes, and in turn, these students were more likely to report negative emotions, such as anger or anxiety, towards mistakes (Tulis, 2012). In contrast, students whose teachers expressed adaptive responses to mistakes – for example, the teacher started a discussion with the class to brainstorm and evaluate different solutions – demonstrated more positive attitudes towards mistakes, and in turn, these students were more likely to report more positive emotions towards mistakes (Tulis, 2012). Based on these results, one can infer that the way teachers respond to mistakes during class can affect the value students place on learning from mistakes and their adoption of error-related attitudes towards their mistakes.

Moreover, research has indicated students' own attitudes towards their mistakes predicts their academic achievement (Leighton et al., 2018). Notably, a person's attitude toward mistakes can be operationalized by how the person feels, behaves, and thinks in association with making mistakes (Leighton, Tang, & Guo, 2015). Specifically, positive attitudes towards making mistakes was directly predictive of higher academic achievement (Leighton et al., 2018). Therefore, teachers' error-handling strategies in the classroom may indirectly impact students' academic achievement if students adopt error-related attitudes that are based on their own teachers' responses to mistakes. Given that students may attribute failure to a lack of ability – that is, an attribute which is perceived as uncontrollable and can be attached to feelings of self-worth – it is even more critical that teachers help mitigate negative experiences with mistakes by using positive and adaptive error-management strategies when children make

mistakes in the classroom. However, not surprisingly, the way teachers handle children's mistakes has been found to be influenced by their own pedagogical beliefs and attitudes (Bray, 2011).

Teachers Beliefs about Children's Mistakes

There are several studies that examine students' beliefs and attitudes towards making mistakes in school and how this may affect student motivation and learning behaviour (e.g., Tulis et al., 2018). However, large-scale studies examining teachers' perspectives of students' mistakes are relatively scarce. Nonetheless, some research has investigated teachers' pedagogy and how it is related to error-handling strategies (Bray, 2011). For example, a study conducted by Bray (2011), demonstrated that teachers' beliefs about teaching mathematics predicted how they managed errors in the classroom. Teachers' beliefs about teaching mathematics was measured by the *Integrating Mathematics and Pedagogy* web-based survey, which included seven beliefs about mathematics and how math should be taught and how it is learned. Teachers were then observed while teaching mathematics to children in grades Kindergarten through Six. The findings indicated that while teaching mathematics, teachers who avoided addressing students' errors publicly in front of the class were those who were more apt to believe this would embarrass the child, or that emphasis on errors would confuse students; whereas, teachers who intentionally focused on mistakes in a class discussion were more likely to believe that focusing on errors provided greater opportunities for learning – both for the individual student and the class as a whole (Bray, 2011). Although this study was specific to teachers' beliefs about teaching mathematics and not solely about teachers' beliefs about mistakes, the importance of Bray's (2011) study for the present research is that teachers' underlying beliefs have the potential to influence how they handle children's mistakes during the learning process.

The literature surrounding teachers' beliefs about children's mistakes more specifically, is limited. Part of the challenge with studying this construct is the lack of measurement tools for investigating teachers' beliefs about children's errors. Nevertheless, a study by Matteucci, Corazza, and Santagata (2015) investigated teachers' beliefs about mistakes in relation to error-handling practices in the classroom. The researchers adapted Rybowiak et al.'s (1999) *Error Orientation Questionnaire* (EOQ) to assess teachers' beliefs about errors, and coded teachers' various error-handling strategies by observing videotaped classes. The EOQ is a scale originally developed to measure workers' attitudes and beliefs towards making mistakes in the workplace (Rybowiak et al., 1999). The results indicated that teachers with a positive error orientation used more adaptive error-management strategies, such as providing hints to the student who made the error or not directing the question to other classmates (Matteucci et al., 2015). However, Matteucci et al. (2015) reported an important limitation, namely, that the adapted EOQ did not have ideal psychometric properties.[1] Specifically, the internal consistency of the subscales of the EOQ ranged from .29 to .66. Normally, internal consistency values that are less than .70 are considered less than satisfactory (Nunnally, 1970). It was concluded that further validation of the scale was needed for use with teachers (Matteucci et al., 2015). Besides the research conducted by Matteucci and colleagues (2015), there are two other studies examining teachers' beliefs about mistakes that have been cited; however, these studies are not available in the researcher's native language, that is, English, and thus could not be interpreted for inclusion in

[1] The author contacted Dr. Maria C. Matteucci, first author of the Matteucci et al. (2015) article, to hopefully request access to their adapted EOQ instrument for the present study. Dr. Matteucci advised that the psychometric properties of the instrument were not excellent and thus she was unable to provide access to the scale.

the present study. No other similar work investigating teachers' beliefs about students'/children's mistakes was found in the educational psychology literature.

Although it is known that mistakes are critical opportunities for learning (Ohlsson, 1996), not understanding teachers' beliefs about students' errors and how teachers handle mistakes in the classroom is a significant deficiency, considering that teachers are assumed to play a profound role in helping students develop academic competency. However, many students and teachers still perceive mistakes as something to avoid or cover up since errors can be threatening to a person's self-worth because errors are often attributed to uncontrollable traits, such as ability (Covington, 1992; Dweck, 1986). As well, if students observe how their teachers handle mistakes, this may influence how students perceive whether their own mistakes are useful learning opportunities or events to be hidden or minimized. The modeling role teachers play in students' lives cannot be underestimated (Lunenberg, Korthagen, & Swennen, 2007). To help reduce the anxiety and stress associated with making mistakes, and to maximize the learning potential of errors, understanding teachers' error-management strategies in the classroom needs to be further researched. Notably, studying teachers' beliefs about mistakes in the learning process is an important step in this research.

Gender Bias

In a different line of research, a systematic review by Greenwald and Krieger (2006) revealed that explicit and implicit gender biases have the potential to shape human behaviour, influencing how people make judgements and treat others. *Explicit bias* is defined as beliefs or attitudes that are consciously endorsed and can be potentially discriminatory depending on the nature of the bias; whereas, *implicit bias* is defined as beliefs or attitudes that are unconscious but also relevant to leading to potential discrimination (Greenwald & Krieger, 2006, pp. 946-

948). Gender bias has been an important factor in explaining women's disengagement and underrepresentation in science, technology, engineering and mathematics (STEM) careers (Moss-Racusin et al., 2012; Reuben et al., 2014). In fact, not only do women self-select out of STEM careers, but Ma and Cartwright's (2003) longitudinal study indicated that girls' disengagement in math and science begins early on during middle school years.

Stereotype Threat

Some researchers have attributed the trend of women's disengagement and underrepresentation in STEM fields to gender stereotypes that portray women as having weaker math and science abilities as compared to men. Another common stereotype is that women do not like math. A phenomenon known as *stereotype threat* has been shown, at least in preliminary research, to be a partial factor that accounts for this gender gap among certain subject areas (Spencer, Steele, & Quinn, 1999). Stereotype threat occurs when a traditionally stereotyped group, such as high-achieving females or Black students, worry that their performance on a task will be judged according to the negative stereotype, which will then confirm some inferiority in the subject domain. For example, women and girls have been stereotypically associated with weaker math performance than men. In turn, women and girls, especially high-achieving ones, may then begin to worry about their performance on evaluative math tasks. Due to anxiety about confirming the stereotype, it can lead to anxiety during the task performance and disrupt test performance; ultimately, disengagement from the domain ensues (Steele, 1997; Major et al., 1998). A more concrete example of this can be demonstrated through a series of studies by Spencer, Steele and Quinn (1999). The authors investigated gender stereotype threat and its effect on women's math performance in university courses. Their first study involved asking high-achievers in mathematics courses to do a difficult math

test taken from the Graduate Records Exam and found that men outperformed women. Their second study involved two experimental conditions: (1) participants were told the math test *would* produce gender differences, and (2) participants were told the math test *would not* produce gender differences. The findings of the second study showed the gender gap remained when test-takers were told the math test *would* produce gender differences (Condition 1). Interestingly, the gender gap on test scores was eliminated by informing test-takers the test would *not* produce any gender differences (Condition 2). Their third study then aimed to replicate the second study's findings, but without telling test-takers that the test *would* produce gender differences. The results showed that women underperformed men without being told that the test would produce gender differences, replicating Study 1, but that women performed equally as well as men when test-takers were told there would *not* be any gender differences on the test, replicating Study 2. Thus, what can be concluded from these results is that the threat of a stereotype may be assumed by the stereotyped group when they are told nothing about the test and interfere with performance. However, being explicitly told that this threat has been removed appears to facilitate the performance of the stereotyped group (Steele et al., 1997).

Gender-Related Differential Treatment of Children in the Classroom

Teachers' gender biases are of particular interest in this study because research has shown teachers' gender beliefs may influence the expectations and treatment of children (Andersson, 2010; Dweck et al., 1978; Mizala, 2015; Sadker, Sadker, & Zittleman, 2009; Stevens, 2015). For example, a study investigating pre-service mathematics teachers showed that their expectations of students depended on the student's gender, such that pre-service teachers had lower expectations for girls than for boys (Mizala, 2015). Not only may teachers' expectations of their students depend on whether the student is male or female, but this gender

bias that is most likely implicit has the potential to influence how teachers treat students and provide valuable feedback. Accordingly, by observing and examining teacher interactions with fourth- and fifth-graders, Dweck et al. (1978) demonstrated that 90% of the positive feedback that boys received was related to the intellectual quality of their work, such as the correctness of the work; whereas, for girls, less than 80% of the positive feedback referred to the intellectual quality of their work. However, in terms of negative feedback from teachers, almost 90% of work-related criticism given to girls referred to their intellectual performance – for example, whether their answers were wrong and little more – whereas, for boys, only about 54% referred to their intellectual performance and about 45% referred to their effort or motivation. Importantly, the results also showed that all children were more likely to attribute failure to inadequate intellectual abilities after receiving negative feedback referring to their intellectual performance – simply being told that something was wrong (Dweck et al., 1978). Taken altogether, Dweck et al. (1978) argued that teachers provide more negative work-related feedback to boys that tends to be focused on motivation and/or effort, which is an attribute that is perceived to be controllable because one can increase the amount of time expended on a task; and, more negative work-related feedback to girls that tends to be focused on ability, which is an attribute that is perceived to be uncontrollable especially in Western countries as it is often linked to genetics (see Devlin, Daniels & Roeder, 1997).

In line with Dweck and colleagues' research, Sadker et al. (2009) identified the differential ways in which teachers provide feedback to boys and girls. In investigations of over one hundred classrooms, boys were more likely to receive teacher interactions and better-quality feedback than girls. Specifically, boys received more praise, help, correction and criticism, whereas girls received more superficial feedback that briefly acknowledged the

correct answer (Sadker et al., 2009). For example, girls more often than boys received a routine, quick, and neutral "okay," which is least conducive to challenging students and stimulating thoughtful ideas (Sadker et al., 2009). More recent empirical evidence continues to show that boys receive more teacher interactions than girls and that girls often receive more neutral or less helpful feedback than boys (Stevens, 2015; Berekashvili, 2012).

In addition to differential feedback, other research has shown that teachers provide more wait-time to boys than girls when asking questions during mathematics instruction (Gore & Roumagoux, 1983). Specifically, boys often received twice the amount of wait-time than girls, which the authors suggest may have a negative impact on girls' mathematics achievement over time because receiving more time to respond to a question provides greater opportunity for students to ponder the material (Gore & Roumagoux, 1983). Notably, *waiting* in terms of handling students' mistakes in the classroom is considered one of the positive error-handling strategies because this gives the student an opportunity to think more thoughtfully and correct his or her mistake (Tulis, 2012). In addition, waiting time may also implicitly communicate that the teacher holds high expectations for the child as the teacher patiently waits for the student to come up with the correct answer.

Gender Bias and Children's Mistakes in the Classroom

Taken altogether, academic mistakes may serve as a useful platform for studying gender bias. Teachers' error-handling strategies often reflect either adaptive or maladaptive responses to students' errors, which has been shown to lead students to adopt positive or negative error-related attitudes and beliefs (Tulis, 2012). Additionally, a substantial amount of research has shown that boys and girls receive differential feedback in the classroom (e.g., Dweck et al., 1978).

Teachers may not be aware of the different ways in which they provide feedback to students. In fact, Sadler et al., (2009) contend that most teachers who watch themselves during videotaped classroom lessons are often surprised after seeing themselves interact with girls and boys differently. Nonetheless if teachers act on their implicit gender biases, their feedback conversations with students may influence how boys and girls learn to see their mistakes and, importantly, the controllability they perceive in dealing with these mistakes. This could lead to girls adopting more negative error-related attitudes towards mistakes than boys, especially in particular academic domains such as mathematics or science. However, an important step in examining teachers' error-handling strategies is to investigate their beliefs about children's mistakes, and there is surprisingly little research on how pre-service teachers' implicit gender beliefs and attitudes may be associated with their beliefs about children's mistakes. As has been mentioned, part of the challenge of investigating this topic is the lack of measurement tools for assessing teachers' beliefs about children's mistakes.

Purpose of Present Study and Hypotheses

The purpose of the present study is twofold. First, this study involves adapting the *Error Orientation Questionnaire* (EOQ) to reflect teachers' beliefs towards children's mistakes and examine its internal consistency. Second, the present study involves investigating whether pre-service teachers' gender beliefs and attitudes towards their mistakes predict how they, in turn, view children's mistakes in the classroom. Thus, the research questions are as follows: (1) Can the EOQ be adapted to provide an internally consistent measure of pre-service teachers' attitudes and beliefs about children's mistakes? And, (2) Do pre-service teachers' gender beliefs and beliefs about mistakes predict how they view children's mistakes in the classroom?

First, it is hypothesized that the adapted EOQ will demonstrate satisfactory internal consistency, indicating it can be used as an adequate measure of pre-service teachers' beliefs about children's mistakes in the classroom. Second, it is hypothesized that pre-service teachers who hold more hostile and benevolent sexist attitudes towards women and who have more negative attitudes towards mistakes will be more likely to have a negative error orientation of children's mistakes. In the next section, the methods used to conduct the study are outlined.

Method

Participants

Pre-Service Teachers Enrolled in EDPY 302

Eighty pre-service teachers enrolled in a Child Development course (EDPY 302) at the University of Alberta participated in the present study. In the study, 70 (87.5%) pre-service teachers were women, 6 (7.5%) were men, and four (5%) did not specify their gender. Pre-service teachers ranged in age from 19 to 37 years old, with a mean age of 21.7 years old (SD = 2.9). Regarding ethnicity, the most frequently reported was Caucasian (59 pre-service teachers or 73.8%), followed by Asian (7 pre-service teachers or 8.8%), Indigenous (4 pre-service teachers or 5%) and Black/African (1 pre-service teacher or 1.3%). Five (6.3%) pre-service teachers self-identified as having another ethnic background, one (1.3%) preferred not to answer, and three (3.8%) did not specify. Pre-service teachers also reported their program of study at the University of Alberta. Seventy-five (93.8%) pre-service teachers reported their program route as a Bachelor of Education, Elementary Route, two (2.5%) reported other program routes, including a combined Bachelor of Education and Bachelor of Native Studies degree, and a combined Bachelor of Education and Bachelor of Kinesiology degree, and three (3.8%) did not specify.

Pre-Service Teachers Enrolled in EDPY 304

Fifty pre-service teachers enrolled in an Adolescent Development course (EDPY 304) at the University of Alberta participated in the study. Twenty-five (50%) pre-service teachers were men, 23 (46%) were women, one (2%) preferred not to say, and one (2%) did not specify. Pre-service teachers' age ranged from 20 to 47 years old, with a mean age of 26.4 years (SD = 7.4). Regarding ethnic background, 41 pre-service teachers self-identified as Caucasian (82%), three (6%) self-identified as another ethnicity, two (4%) preferred not to answer, one (2%) reported their ethnic background as unknown, and one (2%) did not specify. With respect to pre-service teachers' program of study, 47 (94%) reported their program route as a Bachelor of Education, Secondary Route, one (2%) reported their program route as a combined Bachelor of Education and Bachelor of Science, and two (4%) did not specify.

Procedure

Pre-service teachers enrolled in these two undergraduate education courses at the University of Alberta were asked to participate in an online survey to investigate their attitudes and beliefs about gender and children's mistakes. The courses as mentioned included Child Development in Fall 2019 (Course 1; EDPY 302) and Adolescent Development (Course 2; EDPY 304) in Winter 2020. Pre-service teachers were given the option of either participating in the present research study or completing an alternative assignment in exchange for 5% added to their final course grade. Pre-service teachers were informed that their participation in the research study was completely voluntary and they could withdraw from the study at any time. However, if they wished to receive 5% credit for research participation in the course, they needed to complete the alternative assignment. The alternative assignment was graded as credit/non-credit and pre-service teachers were encouraged to spend no more time on it than

they would have spent participating in the research study. The research study was anticipated to take 30 minutes.

The data were collected by a research assistant who was trained in the handling of data in order to keep knowledge of students' participation confidential from the teaching assistant (TA) and instructor of the courses. The principal investigator for the present study was the TA for the courses and the supervisor of the present research was the instructor. Pre-service teachers were informed that neither the principal investigator nor the research supervisor would have access to who participated and the data until the very end of the course and after final grades were approved. Data were collected during two in-person sessions during class time: once for students enrolled in Course 1 (EDPY 302) in Fall 2019, and once for students enrolled in Course 2 (EDPY 304) in Winter 2020. Students were also given the option to complete the survey from home. The research assistant provided a short in-class demonstration of how to complete the survey on Google Forms to help participants through the process of completing each research questionnaire, or alternative assignment. The procedure for EDPY 302 and 304 students is described in two sections because there was a small change in the materials in order to fix a problem uncovered during Fall 2019.

Procedure for Pre-service Teachers Enrolled in EDPY 302

The online survey consisted of the following order of scales: *Implicit Association Test* (IAT), the *Ambivalent Sexism Inventory* (ASI), the *Attitudes Towards Mistakes Inventory* (ATMI), an adapted version of the *Error Orientation Questionnaire* (EOQ), and a short demographic questionnaire. The scales are described in the Materials section.

Each of the scales were compiled into a single survey and delivered using Google Forms. The access link for the survey was posted on e-Class, which is the University of

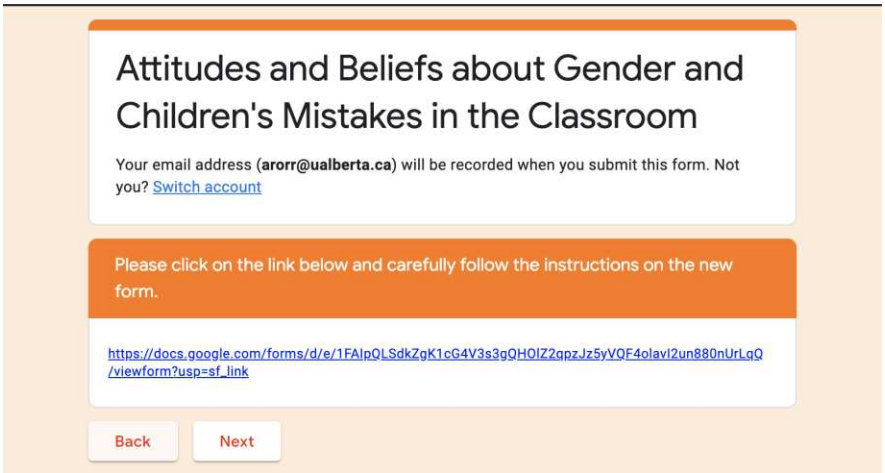
Alberta's online system for hosting courses online and for providing access to relevant course materials and for grading purposes. Pre-service teachers clicked on the link posted on e-Class to access the research study consent form. The consent form included two options: (1) by clicking on the first option, participants agreed to consent to participate in the research study, and (2) by clicking on the second option, participants did not consent to participate in the research study and opted to complete the alternative course assignment. All participants completed the scales in the same order.

Although the scales were administered in the same order for all participants, items within each scale were randomized. The IAT was administered first at the beginning of the survey because it was designed to measure implicit attitudes. As such, it needed to be administered first in an attempt to minimize priming effects that could impact the remainder of responses to the survey items. Additionally, as a test of implicit attitudes, the IAT was created as a separate Google Form embedded within the overall Google Form survey, in order to calculate completion times for each condition. However, completion times were unable to be calculated, as the two conditions of the IAT were improperly separated within the Google Form. Each IAT condition in the Google Form needed to prompt students for their start time in order to calculate the time students spent on each condition. However, by mistake only the initial start time was prompted and recorded. Thus, completion times for the overall time it took participants to complete both IAT conditions were calculated, but not the time per condition. This procedural element is elaborated in the Materials section and was corrected for data collection in Winter 2020. Prior to collecting data from students in Course 2, the Google format of the IAT was fixed to permit calculation of participants' completion time per condition.

Screenshots of the online survey as it appeared for students in Course 1 are shown in Figure 1, Figure 2 and Figure 3.

Figure 1

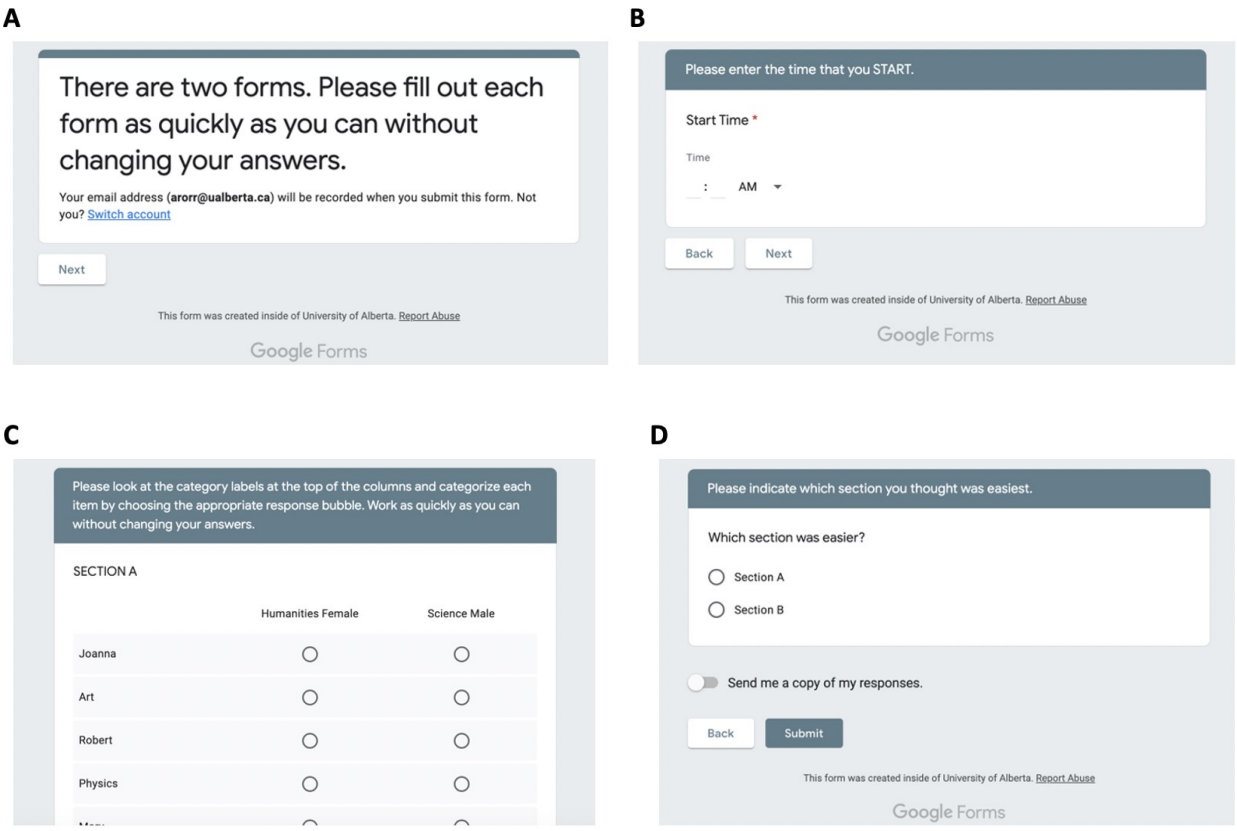
Introduction to Online Survey



Note. Screenshot of the introduction to the online survey. Students were redirected to the IAT upon clicking the link.

Figure 2

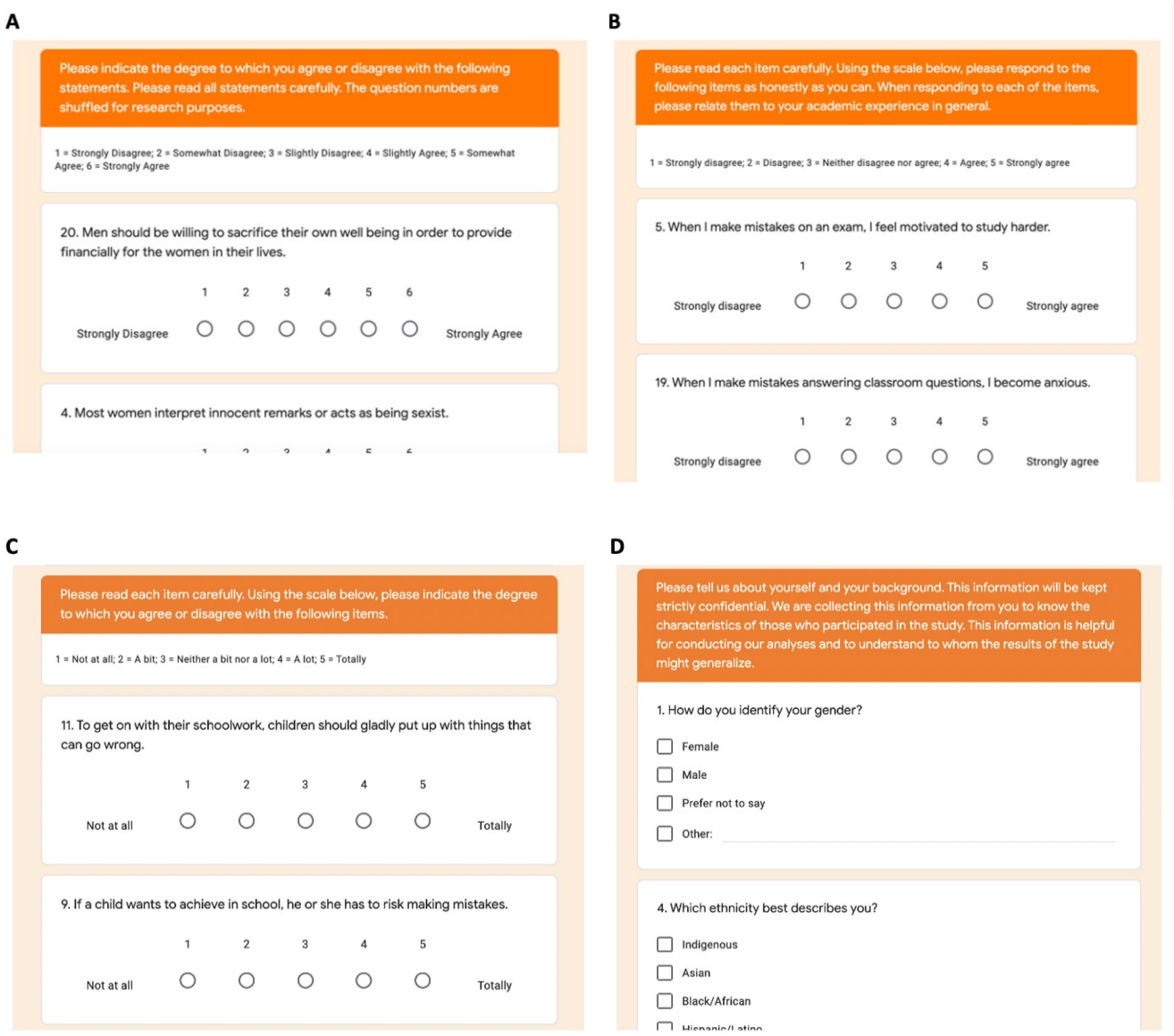
Screenshots of the IAT for EDPY 302 Students



Note. Panel A: The introduction to the IAT. Condition 1 of the IAT was labelled as *Section A* and Condition 2 as *Section B*. Panel B: Screenshot of how participants entered their start time prior to completing the IAT. Panel C: An example of how Condition 1 (Section A) of the IAT appeared to students. Panel D: Screenshot of how participants indicated which IAT condition they thought was easiest. Upon clicking *submit*, students were redirected out of the IAT scale and back to the survey to complete the remaining scales.

Figure 3

Screenshots of the ASI, ATMI, EOQ and Demographic Questionnaire

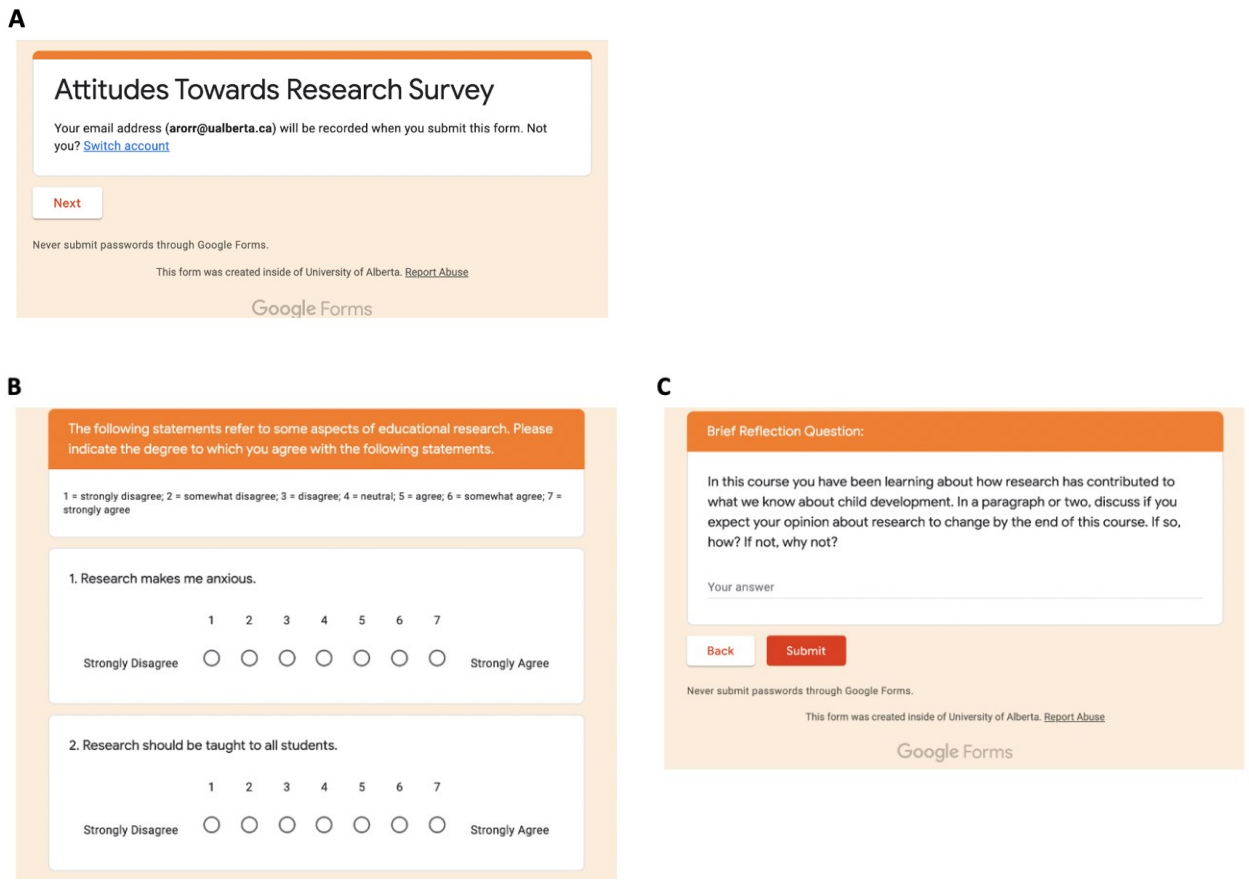


Note. Panel A: Screenshot of the Ambivalent Sexism Inventory (ASI). Panel B: Screenshot of the Attitudes Towards Mistakes Inventory (ATMI). Panel C: Screenshot of the adapted Error Orientation Questionnaire (EOQ). Panel D: Screenshot of the demographic questionnaire (see Appendix D for full questionnaire). All items were randomized for each scale.

The alternative course assignment was also administered using Google Forms, and consisted of Papanastasiou's (2005) Attitudes Towards Research Scale, as well as an open-ended question about students' feelings toward research. This assignment was strictly used for course research participation marks thus the data were not analyzed, nor presented and will not be used for research purposes. Screenshots of the alternative assignment are shown in Figure 4.

Figure 4

Screenshots of Alternative Assignment



Note. Panel A: Introduction to the alternative assignment. Panel B: Screenshot of the Attitudes Towards Research Scale (Papanastasiou, 2015). Panel C: Screenshot of the short open-ended reflection question.

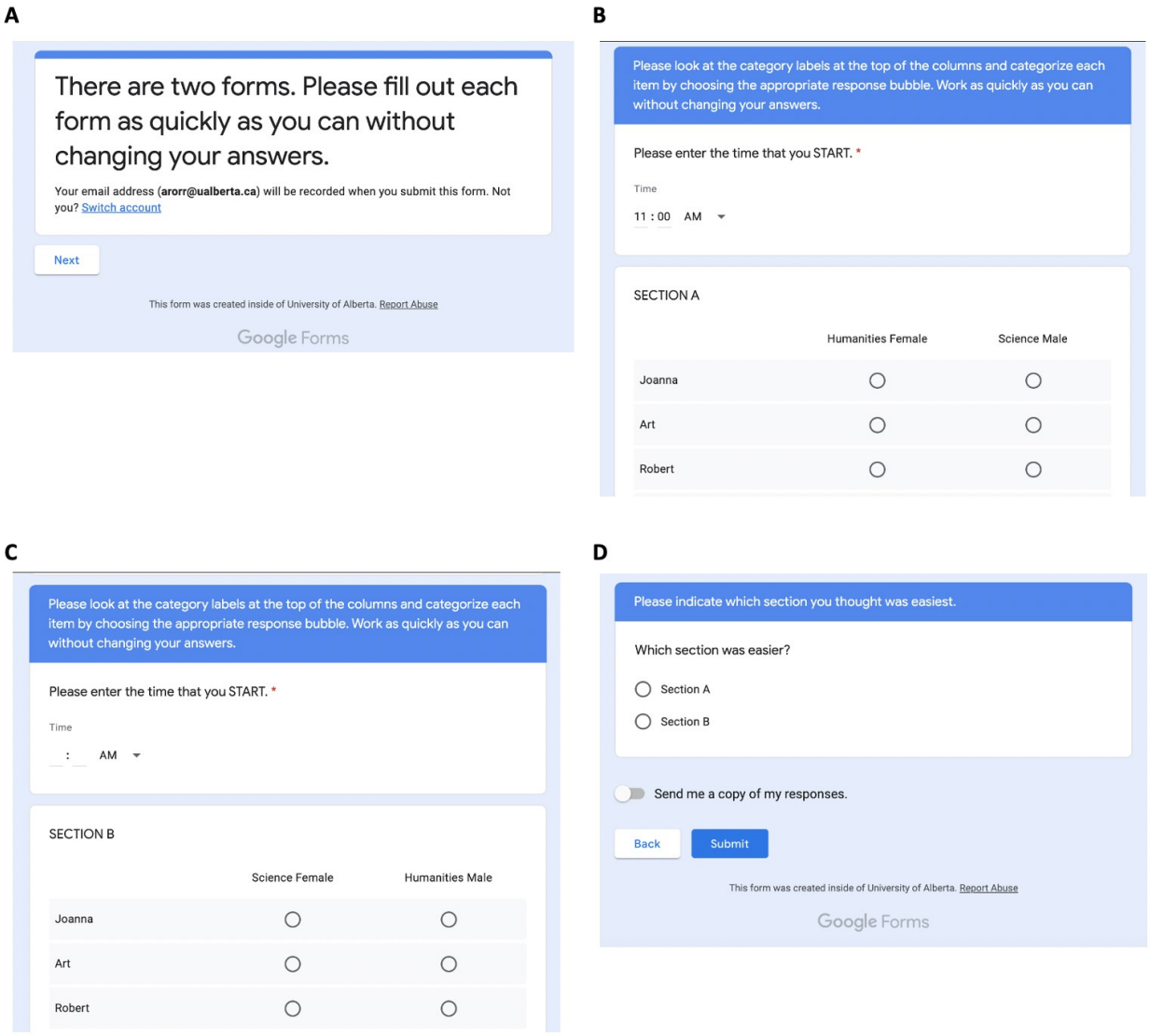
Procedure for Pre-service Teachers Enrolled in EDPY 304

Due to the change in procedure, participating pre-service teachers enrolled in EDPY 304 were randomly assigned to one of two survey treatment groups. Based upon the treatment group assigned, they were directed to the appropriate sequence of survey materials. Non-participating pre-service teachers were directed to a link to complete the alternative assignment.

After consenting to participate and being directed to either condition 1 or 2, participants were shown the IAT scale. Upon presentation of the IAT scale, participants were asked to indicate their start time at the beginning of *each condition of the IAT*, which permitted calculation of the response time per condition of the IAT. The rest of the procedure remained the same as the first session of data collection; the presentation order of the scales did not change, and all items within each scale were randomized. Screenshots of the IAT are presented in Figure 5 (Condition 1) and Figure 6 (Condition 2) to demonstrate the scale as it appeared for EDPY 304 students.

Figure 5

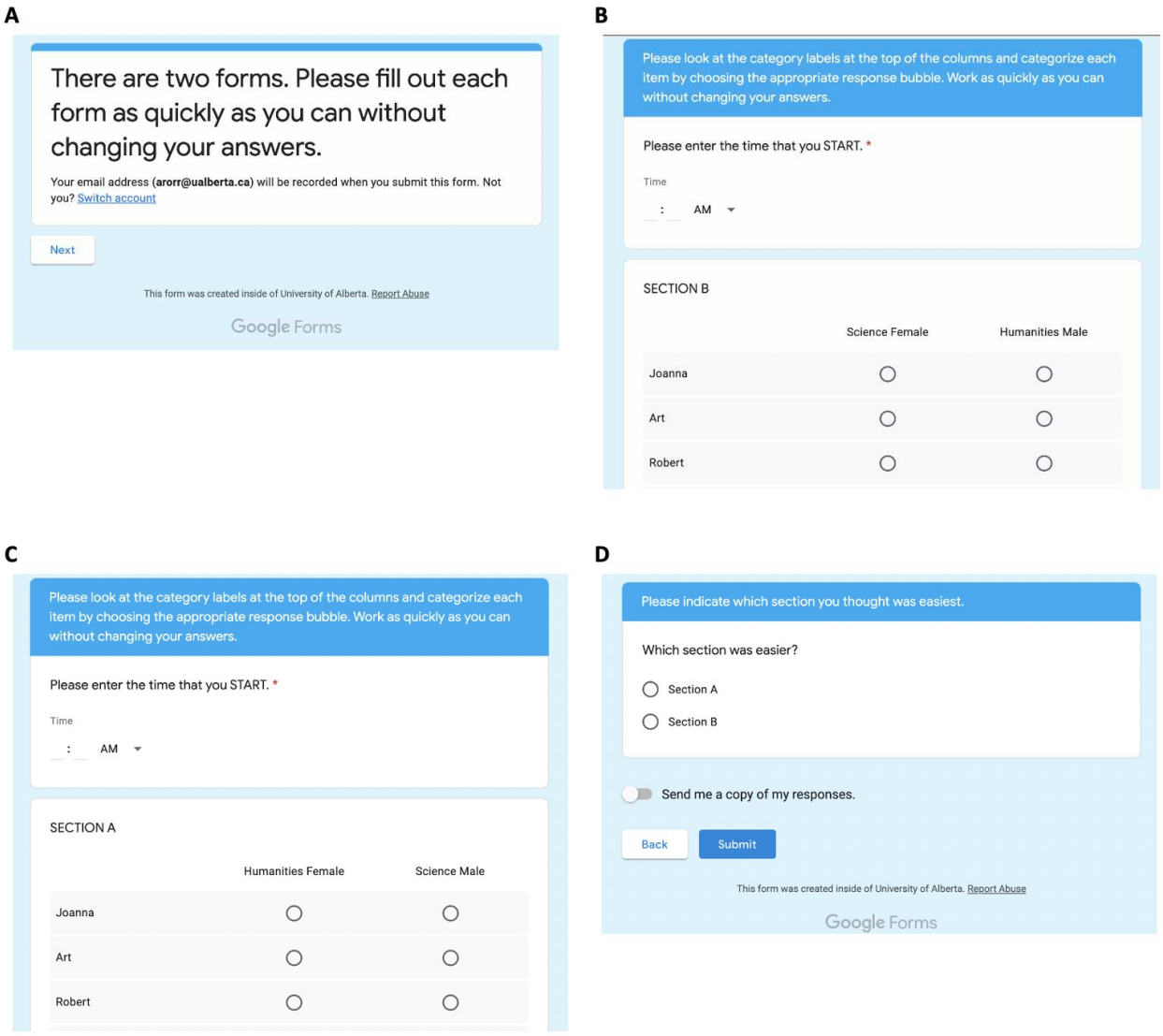
Screenshots of the IAT as it Appeared for EDPY 304 Students in Condition 1



Note. Panel A: Introduction to the IAT. Condition 1 of the IAT was labelled as *Section A* and Condition 2 as *Section B*. Panel B: Participants indicated their start time prior to completing Condition 1 (Section A) of the IAT. Panel C: Participants indicated their start time prior to completing Condition 2 (Section B) of the IAT. Panel D: The final question, where participants indicated the condition they thought was easiest.

Figure 6

Screenshots of the IAT as it Appeared for EDPY 304 Students in Condition 2



Note. Panel A: Introduction to the IAT. Condition 1 of the IAT was labelled as *Section A* and Condition 2 as *Section B*. Panel B: Participants indicated their start time prior to completing Condition 2 (Section B) of the IAT. Panel C: Participants indicated their start time prior to completing Condition 1 (Section A) of the IAT. Panel D: The final question, where participants indicated the condition they thought was easiest.

Materials

The present study included four scales, three of which were envisioned as predictors and one as a criterion. The first predictor was the *Implicit Association Test* (Lemm et al., 2008) used to measure pre-service teachers' implicit gender bias. The second predictor was the *Ambivalent Sexism Inventory* (Glick & Fiske, 1996) used to measure pre-service teachers' explicit gender bias. The third predictor was the *Attitudes Towards Mistakes Inventory* (Leighton et al., 2015), which was used to assess pre-service teachers' attitudes towards their own errors. The outcome or criterion variable was the fourth instrument, the *Error Orientation Questionnaire* (Rybowiak et al., 1999). This questionnaire was adapted for use with a pre-service teacher population, to measure pre-service teachers' attitudes towards children's mistakes instead of their own mistakes. Each instrument is outlined in more detail as follows.

Implicit Association Test

The *Implicit Association Test* (IAT) is a well-established research tool for studying implicit attitudes and beliefs (Lemm et al., 2008). The IAT was originally designed as a computerized task that measures response times to assess the strength of subconscious associations between concepts in different categories (Greenwald, McGhee, & Schwartz, 1998). For example, in one condition, *flower* and *pleasant* would be presented together as reflecting a typical association or category and *insect* and *unpleasant* would be presented together as reflecting another typical association. Then participants would be asked to categorize exemplars of these associations (e.g., butterfly, rose, joy, distasteful) as fast as possible without making mistakes (Lemm et al., 2008). In the second condition, the original concepts would be paired with their opposite. For example, *flower* and *unpleasant* would now be presented as a pair and *insect* and *pleasant* would now be presented as a pair. Then, participants would again be timed

to categorize new exemplars into one of the two categories. The difference in response times between the two conditions is used to reflect the strength of associations (Lemm et al., 2008). The logic underlying the test is that associations that are implicitly viewed as stronger (e.g., flower and pleasant) lead to faster categorization of new exemplars than associations that are viewed as weaker (e.g., flower and unpleasant). In this example, it is expected that participants would categorize exemplars in the first condition (i.e., flower and pleasant; insects and unpleasant) more quickly than in the second, reflecting the typically stronger association between flowers and pleasantness in comparison to insects and pleasantness (Lemm et al., 2008).

The computerized IAT has been adapted for use in paper-format (Lemm et al., 2008). The paper format of the scale is considered a reliable and valid measure of implicit attitudes and beliefs (Lemm et al., 2008). For example, Lemm et al. (2008) reported test-retest reliability for the paper-format at .62, which was in alignment with the computerized IAT. The correlation between the computerized IAT and the paper-format IAT was reported as .78, which provides evidence that the paper IAT measures a similar underlying construct (i.e., implicit attitudes) as the computerized IAT (Lemm et al., 2008).

Unlike the computerized version of the IAT, the paper-format IAT records the number of correct items in each category within the given time-limit given per condition (Lemm et al., 2008). For example, participants are given five minutes to complete the first condition and five minutes to complete the second condition. The condition that holds the highest number of correct responses reflects the strongest association between concepts for the participant (Lemm et al., 2008). This is because close associations between concepts should make the task easier,

leading to better performance; hence, better performance can be measured by assessing the number of correct responses (Lemm et al., 2008).

The current study utilized the paper-format IAT and converted it into a Google Form for online access as shown in Appendix A. The concepts used were female/male and humanities/science, as it was reasoned that these would tap into pre-service teachers' implicit beliefs and attitudes about gender and academic domains. Traditionally, males are often more closely associated with science and math than females; whereas, females are often more closely associated with arts or humanities than males. The strength of these associations was tested with the IAT. As such, participants were exposed to one of two counter-balanced conditions:

(1) The traditional pairing of female and humanities and male and science followed by the non-traditional pairing, or

(2) The non-traditional pairing of female and science and male and humanities followed by the traditional pairing.

Participants were asked to categorize traditionally female and male exemplar names, such as *Mary*, as well as different exemplars of academic domains, such as *Physics*. Prior to filling out the IAT, participants were asked to indicate their start time. Following the IAT, participants were asked to indicate which condition they thought was easiest. Those who hold stronger traditional gender associations were expected to indicate that the traditional classifications were easier to do than the non-traditional classifications.

Ambivalent Sexism Inventory

Participants' explicit gender bias was measured using Glick and Fiske's (1996) *Ambivalent Sexism Inventory* (ASI), which consists of two underlying dimensions: (a) hostile sexism, and (b) benevolent sexism. Hostile sexism (HS) refers to antipathic attitudes towards

women that are often expressed through negative stereotyping. Benevolent sexism (BS) refers to sexist attitudes towards women that have an overly positive tone with underpinnings of masculine dominance and more traditional stereotyping, which is viewed as often leading to behaviour that is seen as "prosocial" (e.g., helping) or "intimacy-seeking." BS is theorized to be a deep-seated social ideology within patriarchal societies that views women as needing protection and respect as wives, mothers, and romantic partners (Glick & Fiske, 1996). Thus, even though BS might be portrayed as reflecting helping behaviour, the underlying motivation is premised on female weakness and masculine dominance (Glick & Fiske, 1996). Although HS and BS are presented as dimensional opposites, it is possible to hold both opposing attitudes and beliefs. For example, a person may believe women are incompetent at work but also believe women should be protected and cared for as primary caregivers in the home (Glick & Fiske, 1996). Glick and Fiske (1996) therefore propose that men and women can have genuinely positive and hostile feelings toward women that are sexist in nature.

Participants responded to the ASI using a 6-point Likert scale, where 1 to 6 indicated "Strongly Disagree," "Somewhat Disagree," "Slightly Disagree," "Slightly Agree," "Somewhat Agree," and "Strongly Agree," respectively. The ASI consists of 22 items; both the HS and BS dimensions consist of 11 items each (see Appendix B for the full scale). Glick and Fiske (1996) reported a range of internal consistency values across six studies for the aggregated ASI scale, where Cronbach's alpha ranged from .83 to .90. Internal consistency values for BS and HS subscales were also reported. The BS subscale demonstrated consistently lower alpha values than the HS scale, ranging from .73 to .85 across six studies (Glick & Fiske, 1996). Whereas, the HS subscale demonstrated internal consistency values ranging from .80 to .92 across six

studies (Glick & Fiske, 1996). Glick and Fiske (1996) also reported strong convergent, discriminant and predictive validity across six studies.

For the present study, participants' gender biases were determined by examining their scores on the BS and HS subscales separately. As such, participants' scores on all 11 items of the HS subscale were averaged after reverse scoring; and, participants' scores on all 11 items of the BS subscale were averaged after reverse scoring. Higher scores on the HS subscale indicated increased hostility towards women, and higher scores on the BS subscale indicated increased positive attitudes towards women that are sexist in nature. Therefore, higher scores on both the HS and BS subscales demonstrate more sexist attitudes towards women – or, a greater gender bias.

Attitudes Towards Mistakes Inventory

Leighton et al.'s (2015) Attitudes Towards Mistakes Inventory (ATMI) was used to measure pre-service teachers' attitudes towards their mistakes. The ATMI consists of three subscales: affect, behaviour and cognition. Affect refers to a student's emotional reaction or feelings towards making a mistake; behaviour reflects the type of actions a student is likely to take following a mistake; and cognition measures a student's beliefs about making mistakes during learning (Leighton et al., 2015). Overall, the ATMI included 26 items, and participants responded by using a 5-point Likert scale, where 1 to 5 indicated "Strongly Disagree," "Disagree," "Neither Disagree nor Agree," "Agree," and "Strongly Agree," respectively. Cronbach's alpha values were reported at .92, .82, and .82 for the affect, behaviour, and cognition subscales, respectively (Leighton et al., 2015). Please see Appendix C for the full scale.

Error Orientation Questionnaire

Rybowiak et al.'s (1999) *Error Orientation Questionnaire* (EOQ) was originally designed to include 8 dimensions or subscales: (1) error competence, (2) learning from errors, (3) error risk-taking, (4) error strain, (5) error anticipation, (6) covering up errors, (7) error communication, and (8) thinking about errors, to measure working people or employees' attitudes and beliefs towards making mistakes in the workplace. Rybowiak et al. (1999) reported internal consistency values of .56, .89, .74, .79, .73, .78, .67, and .83 for each of the eight original subscales, respectively. Confirmatory factor analysis for each subscale supported the EOQ's construct validity (Rybowiak et al., 1999). In the present study, all 8 subs-subscales of the EOQ were adapted for use with pre-service teachers to measure their perceived error orientations in relation to children's mistakes in the classroom. The full adapted scale for the present study is provided in Appendix D. In total, 37 items across 8 subscales were rated by pre-service teachers, using a 5-point Likert scale, where 1 to 5 indicated "Not at All," "A Bit," "Neither a Bit nor a Lot," "A Lot," and "Totally," respectively.

It is important to reiterate that the EOQ was modified in two ways. First, items were modified to probe respondents' evaluations of *others' mistakes* instead of their own, as originally included in the EOQ. Second, the "others' mistakes" in items reflected children's mistakes in the classroom and not adults' mistakes in the workplace. Given these two significant adaptations, the overall functioning of the adapted EOQ is a key aspect of the present study. Specifically, then, the following eight subscales of the EOQ were adapted: (1) *error competence*, which was designed to measure pre-service teachers' beliefs about children's knowledge and capability to immediately deal with making a mistake; (2) *learning from errors*, which was designed to measure pre-service teachers' beliefs about children's competency to

learn from their mistakes for the future/in the long-term; (3) *error risk taking*, which was designed to measure pre-service teachers' beliefs about whether it is important for children to be generally flexible and open to making mistakes; (4) *error strain*, which was designed to measure pre-services teachers' perceptions of whether children feel strained by making errors and if they fear the occurrence of errors; (5) *error anticipation*, which was designed to measure pre-service teachers' beliefs about whether or not to generally expect children to make mistakes; (6) *covering up errors*, which was designed to measure pre-service teachers' beliefs about whether children should avoid or hide their mistakes; (7) *error communication*, which was designed to measure pre-service teachers' beliefs about whether children should be open to discussing mistakes; and (8) *thinking about errors*, which was designed to measure pre-service teachers' beliefs about whether children should think about their mistakes.

Results

Prior to conducting preliminary analyses, all variables were initially checked for accuracy of data entry and missing data. For the 304 participants, one participant completed both conditions, thus responding to the same questionnaires twice. The participant's second attempt was eliminated from the data file and the first attempt kept. It was important to analyze participants' first responses to the questionnaires in order to minimize any potential practice and/or priming effects. With respect to systematic missing data, three participants in 302 and one participant in EDPY 304 did not complete the ASI, ATMI, EOQ, and demographic questionnaire. Thus, these cases were eliminated from the data file. Additional unsystematic missing data included: Two participants enrolled in EDPY 302 did not answer one question on the ATMI questionnaire. One participant enrolled in EDPY 302 did not answer one question on the EOQ Error Communication subscale.

In terms of scoring, sub-scores were created wherever this was recommended based on previous published use of scales. First, data on participants' gender beliefs were aggregated by calculating total scores for each subscale on the ASI. The scores on items 3, 6, 7, 13, 18 and 21 were reverse coded to match the same direction of the other items within the same scale. Second, data on participants' attitudes towards their own mistakes were summarized by calculating total scores for each subscale of the ATMI. Also, scores on ATMI items 10, 13, 15, 18, 25 and 26 were reverse-coded. Third, participants' responses on beliefs about children's mistakes were also summarized by calculating total scores for each subscale of the adapted EOQ. Fourth, the IAT responses were coded as 1 (correct) or 0 (incorrect), with each participant receiving an aggregated total score for each IAT condition. Preliminary analyses, namely, internal consistency of subscales, full scales and correlations among variables, were conducted to determine which variables should be considered for regression analyses.

Preliminary Analyses

The internal consistency of the ASI, ATMI and EOQ subscales were investigated. This was done because each of the subscales was designed to measure an underlying construct. In order to warrant the summation of scores within subscales, it was important to investigate whether subscales reflected sufficient stability for the creation of sub-scores. Based on these results, descriptive statistics and correlation analyses were calculated for select variables.

Reliability

Ambivalent Sexism Inventory (ASI). Cronbach's alpha was calculated for 302 and 304 responses to each of the subscales to examine internal consistency. Based on Tabachnick and Fidell's (2007) internal consistency guidelines, a Cronbach's alpha coefficient at or above .70 is sufficient to meet the requirements of internal consistency. For 302 respondents, Cronbach's

alpha values for the ASI Benevolent and Hostile subscales were .70 and .86, respectively. Regarding the 304 respondents, Cronbach's alpha values for the ASI Benevolent and Hostile subscales were .79 and .88, respectively. These results suggest satisfactory internal consistency for ASI subscales for responses collected from both 302 and 304 participants.

Attitudes Towards Mistakes Inventory (ATMI). The internal consistency of the ATMI's Affect, Behaviour, and Cognitive subscales were calculated for both 302 and 304 responses. With respect to 302 responses, Cronbach's alpha values for the Affect, Behaviour and Cognitive subscales were .90, .72, and .70, respectively. For 304 responses, Cronbach's alpha values for the Affect, Behaviour, and Cognitive subscales were .90, .82, and .76. respectively. These results suggest that all three ATMI subscales for both the 302 and 304 datasets have satisfactory internal consistency.

Adapted Error Orientation Questionnaire (EOQ). The internal consistency of the adapted EOQ was examined for similar reasons as stated previously. It was important to evaluate the consistency of responses for each of the subscales to warrant summation and creation of sub-scores. Cronbach's alpha values were thus calculated for each subscale, with a total of eight subscales. For ease of presentation, the results are presented in Table 1. With respect to EDPY 302 responses, only two out of eight subscales demonstrated Cronbach's alpha values at or above .70, which were the Learning from Errors and Error Strain subscales. For EDPY 304 responses, three out of eight subscales had Cronbach's alpha values at or above .70, namely, Learning from Errors, Error Risk Taking, and Thinking about Errors.

In order to conduct parallel analysis for both 302 and 304 participants, the decision to use subscales that approximated the .70 criterion was taken. This decision meant that four subscales, the Error Competence, Error Anticipation, Covering Up Errors, and Error

Communication, were not part of further analyses as their internal consistencies were below .70 for both 302 and 304 responses. However, the decision was made to use the remaining four subscales, Learning from Errors, Error Strain, Error Risk Taking, and Thinking about Errors, in subsequent analyses since these subscales met or approximated the .70 criterion in one or both of 302 and 304 responses. These four subscale responses served as indicators of how pre-service teachers viewed children's mistakes.

Table 1

Internal Consistency of the Adapted EOQ

Scale	EDPY 302	EDPY 304
	Cronbach's α	Cronbach's α
EOQ		
Error Competence	.55	.44
Learning from Errors	.83*	.81*
Error Risk Taking	.43*	.79*
Error Strain	.75*	.66*
Error Anticipation	.59	.57
Covering Up Errors	.53	.65
Error Communication	.50	.54
Thinking about Errors	.64*	.81*

Note: Asterisk indicates that subscale was used in subsequent analyses.

Descriptive Statistics and Correlations

Descriptive statistics, including means, standard deviations, and ranges were calculated for all relevant variables for each of the EDPY 302 and EDPY 304 samples, disaggregated by

gender (see Tables 2 and 3), by age (see Tables 4 and 5), and by program route (see Tables 6 and 7). Correlations between selected variables are presented in Table 8 for EDPY 302 and EDPY 304.

Descriptive Statistics.

Ambivalent Sexism Inventory (ASI). The ASI was administered to pre-service teachers to measure their gender beliefs towards women. The scale was designed to measure both benevolent and hostile aspects of sexism. Thus, the mean of the scores on each subscale was calculated. Each subscale comprised 11 items that were rated on a 5-point Likert response scale. Therefore, scores on each of the Benevolent and Hostile subscales can range from 11-55, with higher scores indicating greater sexist beliefs towards women. In the EDPY 302 sample, the Kolmogorov-Smirnov test of normality indicated that both the Benevolent and Hostile subscale scores did not significantly differ from normal, $D(77) = 0.08$, $p > .20$, and, $D(77) = 0.08$, $p > .20$, respectively. With respect to the EDPY 304 sample, the Kolmogorov-Smirnov test of normality indicated that the Benevolent subscale scores also did not deviate from normal $D(49) = 0.06$, $p > .20$. Whereas, the Hostile subscale scores significantly differed from normal and $D(49) = 0.15$ $p = .01$.

Attitudes Towards Mistakes Inventory (ATMI). The ATMI was administered to pre-service teachers to evaluate their attitudes towards mistakes. The full scale was designed to measure attitudes within three domains: affect, behaviour and cognitive. Thus, the mean of the scores was calculated for each subscale. The Affect, Behaviour and Cognitive subscales comprised 11, 8, and 7 items, respectively, and items were rated on a 5-point Likert response scale. Therefore, scores on the Affect subscale can range between 11-55, scores on the Behaviour subscale can range between 8-40, and scores on the Cognitive subscale can range

between 7-35. Higher scores on the Affect subscale indicate more negative emotions towards making mistakes. Higher scores on the Behaviour subscale indicate more positive behavioural attitudes towards making mistakes. Higher scores on the Cognitive subscale indicate more negative beliefs towards making mistakes. In the EDPY 302 sample, the Kolmogorov-Smirnov test of normality indicated that the Affect and Behaviour subscale scores did not significantly differ from normal, $D(74) = 0.09$, $p = .09$, and, $D(74) = 0.08$, $p > .20$, respectively. However, the Cognitive subscale scores did not follow a normal distribution, $D(74) = 0.13$, $p = .01$. With respect to the EDPY 304 sample, the Kolmogorov-Smirnov test of normality indicated that the Affect and Behaviour subscale scores also did not deviate from normal $D(48) = 0.09$, $p > .20$, and $D(48) = 0.09$, $p > .20$, respectively. Again, the Cognitive subscale scores did not follow a normal distribution, $D(48) = 0.13$, $p = .04$.

Adapted Error Orientation Questionnaire (EOQ). The full EOQ subscale was used to measure pre-service teachers' beliefs about children's mistakes in the classroom, using eight different subscales. As previously discussed, only four out of the eight subscales were used for further analyses due to their approximate internal consistency values of .70. Thus, each of these four subscales was analyzed separately. The Learning from Errors, Error Risk Taking, Error Strain, and Thinking about Errors subscales comprised 3, 4, 5 and 5 items, respectively, and items were rated on a 5-point Likert response scale. Therefore, scores on the Learning from Errors subscale can range between 3-15, scores on the Error Risk Taking subscale can range between 4-20, and scores on both the Error Strain and Thinking about Errors subscales can range between 5-25. Higher scores on the Learning from Errors subscale indicated more positive beliefs about whether children should learn from their mistakes. Higher scores on the Error Risk Taking subscale indicated more positive beliefs about whether children are, or

should be, willing and open to making mistakes. Higher scores on the Thinking about Errors subscale indicated more positive beliefs about whether children should think about their mistakes. Whereas, higher scores on the Error Strain subscale indicated more negative beliefs about whether children feel, or should feel, strained by errors and fear the occurrence of mistakes. In the EDPY 302 sample, the Kolmogorov-Smirnov test of normality indicated that the Error Strain subscale scores did not significantly differ from normal, $D(76) = 0.10$, $p > .05$. However, the Learning from Errors and Error Risk Taking, and Thinking about Errors subscale scores did not follow a normal distribution, $D(76) = 0.25$, $p < .01$, and $D(76) = 0.16$, $p < .01$, and $D(76) = 0.11$, $p = .02$, respectively. With respect to the EDPY 304 sample, the Kolmogorov-Smirnov test of normality indicated that the Error Strain and Thinking about Errors subscale scores did not significantly differ from normal, $D(49) = 0.11$, $p = .17$, and, $D(49) = 0.11$, $p = .19$, respectively. However, the Learning from Errors and Error Risk Taking subscale scores did not follow a normal distribution, $D(49) = 0.23$, $p < .01$, and $D(49) = 0.14$, $p = .02$, respectively.

Table 2

Descriptive Statistics of Key Variables for EDPY 302 by Participant Gender

Scale	Male						Female					
	n	*M*	*SD*	Range	Skew	Kurtosis	*n*	*M*	*SD*	Range	Skew	Kurtosis
ASI												
Benevolent	6	35.17	9.04	24-49	0.40	-0.44	70	32.30	7.47	16-50	0.08	-0.30
Hostile	6	39.83	7.71	34-55	2.08	4.58	70	28.14	9.28	13-49	0.33	-0.67
ATMI												
Affect	6	25.33	7.31	14-34	-0.43	-0.31	68	37.79	8.21	17-55	-0.30	-0.08
Behaviour	6	25.17	4.92	18-30	-0.41	-1.56	70	28.00	4.87	17-39	0.42	-0.70
Cognitive	6	15.00	6.69	8-22	-0.07	-2.98	70	13.06	3.68	7-22	0.23	-0.53
EOQ												
Learning from Errors	6	12.17	2.32	9-15	-0.30	-1.42	70	13.49	1.81	6-15	-1.86	4.26
Error Risk Taking	6	16.33	2.16	13-19	-0.46	-0.30	70	16.53	1.89	12-20	-0.45	-0.04
Error Strain	6	16.83	2.14	14-20	0.14	-0.27	70	17.10	3.40	9-24	-0.37	-0.28
Thinking about Errors	6	18.67	2.50	15-22	-0.24	-0.57	70	18.59	2.73	11-25	0.21	0.57

Table 3

Descriptive Statistics of Key Variables for EDPY 304 by Participant Gender

Scale	Male						Female					
	n	*M*	*SD*	Range	Skew	Kurtosis	*n*	*M*	*SD*	Range	Skew	Kurtosis
ASI												
Benevolent	25	31.92	8.13	17-49	0.14	-0.23	23	26.00	8.17	12-39	0.06	-1.11
Hostile	25	27.00	10.45	14-47	0.53	-1.11	23	24.83	8.41	11-40	0.26	-0.94
ATMI												
Affect	25	31.80	9.55	19-50	0.67	-0.73	23	33.96	8.91	16-51	-0.25	-0.10
Behaviour	25	29.28	6.21	17-40	-0.11	-0.73	22	28.55	4.64	19-38	0.07	-0.10
Cognitive	25	19.16	3.94	12-32	1.26	4.15	23	19.22	3.40	11-26	-0.28	0.37
EOQ												
Learning from Errors	25	13.72	1.46	10-15	-0.78	-0.23	23	13.17	1.61	9-15	-0.59	0.23
Error Risk Taking	25	17.32	1.95	13-20	-0.56	-0.36	23	15.91	2.94	10-20	-0.27	-0.76
Error Strain	25	18.48	2.26	13-23	-0.04	0.50	23	18.83	3.28	11-24	-0.62	0.02
Thinking about Errors	25	19.60	3.12	14-24	-0.10	-1.11	23	17.70	3.52	10-25	-0.36	0.47

Table 4

Descriptive Statistics of Key Variables for EDPY 302 by Participant Age

Scale	Under 25 Years				25-34 Years				Above 35 Years			
	n	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range
ASI												
Benevolent	70	33.06	7.53	16-50	4	23.25	3.30	20-27	2	35.50	0.71	35-36
Hostile	70	29.00	9.90	13-55	4	26.50	7.60	19-34	2	32.00	2.82	30-34
ATMI												
Affect	68	36.75	8.81	14-55	4	36.25	10.72	22-48	2	42.50	2.12	41-44
Behaviour	70	27.66	4.96	17-39	4	27.75	2.87	26-32	2	31.00	7.07	26-36
Cognitive	69	13.39	3.97	7-22	4	11.25	4.92	7-16	2	12.00	2.83	10-14
EOQ												
Learning from Errors	70	13.41	1.85	6-15	4	14.00	1.41	12-15	2	12.00	4.24	9-15
Error Risk Taking	70	16.54	1.78	12-20	4	16.25	2.99	12-19	2	16.50	4.95	13-20
Error Strain	69	16.99	3.39	9-24	4	18.00	1.41	16-19	2	18.25	4.95	15-22
Thinking about Errors	70	18.73	2.64	11-25	4	17.25	2.36	14-19	2	17.00	5.66	13-21

Table 5

Descriptive Statistics of Key Variables for EDPY 304 by Participant Age

Scale	Under 25 Years				25-34 Years				Above 35 Years			
	n	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range
ASI												
Benevolent	30	30.77	8.44	12-49	11	26.27	8.01	17-40	8	26.25	8.80	14-37
Hostile	30	26.87	9.43	15-47	11	23.73	7.51	14-38	8	24.50	12.39	11-44
ATMI												
Affect	30	35.67	9.05	19-51	11	27.36	6.45	16-35	8	30.38	9.32	18-46
Behaviour	30	29.63	5.00	20-40	11	28.27	5.46	19-39	7	27.71	7.70	17-38
Cognitive	30	19.37	4.11	11-32	11	18.45	2.88	12-22	8	18.75	3.45	15-26
EOQ												
Learning from Errors	30	13.53	1.41	11-15	11	12.91	1.81	9-15	8	13.63	1.85	10-15
Error Risk Taking	30	16.80	2.17	12-20	11	15.36	3.35	10-20	8	17.63	2.13	13-20
Error Strain	30	19.10	2.31	14-24	11	16.00	2.65	11-20	8	20.13	2.64	17-23
Thinking about Errors	30	19.33	2.88	15-25	11	17.27	4.00	10-22	8	18.12	4.02	11-24

Table 6

Descriptive Statistics of Key Variables for EDPY 302 by Participant Program Route

Scale	B. Ed. Elementary Route				Other			
	n	*M*	*SD*	Range	*n*	*M*	*SD*	Range
ASI								
Benevolent	75	32.73	7.50	16-50	2	27.50	10.61	20-35
Hostile	75	29.16	9.61	13-55	2	23.50	10.61	16-31
ATMI								
Affect	73	36.58	8.72	14-55	2	45.50	2.12	44-47
Behaviour	75	27.71	4.90	17-39	2	30.50	2.12	29-32
Cognitive	74	13.23	4.01	7-22	2	12.50	2.12	11-14
EOQ								
Learning from Errors	75	13.40	1.89	6-15	2	13.50	0.71	13-14
Error Risk Taking	75	16.48	1.91	12-20	2	17.50	0.71	17-18
Error Strain	74	17.18	3.25	9-24	2	13.50	4.95	10-17
Thinking about Errors	75	18.59	2.71	11-25	2	19.00	1.41	18-20

Note. Other = Combined Bachelor of Education and Bachelor of Native Studies degree, and, Combined Bachelor of Education and Bachelor of Kinesiology degree.

Table 7

Descriptive Statistics of Key Variables for EDPY 304 by Participant Program Route

Scale	B. Ed. Secondary Route				Other			
	n	*M*	*SD*	Range	*n*	*M*	*SD*	Range
ASI								
Benevolent	47	28.68	8.51	12-49	1	34.00	-	-
Hostile	47	25.34	9.35	36-42	1	42.00	-	-
ATMI								
Affect	47	33.38	9.07	16-51	1	24.00	-	-
Behaviour	46	28.96	5.38	17-40	1	38.00	-	-
Cognitive	47	19.04	3.80	11-32	1	20.00	-	-
EOQ								
Learning from Errors	47	13.38	1.58	9-15	1	15.00	-	-
Error Risk Taking	47	16.57	2.53	10-20	1	20.00	-	-
Error Strain	47	18.62	2.84	11-24	1	17.00	-	-
Thinking about Errors	47	18.55	3.37	10-20	1	24.00	-	-

Note. Other = Combined Bachelor of Education and Bachelor of Science degree.

Correlations. Predictor variables that were significantly correlated with the outcome variables (i.e., any of the EOQ subscales) were considered for regression analyses (see Table 8). As such, select correlational relationships are discussed next.

EDPY 302. Both ASI Benevolent and Hostile subscales were significantly and negatively correlated with the EOQ Learning from Errors subscale, suggesting that increased levels of hostile and benevolent sexism were associated with less positive beliefs and attitudes about children learning from their mistakes. As well, the ATMI Cognitive subscale was significantly and negatively correlated with the EOQ Learning from Errors subscale, meaning that increased negative beliefs about one's own mistakes were associated with less positive beliefs and attitudes towards children learning from their mistakes. The ASI Hostile subscale was significantly and negatively associated with the EOQ Error Risk Taking subscale, meaning that increased levels of hostility toward women was associated with less positive beliefs about the importance of children to be open and willing to making mistakes. Lastly, the ATMI Behaviour subscale and the EOQ Thinking about Errors subscale were significantly and positively correlated, suggesting that better behavioural attitudes towards one's own mistakes was associated with more positive beliefs towards children thinking about their mistakes. None of the ASI or ATMI scales were significantly correlated with the EOQ Error Strain subscale.

Based on these results, the variables that were selected to be included in the regression analyses for the EDPY 302 sample were: (a) the ASI Benevolent subscale (predictor), (b) the ASI Hostile subscale (predictor), (c) the ATMI Behaviour subscale (predictor), (d) the ATMI Cognitive subscale (predictor), (e) the EOQ Learning from Errors subscale (criterion), (f) the EOQ Error Risk Taking subscale (criterion), and (g) the EOQ Thinking about Errors subscale (criterion).

EDPY 304. The ASI Benevolent subscale and the EOQ Learning from Errors subscale were significantly and negatively correlated, indicating that increased benevolent sexism towards women was associated with less positive beliefs about the importance of children learning from their mistakes. With respect to the ATMI, the Affect subscale and the EOQ Error Strain subscale were significantly and positively correlated, suggesting that more negative emotional attitudes towards mistakes were associated with more negative beliefs about whether children feel (or should feel) strained by errors and fear making mistakes. A significant and positive correlation was found between the ATMI Behaviour subscale and the EOQ Error Risk Taking subscale, suggesting that better behavioural attitudes towards mistakes were associated with more positive beliefs about the importance for children to be open and willing to making mistakes. The ATMI Behaviour subscale was also positively correlated with the EOQ Thinking about Errors subscale, meaning that better behavioural attitudes towards one's own mistakes was associated with increased positive beliefs about whether children would think about their mistakes. The ATMI Cognitive subscale did not correlate significantly with any of the outcome EOQ subscales.

Based on these correlations, the variables selected for the regression analyses with the EDPY 304 sample were: (a) the ASI Benevolent subscale (predictor), (b) the ATMI Affect subscale (predictor), (c) the ATMI Behaviour subscale (predictor), (d) the EOQ Learning from Errors subscale (criterion), (e) the EOQ Error Risk Taking subscale (criterion), (f) the EOQ Error Strain subscale (criterion), and (g) the EOQ Thinking about Errors subscale (criterion).

Table 8

Correlation Matrix of Key Study Variables Disaggregated by EDPY Course

Variable	1	2	3	4	5	6	7	8	9
1. ASI Benevolent	–	.52**	.03	-.08	.24	-.29*	-.08	-.01	-.07
2. ASI Hostile	.48**	–	.09	-.02	.33*	-.23	-.18	.06	.24
3. ATMI Affect	-.00	-.09	–	.05	-.03	-.12	-.12	.30*	.10
4. ATMI Behaviour	-.02	-.29*	.09	–	-.04	.07	.29*	-.10	.35*
5. ATMI Cognitive	.22	.29**	.19	-.22	–	-.05	-.09	.16	.26
6. EOQ Learning from Errors	-.27*	-.39**	.07	.20	-.38**	–	.67**	.11	.32*
7. EOQ Error Risk Taking	-.18	-.24*	.12	.11	-.21	.60**	–	.24	.50*
8. EOQ Error Strain	-.16	-.15	.04	.06	-.21	.17	.07	–	.33*
9. EOQ Thinking about Errors	-.10	-.22	-.04	.24*	-.21	.53**	.38**	.31**	–

Note. The results for the EDPY 302 sample (n = 76) are shown below the diagonal. The results for the EDPY 304 sample (n = 49) are shown above the diagonal.

*$p < .05$. **$p < .01$

Implicit Association Test. The Implicit Association Test (IAT) was not included in the regression analyses because neither condition significantly correlated with any of the EOQ subscales in either sample.

Regression Analyses

Based on the statistically significant correlations presented in the preliminary analyses, three separate regression analyses were conducted to explore the following relationships within the EDPY 302 sample: (a) predicting pre-service teachers' beliefs about the importance of children learning from their mistakes based on both subscales of gender beliefs (ASI) and beliefs towards making mistakes (ATMI Cognitive subscale); (b) predicting pre-service teachers' beliefs about whether children should be willing and open to making mistakes based on their hostile sexist attitudes (ASI Hostile subscale); and (c) predicting pre-service teachers' beliefs about whether children should think about their mistakes based on their behavioural attitudes towards making mistakes (ATMI Behaviour subscale).

Within the EDPY 304 sample, the following relationships were explored further using four separate regression analyses: (a) predicting pre-service teachers' beliefs about the importance of children learning from their mistakes based on pre-service teachers' benevolent sexist attitudes towards women (ASI Benevolent subscale); (b) predicting pre-service teachers' beliefs about whether children should be willing and open to making mistakes based on pre-service teachers' behavioural attitudes towards mistakes (ATMI Behaviour subscale); (c) predicting pre-service teachers' beliefs about children's error strain based on pre-service teachers' emotional attitudes towards mistakes (ATMI Affect subscale); and (d) predicting pre-service teachers' beliefs about whether children should think about their mistakes based on pre-service teachers' behavioural attitudes towards mistakes (ATMI Behaviour subscale).

EDPY 302

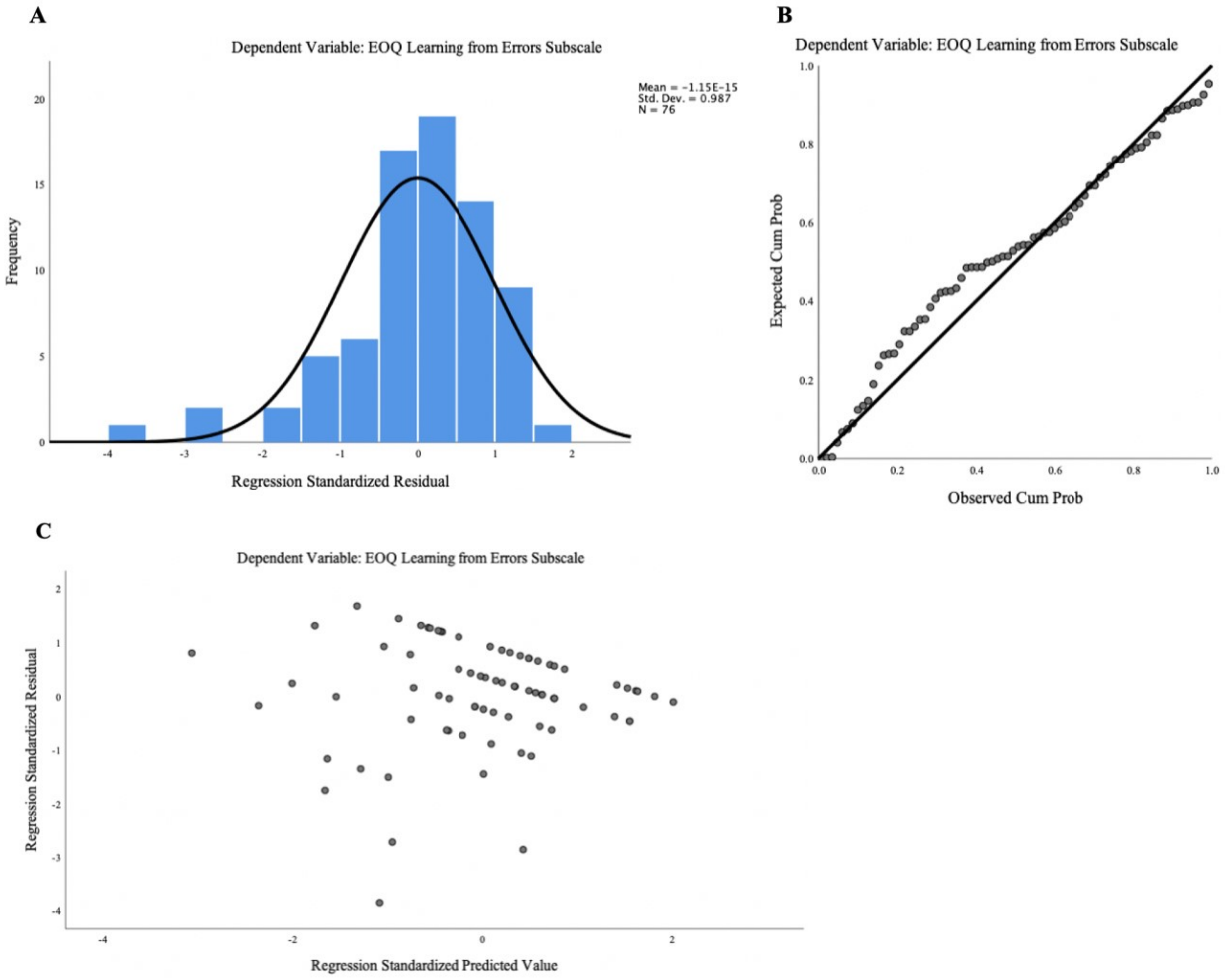
Regression 1. First, a stepwise regression was conducted to predict pre-service teachers' beliefs about the importance of children learning from mistakes (EOQ Learning from Errors) based on their gender beliefs (ASI Benevolent and Hostile subscales), and their beliefs towards making their own mistakes (ATMI Cognitive subscale). The initial analysis checks indicated no violations of the assumptions. As shown in Figure 7, the data met the assumptions of approximately normally distributed residuals, linearity, and homoscedasticity. There was no multicollinearity, as indicated by the collinearity statistics (Tolerance values > .2, VIF values < 10, see Table 9). Additionally, the data met the assumption of independent errors, as the Durbin-Watson value was 1.64, which is within the boundaries of between 1 and 3.

As shown in Table 9, a significant initial step-wise regression model was found, where the ASI Hostile subscale accounted for 15% of the variance in predicting pre-service teachers' beliefs about the importance of children learning from mistakes, $F(1,74) = 13.09$, $p = .001$. When the ATMI Cognitive subscale was added to the model as a predictor in the second stage, the model accounted for another 7% of the variance in predicting pre-service teachers' beliefs about the importance of children learning from mistakes, $F(1,73) = 7.33$, $p = .008$. Further examination of the standardized regression coefficients indicated that scores on ASI Hostile subscale significantly predicted EOQ Learning from Errors scores ($\beta = -0.30$, $p = .01$), as did scores on the ATMI Cognitive subscale ($\beta = -0.29$, $p = .01$). The ASI Benevolent subscale and the ATMI Behaviour subscales were excluded from the regression model as neither variable contributed uniquely to predicting the outcome variable. Taken altogether, for every standard deviation unit increase in pre-service teachers' hostile attitudes towards women, there was a decrease of .30 standard deviations of their beliefs about the importance of children learning

from mistakes. Moreover, for every standard deviation unit increase in pre-service teachers' negative beliefs towards mistakes, there was a decrease of .29 standard deviations in their beliefs about the importance of children learning from mistakes.

Figure 7

Graphs Demonstrating Normally Distributed Errors, Linearity, and Homoscedasticity for EOQ Learning from Errors



Note. Panel A: Histogram of standardized residuals for the outcome variable, EOQ Learning from Errors, representing approximately normally distributed errors. Panel B: Normal P-P plot of standardized residuals for the outcome variable, EOQ Learning from Errors, representing that the data met the linearity assumption. Panel C: Scatter plot of standardized residuals versus standardized predicted values, representing that the data met the homoscedasticity assumption.

Table 9

Summary of Regression Analysis for Predicting Pre-service Teachers' Beliefs about Children Learning from Mistakes

Model	*B*	*SE B*	β	*t*	*p*	Tolerance	VIF	R^2	ΔR^2
1								.15	.15**
Constant	15.56	0.64		24.52	.00				
ASI Hostile	-0.08	0.02	-.39	-3.62	.00	1.00	1.00		
2								.23	.07**
Constant	16.90	0.78		21.57	.00				
ASI Hostile	-0.06	0.02	-.30	-2.81	.01	0.91	1.10		
ATMI Cog	-0.14	0.05	-.29	-2.71	.01	0.91	1.10		

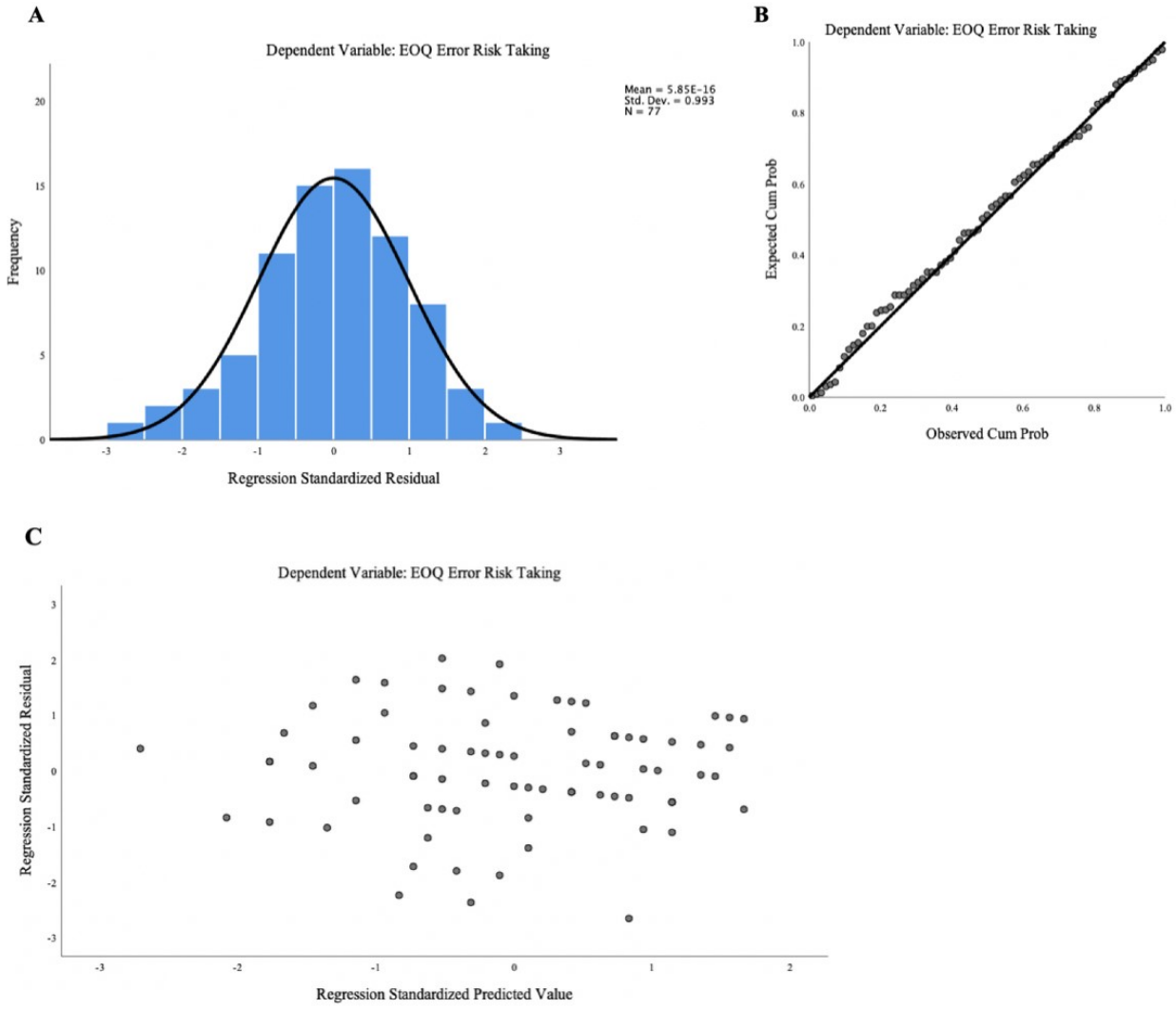
Note. ASI Hostile = Ambivalent Sexism Inventory, Hostile subscale. ATMI Cog = Attitudes Towards Mistakes Inventory, Cognitive subscale. **p < .01.

Regression 2. A simple linear regression was calculated to predict pre-service teachers' beliefs about whether children are open and willing to make mistakes (EOQ Error Risk Taking) based on their hostile attitudes towards women (ASI Hostile subscale). The initial analysis checks indicated no violations of the assumptions. As shown in Figure 8, the data met the assumptions of approximately normally distributed residuals, linearity, and homoscedasticity. The data also met the assumption of independent errors, as the Durbin-Watson value was 2.08. As presented in Table 10, a linear regression model was found, where the ASI Hostile subscale accounted for 6% of the variance in pre-service teachers' beliefs about whether children are willing or open to making mistakes, $F(1, 75) = 4.75$, $p = .03$. The standardized coefficient of -.24 indicates that for every standard deviation unit increase in pre-service teachers' hostile

attitudes towards women, there was a decrease of .24 standard deviations in their beliefs about whether children are, or should be, willing to risk making mistakes.

Figure 8

Graphs Demonstrating Normally Distributed Errors, Linearity, and Homoscedasticity for EOQ Error Risk Taking



Note. Panel A: Histogram of standardized residuals for the outcome variable, EOQ Error Risk Taking, representing approximately normally distributed errors. Panel B: Normal P-P plot of standardized residuals for the outcome variable, EOQ Error Risk Taking, representing that the data met the linearity assumption. Panel C: Scatter plot of standardized residuals versus standardized predicted values, representing that the data met the homoscedasticity assumption.

Table 10

Summary of Simple Linear Regression Analysis for Predicting Pre-service Teachers' Beliefs about Children's Openness and Willingness to Making Mistakes

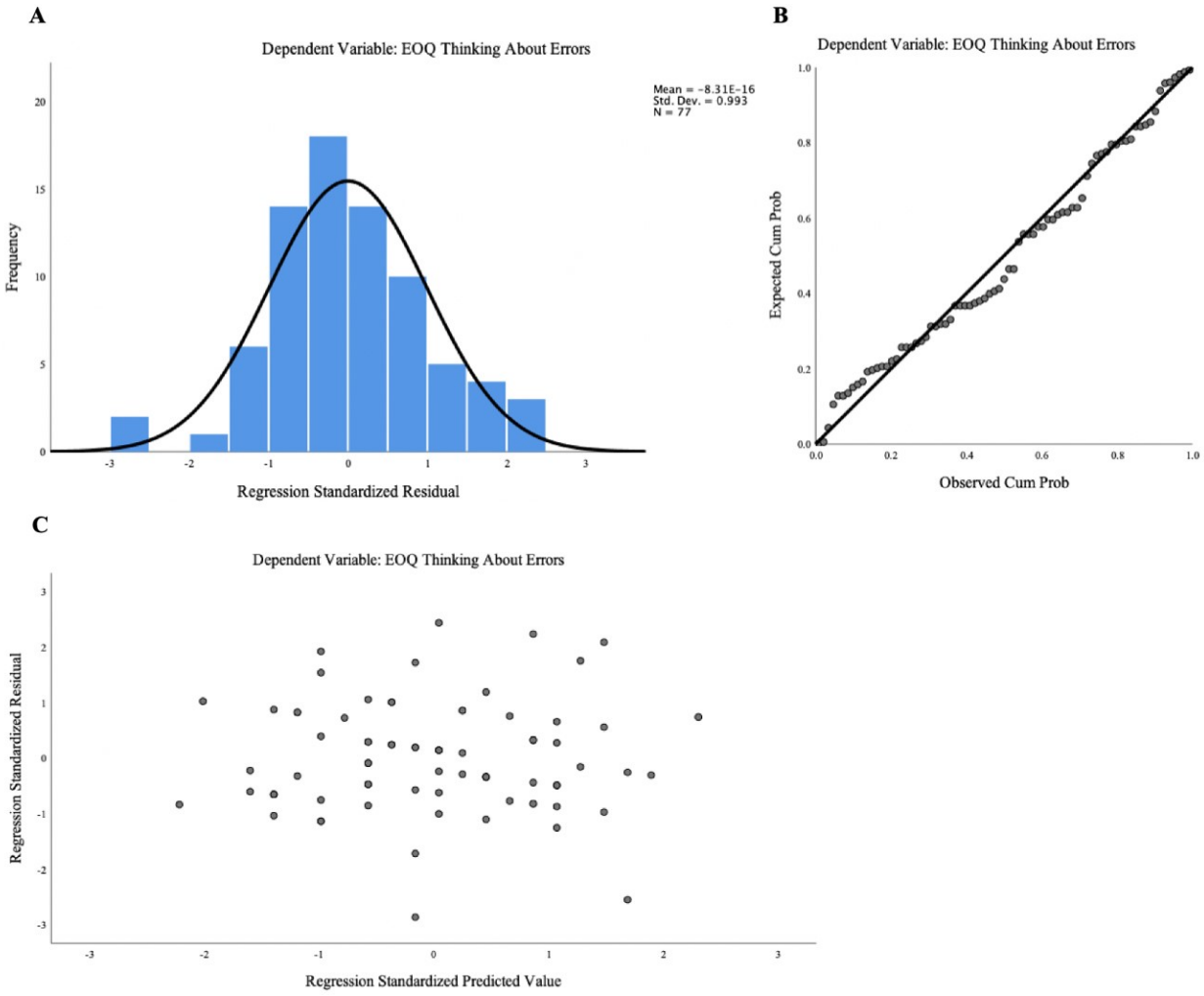
Model	*B*	*SE B*	β	*t*	*p*	R^2
1						.06*
Constant	17.90	0.67		26.61	.00	
ASI Hostile	-0.05	0.02	-.24	-2.18	.03	

Note. ASI Hostile = Ambivalent Sexism Inventory, Hostile subscale. *p < .05.

Regression 3. Another simple linear regression was calculated to predict pre-service teachers' beliefs about whether children should think about their mistakes (EOQ Thinking about Errors) based on their behavioural attitudes towards mistakes (ATMI Behaviour subscale). Upon initial analysis checks, the data met the assumptions of approximately normally distributed errors, linearity, and homoscedasticity (see Figure 9). As well, the data met the assumption of independent errors, as the Durbin-Watson value was 2.08. As presented in Table 11, a significant regression model was found, where the ATMI Behaviour subscale accounted for 6% of the variance in pre-service teachers' beliefs about whether children should think about their mistakes, $F(1, 75) = 4.49$, $p = .04$. The standardized coefficient of .24 means that for every standard deviation unit increase in pre-service teachers' positive behavioural attitudes towards mistakes, there was an increase of .24 standard deviations in their beliefs that children should consider and think about their mistakes.

Figure 9

Graphs Demonstrating Normally Distributed Errors, Linearity, and Homoscedasticity for EOQ Thinking about Errors



Note. Panel A: Histogram of standardized residuals for the outcome variable, EOQ Thinking about Errors, representing approximately normally distributed errors. Panel B: Normal P-P plot of standardized residuals for the outcome variable, EOQ Thinking about Errors, representing that the data met the linearity assumption. Panel C: Scatter plot of standardized residuals versus standardized predicted values, representing that the data met the homoscedasticity assumption.

Table 11

Summary of Regression Analysis for Predicting Pre-service Teachers' Beliefs towards Children Thinking about Mistakes

Model	*B*	*SE B*	β	*t*	*p*	R^2
1						.06*
Constant	14.97	1.74		8.60	.00	
ATMI Behaviour	0.13	0.06	.24	2.12	.04	

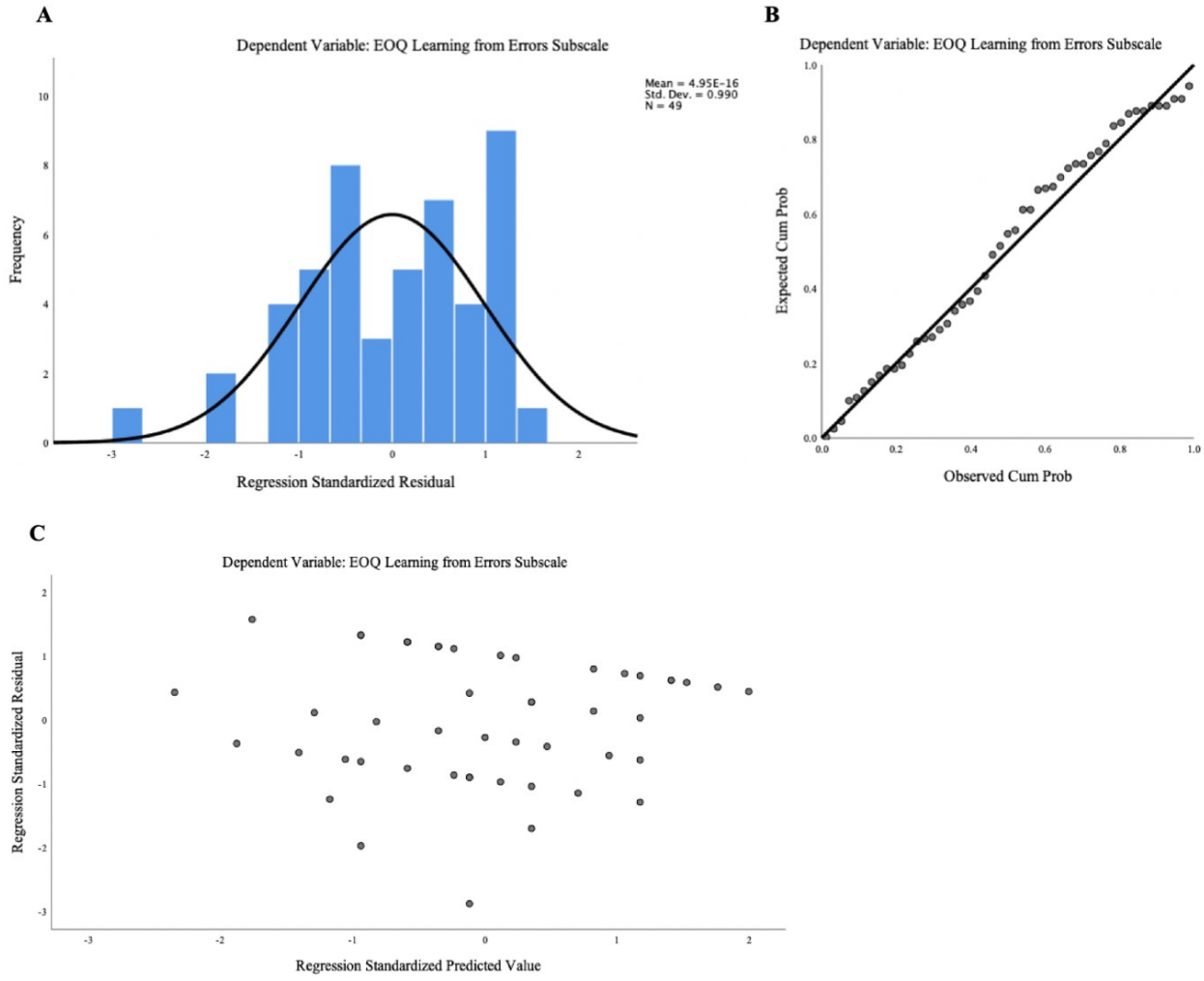
Note. ATMI Behaviour = Attitudes Towards Mistakes Inventory, Behaviour subscale. *p < .05.

EDPY 304

Regression 1. A simple linear regression was calculated to predict pre-service teachers' beliefs about the importance of children learning from mistakes (EOQ Learning from Errors) based on their benevolent sexist attitudes towards women (ASI Benevolent subscale). The initial analysis checks indicated that the assumptions of normally distributed errors, linearity, and homoscedasticity were met (see Figure 10). Also, the assumption of independent errors was met, as indicated by the Durbin-Watson value of 1.89. As shown in Table 12, a significant regression model was found, where the ASI Benevolent subscale accounted for 9% of the variance in pre-service teachers' beliefs about the importance of children learning from their mistakes, $F(1, 48) = 9.98$, $p = .04$. The standardized coefficient of -.29 means that for every standard deviation unit increase in pre-service teachers' benevolent sexist attitudes towards women, there was a decrease of .29 standard deviations in their beliefs about the importance of children learning from mistakes.

Figure 10

Graphs Demonstrating Normally Distributed Errors, Linearity, and Homoscedasticity for EOQ Learning from Errors



Note. Panel A: Histogram of standardized residuals for the outcome variable, EOQ Learning from Errors, representing approximately normally distributed errors. Panel B: Normal P-P plot of standardized residuals for the outcome variable, EOQ Learning from Errors, representing that the data met the linearity assumption. Panel C: Scatter plot of standardized residuals versus standardized predicted values, representing that the data met the homoscedasticity assumption.

Table 12

Summary of Regression Analysis for Predicting Pre-service Teachers' Beliefs towards Children Learning from Errors

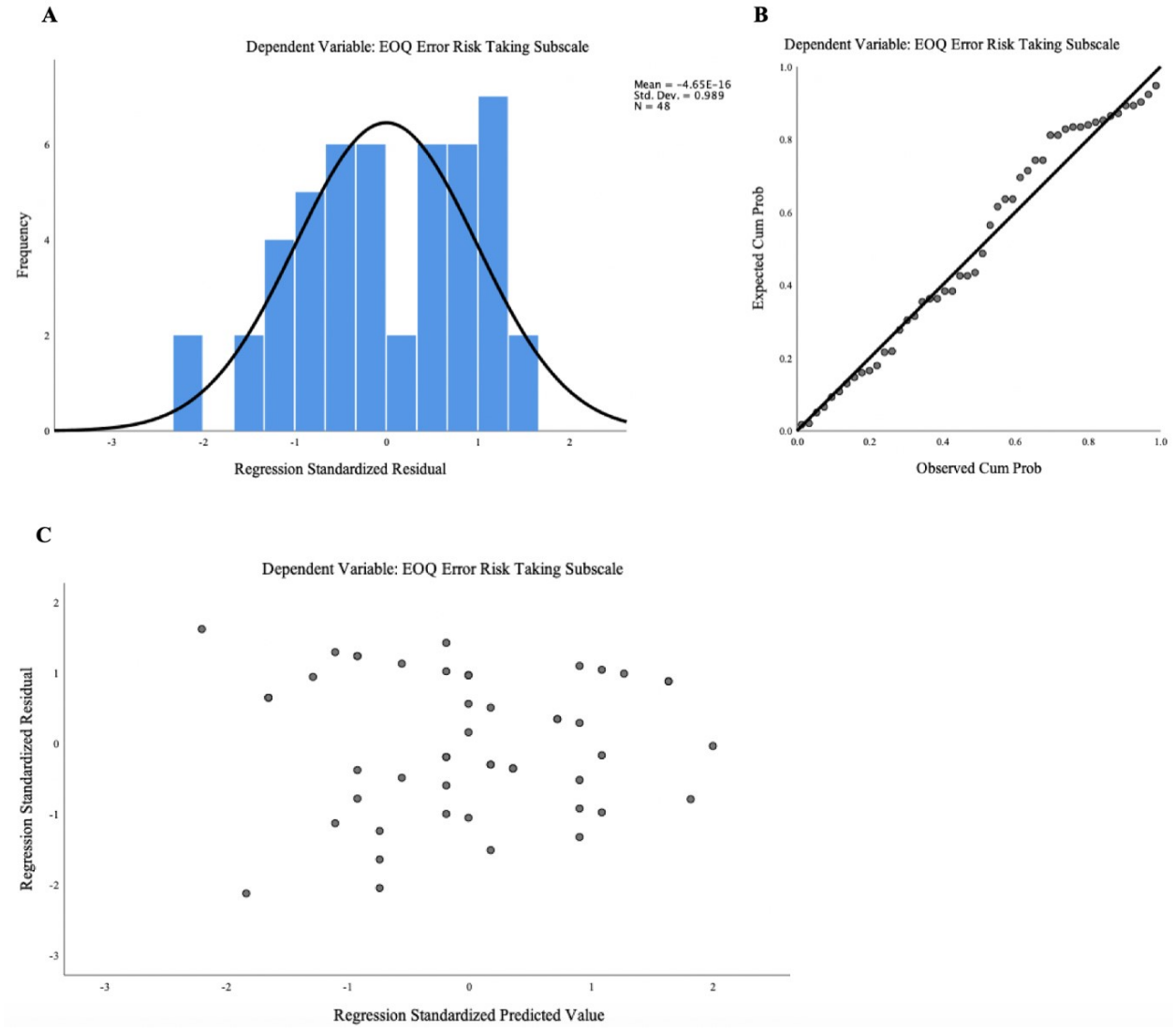
Model	*B*	*SE B*	β	*t*	*p*	R^2
1						.09*
Constant	14.96	0.78		19.29	.00	
ASI Benevolent	-0.05	0.03	-.29	-2.09	.04	

Note. ASI Benevolent = Ambivalent Sexism Inventory, Benevolent subscale. *p < .05.

Regression 2. Another simple linear regression was calculated to predict pre-service teachers' beliefs about whether children are, or should be, willing or open to making mistakes (EOQ Error Risk Taking) based on their behavioural attitudes towards mistakes (ATMI Behaviour subscale). The initial analysis checks indicated that the assumptions of approximately normally distributed errors, linearity, and homoscedasticity were met (see Figure 11). Also, the assumption of independent errors was met, as indicated by the Durbin-Watson value of 1.89. As shown in Table 13, a significant regression model was found, where the ATMI Behaviour subscale accounted for 8% of the variance in pre-service teachers' beliefs about whether children are willing or open to making mistakes, $F(1, 47) = 4.18$, $p = .05$. The standardized coefficient of .29 means that for every standard deviation unit increase in pre-service teachers' positive behavioural attitudes towards mistakes, there was an increase of .29 standard deviations in their beliefs about whether children are willing to risk making mistakes.

Figure 11

Graphs Demonstrating Normally Distributed Errors, Linearity, and Homoscedasticity for EOQ Error Risk Taking



Note. Panel A: Histogram of standardized residuals for the outcome variable, EOQ Error Risk Taking, representing approximately normally distributed errors. Panel B: Normal P-P plot of standardized residuals for the outcome variable, EOQ Error Risk Taking, representing that the data met the linearity assumption. Panel C: Scatter plot of standardized residuals versus standardized predicted values, representing that the data met the homoscedasticity assumption.

Table 13

Summary of Simple Linear Regression Analysis for Predicting Pre-service Teachers' Beliefs about Children's Openness and Willingness to Making Mistakes

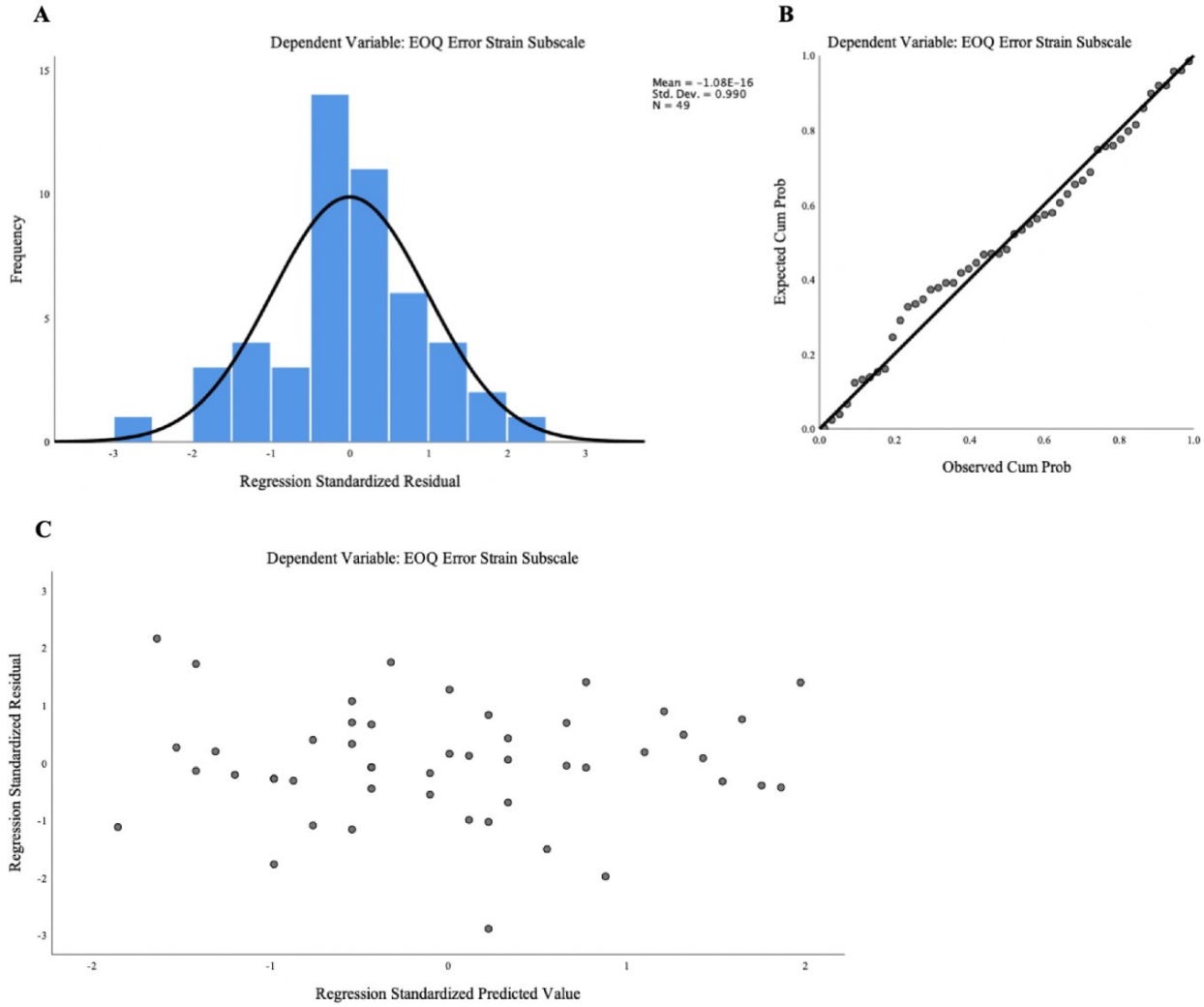
Model	*B*	*SE B*	β	*t*	*p*	R^2
1						.08*
Constant	12.69	1.95		6.51	.00	
ATMI Behaviour	0.14	0.07	.29	-2.04	.05	

Note. ATMI Behaviour = Attitudes Towards Mistakes Inventory, Behaviour subscale. *p < .05.

Regression 3. A simple linear regression was calculated to predict pre-services teachers' beliefs about whether children feel strained by making errors and if children fear the occurrence of errors (EOQ Error Strain) based on their emotional attitudes towards mistakes (ATMI Affect subscale). Upon initial analysis checks, the data met the assumptions of approximately normally distributed errors, linearity, and homoscedasticity (see Figure 12). As well, the data met the assumption of independent errors, as the Durbin-Watson value was 1.93. As presented in Table 14, a significant regression model was found, where the ATMI Affect subscale accounted for 9% of the variance in pre-service teachers' beliefs about whether children feel strained by errors or fear the occurrence of making mistakes, $F(1, 47) = 4.76$, $p = .03$. The standardized coefficient of .30 means that for every standard deviation unit increase in pre-service teachers' negative emotional attitudes towards mistakes, there was an increase of .30 standard deviations in their beliefs about children feeling strained by errors or fearing the making of mistakes.

Figure 12

Graphs Demonstrating Normally Distributed Errors, Linearity, and Homoscedasticity for EOQ Error Strain



Note. Panel A: Histogram of standardized residuals for the outcome variable, EOQ Error Strain, representing approximately normally distributed errors. Panel B: Normal P-P plot of standardized residuals for the outcome variable, EOQ Error Strain, representing that the data met the linearity assumption. Panel C: Scatter plot of standardized residuals versus standardized predicted values, representing that the data met the homoscedasticity assumption.

Table 14

Summary of Regression Analysis for Predicting Pre-service Teachers' Beliefs towards Children's Error Strain

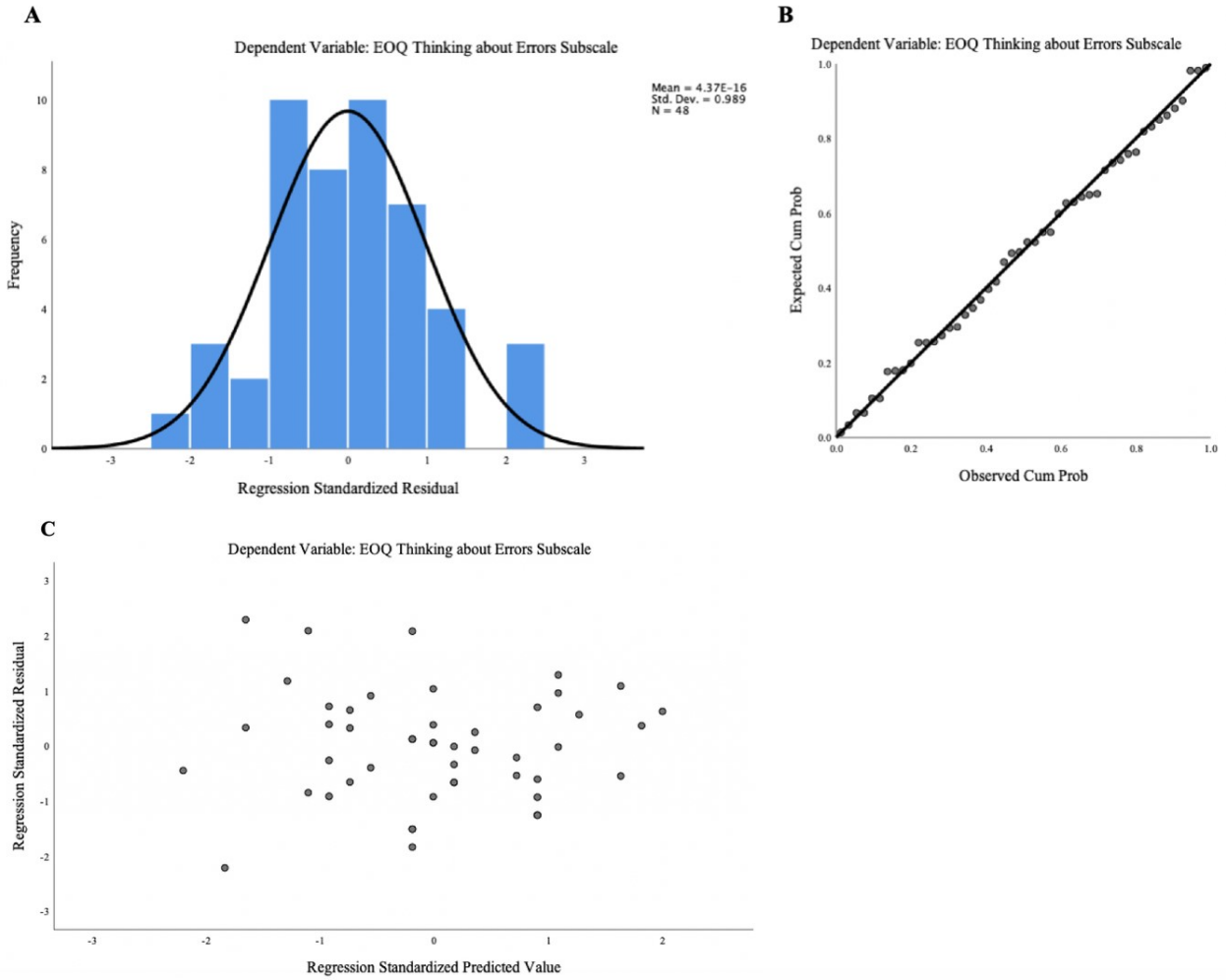
Model	*B*	*SE B*	β	*t*	*p*	R^2
1						.09*
Constant	15.52	1.45		10.71	.00	
ATMI Affect	0.09	0.04	.30	2.18	.03	

Note. ATMI Affect = Attitudes Towards Mistakes Inventory, Affect subscale. *p < .05.

Regression 4. A final simple linear regression was calculated to predict pre-service teachers' beliefs about whether children should think about their mistakes (EOQ Thinking about Errors) based on their behavioural attitudes towards mistakes (ATMI Behaviour subscale). Upon initial analysis checks, the data met the assumptions of approximately normally distributed errors, linearity, and homoscedasticity (see Figure 13). As well, the data met the assumption of independent errors, as the Durbin-Watson value was 2.08. As presented in Table 15, a significant regression model was found, where the ATMI Behaviour subscale accounted for 12% of the variance in pre-service teachers' beliefs about whether children should think about their mistakes, $F(1, 47) = 6.29$, $p = .02$. The standardized coefficient of .35 means that for every standard deviation unit increase in pre-service teachers' positive behavioural attitudes towards mistakes, there was an increase of .35 standard deviations in their beliefs about whether children should consider and think about their mistakes.

Figure 13

Graphs Demonstrating Normally Distributed Errors, Linearity, and Homoscedasticity for EOQ Thinking about Errors



Note. Panel A: Histogram of standardized residuals for the outcome variable, EOQ Thinking about Errors, representing approximately normally distributed errors. Panel B: Normal P-P plot of standardized residuals for the outcome variable, EOQ Thinking about Errors, representing that the data met the linearity assumption. Panel C: Scatter plot of standardized residuals versus standardized predicted values, representing that the data met the homoscedasticity assumption.

Table 15

Summary of Regression Analysis for Predicting Pre-service Teachers' Beliefs towards Children Thinking about Mistakes

Model	*B*	*SE B*	β	*t*	*p*	R^2
1						.12*
Constant	12.89	2.41		5.34	.00	
ATMI Behaviour	0.21	0.08	.35	2.51	.02	

Note. ATMI Behaviour = Attitudes Towards Mistakes Inventory, Behaviour subscale. *p < .05.

Additional Analyses

Two additional regression analyses were calculated for each sample to leverage the correlations among the subscales. For the first regression, a new outcome variable (EOQ Combined scale) was created using three combined EOQ subscales: Learning from Errors, Error Risk Taking, and Thinking about Errors. For the second regression, the EOQ Error Strain subscale was retained as the sole outcome variable. The Error Strain EOQ subscale required its own regression because this subscale could not be combined with the others, as the direction of this subscale was negative while the others were positive. In addition, when the EOQ Error Strain was reverse-coded and added to the EOQ Combined scale, the overall internal consistency of the composite variable decreased.

Both the Error Strain subscale and Combined EOQ subscale were further assessed in each participant sample to determine whether items could be removed for greater internal consistency. For example, in the EDPY 302 sample, items 16 and 17 were removed from the EOQ Error Strain subscale in order to increase the internal consistency from $\alpha = .75$ to .83; whereas only item 16 was removed in the EDPY 304 sample to improve the internal

consistency from α = .66 to .76. As well, items 11, 34, and 36 were removed from the EOQ Combined scale for the EDPY 302 sample to improve its internal consistency from α = .82 to .87; and, only item 34 was removed from the EOQ Combined scale for the EDPY 304 sample to improve its internal consistency from .87 to .88.

Preliminary correlation analyses for the EDPY 302 data indicated that the EOQ Combined scale was significantly and negatively correlated with both the ASI Benevolent and Hostile subscales, as well as the ATMI Cognitive subscale, r = -.25, r = -.36, and r = -.35, respectively; and, significantly and positively correlated with the ATMI Behaviour subscale, r = .27. Based on these results, the first multiple regression analysis included the following subscales as predictor variables: (a) ASI Benevolent subscale, (b) ASI Hostile subscale, (c) ATMI Behaviour subscale, and (d) ATMI Cognitive subscale. Moreover, the EOQ Error Strain subscale was significantly and negatively correlated with the ASI Benevolent subscale and the ATMI Cognitive subscale, r = -.23 and r = -.27, respectively. Therefore, the second multiple regression analysis included the following subscales as predictor variables: (a) ASI Benevolent subscale and (b) ATMI Cognitive subscale.

Preliminary correlations analyses for the EDPY 304 data indicated that the EOQ Combined scale was significantly and negatively correlated with the ATMI Behaviour subscale, r = -.31, but did not significantly correlate with any other predictors. The new EOQ Error Strain subscale was significantly and positively correlated with the ATMI Affect subscale, r = .36, but did not significantly correlate with the other predictors. Based on these results, a simple regression analysis was calculated with the EOQ Combined scale as the outcome variable and the ATMI Behaviour subscale as the predictor. A second simple regression was conducted with

the new EOQ Error Strain scale as the outcome variable and the ATMI Affect subscale as the predictor.

EDPY 302

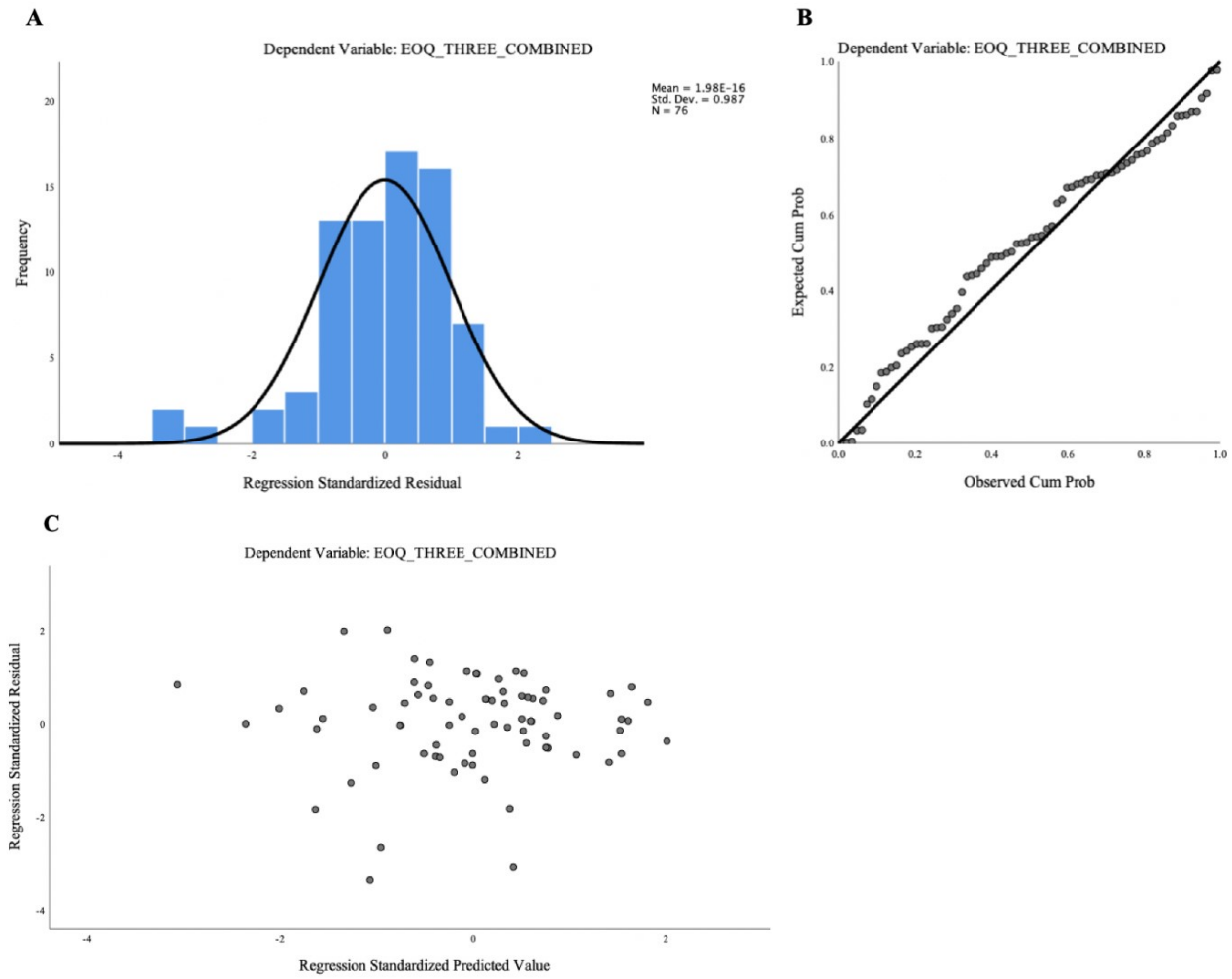
Regression 1. A stepwise regression was calculated to predict pre-service teachers' beliefs about children's mistakes (EOQ Combined scale) based on their gender beliefs (ASI Benevolent and Hostile subscales) and their behavioural attitudes and beliefs towards making their own mistakes (ATMI Behaviour and Cognitive subscales). The initial analysis checks indicated no violations of the assumptions (see Figure 14). There was no multicollinearity, as indicated by the collinearity statistics (Tolerance values > .2, VIF values < 10, see Table 16). Additionally, the data met the assumption of independent errors, as the Durbin-Watson value was 1.72, which is within the boundaries of between 1 and 3.

As shown in Table 16, a significant initial step-wise regression model was found, where the ASI Hostile subscale accounted for 13% of the variance in predicting pre-service teachers' beliefs about children's mistakes, $F(1,74) = 11.26$, $p = .001$. When the ATMI Cognitive subscale was added to the model as a predictor in the second stage, the model accounted for another 6% of the variance in pre-service teachers' beliefs about children's mistakes, $F(1,73) = 4.97$, $p = .02$. Further examination of the standardized regression coefficients indicated that scores on ASI Hostile subscale significantly predicted the combined EOQ Combined scale scores ($\beta = -0.29$, $p = .01$), as did scores on the ATMI Cognitive subscale ($\beta = -0.26$, $p = .02$). The ASI Benevolent subscale and the ATMI Behaviour subscales were excluded from the regression model as neither variable contributed uniquely to predicting the outcome variable. Overall, for every standard deviation unit increase in pre-service teachers' hostile attitudes towards women, there was a decrease of .29 standard deviations of their positive beliefs about

children's mistakes. Moreover, for every standard deviation unit increase in pre-service teachers' negative beliefs towards their own mistakes, there is a decrease of .26 standard deviations in their positive beliefs about children's mistakes.

Figure 14

Graphs Demonstrating Normally Distributed Errors, Linearity, and Homoscedasticity for the EOQ Combined Scale



Note. Panel A: Histogram of standardized residuals for the outcome variable, EOQ Combined scale, representing approximately normally distributed errors. Panel B: Normal P-P plot of standardized residuals for the outcome variable, EOQ Combined scale, representing that the data did not violate linearity assumption. Panel C: Scatter plot of standardized residuals versus standardized predicted values, representing that the data met the homoscedasticity assumption.

Table 16

Summary of Regression Analysis for Predicting Pre-service Teachers' Beliefs about Children's Mistakes (EOQ Combined Scale)

Model	*B*	*SE B*	β	*t*	*p*	Tolerance	VIF	R^2	ΔR^2
1								.12	.12**
Constant	43.44	1.52		28.55	.00				
ASI Hostile	-0.17	0.05	-.36	-3.36	.00	1.00	1.00		
2								.18	.06*
Constant	46.28	1.90		24.38	.00				
ASI Hostile	-0.13	0.05	-.29	-2.61	.01	0.91	1.10		
ATMI Cog	-0.29	0.12	-.26	-2.38	.02	0.91	1.10		

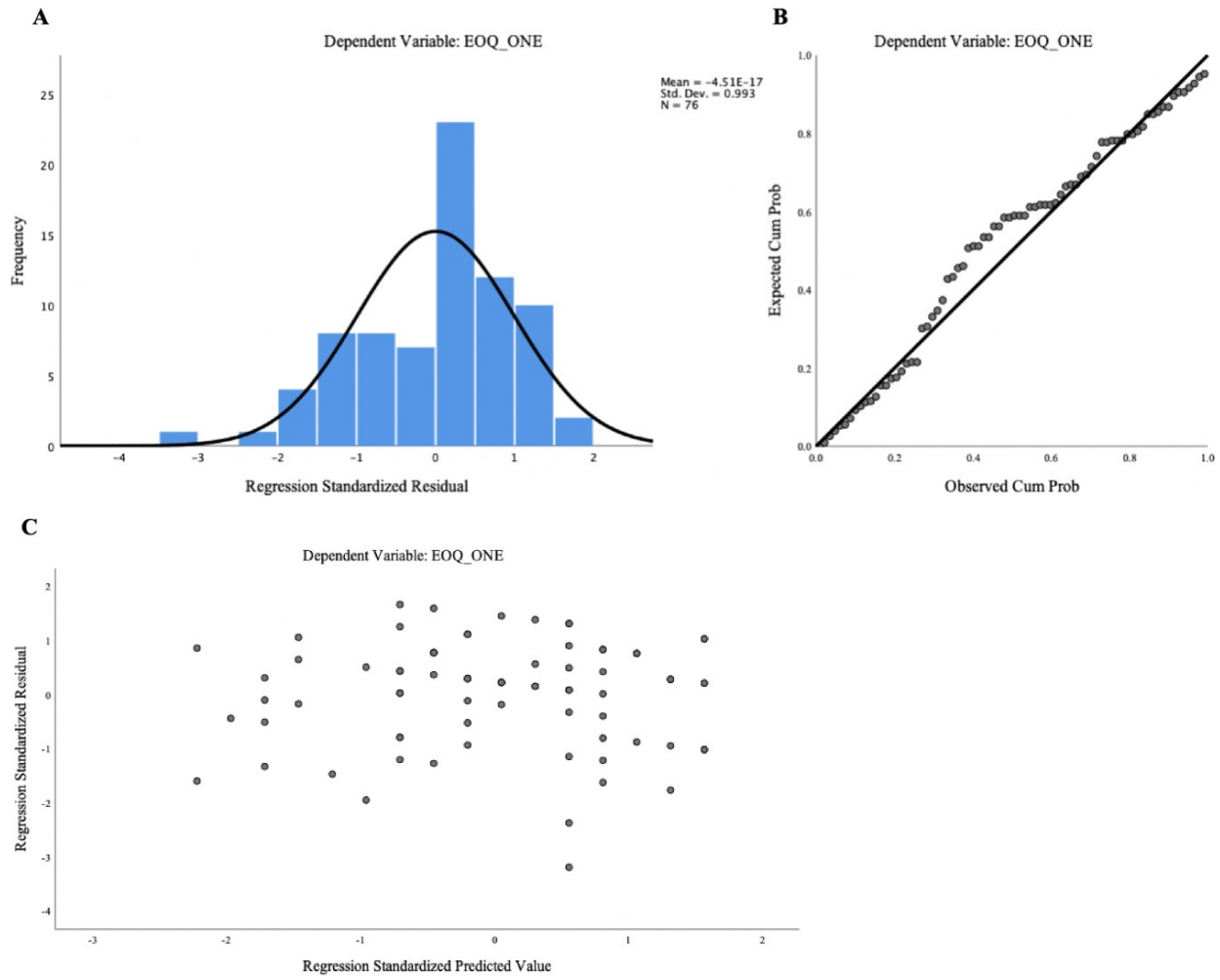
Note. Results representing the EDPY 302 sample of pre-service teachers. ASI Hostile = Ambivalent Sexism Inventory, Hostile subscale. ATMI Cog = Attitudes Towards Mistakes Inventory, Cognitive subscale. *p < .05. **p < .01.

Regression 2. Another stepwise regression analysis was calculated to predict pre-service teachers' beliefs about children feeling strained by or fearing making mistakes (new EOQ Error Strain) based on their benevolent sexist attitudes towards women (ASI Benevolent subscale) and their beliefs towards their own mistakes (ATMI Cognitive subscale). Initial analysis checks revealed that the assumptions of linearity, homoscedasticity and normally distributed errors were met (see Figure 15). The data also met the assumption of independent errors, as the Durbin-Watson value was 1.92. As shown in Table 17, a significant regression model was found, where the ATMI Cognitive subscale accounted for 7% of the variance in predicting pre-service teachers' beliefs about whether children feel, or should feel, strained by or fear making

mistakes $F(1,74) = 5.84$, $p = .02$. The standardized coefficient of -.27 means that for every standard deviation unit increase in pre-service teachers' negative beliefs towards mistakes, there was a decrease of .27 standard deviations in their beliefs about whether children feel strained by errors or fear making mistakes.

Figure 15

Graphs Demonstrating Normally Distributed Errors, Linearity, and Homoscedasticity for the New EOQ Error Strain Variable



Note. Panel A: Histogram of standardized residuals for the new outcome variable, EOQ Error Strain, representing approximately normally distributed errors. Panel B: Normal P-P plot of standardized residuals for the outcome variable, EOQ Error Strain, representing that the data met the linearity assumption. Panel C: Scatter plot of standardized residuals versus standardized predicted values, representing that the data met the homoscedasticity assumption.

Table 17

Summary of Regression Analysis for Predicting Pre-service Teachers' Beliefs about Children Feeling Strained by or Fearing Making Mistakes (New EOQ Error Strain)

Model	*B*	*SE B*	β	*t*	*p*	R^2
1						.07*
Constant	13.68	.982		13.94	.00	
ATMI Cognitive	-0.17	0.07	-.27	-2.42	.02	

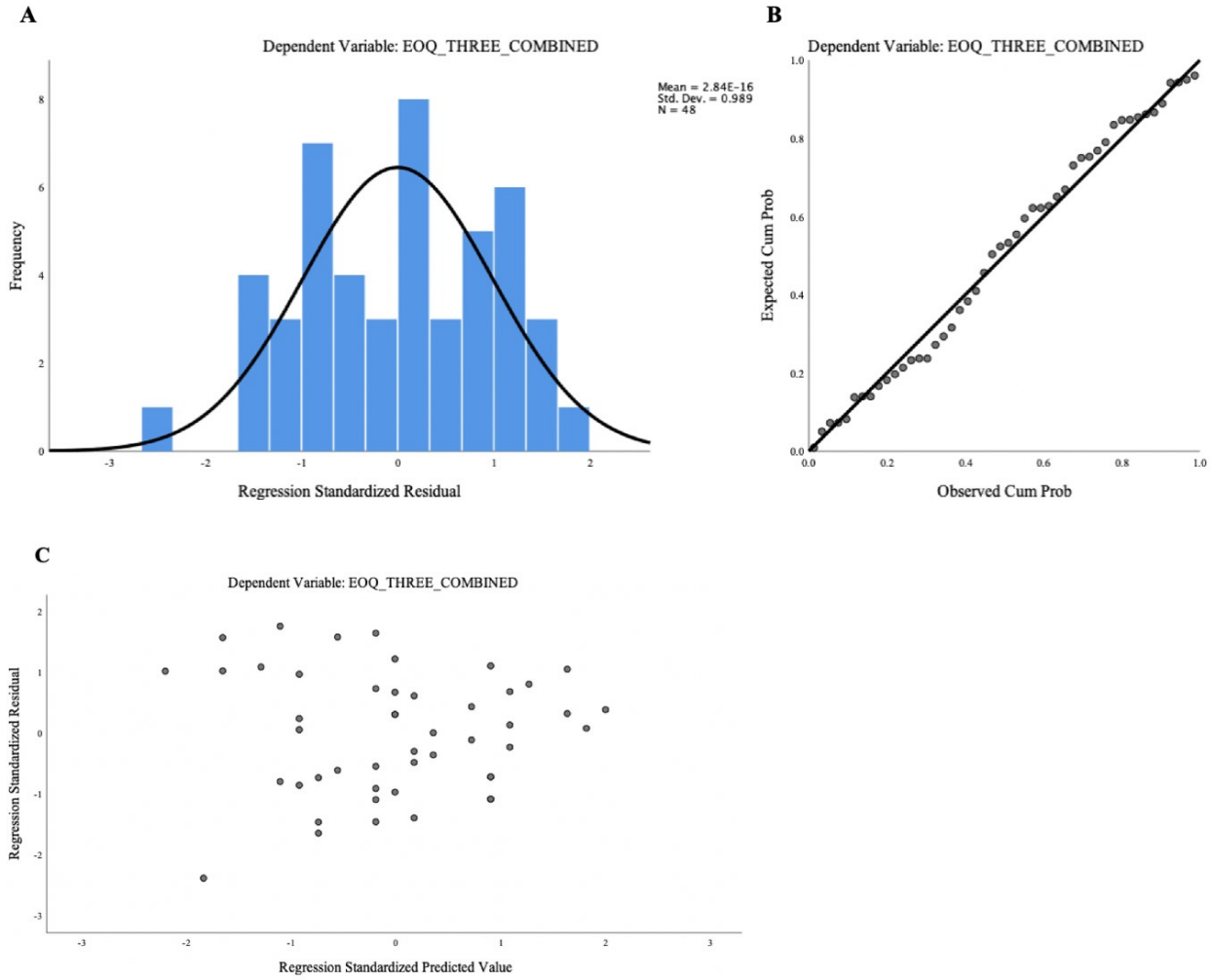
Note. Results representing the EDPY 302 sample of pre-service teachers. ATMI Cognitive = Attitudes Towards Mistakes Inventory, Cognitive subscale. *p < .05.

EDPY 304

Regression 1. A simple linear regression was calculated to predict pre-service teachers' beliefs about children's mistakes (EOQ Combined scale) based on their behavioural attitudes towards mistakes (ATMI Behaviour subscale). Initial analysis checks revealed that the assumptions of approximately normally distributed errors, linearity, and homoscedasticity were met (see Figure 16). As well, the data met the assumption of independent errors, as the Durbin-Watson value was 1.29. As presented in Table 18, a significant regression model was found, where the ATMI Behaviour subscale accounted for 10% of the variance in pre-service teachers' positive beliefs towards children's mistakes, $F(1, 46) = 4.95$, $p = .03$. This means that for every standard deviation unit increase in pre-service teachers' positive behavioural attitudes towards mistakes, there was an increase of .31 standard deviations in their positive beliefs about children's errors.

Figure 16

Graphs Demonstrating Normally Distributed Errors, Linearity, and Homoscedasticity for the EOQ Combined Scale



Note. Panel A: Histogram of standardized residuals for the new outcome variable, EOQ Combined scale, representing approximately normally distributed errors. Panel B: Normal P-P plot of standardized residuals for the outcome variable, EOQ Combined scale, representing that the data met the linearity assumption. Panel C: Scatter plot of standardized residuals versus standardized predicted values, representing that the data met the homoscedasticity assumption.

Table 18

Summary of Regression Analysis for Predicting Pre-service Teachers' Beliefs about Children's Mistakes (EOQ Combined Scale)

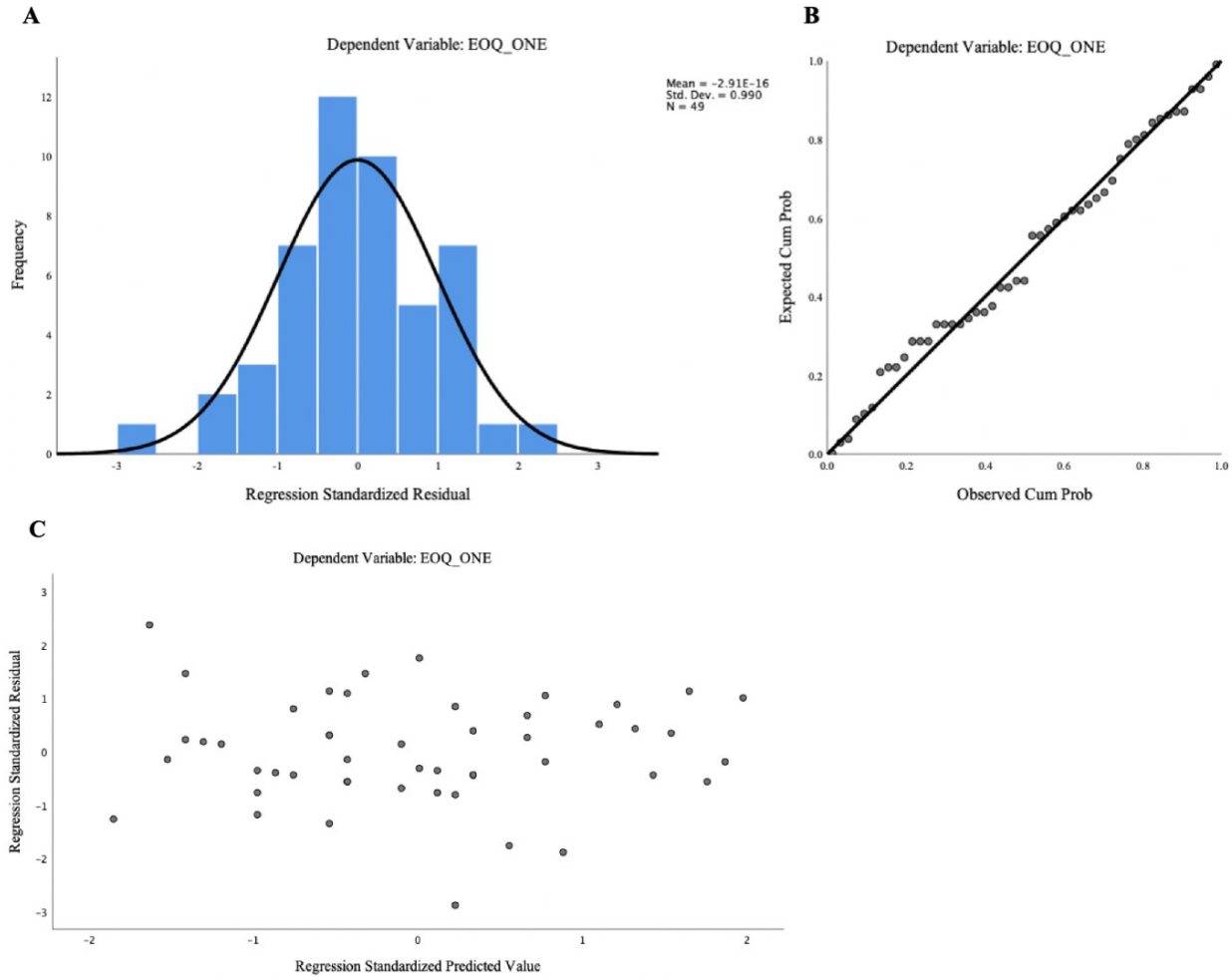
Model	*B*	*SE B*	β	*t*	*p*	R^2
1						.10*
Constant	35.88	4.32		8.32	.00	
ATMI Behaviour	0.33	0.15	.31	-2.22	.03	

Note. Results representing the EDPY 304 sample of pre-service teachers. ATMI Behaviour = Attitudes Towards Mistakes Inventory, Behaviour subscale. *p < .05.

Regression 2. A final simple linear regression was calculated to predict pre-service teachers' beliefs about children feeling strained by or fearing making mistakes (new EOQ Error Strain) based on their emotional attitudes towards mistakes (ATMI Affect subscale). The initial analysis checks revealed that the assumptions of approximately normally distributed errors, linearity, and homoscedasticity were met (see Figure 17). As well, the data met the assumption of independent errors, as the Durbin-Watson value was 2.03. As presented in Table 19, a significant regression model was found, where the ATMI Affect subscale accounted for 13% of the variance in pre-service teachers' beliefs about whether children feel, or should feel, strained by or fear making mistakes, $F(1, 47) = 6.89$, $p = .01$. The standardized coefficient of .36 means that for every standard deviation unit increase in pre-service teachers' negative emotional attitudes towards mistakes, there was an increase of .36 standard deviations in their beliefs about whether children feel strained by errors or fear making mistakes.

Figure 17

Graphs Demonstrating Normally Distributed Errors, Linearity, and Homoscedasticity for the New EOQ Error Strain Variable



Note. Panel A: Histogram of standardized residuals for the new outcome variable, EOQ Error Strain, representing approximately normally distributed errors. Panel B: Normal P-P plot of standardized residuals for the outcome variable, EOQ Error Strain, representing that the data met the linearity assumption. Panel C: Scatter plot of standardized residuals versus standardized predicted values, representing that the data met the homoscedasticity assumption.

Table 19

Summary of Regression Analysis for Predicting Pre-service Teachers' Beliefs about Children Feeling Strained by or Fearing Making Mistakes (EOQ Error Strain)

Model	*B*	*SE B*	β	*t*	*p*	R^2
1						.13*
Constant	12.46	1.30		9.56	.00	
ATMI Affect	0.10	0.04	.36	2.63	.02	

Note. Results representing the EDPY 304 sample of pre-service teachers. ATMI Affect = Attitudes Towards Mistakes Inventory, Affect subscale. *p < .05.

Discussion

The objective of the present study was to investigate pre-service teachers' beliefs about children's mistakes alongside their gender beliefs, and, to adapt an existing measurement tool (EOQ) to assess pre-service teachers' beliefs about children's mistakes. The first few paragraphs of this discussion will focus on addressing the research questions, followed by discussing implications, limitations, and conclusions.

Measuring Pre-service Teachers' Beliefs about Children's Mistakes

Research Question #1

Does the present adaptation of the Error Orientation Questionnaire (EOQ), originally developed by Rybowiak et al., (1999), provide an internally consistent measure of pre-service teachers' attitudes and beliefs about children's mistakes?

In the present study, only two out of eight subscales demonstrated satisfactory internal consistency, whereby Cronbach's alpha values were above .70 in the EDPY 302 sample (i.e.,

Learning from Errors [.83] and Error Strain [.75] – see Table 1). However, the Thinking about Errors subscale approached adequate internal consistency (.66). Likewise, only three out of eight subscales demonstrated satisfactory internal consistency for the EDPY 304 sample (i.e., Learning from Errors [.81], Error Risk Taking [.79], Thinking about Errors [.81] - see Table 1). However, the Error Strain subscale approached an adequate internal consistency (.66).

These results suggest that the adapted EOQ requires further revisions to become a more internally consistent measure of pre-service teachers' attitudes towards children's mistakes before it can be used with greater precision in educational contexts. This is not surprising given that this is the first study, after Matteucci et al.'s (2015) study, to modify the wording of the EOQ items for use with a different purpose than the original and with a different population to the one used for the EOQ's initial development – that is, working professionals. Nonetheless, the Learning from Errors subscale demonstrated good internal consistency in both samples (i.e., alpha value above .80), suggesting it is a stable measure of pre-service teachers' attitudes and beliefs towards children *learning* from their mistakes. Furthermore, the internal consistency for other subscales such as the Error Strain, Error Risk Taking, and Thinking about Errors subscales, was satisfactory depending on the sample (i.e., EDPY 302 or EDPY 304). These differential results by sample may reflect stable differences between each group of pre-service teachers, such as factors that propel them into one or another program of study. However, upon review of the modified item wording for the EOQ, it could also be that the low alpha values in general were attributable to awkward phrasing for items in these subscales. Because the modifications of the EOQ scale were done to retain as much of the same language as in the original scale in order to preserve measurement of the same constructs, in some instances the phrasing became awkward. Therefore, future research should refocus attention on generating

more straightforward and clear items in the context of measuring pre-service teachers' beliefs about children's mistakes in order to improve the internal consistencies of these subscales. However, this additional work would most likely be part of a larger program of validation of a modified EOQ to preserve the intended constructs of each subscale.

The internal consistencies of subscales informed the subsequent correlation and regression analyses for investigating the second research question. Accordingly, the Learning from Errors, Error Risk Taking, Error Strain, and Thinking about Errors subscales were used because they approximated or met the criterion of satisfactory internal consistency in both samples.

Pre-service Teachers' Gender Beliefs in Relation to their Beliefs about Children's Mistakes

Research Question #2

Do pre-service teachers' gender beliefs and beliefs about mistakes predict how they view children's mistakes in the classroom?

This question can only be partly answered because not all of the EOQ subscales were used given the lower than expected internal consistencies. Overall, the correlation analyses suggested there were stable relationships between pre-service teachers' gender beliefs, beliefs about their own mistakes, and beliefs about children's mistakes. However, as already noted, results differed for the EDPY 302 and 304 samples. The regression analyses demonstrated that pre-service teachers' gender beliefs in part predicted their beliefs about children's mistakes. Moreover, pre-service teachers' beliefs about their own mistakes also in part predicted their beliefs about children's mistakes. In the following sections, the results for the two samples are

discussed specifically in relation to the relevant subscales that were associated with pre-service teachers' views on children's mistakes.

EDPY 302. The three EOQ subscales that showed statistically significant associations with gender beliefs and attitudes towards mistakes were: Learning from Errors, Error Risk Taking, and Thinking about Mistakes. Despite the fact that the Error Risk Taking subscale had a much lower Cronbach's alpha than expected (.43), it was used in subsequent analyses because it correlated with responses to the ASI Hostility subscale (r = -.24). Interestingly, the Error Strain subscale (Cronbach's alpha = .75) did not correlate significantly with any of the predictors.

Based on statistically significant correlation coefficients, regression analyses revealed that pre-service teachers' hostility towards women (ASI Hostile subscale) and negative beliefs about making errors (ATMI Cognitive subscale) significantly and negatively predicted their views about children learning from their errors (Learning from Errors subscale - see Table 9). What this result means is that pre-service teachers who reported more negative views on women and more negative beliefs about their own mistakes were less likely to believe children could learn from making mistakes. Pre-service teachers' hostility toward women also significantly and negatively predicted their views that children should take learning risks that might involve making mistakes (Error Risk Taking subscale - see Table 10). In other words, pre-service teachers who reported more hostility against women were less likely to believe children should take learning risks that might lead to errors. Finally, pre-service teachers' attitudinal behaviors about their mistakes (ATMI Behaviour subscale) significantly and positively predicted their views about children's thinking about errors (EOQ Thinking about Errors subscale - see Table 11). In other words, pre-service teachers who reported more positive attitudinal behaviors

following their own mistakes were more likely to endorse beliefs suggesting that children think, or should think, about their mistakes.

In terms of gender beliefs, then, pre-service teachers' reported hostile sexism against women was the only significant predictor of pre-service teachers' views on specific aspects of children's mistakes (i.e., Learning from Errors, Error Risk Taking). Pre-service teachers' benevolent sexism against women was not predictive of pre-service teachers' views on these aspects of children's mistakes. It is possible that hostile sexism against women reveals a more rigid and entrenched pattern of cognition against a group of people (women) than benevolent sexism. This entrenchment may also influence patterns of thinking about children's errors and how much learning can come from them. Second, the results also suggest that pre-service teachers' negative beliefs about their own mistakes (e.g., *I make mistakes on my assignment because I am not smart enough*) are predictive of their beliefs about whether or not they believe children learn, or should learn, from making mistakes. This is not a surprising result and yet it reveals how patterns of thought about oneself can be projected onto others – in this case children. Third, pre-service teachers' positive behavioural attitudes towards their own mistakes (e.g., *When I make mistakes on an exam, I feel motivated to study harder*) were also predictive of their beliefs that children think, or should think, about mistakes. Again, this result is not surprising but reveals the importance of patterns of behavioral attitudes on how others are viewed; in this context, pre-service teachers' more proactive attitudes about actions surrounding their own mistakes were associated with how they viewed the importance of children thinking about mistakes.

Pre-service teachers' attitudinal affect, or emotions, towards their mistakes (e.g., *When I make mistakes answering classroom questions, I feel humiliated*) was not significantly

associated with any beliefs about children's mistakes in the classroom. This was a surprising result because one would expect that instructors' negative emotions about mistakes, such as fear or humiliation, might be projected onto children. For example, a pre-service teacher who is mortified about making a mistake in public might be expected to share a form of anxiety with students. Moreover, the Error Strain subscale reflected emotional attributes and so was expected to correlate with pre-service teachers' attitudinal affect about mistakes – and, it did in the EDPY 304 sample. In fact, a test of the mean differences between the 302 and 304 sample on their responses of attitudinal affect showed a statistically significant difference, $t(122) = 2.37$, $p = .019$. Pre-service teachers from 302 reported more negative attitudinal affect ($\bar{X} = 36.81$) than pre-service teachers from 304 ($\bar{X} = 33.38$). It is not clear why pre-service teachers' negative attitudinal affect about their own mistakes would not be associated with children's error strain. This should be investigated in future research.

Additional Analyses and Interpretations for EDPY 302. The EOQ subscales (i.e., Learning from Errors, Error Risk Taking, and Thinking about Errors) were combined and evaluated as a whole given their strong associations. This was done to see whether, overall, the internal consistency could be improved, and this new construct showed better results. In the process, items 11, 34, and 36 were removed from the combined scale. Item 11 belonged to the Error Risk Taking subscale and items 34 and 36 belonged to the Thinking about Errors subscale. Pre-service teachers' reported hostility against women and their attitudinal beliefs about mistakes again significantly and negatively predicted their views about children's mistakes (see Table 16). Interestingly, the ATMI Behaviour subscale was no longer a significant predictor of the EOQ Combined scale even though it had been a significant predictor of the EOQ Thinking about Errors subscale (see Table 11). The absence of this effect may be

the result of removing items 34 and 36 from the combined scale to improve its internal consistency. While removing scale items can increase the internal consistency, it can simultaneously affect the factor structure of the construct (Field, 2013). In combining the three subscales into one, the construct may have shifted overall since it is now measuring multiple aspects of children's mistakes. Furthermore, because the Thinking about Errors subscale originally had an alpha value of .64, it is possible that the earlier simple regression analysis (see Table 11) results may not have been stable – although this is unlikely given that an alpha of .64 is approximating .70. Nonetheless, the inconsistent results are likely due to a construct shift but also, possibly, measurement error.

It is important to also consider the regression coefficient in the simple regression model (see Table 11) in comparison to the coefficient in the stepwise regression. Although the standardized coefficient for the ATMI Behaviour subscale was not statistically significant in the stepwise regression for the Combined subscale, it nonetheless had a positive value as in the simple regression ($\beta = 0.15$, $p = .19$, *ns*). Moreover, since the ATMI Behaviour subscale was correlated with both the ASI Hostile and the ATMI Cognitive subscales, it is not surprising that the shared variance could have led to the exclusion of one of these predictors in accounting for the variance in the Combined subscale.

Finally, a new Error Strain subscale was created by removing items 16 and 17 in order to improve its internal consistency – the original was an alpha value of .75. Pre-service teachers' beliefs about their own mistakes (ATMI Cognitive subscale) significantly and negatively predicted their views about children feeling strained by or fearing making mistakes (the new EOQ Error Strain subscale - see Table 17). What this means is that pre-service teachers who reported more negative beliefs towards their own mistakes were less likely to

endorse children feeling strained by or fearing making mistakes. These results are surprising because one would expect that if an individual holds negative beliefs about their own mistakes, these beliefs would extend to how they might think about others such as children feeling strained about making mistakes or fearing errors. Interestingly, responses to the new EOQ Error Strain subscale significantly correlated with pre-service teachers' responses to the ASI Benevolent *and* ATMI Cognitive subscales. This is interesting because when the original Error Strain subscale – with items 16 and 17 included – was previously examined for the EDPY 302 data, it did not significantly correlate with any of the predictor variables (see Table 8), which is why it was not included in the earlier regression analyses. One possible explanation to consider is that by removing items 16 and 17 from the scale, the Error Strain construct may have been slightly changed and in fact improved by a little because the internal consistency improved to .83 (Field, 2013). As a result, it is possible that the new Error Strain construct shared a detectable relationship with both the ASI Benevolent and ATMI Cognitive subscales. Another possible explanation is that the sample size was not sufficient to detect an effect with the original EOQ Error Strain subscale given its lower internal consistency, with items 16 and 17 included. The two versions of the Error Strain subscales may reflect slightly different constructs and thus each construct may require a different sample size to detect significant effects. Therefore, a sample of 76 may have been large enough to detect effects in the EOQ Learning from Errors and Thinking about Errors subscales, but not large enough for the original EOQ Error Strain subscale if the Error Strain subscale provides a measure of a subtle, or smaller, effect. However, with improved internal consistency from removing items 16 and 17, and a potential shift in the construct, the sample size for the new Error Strain subscale may have been sufficient for detecting effects.

EDPY 304. The EOQ subscales that will be discussed are as follows: Learning from Errors, Error Risk Taking, and Error Strain, and Thinking about Mistakes. Based on statistically significant correlations, the regression analyses showed that pre-service teachers' benevolent sexist attitudes towards women (ASI Benevolent subscale) significantly and negatively predicted their views about children learning from their errors (EOQ Learning from Errors subscale - see Table 12). In other words, pre-service teachers who reported more positive views of women that are sexist in nature were less likely to believe that children could learn from making mistakes. Pre-service teachers' attitudinal behaviours about their mistakes (ATMI Behaviour subscale) significantly and positively predicted their beliefs about whether children should take learning risks that might involve making mistakes (EOQ Error Risk Taking subscale - see Table 13). What this finding means is that pre-service teachers who reported more positive attitudinal actions following their own mistakes were more likely to endorse beliefs that children should take learning risks that could lead to making errors. Pre-service teachers' attitudinal behaviours about their own mistakes also significantly and positively predicted their views about children's thinking about their mistakes (EOQ Thinking about Errors subscale - see Table 15). In other words, pre-service teachers who reported more positive attitudinal behaviours following their own mistakes were more likely to believe children think, or should think, about their mistakes. Finally, pre-service teachers' attitudinal affect (ATMI Affect subscale) towards their own mistakes significantly and positively predicted their views that children feel, or should feel, strained by or fear making mistakes (EOQ Error Strain subscale - see Table 14). In other words, pre-service teachers who reported more negative emotions following their own mistakes were more likely to endorse beliefs suggesting that children feel, or should feel, strained about making mistakes or fear making errors. This latter

result was expected, and it provides an interesting point of departure with the EDPY 302 sample, where no association was found between pre-service teachers' attitudinal affect and their views on children's error strain. These results are discussed in the following paragraphs.

First, regarding gender beliefs, pre-service teachers' overly positive attitudes towards women that are nonetheless sexist in nature – that is, benevolent sexism – was the only significant gender belief in relation to pre-service teachers' views on children's mistakes. Hostile sexism against women was not predictive of pre-service teachers' views of children's mistakes. This is another point of departure in comparison with the EDPY 302 sample. It is possible that since this group of pre-service teachers included substantially more men than the group of pre-service teachers in the 302 course – in fact, there were more men than women in the 304 sample – that there may be a stronger propensity for social desirability response bias, which is when participants respond to sensitive research topics in the most socially acceptable way (Hoffman & Musch, 2018). Given that the ASI questionnaire is an explicit measure of gender bias that uses direct questioning, and given that hostility towards women is likely more noticeable in terms of violating social norms in comparison to benevolent sexism because "benevolence" may appear prosocial, men may be more cautious in terms of their responses to hostility towards women and thus unwilling to risk "appearing sexist."

Given the recent news and social media events surrounding the #MeToo Movement[2], this would be understandable because men may be especially aware of how they portray

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[2] The *#MeToo Movement* is a social justice movement targeted at bringing awareness to sexual misconduct and sexual violence – particularly against women (Issitt, 2018). The movement gained worldwide recognition starting online on *Twitter*, a social media platform, in which women survivors of sexual violence began to publicly speak out about their experiences by hash-tagging the words "me too" on their posts (Issitt, 2018). The movement has led

themselves when asked questions about women. Indeed, according to the National Post (2018), some experts have suggested that some men, especially young men, may be afraid of making any "missteps" with women and are concerned with doing anything wrong – even accidentally or unconsciously. Although this may not be empirically validated, it could still be a possible obstacle in terms of gathering men's explicit attitudes and beliefs towards women. Therefore, perhaps responses on the ASI Hostile subscale were obscured. Another potential explanation for this result may include differences in gender beliefs based on pre-service teachers' program of study. For example, perhaps pre-service teachers who aim to teach young children have stronger hostile sexist beliefs towards women, whereas those who plan to teach adolescents have more benevolent sexist views towards women. It is also possible that for this particular group of pre-service teachers, hostility towards women was genuinely not a factor in how they view children's mistakes.

Second, the regression results also suggest that pre-service teachers' positive behavioural attitudes towards their own mistakes are predictive of their views about whether children should take learning risks that might involve making mistakes and also whether children should think about their mistakes. This is important for understanding how one's own behavioural attitudes can be projected onto others; in this case, pre-service teachers' more proactive attitudes following their own mistakes are associated with how they view children's mistakes – which is that they reported more positive beliefs about the importance of children taking learning risks that could lead to errors as well as children's thinking about their mistakes.

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to several politicians, actors, and other celebrities facing allegations and many have also faced legal and/or vocational consequences (Issitt, 2018).

The importance of this result lies in considering the role modeling teachers do. If teachers, or in this case pre-service teachers, have internalized positive behavioral attitudes towards mistakes, one can argue that they will serve as better role models for children. Finally, pre-service teachers' attitudinal affect towards their own mistakes significantly and positively predicted their views about whether children feel, or should feel, strained by or fear making mistakes. This is not a surprising result as it can be expected that if pre-service teachers' experience negative emotions such as fear or humiliation following their own mistakes, they may also feel similar negative emotions when children make mistakes. Although this may not be surprising, it again has to be underscored that the emotional "baggage" that teachers bring to the "learning table" does not bode well for their role as instructors in children's lives.

Additional Analyses and Interpretations for EDPY 304. The EOQ subscales (i. e., Learning from Errors, Error Risk Taking, and Thinking about Errors) were combined and evaluated as a whole as they were strongly associated with each other. This was done to see whether, overall, the internal consistency could be improved, and this new construct showed better results. However, item 34 from the Thinking about Errors subscale was removed in the process to improve the internal consistency of the combined scale. Pre-service teachers' reported behavioural attitudes towards their own mistakes (ATMI Behaviour subscale) significantly and positively predicted their beliefs about children's mistakes (EOQ Combined scale - see Table 18). Interestingly, pre-service teachers' benevolent sexism towards women (ASI Benevolent subscale) was now no longer a significant predictor of their views towards children's mistakes (EOQ Combined scale), even though it had been a significant predictor of their beliefs about the importance of children learning from their errors (EOQ Learning from Errors - see Table 12).

There are a few different possible explanations for these results. First, the elimination of item 34 from the EOQ Combined scale, in addition to combining all three subscales into one new variable, likely changed the construct in ways that altered its relationship with the predictor variables. First, the EOQ Combined scale is a multifaceted construct compared to the unitary subscales that comprise it. Second, it is possible that the sample size was not large enough to detect a significant effect between this new multifaceted construct and the ASI Benevolent subscale. If there is a real association between the EOQ Combined scale and views on benevolent sexism but it is small, then a small sample size (n = 49) diminishes the detection of such an effect. If the sample size had been larger, this would have facilitated the detection of a smaller effect.

Lastly, a new Error Strain variable was created by removing item 16 in order to improve its original internal consistency from an alpha value of .66 to .76. Pre-service teachers' attitudinal affect significantly and positively predicted their responses to the new EOQ Error Strain subscale (see Table 19). What this result means is that pre-service teachers who reported more negative emotions following their own mistakes were more likely to endorse responses suggesting that children feel, or should feel, strained by or fear making mistakes. These results are not surprising, as it would be expected that a pre-service teacher who feels anxious or humiliated by making mistakes might also share similar negative emotions towards children making mistakes. Additionally, this result is similar to the earlier finding where the ATMI Affect subscale significantly and positively predicted the original EOQ Error Strain subscale (see Table 14). However, pre-service teachers' attitudinal affect accounted for 13% of the variance in the new EOQ Error Strain subscale, which is about 4% more than the original EOQ Error Strain subscale (i.e., R^2 = 0.09; see Table 14); and, in comparison to a standardized

coefficient of .30, the new Error Strain subscale provided a slightly higher account of pre-service teachers' beliefs about children feeling strained by or fearing making mistakes, with a standardized coefficient of .36. There are a few possible explanations for the difference in results. First, the removal of item 16 from the EOQ Error Strain subscale increased the internal consistency of the subscale, and thus reduced the measurement error. Therefore, the new EOQ Error Strain subscale may have been able to more closely reflect pre-service teachers' beliefs about whether children feel strained or fearful after making a mistake. Second, it is also possible that by removing item 16, this again changed the construct slightly and in so doing improved its specification. As mentioned earlier, increasing the internal consistency of a subscale by deleting items has the potential to change the construct (Field, 2013). A change in construct – even slightly – may have a significant impact on the relationships it shares with other variables. Thus, a more internally consistent scale may help explain the increase in unique variance explained by the ATMI Affect predictor variable for the present analysis.

Differences in Results Between EDPY 302 and EDPY 304

As the previous discussion has shown, results are different for the two groups of pre-service teachers. The variables that accounted for pre-service teachers' beliefs about children's mistakes were not the same in the 302 and 304 samples. It is important to note that although the different groups of pre-service teachers (i.e., those in EDPY 302 and those in EDPY 304) cannot be equated to each other because the groups undoubtedly differ in more than their choice of program, comparisons can still be made between these two populations precisely because they *do* represent different populations. However, even from a methodological perspective, there are important differences. For example, the sample size is substantially smaller in the EDPY 304 sample (n = 49) than in the EDPY 302 sample (n = 76). This could impact the

detection of potentially small effects because sample size affects power. Another difference is that only about 8% of pre-service teachers enrolled in the EDPY 302 course identified as men, whereas about 51% of pre-service teachers enrolled in the EDPY 304 course identified as men. In the EDPY 302 sample, most of the pre-service teachers identified as women. There is some research suggesting that gender identification can influence online survey responses (see Smith, 2008). Thus, women may interpret and respond to survey questions differently than men. Moreover, pre-service teachers enrolled in EDPY 302 were studying child development, whereas pre-service teachers enrolled in EDPY 304 were studying adolescent development. It is possible that there are differences in responses and perspectives between those who wish to work with older children and adolescents versus those who wish to work with younger children. Overall, the differences between these two samples create several opportunities for explaining the different results, above and beyond the psychometric properties and potential measurement error of the EOQ subscales.

Despite these differences, at least one overarching pattern can be observed. Across both groups of pre-service teachers, it could be argued that pre-service teachers' explicit gender bias – benevolent or hostile sexism towards women – appears to be associated with their beliefs about the importance of children *learning* from their mistakes. This is because hostility towards women among pre-service teachers enrolled in EDPY 302 predicted their beliefs about whether children learn, or should learn, from their mistakes (EOQ Learning from Errors subscale), while seemingly charitable beliefs towards women that are sexist in nature among pre-service teachers enrolled in EDPY 304 predicted this same outcome measure. Given that the EOQ Learning from Mistakes subscale was the most stable subscale across both samples in terms of its internal

consistency, this may suggest that these findings would likely be observable in future research as well.

Implications

The present study has several practical implications. First, this research was able to explore pre-service teachers' gender biases and their beliefs about children's mistakes by adapting the Error Orientation Questionnaire (EOQ). The exploration of the instrument revealed that four out of eight subscales were psychometrically reliable, depending on the sample. Although not all subscales could be deemed internally consistent, this study was nonetheless able to capture pre-service teachers' beliefs about whether children learn, or should learn, from mistakes, fear or avoid mistakes, think about mistakes, and be open/willing to make mistakes in class, which are all valuable constructs in terms of investigating teachers beliefs about children's mistakes in general. Thus, these may be used to inform and develop a more complete and psychometrically sound measure of teachers' beliefs about children's mistakes.

Second, despite not using the other half of the EOQ subscales, this study was still able to investigate gender biases alongside beliefs about children's mistakes at school. Of particular importance, hostile and benevolent sexist attitudes towards women among pre-service teachers, albeit depending on whether pre-service teachers were enrolled in EDPY 302 or 304, predicted their beliefs about the importance of children learning from mistakes during the learning process. This may have important implications for girls in the classroom; if pre-service teachers hold stronger gender biases that are related to their views about children's learning from mistakes, then this may unintentionally affect how they encourage and promote learning from mistakes to children once they are working with children, which may be different depending on whether the child is a boy or a girl. Since previous research has shown girls and boys tend to

receive differential feedback in class (Dweck et al., 1978; Sadker et al., 2009), and even some research has shown that boys receive better quality feedback from teachers than girls (Sadker et al., 2009; Berekashvili, 2012), it seems possible and if not, likely, that pre-service teachers' gender biases may impact how they encourage boys versus girls to learn from their mistakes. For example, once a pre-service teacher is working with children in the classroom, they may more often reinforce the learning opportunity of a mistake (e.g., the teacher asks the student to reflect on their answer) for boys than for girls, which could be detrimental for girls if they are not provided with the same level of support and encouragement to perceive their mistakes as valuable learning opportunities. Moreover, teachers may be communicating higher expectations for boys than girls if they encourage the former but not the latter to learn from mistakes. However, this is dependent on whether or not pre-service teachers' beliefs about children's mistakes translates to their error-handling strategies in the classroom; Bray (2011) shows that teachers' underlying beliefs about mathematics have the potential to influence how they handle children's mistakes. Moreover, research has shown the differential treatment and expectations of boys and girls in mathematics and science classrooms by their teachers (Andersson, 2010; Bray, 2011; Gore & Roumagoux, 1983; Mizala, 2015; Stevens, 2015). Thus, it is conceivable that girls' interest and engagement in math or science may be at risk if pre-service teachers' gender beliefs discourage learning from mistakes, which in turn, may influence how pre-service teachers emphasize the learning opportunities of students' errors.

Finally, the results showed that pre-service teachers' attitudes towards their own mistakes can be projected onto children, which could have critical implications for when pre-service teachers begin working in classrooms. It was revealed that, for both groups of pre-service teachers, more positive attitudinal behaviours towards their own mistakes (e.g., *When I*

make mistakes on an exam, I find similar exercises to practice) predicted more positive beliefs about whether children should think about mistakes. In contrast, pre-service teachers' who reported more negative beliefs about their own mistakes (e.g., *I believe successful students make fewer mistakes during learning than others*) were more likely to endorse more negative beliefs about the importance of children learning from mistakes. In addition, in the 304 sample of pre-service teachers, more negative attitudinal affect, or emotions, towards their own mistakes (e.g., *When I make mistakes answering classroom questions, I feel humiliated*) predicted more negative beliefs about whether children should feel strained by or fear making mistakes. Although these results are not surprising, they could have important implications for how mistakes are viewed – and potentially handled – in the classroom. It is conceivable that pre-service teachers' perceptions of mistakes may impact how they eventually promote and encourage using mistakes as learning opportunities to children. For example, pre-service teachers who feel embarrassed or anxious about making their own mistakes may role model negative emotions in the classroom when children make mistakes. This in turn could engender perfectionistic attitudes towards learning among children, especially high achievers, that not only lead to anxiety but also to a lack of creativity (see, for example, Sagar & Stoeber, 2009).

As Tulis' (2012) research has shown, the way teachers handle mistakes in the classroom can impact children's perceptions of mistakes, leading students to adopt adaptive or maladaptive error-related attitudes. Thus, the current results are important for understanding how a teacher's own attitudes and beliefs can be projected onto children, which is important for teacher training and pedagogy and should be a direction of future research.

Limitations

The results of the present study need to be interpreted with the consideration of several limitations. First, the implicit gender bias measurement tool could not be used in the present study as its conversion to Google Forms from paper-format was not ideal. This means that the only measure of pre-service teachers' gender bias that was included in the present study was an explicit gender bias measure. The challenge with using self-report measurement tools that use direct questioning when researching sensitive topics is that there is a strong possibility of social desirability response (SDR) bias in the data. As briefly mentioned earlier, SDR bias is when participants may be unwilling to disclose their true attitudes, beliefs, or feelings because they could have the potential to be viewed as violating social norms, and thus would reflect unfavourably upon the participant (Hoffman & Musch, 2018). It is important to consider and attempt to control for this type of response bias. Research has shown that implicit methodology, such as using indirect questions, when researching gender prejudice tends to produce less SDR bias. For example, a study by Hoffman and Musch (2018) examining prejudice against women leaders showed that both women and men were more likely to disclose prejudice against women leaders when asked indirect questions than when asked direct/explicit questions. Therefore, in the present study, by asking pre-service teachers explicit questions about their thoughts and beliefs about women, and without using the IAT data consisting of pre-service teachers' implicit gender attitudes and beliefs – theoretically, more truthful responses – pre-service teachers may have been more likely to respond in more socially desirable ways. Thus, SDR bias could be a threat to the validity of the results. Interestingly, despite this potential bias, the present study showed that hostile and benevolent sexism accounted for pre-service teachers' responses.

Another limitation that warrants consideration is the sample size, as only two relatively small convenience samples of pre-service teachers were surveyed. This small sample size may have contributed to discrepancies within and between each sample. For example, some predictors were significant in the simple regression analyses but not in the multiple regression analyses within each sample. Not all statistically significant predictors were the same in predicting the outcome measures in the EDPY 302 sample as compared to the EDPY 304 sample. Furthermore, both samples were recruited from the University of Alberta and were samples of convenience, which means that the generalization of results may be limited to the specific attributes of the two samples.

Additionally, the adapted Error Orientation Questionnaire (EOQ) could not be used in its entirety to measure pre-service teachers' beliefs about children's mistakes; therefore, the findings do not reflect a full-rounded measure of teachers' beliefs about children's mistakes. As such, some constructs were excluded that may still be relevant and important to understanding teachers' beliefs about children's errors, such as how pre-service teachers view the importance of children's communication about mistakes, how capable they believe children to be in correcting their mistakes, whether they generally anticipate children to make mistakes, and whether they believe children should hide or cover up their mistakes.

Future Directions

One of the main directions of future research is to develop a measurement tool that better captures pre-service teachers' beliefs surrounding children's mistakes in the classroom as a whole, as these beliefs may have an impact on student learning processes. Specifically, the adapted EOQ requires further revisions in terms of clearer wording of items as well as further analyses to examine the constructs of each subscale in more depth. Based on the present study,

one construct of the EOQ was able to be reliably measured across both groups of pre-service teachers (i.e., Learning from Errors); three constructs approximated or met satisfactory internal consistency, depending on the sample (i.e., Error Risk Taking, Error Strain, and Thinking about Errors); and, four remaining constructs demonstrated unsatisfactory internal consistency (i.e., Error Competence, Error Anticipation, Covering up Errors, and Error Communication). Consequently, this scale requires further development prior to being more consistently used with a pre-service or teacher population in educational contexts. Therefore, future research might focus on (1) refining the items of the EOQ to improve its reliability and (2) assessing its relationship to other constructs – for example, fear of failure – to evaluate its validity.

Future research may also consider gathering more data by recruiting a larger sample of participants. Some of the difference in results in the present study may be attributable to the small sample size, and therefore, some of the subtler effects may have gone undetected for some of the constructs – for example, Error Strain. However, it is important to note that there were no pre-existing reasons to expect the responses of 302 and 304 to be the same given (a) these groups represent distinct populations and (b) little research has been conducted on this topic. In any case, since sample size affects the statistical power of a study, more participants may be required for examining these constructs.

Another direction to consider is the use of a measurement tool for measuring pre-service teachers' *implicit gender biases.* The present study attempted to adapt the paper-format Implicit Association Test (IAT), an adaptation from the original computer technology that records participants' response times. Capturing participants' implicit biases via Google Forms was not well executed in the present study, and future research might consider using other survey platforms, other technology, or ways of incorporating the paper-format IAT into the study

design. As previously mentioned, when studying sensitive research topics, it is important to try and capture participants' unconscious thoughts, beliefs, and attitudes by using more indirect questioning, as this is likely to more closely measure the construct due to eliciting more truthful responses from respondents (Hoffman & Musch, 2018).

Conclusion

The purpose of this study was to explore an instrument that was adapted to measure pre-service teachers' beliefs about children's mistakes in a classroom setting, as well as to investigate pre-service teachers' gender beliefs and errors alongside their beliefs about children's mistakes in the classroom. The results showed that the adaptation of the Error Orientation Questionnaire (EOQ) to measure pre-service teachers' beliefs about children's mistakes led to a mixed profile of internal consistency values, which informed subsequent analyses. Four out of eight EOQ subscales were retained for these further analyses because they were the most internally consistent. Regression analyses revealed a different profile of results for 302 and 304 samples, of which several potential explanations were discussed, such as potential measurement error, small sample size, and shifts in constructs. Nonetheless, results also revealed important patterns among pre-service teachers' gender beliefs and their own errors in relation to their beliefs about children's mistakes. Potential implications are that pre-service teachers' own beliefs and attitudes can be projected onto children, and, this may have an impact on how pre-service teachers eventually handle children's mistakes in the classroom. Additionally, pre-service teachers' gender bias may unintentionally impact how they promote and encourage boys versus girls learning from their mistakes. If pre-service teachers' hold gender biases in relation to how they view children's mistakes, and if their own attitudes and beliefs about mistakes can be projected onto children, this may influence whether girls and boys

are differentially taught to learn from their mistakes. That the very individuals who are responsible for inculcating positive learning values in children may be doing the opposite because of the belief they harbor is of profound consequence for teacher training and children's education. Overall, the results from this study contribute to addressing fundamental and persistent issues surrounding gender beliefs in relation to children. This research may help reveal the hidden gender biases that continue to reside in classrooms, and that may form part of understanding the genesis of girls' disengagement and underrepresentation in science, technology, engineering and mathematics (STEM) careers.

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Appendix A

Implicit Association Test

Condition 1		
Female Humanities		Male Science
O	Joanna	O
O	Art	O
O	Robert	O
O	Physics	O
O	Mary	O
O	Literature	O
O	Tom	O
O	Mathematics	O
O	Leanne	O
O	History	O
O	William	O
O	Engineering	O
O	Victoria	O
O	Music	O
O	Henry	O
O	Chemistry	O
O	Cynthia	O
O	Drama	O
O	Claudio	O
O	Biology	O
O	Sophie	O
O	Classics	O
O	Mark	O
O	Computing	O
O	Monica	O
O	Philosophy	O
O	David	O
O	Genetics	O
O	Karen	O
O	Poetry	O
O	Gregory	O
O	Astronomy	O
O	Megan	O
O	Dance	O
O	George	O
O	Biomedicine	O
O	Janet	O
O	Linguistics	O
O	Jonathan	O
O	Pharmacy	O

Condition 2		
Female Science		Male Humanities
O	Joanna	O
O	Art	O
O	Robert	O
O	Physics	O
O	Mary	O
O	Literature	O
O	Tom	O
O	Mathematics	O
O	Leanne	O
O	History	O
O	William	O
O	Engineering	O
O	Victoria	O
O	Music	O
O	Henry	O
O	Chemistry	O
O	Cynthia	O
O	Drama	O
O	Claudio	O
O	Biology	O
O	Sophie	O
O	Classics	O
O	Mark	O
O	Computing	O
O	Monica	O
O	Philosophy	O
O	David	O
O	Genetics	O
O	Karen	O
O	Poetry	O
O	Gregory	O
O	Astronomy	O
O	Megan	O
O	Dance	O
O	George	O
O	Biomedicine	O
O	Janet	O
O	Linguistics	O
O	Jonathan	O
O	Pharmacy	O

Appendix B

Ambivalent Sexism Inventory

Please indicate the degree to which you agree or disagree with the following statements. Please read all statements carefully. The question numbers are shuffled for research purposes.

1 = Strongly Disagree; 2 = Somewhat Disagree; 3 = Slightly Disagree; 4 = Slightly Agree; 5 = Somewhat Agree; 6 = Strongly Agree

1. No matter how accomplished he is, a man is not truly complete as a person unless he has the love of a woman.	1	2	3	4	5	6
2. Many women are actually seeking special favours, such as hiring policies that favour them over men, under the guise of asking for "equality."	1	2	3	4	5	6
3. In a disaster, women ought not necessarily to be rescued before men.	1	2	3	4	5	6
4. Most women interpret innocent remarks or acts as being sexist.	1	2	3	4	5	6
5. Women are too easily offended.	1	2	3	4	5	6
6. People are often truly happy in life without being romantically involved with a member of the other sex.	1	2	3	4	5	6
7. Feminists are not seeking for women to have more power than men.	1	2	3	4	5	6
8. Many women have a quality of purity that few men possess.	1	2	3	4	5	6
9. Women should be cherished and protected by men.	1	2	3	4	5	6
10. Most women fail to appreciate fully all that men do for them.	1	2	3	4	5	6
11. Women seek to gain power by getting control over men.	1	2	3	4	5	6
12. Every man ought to have a woman whom he adores.	1	2	3	4	5	6
13. Men are complete without women.	1	2	3	4	5	6
14. Women exaggerate problems they have at work.	1	2	3	4	5	6
15. Once a woman gets a man to commit to her, she usually tries to put him on a tight leash.	1	2	3	4	5	6
16. When women lose to men in a fair competition, they typically complain about being discriminated against.	1	2	3	4	5	6
17. A good woman should be set on a pedestal by her man	1	2	3	4	5	6
18. There are actually very few women who get a kick out of teasing men by seeming sexually available and then refusing male advances.	1	2	3	4	5	6
19. Women, compared to men, tend to have a superior moral sensibility.	1	2	3	4	5	6

20. Men should be willing to sacrifice their own well being in order to provide financially for the women in their lives.	1	2	3	4	5	6
21. Feminists are making entirely reasonable demands of men.	1	2	3	4	5	6
22. Women, as compared to men, tend to have a more refined sense of culture and good taste.	1	2	3	4	5	6

Appendix C

Attitude Towards Mistakes Inventory

Please read each item carefully. Using the scale below, please respond to the following items as honestly as you can. When responding to each of the items, please relate them to your academic experience in general.

1 = Strongly Disagree; 2 = Disagree; 3 = Neither Disagree nor Agree; 4 = Agree; 5 = Strongly Agree

1. When I make mistakes in group discussions, I am afraid that others look down upon me.	1	2	3	4	5
2. When I make mistakes on my assignment, I am quite curious about where I went wrong.	1	2	3	4	5
3. I believe successful students make fewer mistakes during learning than others.	1	2	3	4	5
4. If I make mistakes in group discussions, I don't want others to notice them.	1	2	3	4	5
5. When I make mistakes on an exam, I feel motivated to study harder.	1	2	3	4	5
6. I believe it is smart to avoid making mistakes during learning.	1	2	3	4	5
7. When I make mistakes answering classroom questions, I am overwhelmed with embarrassment.	1	2	3	4	5
8. If I make mistakes on my assignment, I will redo it.	1	2	3	4	5
9. I believe making mistakes is not an efficient way to learn academic materials.	1	2	3	4	5
10. I seldom feel bothered by the mistakes I make in group discussions.	1	2	3	4	5
11. When I see mistakes on an exam, I meet the instructor to review the errors.	1	2	3	4	5
12. I believe I do not learn much from making mistakes in learning.	1	2	3	4	5
13. When I make mistakes answering classroom questions, I still feel confident about my ability.	1	2	3	4	5
14. When I make mistakes on an exam, I find similar exercises to practice.	1	2	3	4	5
15. I believe I gain knowledge from making mistakes.	1	2	3	4	5
16. When I make mistakes in class, I worry that other students may laugh at me.	1	2	3	4	5
17. When I make mistakes on my assignment, I try to find out why by checking the class notes.	1	2	3	4	5
18. I believe making mistakes is a necessary part of learning.	1	2	3	4	5

19. When I make mistakes answering classroom questions, I become anxious.	1	2	3	4	5
20. When I make mistakes on my assignment, I compare my answers with the examples in the class notes.	1	2	3	4	5
21. I make mistakes on my assignment because I am not smart enough.	1	2	3	4	5
22. When I make mistakes answering classroom questions, I feel humiliated.	1	2	3	4	5
23. When I make mistakes on my assignment, I review what was discussed in class.	1	2	3	4	5
24. When I make mistakes answering classroom questions, I am mortified.	1	2	3	4	5
25. When I make mistakes answering classroom questions, I am not disappointed with my answer.					
26. I feel safe in group discussions even if I make mistakes.	1	2	3	4	5

Appendix D

Adapted Error Orientation Questionnaire

Please read each item carefully. Using the scale below, please indicate the degree to which you agree or disagree with the following items.

1 = Not at All; 2 = A Bit; 3 = Neither a Bit nor a Lot; 4 = A Lot; 5 = Totally

1. When children make mistakes, I believe they know immediately how to correct it.	1	2	3	4	5
2. When children do something wrong in class, I believe they can correct it immediately.	1	2	3	4	5
3. If it is at all possible to correct a mistake, then a child usually knows how to go about it.	1	2	3	4	5
4. I do not wish for a child to let go of his or her goal, although he or she may make mistakes.	1	2	3	4	5
5. Mistakes assist children to improve their learning.	1	2	3	4	5
6. Mistakes provide useful information for children to carry out schoolwork.	1	2	3	4	5
7. Children's mistakes help them to improve their schoolwork.	1	2	3	4	5
8. Children's mistakes have helped them to improve their schoolwork.	1	2	3	4	5
9. If a child wants to achieve in school, he or she has to risk making mistakes.	1	2	3	4	5
10. It is better for children to take the risk of making mistakes than to `sit on their behind.'	1	2	3	4	5
11. To get on with their schoolwork, children should gladly put up with things that can go wrong.	1	2	3	4	5
12. Children should prefer to make mistakes rather than do nothing at all.	1	2	3	4	5
13. Children find it stressful when they make mistakes.	1	2	3	4	5
14. Children are often afraid of making mistakes.	1	2	3	4	5

15. Children feel embarrassed when they make mistakes.	1	2	3	4	5
16. If children make mistakes in class, they `lose their cool' and become angry.	1	2	3	4	5
17. While at school, children are concerned that something will go wrong.	1	2	3	4	5
18. In carrying out a task, the likelihood of a child making errors is high.	1	2	3	4	5
19. Whenever children start a project or an assignment, they should be aware that mistakes occur.	1	2	3	4	5
20. Most of the time children should not be astonished about their mistakes because they should expect them.	1	2	3	4	5
21. Children should anticipate mistakes happening in school.	1	2	3	4	5
22. Children should expect that something will go wrong from time to time.	1	2	3	4	5
23. Why mention a mistake to a child when it isn't obvious?	1	2	3	4	5
24. It is disadvantageous to make a child’s mistakes public.	1	2	3	4	5
25. It is not useful for children to discuss their mistakes.	1	2	3	4	5
26. It can be useful to cover up children’s mistakes.	1	2	3	4	5
27. Children should keep their mistakes to themselves.	1	2	3	4	5
28. Children who admit to their errors, make a big mistake.	1	2	3	4	5
29. When children make a mistake in class, they should tell others about it in order that they do not make the same mistake.	1	2	3	4	5
30. If a child cannot rectify an error by him- or herself, they should seek help from their classmates.	1	2	3	4	5
31. If a child cannot manage to correct a mistake, they should be able to rely on others.	1	2	3	4	5
32. When a child has done something wrong, they ought to ask others how they should do it better.	1	2	3	4	5
33. After a child has made a mistake, he or she should think about how it came about.	1	2	3	4	5

34. Children should often think: `How could I have prevented this?'	1	2	3	4	5
35. If something goes wrong in class, children should think it over carefully.	1	2	3	4	5
36. After a mistake has happened, children should think long and hard about how to correct it.	1	2	3	4	5
37. When a mistake occurs, children should analyze it thoroughly.	1	2	3	4	5

Appendix E

Demographic Questionnaire

This questionnaire asks for information about you and your background. This information will be kept strictly confidential. We are collecting this information from you to know the characteristics of those who participated in the study. This information is helpful for conducting our analyses and to understand to whom the results of the study might generalize.

1. How do you identify your gender?
    a. Female
    b. Male
    c. Prefer not to say
    d. Not listed/other: _____

2. What is your year of birth? (e.g., 2000)
    a. _____

3. To which University of Alberta Program are you enrolled?
    a. Bachelor of Education (Elementary Route)
    b. Bachelor of Education (Secondary Route)
    c. Bachelor of Education (Route Unspecified)
    d. Other: _____

4. Which ethnicity best describes you?
    a. Indigenous
    b. Asian
    c. Black/African
    d. Hispanic/Latino
    e. Caucasian
    f. Unknown
    g. Prefer not to answer
    h. Not listed/other: _____