Pre-service elementary school teachers' expectations about student performance: How their beliefs are affected by their mathematics anxiety and student's gender

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HIGHLIGHTS

- Math anxiety can influence pre-service teachers' expectations about students.
- Pre-service teachers' expectations about math achievement are gender biased.
- Underachievement in math is extrapolated to general achievement only for girls.
- No interaction effects were found between math anxiety and math gender bias.
- Math anxiety may affect teachers' capacity to develop inclusive learning environments.

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ABSTRACT

We examine whether the expectations of pre-service elementary school teachers about students' achievement, and their beliefs regarding student need for academic support, are influenced by future teachers' mathematics anxiety or by student gender and socioeconomic status. We found that mathematics anxiety can negatively influence pre-service teachers' expectations about students, and that future mathematics teachers' expectations of mathematics achievement are lower for girls than for boys. These effects are independent, as we did not find significant interaction effects between pre-service teacher's mathematics anxiety and student gender. Our results also suggest that mathematics anxiety could affect the capacity of pre-service teachers to develop inclusive learning environments in their classrooms.

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1. Introduction

Teacher expectations of student performance play a significant role in the interaction between teachers and students. It has long been established that teachers engage in different forms of classroom practices with students for whom they hold high or low academic expectations (Brophy & Good, 1970), such as praising high expectation students more often for their successes, criticizing low expectation students more often for their failures, waiting less time for low expectation students to answer questions, or interacting less frequently with low expectation students (Good, 1987). Children from a very young age can detect these differential treatments and infer their teachers' beliefs about them (Babad, 2009), a situation which in turn affects their own self-image and motivation (Kuklinski & Weinstein, 2001; Urhahne, 2015). A self-fulfilling prophecy or Pygmalion effect (Rosenthal & Jacobson, 1968) is said to take place when students internalize teacher beliefs and adjust their behavior to meet teacher expectations, leading high-expectation students to perform better and low-expectation...
students to perform worse. Such influence on educational achievement appears to be especially significant for students from culturally stigmatized groups. While two meta-analysis (Raudenbush, 1984; Rosenthal & Rubin, 1978) showed that the size of the average expectancy effect is rather small (binomial effect size of 0.1–0.2), Jussim, Eccles, and Madon (1996) found that self-fulfilling prophecy effects could be up to two and three-times larger in female students, low-income students and African-American students. The cumulative research on the effects of teacher expectations has lead contemporary scholars (Rubie-Davies, 2014; Teddie & Reynolds, 2000; Weinstein, 2002) and education professionals (Lemov, 2010) to advocate high expectations as a key principle of effective teaching.

High teacher expectations, however, can only be achieved through a deeper understanding of the variables that influence them (Brault, Janosz, & Archambault, 2014). This line of inquiry has pointed to several student characteristics that can affect teacher expectations, such as student prior achievement (Dusek & Joseph, 1983; Jussim et al. 1996), socioeconomic status (Auwarter & Aruguete, 2008a; Rist, 2000; Speybroeck et al. 2012), ethnicity (Figlio, 2005; Strand, 2012; Tenenbaum & Ruck, 2007) and gender (Auwarter & Aruguete, 2008a; Hinnant, O’Brien, & Ghazarian, 2009). Surprisingly, there are fewer studies that relate teacher characteristics to teacher expectations. Some authors have theoretically argued that teachers with high self-efficacy could be more prone to set higher goals for their students, but empirical research has produced contradictory results (Archambault, Janosz, & Chouinard, 2012; Rubie-Davies, Flint, & McDonald, 2012). As Li (2014) notes, there is need for further research into the teacher personal traits that may influence their expectations of students. This study offers new insights into this matter by exploring the effect of mathematics anxiety in the development of teacher expectations. Mathematics anxiety is a construct that has received increased attention from teacher education research over the last decades. It is highly prevalent among students enrolled in teacher education programs—especially primary level ones (Hembree, 1990)—and it has been associated with lesser mathematical knowledge and low teaching self-efficacy (Bursal & Paznokas, 2006; Gresham, 2008; Swars, Daane, & Giesen, 2006). However, few studies have explored in depth how mathematics anxiety actually affects the skills and characteristics needed for effective teaching. For instance, we found no studies that evaluated how the mathematics anxiety level of a teacher may affect his or her capacity to make unbiased judgments about students, or how such anxiety relates to student characteristics such as gender that in turn influence teacher expectations.

This paper attempts to address this gap. To do so, we use an experimental setting with a Chilean sample of pre-service elementary school teachers in order to study how mathematics anxiety and gender stereotypes might influence how they envision learning results and need for specialized support in hypothetical students of theirs.

1.1. Teacher expectations: accuracy and bias

Ready and Wright (2011) offer a framework to operationalize and study the concepts of expectation accuracy and bias, distinguishing three possible scenarios. If teachers’ perceptions of students’ skills are consistent with objective assessments, they are accurate and unbiased; if teachers’ perceptions differ from objective measures in a random manner, perceptions are inaccurate but unbiased; but if teachers’ perceptions differ systematically from objective assessments based on students’ characteristics, one might conclude that their perceptions are inaccurate and biased.

Educational psychologists have established that most of the time teachers’ expectations are largely, but not completely accurate (Jussim & Harber, 2005). A first wave of research on this issue used a cross-study perspective to measure the accuracy of teachers’ perceptions (Jussim et al. 1996). The authors considered the average correlation between teacher expectations and student achievement found in previous studies, and the average size of expectation effects found in experimental settings. By subtracting the average size of expectation effects from the correlation between teacher expectations and student achievement, the authors established indirectly that teachers’ perception are about 75% accurate. A meta-analysis of 77 studies by Südkamp, Kaiser, and Möller (2012) looked at the median correlation between teacher expectations and student performance in standardized achievement tests, arriving at a similar result. They found that teachers’ judgments were about 63% accurate. However, as Ferguson (2003) notes, one should focus on the inaccurate component of the predictions in a “glass half empty” fashion. For instance, if the remaining variance is systematically related to student characteristics, then some perception bias takes place.

Two of the most commonly studied sources of perception bias in teachers’ expectations are student socio-economic status and student gender. The perception bias caused by socio-economic status shows a direct association largely consistent across studies: teachers tend to have higher expectations for students of high socio-economic status and lower expectations for students from disadvantaged backgrounds. This phenomenon has been observed at pre-school (Speybroeck et al. 2012), first and second grade (Rist, 2000) and secondary education (Gregory & Huang, 2013). Regarding student gender, the direction of the perception bias is more complex, as it seems to vary according to the domain assessed by teachers. Hinnant, O’Brien, and Ghazarian (2009) finds that teachers have higher expectations of reading ability for girls than boys, while other studies have suggested higher expectations for boys in the fields of mathematics (Spelke, 2005).

1.2. Mathematics anxiety as a source of expectancy bias

Mathematics anxiety is commonly defined as “feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations” (Richardson & Suinn, 1972). Two independently conducted meta-analysis demonstrated that mathematics anxiety has a significant negative correlation with mathematical performance and achievement, consistent across gender, grade levels and ethnic groups (Hembree, 1990; Ma, 1999). Some authors attribute the achievement gap to avoidance of mathematics and learning opportunities: highly mathematics anxious individuals take fewer mathematics elective courses than do low-anxiety individuals, both in high school and college (Hembree, 1990; Scarpello, 2005). In the context of cognitive research, mathematics anxiety has been associated with working memory deficits, independent of the individual’s overall competence in mathematics (Ashcraft & Kirk, 2001, Ashcraft, & Moore, 2009; Ramirez, Gunderson, Levine, & Beilock, 2013).

An emerging trend in the literature has focused specifically on the presence of mathematics anxiety among future teachers. Studies conducted in college settings have consistently found that education majors show a higher prevalence of mathematics anxiety than those in any other fields (Baloglu & Kocak, 2006; Bessant, 1995; Hembree, 1990). More specifically, Hembree (1990) pointed out that university level students preparing as primary teachers presented the highest levels of mathematical anxiety among seven specialization areas included in the meta-analysis. Also mathematics anxiety in future primary teachers is strongly and negatively
related to mathematics teaching efficacy beliefs (Bursal & Paznakos, 2006; Gresham, 2008; Swars et al. 2006).

The relationship between mathematics anxiety and gender is a matter of great interest and has been extensively researched, but results have not been conclusive. Regarding levels of mathematics anxiety, many studies have found higher levels in females than males (Baloglu & Kokac, 2006; Wigfield & Meece, 1988; Woodard, 2004; Yüksel-Sahin, 2008), yet other research has found no significant gender differences (Chinn, 2009; Chiu & Henry, 1990; Devine, Fawcett, Szucs, & Dowker, 2012; Newstead, 1998). In turn, a number of studies examining gender differences in the relationship between mathematics anxiety and performance also show mixed results (Betz, 1978; Birgin, Baloglu, Çatlıoğlu, & Gürbüz, 2010; Miller & Bichsel, 2004).

The high prevalence of mathematics anxiety among future teachers is also crucial considering that teachers might transmit their anxieties to their students (Beilock, Gunderson, Ramirez, & Levine, 2010; Conrad & Tracy, 1992; Sloan, Daane, & Gieser, 2002; Vinson, 2001; Wood, 1988). In particular, Beilock et al. (2010) found that the more mathematics anxious is a female primary teacher, the more likely is it that her female students will endorse gendered mathematics stereotypes. Girls who studied with mathematics anxious female teachers and who believed by the end of one school year that “boys were better at math than girls” actually presented worse mathematics achievement than the rest. As Beilock shows, mathematics anxiety is closely related to the gender stereotype threat that also fuels the perception bias against girls in teacher expectations about mathematical performance. A question that has not yet been addressed by the literature is whether mathematics anxiety by itself can alter teacher expectations, or if mathematics anxiety interacts with gender stereotypes in teacher expectations.

The rest of the paper proceeds as follows. Section 2 states the main research questions of the study and Section 3 explains the methods and data used. Section 4 presents the results, and Section 5 discusses the implications of the results and its conclusions.

2. Research questions

In this study we attempt to integrate two lines of research in order to answer previously unaddressed questions about mathematics anxiety and perceptions bias in teacher expectations. We use expectation constructs and three-way factorial ANOVA models — in an experimental setting—to study how mathematics anxiety and gender stereotypes influence pre-service elementary school teachers’ opinions about students.

In particular, we seek to answer three questions. First, what are the relationships between pre-service elementary school teacher expectations of hypothetical students’ future achievement, their own mathematics anxiety and hypothetical students’ characteristics (gender and socioeconomic status)? Based on previous literature, we hypothesize that student gender and socioeconomic status have a significant influence over academic expectations. In fact, studies in different cultural settings show that teachers tend to favor boys over girls in mathematics — for example, Fennema, Peterson, Carpenter, and Lubiński (1990) and Espinoza, da Luz Fontes, and Arms-Chavez (2014) for the United States, and Keller (2001) for Switzerland. There are studies that also show that teachers tend to favor high socioeconomic students over students from disadvantaged backgrounds — for example, Auwarter and Aruguete (2008a) for England and Del Río and Balladares (2010) for Chile. Moreover, we also expect that pre-service teachers with high mathematics anxiety will project their anxiety on students, thus leading to lower academic expectations. Second, what are the relationships between pre-service elementary school teachers’ perceptions of hypothetical students need for academic support, their own mathematics anxiety and hypothetical students’ characteristics (gender and socioeconomic status)? Since mathematics anxiety is negatively related to teaching self-efficacy (Bursal & Paznakos, 2006; Gresham, 2008; Swars et al. 2006), we hypothesize that pre-service teachers with high mathematics anxiety will feel less able to teach their students and, therefore, think that their students need academic support from other sources. Third, are there interactions between mathematics anxiety and gender perception bias? That is, are gender stereotypes about mathematics stronger in math anxious pre-service elementary school teachers? Here, we expect that math anxious individuals are more prone to hold a bias against girls in the expectation of mathematical achievement; therefore, we presume there will be a significant interaction effect between pre-service teachers’ mathematics anxiety and student gender with regards to that specific dependent variable.

3. Methods and data

3.1. Experimental design

The research design is based on a survey-experimental methodology previously used to study the effects of student level variables on teacher expectations (Auwarter & Aruguete, 2008a, 2008b; Del Río & Balladares, 2010; Tournaki, 2003; Tournaki & Podell, 2005). In the experiment’s setting each participant was asked to read one paragraph describing a primary school student with apparent behavioral difficulties and underachievement in mathematics. The student’s gender and socioeconomic status were systematically varied to produce four experimental conditions by means of four different paragraphs describing a student. These were randomly assigned to each participant as follows: high-SES boy, low-SES boy, high-SES girl and low-SES girl. To indicate gender there were different names used (“John” or “Johanna”) and corresponding pronouns, while Socio-economic status was elicited by altering the occupation of the student’s parents. Other than the mentioned manipulations, descriptions were identical (See a sample description paragraph in Appendix 1).

After reading the paragraph, each participant completed a questionnaire about the student as if s/he were his/her pupil. This questionnaire included scales to measure their achievement expectations regarding the student and scales to measure the kind of support they considered the fictitious student should receive (we discuss this in detail in Section 3.3).

In addition, the experimental design includes pre-service elementary school teacher’s mathematics anxiety as an independent factor. We used three-way ANOVA models to evaluate main and interaction effects of mathematical anxiety and gender stereotypes, while controlling for expectation biases induced by the socioeconomic status of the students.

3.2. Background of participants

Teacher education in Chile is almost entirely offered by universities. It is also highly decentralized and has experienced a major growth over the last decades. During the 1980s, there were few universities that prepared primary teachers and most of them were publicly funded. By 2012, over 94,000 students were enrolled in teacher education programs across 55 universities, many of which were private. Universities are autonomous to set their own admission requirements, which results in a varying degree of selectivity: in 2012, 15% of the education students enrolled attended highly selective research universities, 35% studied in non-research universities with moderate degree of selectivity, while
most of the students (50%) attended programs in low selectivity
non-research universities.

The programs are concurrent and last on average 9 to 10 se-
mesters (five years) and their curriculum content are relatively
similar, providing opportunities to learn general education and
pedagogy, subject-matter knowledge, and field experience. A four
month or semester-long practicum is usually required in addition
to the courses. Once students obtain a teaching certification from a
qualified institution, they are ready to apply for a teaching position
in a public or private school.

To a large extent, elementary school teachers are prepared as
generalists and have to teach several subjects, including math-
ematics. According to the IEA Teacher Education and Development
Study in Mathematics (TEDS-M, tatto et al., 2012) that compared
the mathematics content knowledge (MCK) and mathematics
pedagogy content knowledge (MPCK) of future teachers from 17
countries, Chilean future teachers performed poorly on both tests,
placing Chile second to last among the evaluated countries. The
government has implemented public policies aimed at improving
initial teacher training through the setting of standards, national
tests to measure the content and pedagogical knowledge of future
teachers, and improvement of teacher education programs through
means of competitive funding.

3.2. Participants selection and sample

Participants were 208 pre-service elementary school teachers
recruited from Chilean universities. E-mail invitations to participate
in the study were sent to over 1000 students enrolled in primary
school education programs in 17 Chilean universities, representa-
tive of all three types of universities (highly selective research
universities, non-research universities with moderate degree of
selectivity and non-research universities with low selectivity).
From these, 208 provided their informed consent and completed all
questionnaires (approximately 20% completion rate). Students
from highly selective research universities and non-research uni-
versities with moderate degrees of selectivity were over repre-
sented in the final sample (40% and 41% respectively) and only 19%
of the sample came from less selective universities. Eighty-six
(41.5%) participants were in their first year, 55 (26.1%) in their
second year, 44 (2.3%) in their third year, 18 (8.7%) in their fourth
year, and 5 (2.4%) in their final year. Participants’ teaching experi-
ence was mixed. About half of the sample (54.4%) had taught in
schools under supervision, but only 18 (8.7%) students had worked
in schools as teachers.

The sample included 176 (84.6%) women and 32 (15.4%) men,
which is representative of the gender participation in primary
teacher preparation programs in Chile. The low number of male
participants precluded us from including the participant’s gender
as a key variable in our study due to the reduction of statistical
power.

3.3. Questionnaire and measures

Participants rated hypothetical students on multiple 5-point
Likert-type statements. In order to gain more specific insights
into the future teacher judgments and to improve the psychometric
properties of our instruments, we departed from previous litera-
ture (auwarter & aruguete, 2008a, 2008b; del río & balladares,
2010) in the manner in which we grouped the items into scales.
Future expectations for a student were divided in two separate
scales: expectations of mathematics achievement (including items
“This student’s mathematics grades will not improve in the future”
and “This student will not perform well in mathematics classes”;
Spearman–Brown coefficient $= 0.882$) and expectations of general
academic achievement (including items “This student will probably
perform poorly on standardized tests” and “The student’s chances
of dropping out from high school are high”; Spearman–Brown
coefficient $= 0.649$). These negatively phrased items were reverse
coded so that higher values represented higher expectations.

Perceptions of student’s need for academic support were also
divided in two separate constructs: need for academic support
(including items “This student could benefit from extra tutoring in
math” and “This student could probably benefit from a math
buddy”; Spearman–Brown coefficient $= 0.658$) and need for special
education (including items “The best placement for this student
is a special education class” and “The best placement for this student
is a special education school”; Spearman–Brown coefficient $= 0.786$).

All scales were calculated as the mean of their corresponding
items. Two questions were included to check whether manipula-
tions were perceived as intended: perceived SES of the described
student was rated with a single item scored on a 5-point semantic
differential, ranging from poor to wealthy, and credibility of the
case was evaluated with a single item (“These children in the text I
am reading seem pretty real”) scored on a 5-point Likert scale
(higher scores represent higher credibility).

Mathematics anxiety of the future primary teachers was
measured through means of the abbreviated mathematics anxiety
rating scale (A-MARS, Alexander & Martray, 1989). This instrument
was chosen among a range of mathematics anxiety instruments
because of its length, strong psychometric properties and fit with
the study’s population. The A-MARS is a 25 items, 5-point Likert-
type instrument. Two items were dropped in the translation and
adaptation of the scale for this Spanish-speaking sample. The final
23 items presented excellent internal consistency with a Cronbach
alpha $= 0.94$. A composite summative index was calculated and
later standardized to adjust to a 0–100 scale, in which 0 represents
the minimum theoretical score and 100 represents the highest
theoretical score. As no norm was available for Chilean samples,
final scores were dichotomized around the sample median value
(44.4) to distinguish low and high-mathematics anxiety levels.

3.4. Data analysis

We used three-way full factorial ANOVA models to test our
hypothesis. ANOVA allows us to explore the relationship between
several categorical independent variables (in this case, mathe-
ematics anxiety level, student’s gender and student’ socioeconomic
status) and a metric dependent variable, including the interaction
effect between the independent variables. The model uses a sta-
tistical test based on the ratio of between groups’ variance and the
error variance (within group variance); significant p values of the
test served to reject the null hypothesis that the means of the
dependent variable are equal across groups. We used multiple
ANOVA models, one for each dependent variable in our study: ex-
ceptions of mathematics achievement, expectations of general

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1 TEDS-M defined a concurrent teacher preparation program as a single program that included studies in subjects future teachers would be teaching (academic or subject matter preparation), studies of pedagogy and education (pedagogical and professional studies), and practical experience in the classroom.

2 We use the Spearman–Brown coefficient instead of Cronbach’s Alpha to measure the reliability of 2-item scales, following the recommendations from Eisinger, Te Grotenhuis, and Pelzer (2013).

3 Special education in Chile is conceived as an educational sub-system designed to ensure equal learning opportunities to children with disabilities (Blanco et al., 2004).
academic achievement, need for academic support, and need for special education.

4. Results

First, we performed robustness checks to assess if the experimental conditions were perceived as intended. Credibility of the students’ descriptions was analyzed and a minimum criterion of 4 points (“agree” with the credibility statement) was established to ensure internal validity. Most participants rated the scenarios as believable and only 14 participants (6.7%) presented ratings below the cutoff point. Those cases were filtered out for subsequent analysis, resulting in a final sample of 194 participants that presented a very high case-credibility average (Mean = 4.68, Standard Deviation (SD) = 0.47). The final distribution of participants across conditions is presented in Table 1. We also used an ANOVA analysis to establish that believability was stable across the manipulated variables. We found that no particular case description was deemed as more believable than the others, (F (3,190) = 1.975, p = 0.119). The manipulation of SES was also perceived as intended. We analyzed the scores of the poor-wealthy semantic differential, where 1 represents “poor” and 5 represents “rich”. The participants assigned to low-SES descriptions averaged 2.2 in the semantic differential, significantly lower than the mean of 4.14 points for the high-SES group (t (192) = 17.3, p < 0.001).

Another set of preliminary analysis addressed whether mathematics anxiety constitutes a separate phenomenon from other dimensions of mathematics competency and attitudes in our sample. We performed correlational analysis between mathematics anxiety, mathematics performance (measured by pre-service elementary school teachers’ performance on the mathematics section of the standardized national university admission test, equivalent to the SAT) and mathematics self-efficacy (self-rated in a scale from 1 to 5, where higher scores mean a higher sense of mathematics self-efficacy). Our results are in line with previous research and suggest that mathematics anxiety is correlated but distinct from other math-related measures (Table 2). Future primary teachers with higher mathematics anxiety levels showed significantly lower mathematics self-efficacy (r = –0.196, p < 0.01), but there was no significant correlation between mathematics anxiety and performance (r = –0.104, p = 0.272).

We also found no significant differences in mathematics anxiety scores across the years of study in the teacher education programs (F (5,192) = 1.335, p = 0.251). This was partially expected because mathematics anxiety does not seem to be in the Chilean teachers’ special education. We also used an ANOVA analysis to establish that believability was stable across the manipulated conditions is presented in Table 1. We also used an ANOVA analysis to establish that believability was stable across the manipulated variables. We found that no particular case description was deemed as more believable than the others, (F (3,190) = 1.975, p = 0.119). The manipulation of SES was also perceived as intended. We analyzed the scores of the poor-wealthy semantic differential, where 1 represents “poor” and 5 represents “rich”. The participants assigned to low-SES descriptions averaged 2.2 in the semantic differential, significantly lower than the mean of 4.14 points for the high-SES group (t (192) = 17.3, p < 0.001).

In the general academic achievement model we found that student gender had a statistically significant effect, following the previously observed pattern. Again, boys were assigned higher expectations (Mean = 4.24, SD = 0.78) than girls (Mean = 3.96, SD = 0.84), F(1,189) = 5.0, p < 0.05 (Table 2). This means that pre-service elementary school teachers extrapolate current underperforming in mathematics to general academic underachievement only for girls. There was also an effect for student’s socioeconomic status on general academic achievement: expectations for students of high-SES (Mean = 4.22, SD = 0.81) were higher than for the low-SES students (Mean = 3.98, SD = 0.82), F(1,189) = 5.2, p < 0.05 (Table 2).

We should highlight that our results confirmed that there is a significant bias against female students. Our methodology resulted in cases featuring both male and female students underperforming in mathematics, but pre-service elementary school teachers considered that only in the case of girls these difficulties with mathematics would have long-term consequences over their general academic achievement. In order to double-check this result, we repeated our experimental treatment with a new sample of future primary teachers, but this time we presented hypothetical cases that featured students experiencing difficulties with language classes. In this case we found no significant effects of student gender in the expectation of general academic achievement (Table A1 in the Appendix). In other words the extrapolation of current underachievement to more general future academic problems only occurred in the domain of mathematics.

In relation to our second research question, we found that different variables influenced the choice of a particular support strategy. Academic support, characterized as extra tutoring and peer-based strategies, had a small but statistically significant effect in relation to student SES. Pre-service elementary school teachers were more prone to recommend such support strategies to low-SES children (Mean = 3.93, SD = 0.66) than to their high-SES counterpart (Mean = 3.68, SD = 0.79), F(1,188) = 5.21, p < 0.05 (Table 2). Referral to special education programs in turn was only influenced significantly by mathematics anxiety. Future elementary school teachers who were above the median in mathematics anxiety were more inclined to resort to special education strategies (Mean = 1.68, SD = 0.83) than their below the median counterparts (Mean = 1.36, SD = 0.57), F(1,189) = 8.39, p < 0.001 (Table 2). The fact that mathematics anxiety increases the chance of choosing special-education alternatives for children adds a new dimension to the teaching effects of mathematics anxiety. While previous literature had shown that mathematics anxiety might influence specific instructional practices (Bush, 1989; Karp, 1991), our findings suggest that it may also impact attitudes towards classroom inclusion and inclusive practices.

<table>
<thead>
<tr>
<th>Student</th>
<th>Pre-service teacher</th>
<th>Math anxiety</th>
</tr>
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<tbody>
<tr>
<td>Gender</td>
<td>SES</td>
<td>Low</td>
</tr>
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<td>Male</td>
<td>Low-SES</td>
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</tr>
<tr>
<td>Male</td>
<td>High-SES</td>
<td>28</td>
</tr>
<tr>
<td>Female</td>
<td>Low-SES</td>
<td>20</td>
</tr>
<tr>
<td>Female</td>
<td>High-SES</td>
<td>22</td>
</tr>
</tbody>
</table>

We now turn our attention to our first research question: Which variables affect expectations regarding possible student future achievement? We find that expectations of future mathematics achievement differ significantly as a function of student gender in that the pre-service elementary school teachers studied considered that boys would have better mathematics performance (Mean = 4.4, SD = 0.71) than girls (Mean = 3.99, SD = 0.86), F(1, 189) = 10.4, p < 0.01 (Table 2). These teachers’ anxiety level also had a statistically significant effect on the expectations of mathematics performance of their possible future students: future teachers with math anxiety above the median had lower expectations (Mean = 4.01, SD = 0.85) than those below the median group (Mean = 4.38, SD = 0.73), F(1, 189) = 7.7, p < 0.01 (Table 2). However, the mathematics anxiety of the participants did not affect expectations about their possible future students’ general academic achievement, which we interpret as a confirmation that mathematics anxiety is a very specific phenomenon and that it should not be confused with general anxiety (Table 3).
4.2. Interaction effects between mathematics anxiety levels of pre-service elementary school teachers and student gender

Finally, we analyzed the interaction terms in our models in order to evaluate whether gender stereotypes increase with mathematics anxiety. If such effects were to be significant, we would expect that expectations’ bias against girls would more pronounced among pre-service elementary school teachers with mathematics anxiety above the median. However, the interaction term was non-statistically significant in each ANOVA model tested. There is no effect on: expectations of mathematics achievement \((F(1, 189) = 0.027, p = 0.87)\); expectations of general academic achievement \((F(1, 189) = 1.403, p = 0.238)\); need for academic support \((F(1, 188) = 0.315, p = 0.57)\); or need for special education \((F(1, 189) = 0.127, p = 0.72)\) (Table 4). These findings allow us to broaden our knowledge about the interplay of stereotypes and anxiety in mathematics education. Previous research has shown that elementary school teachers with low math-self-concept tend to endorse math-gender stereotypes (Relich, 1996); but our findings suggest that when pre-service elementary school teachers form expectations about students, gender stereotypes and mathematics anxiety operate as strictly independent factors.

5. Discussion and conclusions

The available evidence allows us to conclude that mathematics anxiety should be considered as a pressing issue in teacher education. It is a phenomenon that affects children from a very young age (Ramirez et al., 2013) and carries significant consequences for their learning of mathematics (Ma, 1999) and career choices (Scarpello, 2005); moreover, it is deeply embedded in the teaching community. Teacher education students are more likely to present mathematics anxiety than students from other fields (Baloglu & Kocak, 2006; Bessant, 1995; Hembree, 1990) and mathematics anxious future teachers show less teaching self-efficacy in mathematics (Bursal & Paznokas, 2006; Gresham, 2008; Swars et al. 2006). Nonetheless, this might be just the tip of the iceberg, as we have yet to uncover the multiples ways in which mathematics anxiety may affect teaching. The purpose of this study has been to contribute to the understanding of the issue by exploring how mathematics anxiety influences future teacher expectations and belief about their students, and how mathematics anxiety relates to gender stereotypes commonly held in the domain of mathematics.

Our results confirmed that indeed, pre-service elementary school teachers project their own mathematics anxiety to the expectations they form about their students. We presented future teachers with descriptions of students facing difficulties at school in mathematics lessons, and asked them to evaluate these cases. We found that pre-service elementary school teachers with mathematics anxiety above the median had statistically significantly lower mathematics achievement expectations of students than their counterparts with mathematics anxiety below the median. We also found that participants had lower achievement expectations of girls than boys, confirming the presence of a gender stereotype threat. The two effects, however, appeared to be strictly independent as we did not find statistically significant interaction effects between future teacher mathematics anxiety and the biases associated with student’s gender.

We must note that our sample did not include enough males to establish whether the gender stereotype threat is more salient in male or female pre-service teachers, an important matter that should be addressed in future research. Another relevant finding was that the pre-service elementary school teachers studied tended to extrapolate underachievement in mathematics to general academic achievement problems only in the case of female students. As we found no such effect when a similar experiment was carried out in relation to language teaching, we are able to conclude that gendered stereotyping only seems to operate in the teaching of mathematics.
Our results also suggest that mathematics anxiety could affect teachers’ capacity to develop inclusive learning environments in their classrooms. We found that the pre-service elementary school teachers above the median on mathematics anxiety were more likely to recommend special education for students facing difficulties in mathematics.

Thus, our results contribute to highlight that not only students’ characteristics can influence pre-service teacher expectations about students, but also future teachers’ personal traits like mathematics anxiety. Therefore, we found that pre-service teachers’ mathematics anxiety can affect several aspects of their teaching experience, not only their mathematical knowledge and teaching self-efficacy as argued in previous literature.

Our research design has some limitations as far drawing conclusions for school settings. Thus, we cannot suggest that these biased decisions will occur when pre-service elementary school teachers begin their professional career. Cady, Meier, and Lubinski (2006) used a longitudinal study to analyze the transition from pre-service to in-service teachers and found that beliefs about the teaching and learning of mathematics tend to change. Therefore, further research on mathematics anxiety and expectations should focus on in-service teachers. This is relevant because if the effects we found in our research take place in real classroom settings, children could be affected by such negative expectations and in turn develop negative self-concepts about mathematics (Kuklinski & Weinstein, 2001).

Further research on future primary teachers should contribute to our understanding of mathematics anxiety as a complex phenomenon, exploring new implications and developing effective strategies to diminish mathematics anxiety during teacher education. To our knowledge, this is an unsolved drawback in the current teacher education curriculum in Chile. A content analysis of the syllabus of elementary school teachers’ education courses—which included eleven Chilean universities—showed that mathematics anxiety was completely absent in pre-service elementary school teachers’ education programs (Varas et al., 2008). Finally, gendered stereotypes should be actively discussed in teacher education programs, in order to increase awareness among teachers and decrease the stereotype threat against women.

Acknowledgments

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Appendix

Sample description paragraph

("John"/"Johanna") is a student in a ("public"/"private") school located in ("Pudahuel"/"Las Condes"), ("He"/"She") lives with both parents and is the middle child in the family. ("His"/"her") mother is a ("physician"/"domestic worker") and his father is ("an attorney"/"currently unemployed"). ("He"/"She") has an average IQ but is earning poor grades in math. ("He"/"She") has not been turning in ("his"/"her") homework in several subjects and does not use his/her classmates by getting into both verbal and physical fights at least once a week. ("His"/"Her") parents have met with the teacher and school counselor on a few occasions, but the situation has not improved.

<table>
<thead>
<tr>
<th>Model (dependent variable)</th>
<th>Source of variation</th>
<th>Sum of squares</th>
<th>df</th>
<th>F-ratio</th>
<th>Partial eta squareda</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Expectation of future mathematics achievement</td>
<td>Constant</td>
<td>3302.766</td>
<td>1</td>
<td>5521.726**</td>
<td>0.967</td>
</tr>
<tr>
<td></td>
<td>Mathematics anxiety</td>
<td>4.607</td>
<td>1</td>
<td>7.703**</td>
<td>0.039</td>
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<tr>
<td></td>
<td>Student’s gender</td>
<td>6.23</td>
<td>1</td>
<td>10.415**</td>
<td>0.052</td>
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<tr>
<td></td>
<td>Student’s SES</td>
<td>0.195</td>
<td>1</td>
<td>0.326</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>Mathematics anxiety × student’s gender</td>
<td>0.016</td>
<td>1</td>
<td>0.027</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>113.048</td>
<td>189</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Expectation of general academic achievement</td>
<td>Constant</td>
<td>3140.368</td>
<td>1</td>
<td>4940.362**</td>
<td>0.963</td>
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<td></td>
<td>Mathematics anxiety</td>
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<tr>
<td></td>
<td>Student’s gender</td>
<td>3.182</td>
<td>1</td>
<td>5.005*</td>
<td>0.026</td>
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<tr>
<td></td>
<td>Student’s SES</td>
<td>3.322</td>
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<td>5.227**</td>
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<tr>
<td></td>
<td>Mathematics anxiety × student’s gender</td>
<td>0.892</td>
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<td>1.403</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>120.139</td>
<td>189</td>
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<td></td>
</tr>
<tr>
<td>3 Need for academic support</td>
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<td>2708.449</td>
<td>1</td>
<td>5087.735**</td>
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<td>0.584</td>
<td>0.003</td>
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<tr>
<td></td>
<td>Mathematics anxiety × student’s gender</td>
<td>0.168</td>
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<td>0.315</td>
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<tr>
<td></td>
<td>Error</td>
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<td>188</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Need for special education</td>
<td>Constant</td>
<td>437.241</td>
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<td>873.489**</td>
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<td>4.201</td>
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<td>8.393**</td>
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<td>1.032</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>Mathematics anxiety × student’s gender</td>
<td>0.064</td>
<td>1</td>
<td>0.127</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Error</td>
<td>94.608</td>
<td>189</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aStatistically significant at 5%.
bStatistically significant at 1%.
c Partial eta square is a measure of the size of the effect that ranges between 0 and 1.
Table A1
Pre-service elementary school teacher expectations, according to pre-service elementary school teacher’s math anxiety, student’s gender and socioeconomic status, about hypothetical students with difficulties in language.

<table>
<thead>
<tr>
<th>(Mean ± standard deviation)</th>
<th>Pre-service teacher</th>
<th>Student</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math anxiety</td>
<td>Gender</td>
<td>SES</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Expectations of language achievement* (F test)</td>
<td>3.91 ± 0.99 F(1, 192) = 0.505</td>
<td>4.01 ± 0.93 F(1, 192) = 0.792</td>
</tr>
<tr>
<td>Expectations of general achievement (F test)</td>
<td>4.01 ± 0.84 F(1, 192) = 0.168</td>
<td>4.16 ± 0.85 F(1, 192) = 0.032</td>
</tr>
</tbody>
</table>

* Statistically significant at 5%.
** Statistically significant at 1%.

References


335–360.


