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 affects teachers' capacity to develop inclusive learning classrooms.

ARTICLE INFO

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; Teddlie & 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 & Paznokas, 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 & Kocak, 2006; Wigfield & Meece, 1988; Woodard, 2004; Yüksel-Şahin, 2008), yet other research has found no significant gender differences (Chinn, 2009; Chiu & Henry, 1990; Devine, Fawcett, Szűcs, & 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, Baloğlu, 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, & Giesen, 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 Lubinski (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 & Paznokas, 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 mathematic 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 semesters (five years) and their curriculum content are relatively similar, providing opportunities to learn general education and pedagogy, subject-matter knowledge, and field experience.[1] 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 mathematics. 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.

3.2.1. 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, representative 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 universities with moderate degrees of selectivity were over represented 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 experience 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 literature (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[2] = 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*[3] (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 manipulations 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 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, mathematics 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 statistical 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: expectations 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 Eisinga, 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' education curricula (Varas et al., 2008). Consequently, our main analyses did not consider as a relevant variable the year of study of each participant.

4.1. Main effects analysis

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).

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 underperformance in mathematics to general academic underachievement only for girls. There was also an effect for student's socio-economic 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 1
Number of participants per experimental condition.

Student		Pre-service teacher	
		Math anxiety	
Gender	SES	Low	High
Male	Low-SES	31	19
Male	High-SES	28	20
Female	Low-SES	20	25
Female	High-SES	22	29

Table 2
Correlations of mathematics anxiety, performance and self-efficacy.

Variable	Mathematics performance	Mathematics self-efficacy
Mathematics anxiety	−0.104	−0.196**
Mathematics performance		0.345**

**Statistically significant at 1%.

Table 3
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 mathematics.

	(Mean ± standard deviation)					
	Pre-service teacher		Student			
	Math anxiety		Gender		SES	
	Low	High	Male	Female	Low	High
Expectations of math achievement[a]	4.38 ± 0.73	4.01 ± 0.85	4.4 ± 0.71	3.99 ± 0.86	4.18 ± 0.83	4.22 ± 0.79
(F test)	$F(1,189) = 7.7^{**}$		$F(1, 189) = 10.4^{**}$		$F(1, 189) = 0.33$	
Expectations of general achievement[b]	4.21 ± 0.82	3.98 ± 0.81	4.24 ± 0.78	3.96 ± 0.84	3.98 ± 0.82	4.22 ± 0.81
(F test)	$F(1, 189) = 2.8$		$F(1, 189) = 5.0^{*}$		$F(1, 189) = 5.2^{*}$	
Need for academic support[c]	3.86 ± 0.72	3.74 ± 0.76	3.88 ± 0.62	3.72 ± 0.84	3.93 ± 0.66	3.68 ± 0.79
(F test)	$F(1, 188) = 0.58$		$F(1, 188) = 1.62$		$F(1, 188) = 5.21^{*}$	
Need for special education[d]	1.36 ± 0.57	1.68 ± 0.83	1.43 ± 0.62	1.6 ± 0.81	1.56 ± 0.72	1.47 ± 0.73
(F test)	$F(1, 189) = 8.39^{**}$		$F(1, 189) = 1.44$		$F(1, 189) = 1.03$	

* Statistically significant at 5%.
** Statistically significant at 1%.
[a] Expectations of math achievement: The scale ranges from 1 to 5, where higher scores represent an attribution of higher expectations.
[b] Expectations of general achievement: The scale ranges from 1 to 5, where higher scores represent an attribution of higher expectations.
[c] Need for academic support: The scale ranges from 1 to 5, where higher scores represent an attribution of higher need for this support strategy.
[d] Need for special education: The scale ranges from 1 to 5, where higher scores represent an attribution of higher need for this support strategy.

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.

Table 4
ANOVA model. Expectations about hypothetical students with difficulties in mathematics.

Model (dependent variable)	Source of variation	Sum of squares	df	F-ratio	Partial eta squared[a]
1 Expectation of future mathematics achievement	Constant	3302.766	1	5521.726**	0.967
	Mathematics anxiety	4.607	1	7.703**	0.039
	Student's gender	6.23	1	10.415**	0.052
	Student's SES	0.195	1	0.326	0.002
	Mathematics anxiety × student's gender	0.016	1	0.027	0
	Error	113.048	189		
2 Expectation of general academic achievement	Constant	3140.368	1	4940.362**	0.963
	Mathematics anxiety	1.772	1	2.787	0.015
	Student's gender	3.182	1	5.005*	0.026
	Student's SES	3.322	1	5.227*	0.027
	Mathematics anxiety × student's gender	0.892	1	1.403	0.007
	Error	120.139	189		
3 Need for academic support	Constant	2708.449	1	5087.735**	0.964
	Mathematics anxiety	0.311	1	0.584	0.003
	Student's gender	0.862	1	1.62	0.009
	Student's SES	2.778	1	5.218*	0.027
	Mathematics anxiety × student's gender	0.168	1	0.315	0.002
	Error	100.082	188		
4 Need for special education	Constant	437.241	1	873.489**	0.822
	Mathematics anxiety	4.201	1	8.393**	0.043
	Student's gender	0.724	1	1.446	0.008
	Student's SES	0.516	1	1.032	0.005
	Mathematics anxiety × student's gender	0.064	1	0.127	0.001
	Error	94.608	189		

*Statistically significant at 5%.
**Statistically significant at 1%.
[a] Partial eta square is a measure of the size of the effect that ranges between 0 and 1.

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.

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 time efficiently in class. ("John"/"Johanna") used to have a positive attitude about school, earned good grades, and was well liked by ("his"/"her") teachers. Recently, ("he"/"she") has become withdrawn and has begun to receive a number of behavioral referrals. For example ("he"/"she") has become aggressive with ("his"/"her") peers 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 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.

	(Mean ± standard deviation)					
	Pre-service teacher		Student			
	Math anxiety		Gender		SES	
	Low	High	Male	Female	Low	High
Expectations of language achievement[a] (F test)	3.91 ± 0.99 F(1, 192) = 0.505	4.01 ± 0.93	4.0 ± 1.0 F(1, 192) = 0.390	3.92 ± 0.91	3.92 ± 0.95 F(1, 192) = 0.242	4.0 ± 0.97
Expectations of general achievement[b] (F test)	4.01 ± 0.84 F(1, 192) = 0.792	4.16 ± 0.85	4.09 ± 0.88 F(1, 192) = 0.032	4.07 ± 0.82	3.89 ± 0.88 F(1, 192) = 9.767**	4.27 ± 0.77

* Statistically significant at 5%.
** Statistically significant at 1%.
  [a] Expectations of language achievement: The scale ranges from 1 to 5, where higher scores represent an attribution of higher expectations.
  [b] Expectations of general achievement: The scale ranges from 1 to 5, where higher scores represent an attribution of higher expectations.

References

Alexander, L., & Martray, C. R. (1989). The development of an abbreviated version of the mathematics anxiety rating scale. *Measurement and Evaluation in Counseling and Development, 22*(3), 143–150.

Archambault, I., Janosz, M., & Chouinard, R. (2012). Teacher beliefs as predictors of adolescents' cognitive engagement and achievement in mathematics. *The Journal of Educational Research, 105*(5), 319–328.

Ashcraft, M. H., & Kirk, E. P. (2001). The relationships among working memory, math anxiety, and performance. *Journal of Experimental Psychology: General, 130*(2), 224–237.

Ashcraft, M. H., & Moore, A. M. (2009). Mathematics anxiety and the affective drop in performance. *Journal of Psychoeducational Assessment, 27*(3), 197–205.

Auwarter, A. E., & Aruguete, M. S. (2008a). Effects of student gender and socioeconomic status on teacher perceptions. *The Journal of Educational Research, 101*(4), 242–246.

Auwarter, A. E., & Aruguete, M. S. (2008b). Counselors perceptions of students who vary in gender and socioeconomic status. *Social Psychology and Education, 11*(4), 389–395.

Babad, E. (2009). *The social psychology of the classroom.* Routledge.

Baloglu, M., & Kocak, R. (2006). A multivariate investigation of the differences in mathematics anxiety. *Personality and Individual Differences, 40*(7), 1325–1335.

Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2010). Female teachers' math anxiety affects girls' math achievement. In *Proceedings of the National Academy of Sciences* (Vol. 107(5), pp. 1860–1863).

Bessant, K. C. (1995). Factors associated with types of mathematics anxiety in college students. *Journal for Research in Mathematics Education, 26*(4), 327–345.

Betz, N. E. (1978). Prevalence, distribution, and correlates of math anxiety in college students. *Journal of Counseling Psychology, 25*(5), 441–448.

Birgin, O., Baloğlu, M., Çatlıoğlu, H., & Gürbüz, R. (2010). An investigation of mathematics anxiety among sixth through eighth grade students in Turkey. *Learning and Individual Differences, 20*(6), 654–658.

Blanco, R., Estévez, F., Meza, M., Godoy, M., Álvarez, M., Blázquez, M., et al. (2004). Nueva Perspectiva y Visión de la Educación Especial. In *Informe de la Comisión de Expertos.* Chile: Ministry of Education.

Brault, M. C., Janosz, M., & Archambault, I. (2014). Effects of school composition and school climate on teacher expectations of students: a multilevel analysis. *Teaching and Teacher Education, 44*, 148–159.

Brophy, J. E., & Good, T. L. (1970). Teachers' communication of differential expectations for children's classroom performance: some behavioral data. *Journal of Educational Psychology, 61*(5), 365–374.

Bursal, M., & Paznokas, L. (2006). Mathematics anxiety and pre-service elementary teachers' confidence to teach mathematics and science. *School Science and Mathematics, 106*(4), 173–180.

Bush, W. S. (1989). Mathematics anxiety in upper elementary school teachers. *School Science and Mathematics, 89*(6), 499–509.

Cady, J., Meier, S. L., & Lubinski, C. A. (2006). Developing mathematics teachers: the transition from pre-service to experienced teacher. *The Journal of Educational Research, 99*(5), 295–306.

Chinn, S. (2009). Mathematics anxiety in secondary students in England. *Dyslexia, 15*(1), 61–68.

Chiu, L. H., & Henry, L. L. (1990). Development and validation of the mathematics anxiety scale for children. *Measurement and Evaluation in Counseling and Development, 23*, 121–127.

Conrad, K. S., & Tracy, D. M. (1992). *Lowering pre-service elementary school teachers' mathematics anxiety through an experience-based mathematics methods course* (ERIC Document Reproductions Service No. ED355099).

Del Río, M. F., & Balladares, J. (2010). Gender and socioeconomic status of children: pre-service elementary school teachers' expectations. *Psykhe, 19*(2), 81–90.

Devine, A., Fawcett, K., Szűcs, D., & Dowker, A. (2012). Gender differences in mathematics anxiety and the relation to mathematics performance while controlling for test anxiety. *Behavioral and Brain Functions, 8*(33), 2–9.

Dusek, J. B., & Joseph, G. (1983). The bases of teacher expectancies: a meta-analysis. *Journal of Educational Psychology, 75*(3), 327–346.

Eisinga, R., Te Grotenhuis, M., & Pelzer, B. (2013). The reliability of a two-item scale: Pearson, Cronbach, or Spearman–Brown? *International Journal of Public Health, 58*(4), 637–642.

Espinoza, P., da Luz Fontes, A. B. A., & Arms-Chavez, C. J. (2014). Attributional gender bias: teachers' ability and effort explanations for students' math performance. *Social Psychology of Education, 17*(1), 105–126.

Fennema, E., Peterson, P. L., Carpenter, T. P., & Lubinski, C. A. (1990). Teachers' attributions and beliefs about girls, boys, and mathematics. *Educational Studies in Mathematics, 21*(1), 55–69.

Ferguson, R. F. (2003). Teachers' perceptions and expectations and the black-white test score gap. *Urban Education, 38*(4), 460–507.

Figlio, D. N. (2005). *Names, expectations and the black-white test score gap (No. w11195).* National Bureau of Economic Research.

Good, T. L. (1987). Two decades of research on teacher expectations: findings and future directions. *Journal of Teacher Education, 38*(4), 32–47.

Gregory, A., & Huang, F. (2013). It takes a village: the effects of 10th grade college-going expectations of students, parents, and teachers four years later. *American Journal of Community Psychology, 52*(1–2), 41–55.

Gresham, G. (2008). Mathematics anxiety and mathematics teacher efficacy in elementary pre-service teachers. *Teaching Education, 19*(3), 171–184.

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education, 21*(1), 33–46.

Hinnant, J. B., O'Brien, M., & Ghazarian, S. R. (2009). The longitudinal relations of teacher expectations to achievement in the early school years. *Journal of Educational Psychology, 101*(3), 662–670.

Jussim, L., Eccles, J., & Madon, S. (1996). Social perception, social stereotypes, and teacher expectations: accuracy and the quest for the powerful self-fulfilling prophecy. *Advances in Experimental Social Psychology, 28*, 281–388.

Jussim, L., & Harber, K. D. (2005). Teacher expectations and self-fulfilling prophecies: knowns and unknowns, resolved and unresolved controversies. *Personality and Social Psychology Review, 9*(2), 131–155.

Karp, K. S. (1991). Elementary school teachers' attitudes toward mathematics: the impact on students' autonomous learning skills. *School Science and Mathematics, 91*(6), 265–270.

Keller, C. (2001). Effect of teachers' stereotyping on students' stereotyping of mathematics as a male domain. *The Journal of Social Psychology, 141*(2), 165–173.

Kuklinski, M. R., & Weinstein, R. S. (2001). Classroom and developmental differences in a path model of teacher expectancy effects. *Child Development, 72*(5), 1554–1578.

Lemov, D. (2010). *Teach like a champion: 49 techniques that put students on the path to college (K-12).* John Wiley & Sons.

Li, Z. (2014). *Teachers matter: Expectation effects in foreign language classrooms at university.* Unpublished doctoral dissertation. New Zealand: University of Auckland.

Ma, X. (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. *Journal for Research in Mathematics Education, 30*, 520–540.

Miller, H., & Bichsel, J. (2004). Anxiety, working memory, gender, and math performance. *Personality and Individual Differences, 37*(3), 591–606.

Newstead, K. (1998). Aspects of children's mathematics anxiety. *Educational Studies in Mathematics, 36*(1), 53–71.

Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2013). Math anxiety, working memory, and math achievement in early elementary school. *Journal of Cognition and Development, 14*(2), 187–202.

Raudenbush, S. W. (1984). Magnitude of teacher expectancy effects on pupil IQ as a function of the credibility of expectancy induction: a synthesis of findings from 18 experiments. *Journal of Educational Psychology, 76*(1), 85–97.

Ready, D. D., & Wright, D. L. (2011). Accuracy and inaccuracy in teachers' perceptions of young children's cognitive abilities the role of child background and classroom context. *American Educational Research Journal, 48*(2),

335—360.

Relich, J. (1996). Gender, self-concept and teachers of mathematics: effects on attitudes to teaching and learning. *Educational Studies in Mathematics, 30*(2), 179—195.

Richardson, F. C., & Suinn, R. M. (1972). The mathematics anxiety rating scale: psychometric data. *Journal of Counseling Psychology, 19*(6), 551—554.

Rist, R. C. (2000). HER classic reprint-student social class and teacher expectations: the self-fulfilling prophecy in ghetto education. *Harvard Educational Review, 70*(3), 257—302.

Rosenthal, R., & Jacobson, L. (1968). Pygmalion in the classroom. *The Urban Review, 3*(1), 16—20.

Rosenthal, R., & Rubin, D. R. (1978). Interpersonal expectancy effects: the first 345 studies. *Behavioral and Brain Sciences, 1*(3), 377—386.

Rubie-Davies, C. (2014). *Becoming a high expectation teacher: Raising the bar.* Routledge.

Rubie-Davies, C. M., Flint, A., & McDonald, L. G. (2012). Teacher beliefs, teacher characteristics, and school contextual factors: what are the relationships? *British Journal of Educational Psychology, 82*(2), 270—288.

Scarpello, G. V. (2005). *The effect of mathematics anxiety on the course and career choice of high school vocational-technical education students. Unpublished doctoral dissertation.* Drexel University.

Sloan, T., Daane, C. J., & Giesen, J. (2002). Mathematics anxiety and learning styles: what is the relationship in elementary pre-service elementary school teachers? *School Science and Mathematics, 102*(2), 84—87.

Spelke, E. S. (2005). Sex differences in intrinsic aptitude for mathematics and science?: a critical review. *American Psychologist, 60*(9), 950—958.

Speybroeck, S., Kuppens, S., Van Damme, J., Van Petegem, P., Lamote, C., Boonen, T., et al. (2012). The role of teachers' expectations in the association between children's SES and performance in kindergarten: a moderated mediation analysis. *PloS One, 7*(4), e34502.

Strand, S. (2012). The white British—black Caribbean achievement gap: tests, tiers and teacher expectations. *British Educational Research Journal, 38*(1), 75—101.

Südkamp, A., Kaiser, J., & Möller, J. (2012). Accuracy of teachers' judgments of students' academic achievement: a meta-analysis. *Journal of Educational Psychology, 104*(3), 743—762.

Swars, S. L., Daane, C. J., & Giesen, J. (2006). Mathematics anxiety and mathematics teacher efficacy: what is the relationship in elementary pre-service elementary school teachers? *School Science and Mathematics, 106*(7), 306—315.

Tatto, M. T., Peck, R., Schwille, J., Bankov, K., Senk, S. L., Rodriguez, M., et al. (2012). *Policy, practice, and readiness to teach primary and secondary mathematics in 17 countries: Findings from the IEA Teacher Education and Development Study in Mathematics (TEDS-MM).* Herengracht 487, Amsterdam, 1017 BT, The Netherlands: International Association for the Evaluation of Educational Achievement.

Teddlie, C., & Reynolds, D. (Eds.). (2000). *The international handbook of school effectiveness research.* Psychology Press.

Tenenbaum, H. R., & Ruck, M. D. (2007). Are teachers' expectations different for racial minority than for European American students? A meta-analysis. *Journal of Educational Psychology, 99*(2), 253—273.

Tournaki, N. (2003). Effect of student characteristics on teachers' predictions of student success. *The Journal of Educational Research, 96*(5), 310—319.

Tournaki, N., & Podell, D. M. (2005). The impact of student characteristics and teacher efficacy on teachers' predictions of student success. *Teaching and Teacher Education, 21*(3), 299—314.

Urhahne, D. (2015). Teacher behavior as a mediator of the relationship between teacher judgment and students' motivation and emotion. *Teaching and Teacher Education, 45*, 73—82.

Varas, L., Felmer, P., Gálvez, G., Lewin, Martínez, C., Navarro, et al. (2008). Oportunidades de preparación para enseñar matemáticas de futuros profesores de educación general básica en Chile. *Calidad en la Educación, 29*, 63—88.

Vinson, B. M. (2001). A comparison of pre-service elementary school teachers' mathematics anxiety before and after a methods class emphasizing manipulatives. *Early Childhood Education Journal, 29*(2), 89—94.

Weinstein, R. S. (2002). *Reaching higher.* Harvard University Press.

Wigfield, A., & Meece, J. L. (1988). Math anxiety in elementary and secondary school students. *Journal of Educational Psychology, 80*(2), 210—216.

Wood, E. F. (1988). Math anxiety and elementary teachers: what does research tell us? *For the Learning of Mathematics, 8*, 8—13.

Woodard, T. (2004). The effects of math anxiety on post-secondary developmental students as related to achievement, gender, and age. *Inquiry, 9*(1).

Yüksel-Şahin, F. (2008). Mathematics anxiety among 4th and 5th grade Turkish elementary school students. *International Electronic Journal of Mathematics Education, 3*, 179—192.