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# Prospective Elementary Teachers' Perceptions of Gender Differences in Children's Attitudes Toward Mathematics

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*Prospective elementary teachers hold preconceived ideas about elementary school students' attitudes toward mathematics. We found that there exists a gender bias with prospective teachers expecting girls to have negative attitudes toward mathematics and boys more likely to have positive attitudes toward mathematics. We found that these expectations exist for both prospective teachers in a traditional undergraduate degree program and prospective teachers in an alternative licensure graduate degree program. We also found that these expectations do change with the completion of a mathematics methods course and classroom experiences.*

Gender stereotypes about ability and attitudes toward mathematics have long been studied with an aim toward combating the traditionally held notion that boys are “better at math” than girls. Although this research attention has likely provided both impetus and support in diminishing the existence of these gender stereotypes, there continues to be a small gender gap in the United States in attitudes toward mathematics (McGraw, Lubienski, & Strutchens, 2006). Because differences in attitudes toward mathematics develop during schooling, the elementary teacher's role in this development is important to examine. Hence, much attention has been paid to the level of teachers' mathematics anxiety and its role in influencing the gender stereotypes in students as young as first and second grade (Beilock, Gunderson, Ramirez, & Levine, 2010). The power of this effect is disturbing when we consider that historically, elementary education majors have had the highest levels of math anxiety of any majors on college campuses (Hembree, 1990). Yet teacher attitudes and anxiety toward mathematics alone may not present the whole picture. We also need to examine teachers' expectations about how their students view mathematics.

Research is mixed on whether or not the gender gap in mathematics has been closed. Some research studies assert no significant difference in test scores of males and females (Hyde, Lindberg, Linn, Ellis, & Williams, 2008). Other studies found that there continues to be a small gender gap in mathematics for U.S. students, and that female students' attitudes and self-concepts about mathematics are more negative than that of male students (McGraw et al., 2006). It has been posited that this difference in research findings occurs because of differences in measures chosen by researchers (Chipman, 2005).

Regardless of whether or not the gap has closed, culturally a perceived difference is very much present, and these

perceptions, when held by teachers, can affect the attitudes and efficacy of students. Teachers with positive attitudes toward mathematics are more effective, and their students have more positive attitudes about mathematics (Karp, 1991). Although gender stereotypes can be masked, they do affect the classroom environment in subtle ways. For example, Fennema, Peterson, Carpenter, and Lubinski (1990) found that teachers attributed mathematics competence in their male students to ability, but in their female students to effort. Similarly, Tiedemann (2002) found that elementary teachers believed their average achieving girls were less talented and had to exert more effort than their average achieving boys. From these teachers, the subtle message to girls is that they are good students, but not necessarily good mathematicians.

Beyond teachers' gender-based beliefs about the mathematics competence and effort of their students, much research has focused on the role teachers' mathematics anxiety plays in the transfer of traditional gender stereotypes to students (Battista, 1986). In a study of first- and second-grade female teachers and their students, Beilock et al. (2010) told students two gender-neutral stories, one about a student who was good at math and one about a student who was good at reading. The students were then asked to draw the students from the stories. Researchers then examined whether the genders in the drawings supported a common gender stereotype that boys are good at mathematics and girls are good at reading. At the beginning of the year, no relationship existed between the first- and second-grade students' gender ability beliefs and their teacher's level of math anxiety. However, when the assessment was completed at the end of the school year, the more anxious the teachers were about mathematics, the more likely girls (but not boys) were to endorse the gender stereotype. In a study of mathematics student achievement, Hadley and Dorward (2011) found that teachers'

anxiety about teaching mathematics, not about mathematics itself, had the greatest effect.

And yet these studies look at teachers' attitudes about their own efficacy, whether in mathematics or in teaching mathematics, not at how they perceive students' attitudes toward mathematics. Do teachers anticipate students' attitudes based on gender in the same way they anticipate competence? We think this is an important question to investigate because preconceived expectations about students' attitudes toward mathematics may play a role in the opportunities teachers offer students and the subtle or overt messages that are sent to students about how they should view mathematics. Competence in mathematics is important and we believe achievable by all, but beyond competence there is also a need for a disposition to do mathematics, that is, to have an enjoyment of mathematics and to see it as useful and worthwhile (Council of Chief State School Officers & National Governors Association, 2010; National Research Council [NRC], 2001).

Encouraged by the research that elementary mathematics methods courses can decrease math anxiety (Battista, 1986; Vinson, 2001), we found ourselves wondering if the study of mathematics learning and experience in the elementary school classroom could change gender-based differences in perceptions of boys' and girls' attitudes toward mathematics as well. Furthermore, we have informally noticed that graduate students seeking initial licensure were often more open about their discomfort with mathematics and more positive about mathematics and mathematics teaching as they studied mathematical learning and engaged with children in the classroom than their undergraduate counterparts. If these differences do in fact exist, does it follow then that the perceptions of students' attitudes would also differ? To examine these issues, this study addresses the following questions:

- What are prospective elementary school teachers' perceptions of boys' and girls' attitudes toward mathematics?
- Is there a difference in these perceptions between prospective elementary school teachers in a traditional, undergraduate program and in an alternative licensure, graduate program? If so, how are their perceptions different?
- Do these perceptions about boys' and girls' attitudes toward mathematics change over time?

## Methods

### Participants and Context

The 129 prospective teachers who completed the assessment were enrolled in a required mathematics education

course for students seeking degrees and initial licensure in elementary education. We taught the mathematics education courses of the participating students. Eighty of the students were graduate students, and 49 were undergraduates. The undergraduate students were traditional college students in their junior or senior year of an elementary education program. The graduate students held undergraduate degrees in disciplines outside of education and were changing careers to elementary school teaching. Only two of the graduate students and three of the undergraduates were males.

The methods courses focused on teaching mathematics for conceptual understanding and on student thinking about elementary mathematics topics. We emphasized using open-ended mathematical tasks that are accessible to all students because of their multiple entry points and solutions, and spent time discussing how teachers facilitate the use of such tasks in the classroom. While particular attention was given to creating the kind of classroom community that supports all students' participation in such tasks, discussions of gender were not explicitly planned.

### Procedures

We took our inspiration from an article by Zambo and Zambo (2006), in which they directed teachers to use gender-specific cartoons with their students, giving boys a copy of the boy cartoon and girls a copy of the girl cartoon (see Figure 1). Students were to express themselves in the cartoon by drawing the face and writing in the thought bubble as the cartoon figure sat in a mathematics classroom. We used the same cartoons in our study to determine how prospective teachers perceived elementary school students' attitudes toward mathematics. On the page given to prospective teachers, both the boy and girl cartoons were followed with the reference (Zambo & Zambo), including the title "Using Thought Bubble Pictures to Assess Students' Feelings About Mathematics." Under the cartoon strips and reference was the statement "Please add your comments about this activity." No additional directions were provided. While additional directions might have been useful in focusing prospective teachers' attention explicitly on gender, we did not want the measures to be biased by any directions or subsequent discussion. Our students completed the activity during the first week of classes. They then repeated the activity at the end of the semester.

For each prospective teacher, the faces and thought bubbles for the cartoon boy and girl were examined in terms of whether they expressed positive, neutral, or negative attitudes about mathematics. We chose the categories

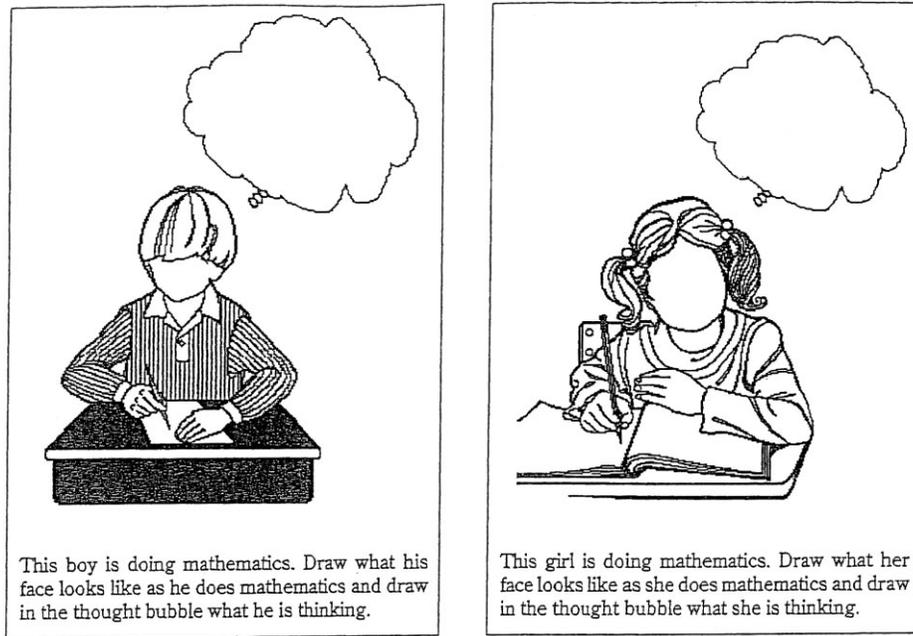


Figure 1. Drawing given to prospective teachers. Activity from Zambo and Zambo (2006). Copyright 2006 by the National Council of Teachers of Mathematics. Reprinted with permission.

“positive” and “negative” based on our use of McLeod’s (1992, p. 581) definition of attitude as an “affective responses that involve positive or negative feelings of moderate intensity,” and on Philipp’s (2007) assertion that attitudes may include positive or negative feelings, but are more cognitive than emotions but less cognitive than beliefs. Pictures in question were most often coded as neutral unless there was a strong consensus among researchers that it was either positive or negative. Positive attitudes about mathematics may have been based on different ideas about the nature of mathematics learning. For example, the statements “Math is easy” and “Math makes sense and can be used in real life” were both coded as positive. While these notions demonstrate different views of mathematics, we did not distinguish between responses in terms of why mathematics was portrayed positively. An interesting area of future research would be to explore possible relationships among gender differences and how “being good at mathematics” is defined.

We next recorded the frequency with which each possible coding combination occurred. For example, in one of the graduate classes, three students expressed a positive attitude in both the boy and girl pictures, two students expressed a positive attitude in the girl picture, but a neutral attitude for the boy picture, etc.

We used chi-square tests to examine differences between our undergraduate and graduate students’ per-

ceived attitudes about mathematics of elementary school boys and perceived attitudes about mathematics of elementary school girls. We also used the chi-square test to determine if the prospective teachers presented different attitudes for the boys and girls. To determine if the prospective teachers changed their presentation of attitudes for the boy and girl students after completing the course, we used the Bowker exact test statistic.

To analyze the prospective teachers’ comments, we used open coding (Strauss & Corbin, 1998) to create descriptive categories. The following five categories emerged. We provide an example comment for each category.

1. Responses that reflected prospective teachers’ own attitudes about mathematics—“I enjoyed being able to draw faces on the kids and express how I felt in math.” (Amy, student-written comment, August 27, 2007)

2. Responses that cited additional interpretations to the model based on the drawing—“The boy seems more focused because of his head position. The girl looks like she is looking up at me.” (Beth, student-written comment, August 27, 2007)

3. Responses that cited gender stereotypes—“Boys are better at spatial and logical reasoning.” (Catherine, student-written comment, December 7, 2009)

4. Responses that reflected on the meaning of the activity for teaching—“I think this activity was good. This way you can tell by students’ answers what their feelings are

Table 1  
Overall Perceptions of Girls' and Boys' Attitudes Toward Mathematics

Girl	Boy		
	Negative	Neutral	Positive
Negative	7	4	34
Neutral	4	7	15
Positive	23	9	26

Note.  $\chi^2(4, N = 129) = 14.64, p = .0055$ .

Table 2  
Graduate and Undergraduates' Perceptions of Boys' Attitudes Toward Mathematics

Students	Negative	Neutral	Positive
Graduate	20	13	47
Undergraduate	14	7	28

Note.  $\chi^2(2, N = 129) = .24, p = .89$ .

towards math." (Donna, student-written comment, December 7, 2009)

5. Responses that were unrelated—"Thanks. I enjoyed this class." (Emily, student-written comment, December 7, 2009)

It is interesting to note in general that graduate students commented more often and in more detail than the undergraduates. Because a noticeable difference did not exist in the content of the comments for the two groups, the comments were analyzed as a whole.

### Results

Seeking to establish the prevalence of gender stereotypes about mathematics in our own students, we first set out to examine our prospective elementary teachers' perceptions of boys' and girls' attitudes toward mathematics. We tested the null hypothesis that there is no difference between the presented attitudes for the boy and for the girl for all participants combined, and found that there was a difference in how the prospective teachers presented the attitudes of a boy and a girl,  $\chi^2(4, N = 129) = 14.64, p = .0055$  (see Table 1). Seventy-six percent of those who presented the girl negatively presented the boy positively. In contrast, only 40% of those who presented the girl positively presented the boy negatively.

Next, we separated the data by graduate and undergraduate responses to the boy doing mathematics and the girl doing mathematics. There was not a significant difference between the graduate and undergraduate students' presentations of the boy's attitude toward mathematics,  $\chi^2(2, N = 129) = .24, p = .89$  (see Table 2). The majority of

Table 3  
Graduate and Undergraduates' Perceptions of Girls' Attitudes Toward Mathematics

Students	Negative	Neutral	Positive
Graduate	23	12	45
Undergraduate	22	14	13

Note.  $\chi^2(2, N = 129) = 11.02, p = .0041$ .

Table 4  
Change in Perceptions of Boys' Attitudes Toward Mathematics

Pre	Post		
	Negative	Neutral	Positive
Negative	1	0	5
Neutral	0	0	3
Positive	0	10	7

Note. Bowker statistic = 8.77,  $p = .01$ .

both the graduate (59%) and undergraduate (57%) prospective teachers presented the boy as having a positive attitude toward mathematics. Slightly more undergraduate students (29%) than graduate students (25%) presented the boy as having a negative attitude. Sixteen percent of the graduate students and 14% of the undergraduates presented the boy as neutral.

Conversely, undergraduate students and graduate students did respond to the girl's attitude in significantly different ways,  $\chi^2(2, N = 129) = 11.02, p = .0041$  (see Table 3). The majority of the graduate students, 56%, compared with 27% of the undergraduates presented a positive attitude for the girl doing mathematics. Approximately 29% of the graduate students compared with 45% of the undergraduate students reported a negative attitude for the girl doing mathematics. Fifteen percent of graduate students and 29% of undergraduate students presented the girl's attitude as neutral.

Finally, we wanted to know if the perceptions about boys' and girls' attitudes toward mathematics changed as a result of participation in a university elementary mathematics methods course. We were able to compare pre- and posttest measures for one course section of graduate students in which the pre- and posttest measures for each student were compared. The selected section was the most recent section taught. Identifiers, which had not been used in previous sections, enabled us to compare the data.

The students' perceptions of boys' attitudes did change significantly over the course of the semester, Bowker statistic = 8.77,  $p = .01$ . The students presented more positive attitudes for the boy (see Table 4). With one exception, all

Table 5  
Change in Perceptions of Girls' Attitudes Toward Mathematics

Pre	Post		
	Negative	Neutral	Positive
Negative	2	2	4
Neutral	1	4	2
Positive	1	2	8

Note. Bowker statistic = 2.13,  $p = .59$ .

students who initially presented negative ( $n = 6$ ) or neutral ( $n = 3$ ) attitudes for the boy presented positive attitudes at the end of the semester. Ten students changed from an initially positive portrayal of boys' attitudes to a neutral portrayal. No student changed from a positive to a negative attitude.

Although there was some change in individual students' presentations of attitudes of a girl doing mathematics, the results in Table 5 indicate that the change was variable and did not trend in a particular direction, Bowker statistic = 2.13,  $p = .59$ .

A total of 102 comments were made. Fifteen comments reflected prospective teachers' own attitudes about mathematics. Twelve comments were specific to the drawing. Twenty comments cited gender stereotypes. Thirty-four comments focused on the meaning of the activity for teaching. Twenty-one comments were labeled as "other."

### Discussion

Knowing that teacher perceptions of gender and mathematics make a difference in subtle and overt ways in the classroom, we set out to determine the extent of the difference in our prospective teachers' perceptions of student attitudes toward mathematics based on gender. We found that, in fact, a slight difference did exist between overall perceptions of boys' attitudes (58.14% positive) and girls' attitudes (44.96% positive). Comments of some students who portrayed the boy positively and the girl negatively indicated that some prospective teachers continue to hold on to traditional gender stereotypes.

More surprising was the extent of the difference when we compared our undergraduate students with the graduate students. The graduate students were almost twice as likely to convey positive responses for the girl's attitude toward mathematics than the undergraduates. More research is needed to understand what factors might affect this outcome. One potential factor is that graduate students hold undergraduate degrees in disciplines other than education and may have more confidence in their own mathematical understanding upon entering the mathematics

methods course. In addition, most of the graduate students in our program are returning to school after working for several years. Perhaps it is this "real-world" experience that made the difference. Because the graduate students are in a compressed teacher preparation program, their development as prospective teachers is also compressed, and positive changes in attitudes toward mathematics may be more pronounced.

The low response of undergraduates who perceived girls as having a positive attitude toward mathematics (26.53%) is disconcerting, given Beilock et al.'s (2010) findings that first- and second-grade teachers' mathematics anxiety affected their students' adoption of gender stereotypes in mathematics. For some prospective teachers, the negative perceptions of the girl's attitude toward mathematics were self-reflective of their own mathematics anxiety, as evidenced by one graduate student's comment: "This activity kind of represents how I feel about math. I either get it right off or I get so confused I give up and think that I hate math" (Felicia, student-written comment, August 26, 2009). Other prospective teachers cited typical gender stereotypes in addition to their own feelings as explanations for their drawings.

Boys are typically better at math than girls are. (Gina, student-written comment, December 7, 2009)

I relate to the girl and how she feels when doing math . . . The boy (and most boys in general) excel in math and make it appear more natural or easy. (Helen, student-written comment, August 26, 2009)

Based on what I know, statistically girls do poorer on math than boys. When I was in school it was not pushed as much with girls as with boys. I have also heard that boys tend to do better in math. The pictures above are based on my own feelings toward math. (Isabel, student-written comment, August 26, 2009)

We investigated whether or not simply participating in a mathematics methods course would help foster change in perceptions of boys' and girls' attitudes toward mathematics. As with many university methods courses, we spend time on open-ended problem solving and analyzing student thinking about mathematics in order to strengthen our students' *mathematics knowledge for teaching* (Ball, Thames, & Phelps, 2008). We wondered if students' perceptions would change because of their own increased confidence and understanding of mathematics. In addition, as part of their coursework, the prospective teachers saw

work samples and videos of elementary school girls engaged in sophisticated mathematics reasoning. However, there was a perceptible difference among even the graduate students who had mostly positive responses for girls and boys during the pretest. In the posttest, most of the neutral attitudes for the boys had changed to positive ones, and no scores moved to the negative. While the overall change in perceptions of the girl's attitude remained largely positive, the changes were much more variable with no distinct pattern.

These findings indicate a need for more explicit consideration of gender stereotypes in mathematics methods courses. Instruction should include classroom activities and discussions to help prospective teachers examine the expectations they hold for girls' and boys' mathematics learning. Taking overt steps to foster productive dispositions toward mathematics (NRC, 2001) and to counteract common gender-based stereotypes about mathematics is a necessary part of preparation for prospective teachers.

This cartoon activity was primarily used as a measure in our study. The data were collected without comment or discussion. We contend, however, that the activity could serve prospective teachers well as a springboard for discussion about gender issues. In fact, even without comment from us, some students began to reflect on the meaning of the activity.

It seems as though the boy is confident with math and the girl may be puzzled, but I drew a picture of a girl smiling to try and change the stereotype of boys good at math and girls not. (Jennifer, student-written comment, December 7, 2009)

Other participants cited the activity as something they could do with their own students one day. Regardless of the activity utilized, explicit discussion of gender stereotypes in mathematics methods, however brief, is needed to bring to the surface prospective teachers' ideas about gender and how it might affect their students.

### Limitations

During discussion with students after completing the activity, some of the students analyzed the facial features of the cartoons and interpreted the boy and girl cartoons as communicating different attitudes. In addition, the prospective teachers did interpret the activity as expressing their future students' attitudes, but it is not clear to what extent the prospective teachers were imposing their attitudes on the cartoon characters. A final limitation is the failure to randomly order the picture of the boy and girl on the instrument. Since the students most likely responded

from left to right, and thus always responded for boy first, the responses may have been biased (Day, 1969). In addition, prospective teachers may have believed that they needed to put different responses for the boy and girl pictures rather than drawing the same thing for both.

### Conclusion

This study indicates that while gender stereotypes in mathematics may be changing, in this specific context, perceptions of students' attitudes toward mathematics still often reflected traditional gender stereotypes, particularly among the undergraduate prospective teachers. Helping prospective teachers increase their self-efficacy in mathematics in order to reduce anxiety is crucial, but not enough. Despite the limited time available in mathematics methods courses to cover content and pedagogy, it remains crucial that more attention be given to developing positive perceptions of girls' attitudes toward mathematics.

Further studies could explore how different activities in methods courses focused on explicit discussion of gender might affect prospective teachers' perceptions of students' attitudes toward mathematics. Also, further examining why the graduate students indicated more positive attitudes for the girl doing mathematics might lend insight into how their "real-world" experience, alternate degrees, and maturity are affecting their decisions. Another important avenue for research is the role that race plays in such perceptions. While we did not include race in the scope of this study, the influence of both the race of the participants and that of the students in the drawings is crucial to investigate.

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