Examining the Link between Math Anxiety and Math Performance in Colombian Students

Titulillo: Math Anxiety and Performance in Colombian Students

Enlace al doi: http://dx.doi.org/10.15446/rcp.v25n2.54532

FLORENCIA REALI

WILLIAM JIMÉNEZ-LEAL

CAROLINA MALDONADO-CARREÑO

Universidad de Los Andes, Bogota, Colombia

AMY DEVINE

DÉNES SZÜCS

University of Cambridge, Cambridge, United Kingdom

How to cite this article: Reali, F., Jiménez-Leal, W., Maldonado-Carreño, C., Devine, A., & Szücs, D. (2016). Examining the link between math anxiety and math performance in Colombian students. *Revista Colombiana de Psicología*, *25*(2), xx-xx. doi: 10.15446/rcp.v25n2.54532

Correspondence concerning this article should be addressed to Dr. Florencia Reali, e-mail: f.reali96@uniandes.edu.co. Department of Psychology, Universidad de Los Andes, Cra 1 # 18A – 12, Bogotá, Colombia. PC. 11001000.

SCIENTIFIC RESEARCH ARTICLE

RECEIVED: 3 DECEMBER 2015 - ACCEPTED: 28 APRIL 2016

Math anxiety (MA) is a state of discomfort associated with performing mathematical tasks. Past research has shown negative correlations between mathematics performance and MA (Ashcraft, 2002; Hembree, 1990; Khatoon & Mahmood, 2010; Ma, 1999; Miller & Bichsel, 2004). In addition, gender differences have been found although some findings are contradictory. A few studies have indicated that MA is higher in boys than in girls (Abed & Alkhateeb, 2001; Reavis, 1989; Sandman, 1979), while most studies have shown that MA negatively affects mathematics performance and that girls may report higher levels of MA than boys (Ashcraft & Faust, 1994; Betz, 1978; Hembree, 1990; Ho et al., 2000; Meece, Wigfield, & Eccles, 1990; Wigfield & Meece, 1988; Yüksel-Şahin, 2008; see Devine, Fawcett, Szücs, & Dowker, 2012, for a review). Finally, many studies have shown no gender differences in MA (Birgin, Baloğlu, Çatlıoğlu, & Gürbüz, 2010; Chinn, 2009; Chiu & Henry, 1990; Ma & Xu, 2004; Newstead, 1998; for a complete list of references see Devine et al., 2012). Importantly, the overwhelming majority of data comes from samples from developed Western European countries and from the United States with about a handful of exceptions (Abed & Alkhateeb, 2001; Baya'a, 1990; Ho et al., 2000; Jain & Dowson, 2009; Khatoon & Mahmood, 2010; Keshavarzi & Ahmadi, 2013; Saigh & Kouri, 1983; Yüksel-Şahin, 2008). It is thus possible that the presence of math anxiety and associated gender differences may depend on the level of math education and gender equality in countries. These background variables may be substantially different in developing than in developed countries. In order to fill the gaps in our knowledge about the developing country context, we report here a study of the math anxiety / math performance relation and gender differences in math anxiety from a Colombian sample. Although some studies have started to study the phenomenon of math anxiety in Latin American countries such as Mexico (García-Santillán, Flóres-Serrano, López-Morales, & Rios-Alvarez, 2014;

Villegas & Cornejo, 2010), to our knowledge, this is the first time in which the relation between math anxiety and math performance has been directly addressed in a Latin American sample. We controlled for general and text anxiety levels.

With regard to gender differences in the relationship between MA and performance, studies have also revealed contradictory findings. The relationship between MA and mathematics performance was investigated in two longitudinal studies of secondary school students from the United States: The Longitudinal Study of American Youth (LSAY; Ma & Cartwright, 2003; Ma & Xu, 2004) and Childhood and Beyond study (CAB; Eccles & Jacobs, 1986; Meece et al., 1990; Wigfield & Meece, 1988). The LSAY found that whilst boys' prior low math achievement predicted later high MA at all grade levels, girls' prior low math achievement only predicted later high MA at critical transition points during schooling (for example, transferring from middle school to secondary school; Ma & Cartwright, 2003; Ma & Xu, 2004). On the other hand, the CAB study found that the relationship between MA and math performance was the same for both genders (Meece et al., 1990; Wigfield & Meece, 1988). More recently, Kyttälä and Björn (2014) found that the relationship between MA and math word problem solving was significant for girls but not for boys.

However, some of these studies have not controlled for test anxiety (TA) or general anxiety (GA). A recent study (Devine et al., 2012) looked at the relation between MA and math performance while controlling for TA. They showed that no gender differences were observed in British secondary school girls' and boys' math performance but higher levels of MA and TA were observed in girls than in boys. Specifically, they found that both girls and boys showed a positive correlation between MA and TA and a negative correlation between MA and math performance. TA was also negatively correlated with math performance, but this relationship was stronger for girls than for boys. When controlling for TA, the negative correlation between MA and performance remained for girls only.

The Colombian Case

PISA 2012 (OECD, 2013b) has revealed that countries and economies where students tend to report higher levels of MA are also those where students tend to perform less well in math. In almost all countries and economies that participated in PISA 2012, girls reported greater MA than boys (OECD, 2013a). This report also revealed that Colombian students perform quite poorly in math –Colombia placed 61st among 64 countries. Even more shocking, 73.8% of Colombian students placed in the lower quartile of performance, while only approximately 23% of students are expected to do so.

Several factors may underlie the poor performance of Colombian students. Like other countries in Latin America, Colombia faces challenges regarding teacher recruitment, standards setting, class assessment and overall improvement of math education (Bruns & Luque, 2014, ICSU-LAC, 2010). Consequently, studies that shed light on how to improve the teaching of math have become a priority. One of the issues that may play a role, as it is the case in many other countries, is the high level of MA in Colombian students revealed by the PISA reports. However, despite its importance, the link between MA and performance has been poorly explored in this region. In fact, the effect of MA has been barely studied in Latin American countries, where research emphasis has been on the relation of academic performance and GA or TA (Macías-Martínez & Hernández, 2008; Hernández-Pozo, Coronado, Araujo, & Cerezo, 2008; Villegas & Cornejo, 2010).

In sum, the reviewed results point to the need for exploring the relation between MA and math performance in Colombia while controlling for other kinds of anxiety, such as GA and TA. The first goal of the current work was to do so. Our second goal was to compare the relation of MA and performance among boys and girls. Given the increasing number of studies exploring gender differences across the globe, we were particularly interested in the question of whether girls and boys in Colombia are affected by MA in comparable ways to those that have been reported in other countries.

Method

Participants

A total of 347 students in primary and secondary education took part in the study. 51 students were excluded from the investigation because they failed to complete the tests. Students were excluded if they answered less than half of the questions of at least one of the four questionnaires applied. Also, because instruments were applied on different sessions, students missing one of them were excluded. The remaining 296 children, 160 girls (54.1%) and 136 boys (45.9%), were included in the sample: 51 children in Grade 3 (M_{age}=8.46 years, *SD*=0.58 years), 55 in Grade 4 (M_{age}=9.49 years, *SD*=0.79 years), 44 in Grade 5 (M_{age}=10.64 years, *SD*=0.94 years), 52 in Grade 6 (M_{age}=11.6 years, *SD*=0.97 years), 41 in Grade 9 (M_{age}=14.4 years, *SD*=0.86 years) and in 53 in Grade 10 (M_{age}=15.9 years, *SD*=0.82 years). Participants attended a public school located in Bogotá, Colombia. The area of the school was predominantly working class and middle class. A middle class school where both boys and girls attend was selected for this study to provide evidence from a non-extreme socioeconomic context. Importantly, academic scores obtained by this school in the 2012 national evaluation were close to the mean obtained in Bogotá (Secretaria de Educación del Distrito, 2013). All children in the classroom were considered as participants but only those who returned the consent form were tested. There were no other a priori exclusion criteria. The sample included different grades (4^{th}, 5^{th}, 6^{th}, 9^{th} and 10^{th}) to have variability in the age range. Participants and guardians gave appropriate informed written consent. The research study was in compliance with the Helsinki Declaration and it was approved by the University Research Ethics Committee of Universidad de Los Andes, Bogotá, Colombia.

Measures and Procedure

Participants were tested in their classrooms, with groups varying between 25 and 40 students. They all filled out the questionnaires corresponding to the measures listed below. Data was collected on two different days. The first day, math performance was assessed and the second day anxiety data was collected.

Math anxiety (MA). In order to measure the levels of MA, we translated to Spanish the Abbreviated Math Anxiety Scale (AMAS; Hopko, Mahadevan, Bare, & Hunt, 2003). This is the shortest valid MA scale –with only nine items– and has good reliability. In English, it has been shown to be just as effective as the longer MARS (Hopko et al., 2003; e.g., internal consistency: Cronbach's α=.90, two-week test-retest reliability: r=.85, convergent validity of AMAS and MARSR r=.85). Using a 5-point Likert scale, participants indicated how much anxiety (e.g., 1=*low anxiety*; 5=*high anxiety*) they would feel during certain situations involving math. The general score obtained as the sum across the nine items (range 0:45) was used in this study. The instrument was translated by a group of three Spanish native speakers who were proficient in English, and the translations were cross-validated by an additional group of three people proficient in both languages. In our study, assessment of internal reliability resulted in a value of Cronbach's α=.69.

Test anxiety (TA). A Spanish translation of Children's Test Anxiety Scale (CTAS; Wren & Benson, 2004) was used to measure TA. The questionnaire contains 30 items that deal with cognitive, emotional, and behavioral reactions during test-taking situations. Participants indicated whether they believe each item applies to them by answering a 1 to 4 Likert scale corresponding to how often the child feels a certain way (1=*almost never* and 4=*almost always*). The general score obtained as the sum across all 30 items (range 1:120) was used in this study. The test has good internal reliability (Cronbach's α=.92; Wren & Benson, 2004), and in the current investigation, assessment of internal reliability resulted in a value of Cronbach's α=.89. A group of four Spanish native speakers who were proficient in English translated the instrument, and the translation was cross-validated by an additional group of three people proficient in both languages.

General anxiety (GA). The Spanish version of Children´s Manifested Anxiety Scale Revised (CMASR-2; Reynolds & Richmond, 2008) was used to measure levels of GA. This test was found to have good internal consistency (Cronbach's α=.84; Domínguez, Villegas, & Padilla, 2013), and in the present study we found a value of Cronbach's α=.67. This test was designed to measure the level of anxiety experienced by children aged between 6 and 19 years, using a simple yes-or-no response format. Participants indicate whether they agree or not with statements about their cognitive, emotional and behavioral reactions by answering *Yes* or *No*. We used the reduced version of the instrument that contains 10 items. *Yes* answers corresponded to 1 point and *No* to 0. Responses were added across items to obtain the general score (range 0:10).

Math performance. A selection of items from the National standardized tests Saber 3º, Saber 5º and Saber 9º were used to assess mathematical performance. These tests were designed by the ICFES (*Instituto Colombiano para la Evaluación de la Educación*, tr. Colombian Institute for Education Evaluation), which is the organization in charge of evaluating primary and secondary educational quality in Colombia. These are standardized tests designed for third, fifth, and ninth grades to measure the school performance level in math. For the purpose of this study, we selected a subset of items that had been used to asses mathematical performance of students in previous years, which are available on the ICFES website. Because the tests were initially designed to be taken at the end of the school year and the sample took the tests at the middle of the school year, the test Saber 3 (20 problem items) was used to assess third and fouth grades, the test Saber 5 (24 problem items) was used to assess fifth and sixth grades and the test Saber 9 (27 problem items) was used to asses ninth and 10th grades. The general score was used in this study, and it was calculated as the sum across all items (range 0:20, 0:24, and 0:27, respectively).

Statistics

Our main interest was to examine the interrelationship of MA, GA, TA and math performance as well as their relation to gender. First, univariate Analysis of Variance (ANOVA) was run on MA, GA, TA and math performance scores as dependent variables with gender (male vs. female) and school year (grades) factors. Second, to assess the effect of anxiety on math performance a multiple regression was run (GA, TA, MA, gender and grade were used as predictors and math performance as the explained variable). Lastly, correlations and multiple regressions were run separately for girls and boys to assess the effect of MA, TA and GA on math performance per individual gender.

Results

The percentage of correct responses was the measure of math performance. A Kolmogorov-Smirnov test, with a significance level of α=.05, revealed that it was safe to assume that math performance data was normally distributed in this sample. The mean ± standard deviation of math performance was 54.2±18.4 (minimum: 4.2; maximum: 95.0). The mean values of math performance per gender were *M*=53.2 (*SD*=19.74) in girls and *M*=55.2 (*SD*=16.86) in boys, and per grade were *M*=45.4 (*SD*=16.1) in Grade 3, *M*=63.9 (*SD*=14.9) in Grade 4, *M*=57.9 (*SD*=19.5) in Grade 5, *M*= 53.6 (*SD*=16.7) in Grade 6, *M*= 41,0 (*SD*=12.3) in Grade 9 and *M*=46.7 (*SD*=12.4) in Grade 10. The univariate ANOVA (DV: Math Performance score; Factor 1: Gender, Factor 2: Grade) found that the grade factor was significant ($F(5, 284)=23.73$, $p<.000$, $\eta^2=.30$), that the gender factor was not significant ($F(1, 284)=0.54$, $p=.46$) and that the interaction between the two factors approached significance ($F(1, 284)=1.99$, $p=.079$). This indicates that math performance decreases in more advanced grades, but there is no effect of gender. Since the interaction was marginally significant, comparisons were made between girls' and boys' performance by segmenting the data per grade, revealing that girls (*M*=72.7, *SD*=15.4) performed significantly better than boys (*M*=63.87, *SD*=14.9) in Grade 4 ($F(1, 53)=4.61$, $p=.036$, $\eta^2=.08$) and that, conversely, boys (*M*=52.2, *SD*=12.3) performed better than girls (*M*=42.2, *SD*=10.7) in grade 10 ($F(1, 51)=9.93$, $p=.003$, $\eta^2=.16$). There was no difference between genders in all the other grades (all *p*'s>.45).

Kolmogorov-Smirnov tests, with a significance level of α=.05 conducted on all three anxiety measurements revealed that it was safe to assume that MA and TA data was uniformly distributed in this sample, with the exception of GA. The mean values of MA per gender were *M*=21.4 (*SD*=6.5) for girls and *M*=21.5 (*SD*=6.2) for boys. The means per grade were the following: *M*=19.8 (*SD*=5.8) in Grade 3, *M*=21.6 (*SD*=5.9) in Grade 4, *M*=23.9 (*SD*=7.5) in Grade 5, *M*=20.1 (*SD*=5.9) in Grade 6, *M*=22.9 (*SD*=7.5) in Grade 9 and *M*=22.0 (*SD*=5.2) in Grade 10. Univariate ANOVA (DV: MA score; Factor 1: Gender, Factor 2: Grade) revealed that while the grade factor was significant with a small effect size ($F(5, 284)=2.37$, $p=.039$, $\eta^2=.04$), the gender factor was not ($p>.6$) and the interaction between the two factors was not significant either ($p>.5$). These results show that there is no difference between boys and girls in the level of MA they experience.

The mean standardized *t*-score values of GA per gender were *M*=40.24 (*SD*=8.45) for girls and *M*=37.40 (*SD*=8.95) for boys. Per grade, the means were: *M*=42.01 (*SD*=10.80) in Grade 3, *M*=38.96 (*SD*=8.24) in Grade 4, *M*=42.15 (*SD*=10.86) in Grade 5, *M*=38.15 (*SD*=9.22) in Grade 6, *M*=36.65 (*SD*=7.61) in Grade 9, and *M*=35.28 (*SD*=6.33) in Grade 10. A Mann-Whitney U test for independent samples revealed significant differences between the distribution of boys' and girls' GA scores ($p=.002$), while a Kruskal-Wallis test for independent samples reveled significant differences between the score distribution across grades ($p=.005$).

Finally, similar results were found for TA. The mean values per gender were the following: *M*=79.52 (*SD*=15.8) for girls and *M*=1.96 (*SD*=14.57) for boys. Per grade the means were: *M*=58.7 (*SD*=13.2) in Grade 3, *M*=62.1 (*SD*=13.8) in Grade 4, *M*=65.9 (*SD*=18.2) in Grade 5, *M*=58.7 (*SD*=13.7) in Grade 6, *M*=63.7 (*SD*=18.2) in Grade 9 and *M*=56.7 (*SD*=13.7) in Grade 10. The univariate ANOVA (DV: TA score) revealed a significant grade effect ($F(5, 284)=2.54$, $p=.028$, $\eta^2=.043$) but the gender factor was not significant ($F(1, 284)=1.5$, $p=.22$). However, the interaction between the two factors reached significance ($F(5, 284)=2.31$, $p=.043$). Comparisons between girls' and boys' TA were made by segmenting the data per individual grade, revealing that only in Grade 4 boys (*M*=65.7, *SD*=14.2) presented more TA than girls (*M*=57.3, *SD*=11.9; $F(1, 53)=5.44$, $p=.023$, $\eta^2=.093$). There was no difference between genders in all the other grades (all *p*'s>.1).

Second, correlation analyses were conducted as shown in Figure 1. Math performance scores were negatively correlated with MA scores (Pearson $r=-.174$, 95% CI[-.050, -.279], $p=.003$). However, performance was not significantly correlated to any other anxiety score (all *p*'s>.1). The MA scores were positively correlated with both GA scores (Pearson $r=.191$, $p<.001$) and TA scores (Pearson $r=.322$, $p=.000$).

In order to explore the relative importance of each factor in predicting math performance we ran a regression model (explained variable: Math Performance, predictor variables: Gender, Grade, MA, TA, GA and the interaction term 'MA × Gender'). The model was highly significant ($F(5, 289)=5.26$, $p<.0001$), accounting for 9.8% of the variance (R^2). Importantly, the only anxiety variable that significantly predicted math performance was MA ($\beta=-.20$, $p=.009$). Additionally, grade was a significant predictor of math performance ($\beta=-.25$, $p<.0001$). Moreover, the interaction term MA × Gender approached significance ($p=.11$) suggesting that gender could have a moderating role on the effect of MA on math performance. To explore this possibility, we ran correlation analyses in girls and boys separately. Among girls, math performance was negatively and significantly correlated with MA scores (Pearson $r=-.230$, $p=.001$) and not correlated to the other two anxiety scores (both *p*'s>.2). In contrast, in boys, correlation analyses established that math performance scores were not correlated with MA, GA or TA scores (all *p*'s>.15).

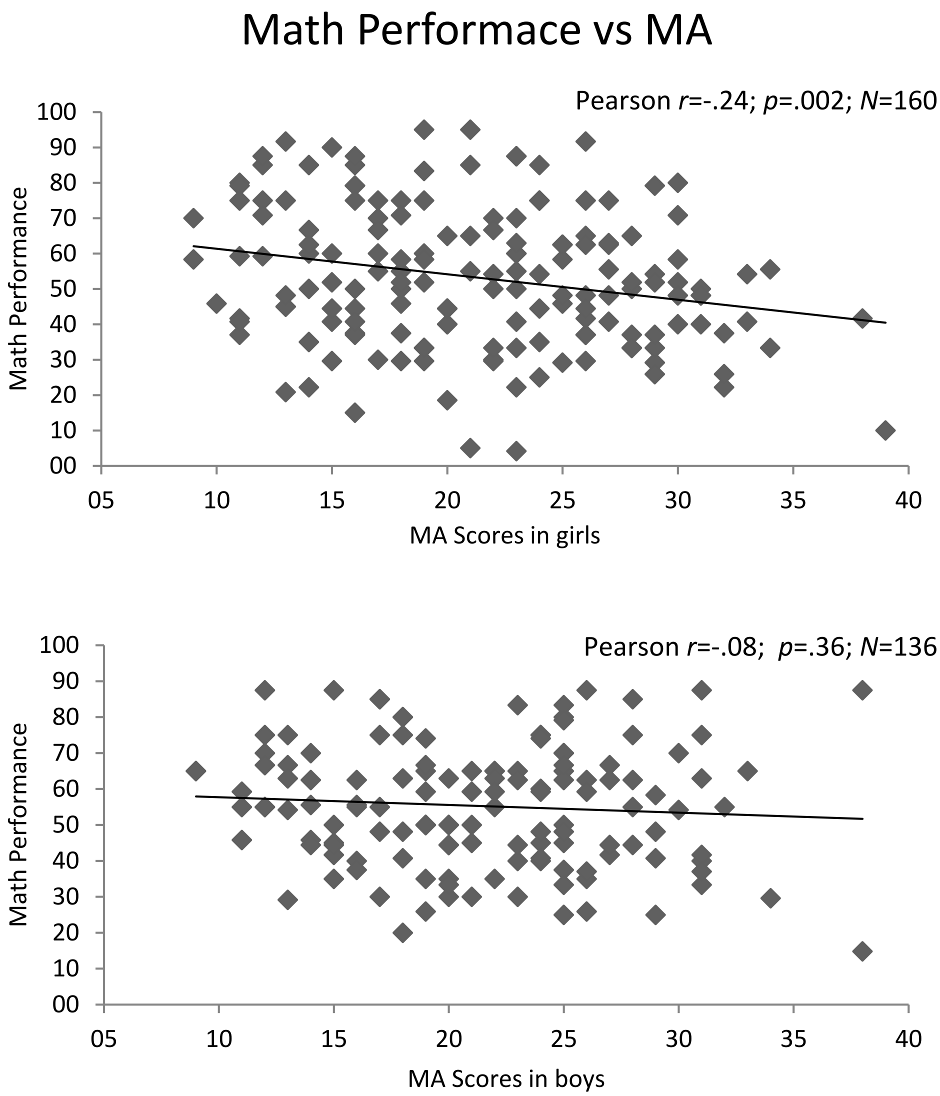

Figure 1. Correlation between math anxiety scores (x-axis) and math performance (y-axis) in girls (top panel) and boys (bottom panel).

To further assess the effect of MA on math performance per gender, we ran multiple regression analyses for boys and girls separately. Among girls, the regression model (explained variable: Math Performance, predictor variables: MA, TA, GA and Grade) was significant ($F(4, 155)=7.07$, $p<.0001$), and accounted for 15.4% of the variance (R^2). Importantly, MA was the only anxiety measure that significantly predicted math performance (β=-.18, *p*=.022), together with grade (β=-.33, *p*<.0001). However, and unlike for girls, the regression model was not significant for boys (*p*>.25) and the MA score was not a significant predictor of math performance (*p*>.7). Taken together, these results suggest that there is a robust association between MA and math performance in girls, but the relation is not so clear in boys.

In order to shed some light on the difference between boys and girls, we looked at the correlation of MA and math performance per gender across individual grades. The data revealed that, for girls, the negative association between MA and math performance reached significance in Grade 3 (Pearson *r*=-.48, *p*=.015) and approached significance in Grade 6 (Pearson *r*=-.33, *p*=.07). For boys, the negative association between MA and math performance reached significance in Grade 9 (Pearson *r*=-.58, *p*=.018) and approached significance in Grade 10 (Pearson *r*=-.38, *p*=.06) and Grade 3 (Pearson *r*=-.34, *p*=.08). However, an unexpected *positive* correlation between MA and math performance was found for boys of Grade 5 (Pearson *r*=.48, *p*=.04). Given this was quite at odds with the negative correlation observed across the board, we decided to look at this data closely. We found one clear outlier among boys in Grade 5 whose MA score was two *SD* above the mean. After removing the outlier, the positive correlation between MA and math performance was no longer significant in boys (*p*=.14).

Discussion

These results contribute to a growing bulk of research on the importance of MA across different countries. This is the first study, though, that directly explores the relation between math performance and MA, while directly controlling for GA and TA, in Colombian girls and boys.

In line with most studies (Ashcraft & Ridley, 2005; Devine et al., 2012; Ma, 1999), we found a robust association between MA and math performance: The higher the MA, the lower the math performance. This result is particularly important when considering that this association remains strong when controlling for GA and TA: Even though MA and other anxiety measures were positively correlated, only the MA was negatively associated with performance, highlighting the specificity of the effect. This is also consistent with PISA reports that show that countries with higher levels of MA show lower scores in math performance (OECD, 2013a). A possible caveat should be mentioned: Because anxiety assessment was conducted after testing performance it is possible that the performance test influenced positively or negatively students' self-perception of anxiety. To diminish the effect of testing performance first, anxiety was measured on a different day. Moreover, we assumed that students are exposed to math examinations as part of their scholar routine. Having said that, the order in which different instruments are administered is a factor worth considering in future directions.

At odds with many studies showing that girls may report higher levels of MA than boys in other countries (e.g., PISA, 2012; OECD, 2013a, 2013b; see also Devine et al., 2012 for a review), we did not find gender differences in levels of anxiety or math performance in our sample. The results of TIMMS[1] (González et al., 2008) have shown that, in Colombia, boys perform better than girls in math. In fact, TIMMS results show that Colombia presents the largest gender gap of all 59 countries assessed in 2007. In our sample, however, only boys in 10th grade perform significantly better than girls, while younger girls seem to perform equally good or even better than boys (as it is the case in our sample of the fourth

[1] TIMSS - Trends in International Mathematics and Science Study is an international meta-report of math performance across 59 different countries.

grade). The results showed that there is variability across grades in the strength of association between MA and performance per gender. However, overall, our data suggest that the negative effect of MA on math performance is stronger in girls than in boys. This is consistent with results of UK students that show that, when controlling for TA, the negative correlation between math anxiety and performance remained valid for girls only (Devine et al., 2012). Finally, the decreasing performance trend found across grades is puzzling. It is possible that the setting of learning objectives might not follow an adequate progression, a problem identified across different countries of Latin America (ICSU-LAC, 2010). This in turn can also be associated with higher levels of frustration and possibly of anxiety in higher grades. Consistently, our results show that the overall levels of MA increase significantly with grade. Another possibility is that the observed trend is partly due to the characteristics of the curricula content. However, the links between curricula contents and changes in math performance and anxiety are yet to be explored.

Finally, the current study has important and noteworthy limitations. First, the sample used is relatively small, coming from a single educational institution. In order to generalize the results to Latin American or even to the Colombian broader population, a much larger and representative sample will be needed. However, the present study is aimed as a first step toward the understanding of a complex and culturally situated phenomenon. Second, two of the instruments used here were translated from English. While they were cross-validated by three experts in English and Spanish, an expanded sample will provide accumulated quantitative psychometric information that will allow for further validation of the instruments in Spanish.

Conclusions

The main goal of this study was to explore the relationship between MA and math performance in a sample of Colombian boys and girls across different grades. The results suggest that the trend previously found in other countries shows in Colombia: Math performance and math anxiety are significantly related and this relationship appears to be mediated by gender. Given the limited number of studies exploring this phenomenon in Latin America and particularly in Colombia, this work fills an important gap in the literature. Our study is particularly important in view of the poor performance in math by Colombian students and the gender differences that have been revealed by the most recent PISA reports (OECD, 2013b). Overall, the results from our sample are congruent with what has been observed in other countries: There is a strong negative association between math performance and MA, and such association seems to be stronger in girls compared to boys. Importantly, the effect of anxiety on math performance seems to be restricted to MA and not to other kinds of anxiety. Because of the complexity of the phenomenon, as well as the particular socioeconomic and cultural characteristics of countries such as Colombia, this work represents only a first step in the exploration of the relation between MA, gender, and math performance in Latin America. We hope this contribution consolidates the beginning of a fruitful research direction.

References

Abed, A. S. & Alkhateeb, H. M. (2001). Mathematics anxiety among eighth-grade students of the United Arab Emirates. *Psychological Reports, 89*, 65-66. doi: 10.2466/pr0.2001.89.1.65

Ashcraft, M. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science, 11*, 181-185. doi: 10.1111/1467-8721.00196

Ashcraft, M. H. & Faust, M. W. (1994). Mathematics anxiety and mental arithmetic performance: An exploratory investigation. *Cognition and Emotion, 8*, 97-125.

Ashcraft, M. & Ridley, K. (2005). Math anxiety and its cognitive consequences: A tutorial review. In J. Campbell (Ed.), *Handbook of mathematical cognition* (pp. 315-327). New York: Psychology Press.

Baya'a, N. F. (1990). Mathematics anxiety, mathematics achievement, gender, and socio-economic status among Arab secondary students in Israel. *International Journal of Mathematical Education in Science and Technology, 21*(2), 319-324. doi: 10.1080/0020739900210221

Betz, N. (1978). Prevalence, distribution, and correlates of math anxiety in college students. *Journal of Counseling Psychology, 25*, 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*, 654-658. doi: 10.1016/j.lindif.2010.04.006

Bruns, B. & Luque, J. (2014). *Great teachers. How to raise student learning in Latin America and the Caribbean*. Washington, D.C.: The World Bank.

Chinn, S. (2009). Mathematics anxiety in secondary students in England. In *Dyslexia: An international journal of research and practice, making links: Selected papers from the 7th conference of the British Dyslexia Association, 68,* 61-68. doi: 10.1002/dys.381

Chiu, L. & Henry, L. L. (1990). Development and validation of the Mathematics Anxiety Scale for Children. *Measurement and Evaluation in Counseling and Development, 23*, 21-127.

Devine, A., Fawcett, K., Szücs, 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), 1-9. doi: 10.1186/1744-9081-8-33

Domínguez, S., Villegas, G., & Padilla, O. (2013). Propiedades psicométricas de la escala de ansiedad manifiesta en niños CMASR en niños y adolescentes de Lima metropolitana. *Revista de Peruana de Psicología y Trabajo Social, 2*, 15-32.

Eccles, J. S. & Jacobs, J. E. (1986). Social forces shape math attitudes and performance. *Signs: Journal of Women in Culture and Society, 11*(2), 367.

García-Santillán, A., Flóres-Serrano, M. S., López-Morales, J. S., & Ríos-Álvarez, L. (2014). Factors associated that explain anxiety toward mathematics in undergraduate students. (An empirical study in Tierra Blanca, Veracruz-México). *Mediterranean Journal of Social Sciences, 5*(15), 483-493. doi: 10.5901/mjss.2015.v6n4p564

González, P., Williams, T., Jocelyn, L., Roey, S., Kastberg, D., & Brenwals, S. (2008). *Highlights from TIMSS 2007: Mathematics and science achievement of U.S. fourth- and eighth-grade students in an international context.* Washington, DC: National

Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education, 221*, 33-46.

Hernández-Pozo, M., Coronado, O., Araújo, V., & Cerezo, S. (2008). Desempeño académico de universitarios en relación con ansiedad escolar y auto-evaluación. *Acta Colombiana de Psicología*, *11*(1), 13-23.

Ho, H. Z., Senturk, D., Lam, A. G., Zimmer, J. M., Hong, S., Okamoto, Y., … Wang, C. P. (2000). The affective and cognitive dimensions of math anxiety: A cross-national study. *Journal for Research in Mathematics Education, 31*(3), 362-379.

Hopko, D., Mahadevan, R., Bare, R., & Hunt, M. (2003). The Abbreviated Math Anxiety Scale (AMAS): Construction, validity and reliability. *Assessment*, 10, 178-182. doi: 10.1177/1073191103010002008.

ICSU-LAC. (2010). *Science for a better life: Developing regional scientific programs in priority areas for Latin America and the Caribbean (Vol. 4). Mathematics education in Latin America and the Caribbean: A reality to be transformed.* Rio de Janeiro: ICSU Regional Office for Latin America and the Caribbean.

Jain, S. & Dowson, M. (2009). Mathematics anxiety as a function of multidimensional self-regulation and self-efficacy. *Contemporary Educational Psychology*, *34*(3), 240-249. doi: 10.1016/j.cedpsych.2009.05.004

Keshavarzi, A. & Ahmadi, S. (2013). A comparison of mathematics anxiety among students by gender. *Procedia Social and Behavioral Sciences, 83,* 542-546. doi: 10.1016/j.sbspro.2013.06.103

Khatoon, T. & Mahmood, S. (2010). Mathematics anxiety among secondary school students in India and its relationship to achievement in mathematics. *European Journal of Social Sciences, 16*, 75-86. doi: 10.3844/ajassp.2012.1828.1832

Kyttälä, M. & Björn, P. M. (2014). The role of literacy skills in adolescents' mathematics word problem performance: Controlling for visuo-spatial ability and mathematics anxiety. *Learning and Individual Differences, 29*, 59-66. doi: 10.1016/j.lindif.2013.10.010

Ma, X. (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. *Journal of Research in Mathematical Education, 30*, 520-540. doi: 10.2307/749772

Ma, X. & Cartwright, F. (2003). A longitudinal analysis of gender differences in affective outcomes in mathematics during middle and high school. *School Effectiveness and School Improvement, 14*(4), 413-439. doi: 10.1076/sesi.14.4.413.17155

Ma, X. & Xu, J. (2004). The causal ordering of mathematics anxiety and mathematics achievement: A longitudinal panel analysis. *Journal of Adolescence, 27*, 165-179. doi: 10.4236/psych.2013.46A2005

Macías-Martínez, D. & Hernández-Pozo, M. (2008). Indicadores conductuales de ansiedad escolar en bachilleres en función de sus calificaciones en un examen de matemáticas. *Universitas Psychologica, 7*(3), 767-785.

Meece, J. L., Wigfield, A., & Eccles, J. S. (1990). Predictors of math anxiety and its influence on young adolescents' course enrollment intentions and performance in mathematics. *Journal of Educational Psychology, 82*(1), 60-70.

Miller, H. & Bichsel, J. (2004). Anxiety, working memory, gender, and math performance. *Personality and Individual Differences, 37*, 591-606. doi: 10.1080/01443410.2016.1152354

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

OECD. (2013a). *PISA 2012 Results: Ready to Learn: Students' Engagement, Drive and Self-Beliefs, (Volume III).* Paris: OECD Publishing. doi: 10.1787/9789264201170-en

OECD. (2013b). *PISA 2012 Results in Focus.* Paris: OECD Publishing.

Reavis, P. S. (1989). *Mathematics anxiety and the relationship between attitude, sex, ethnicity and achievement in mathematics in three high school curriculum tracks* (Unpublished doctoral dissertation). University of Arizona, Tucson.

Reynolds, C. & Richmond, B. (2008). *Revised Children's Manifest Anxiety Scale (2nd ed.).* USA: Western Psychological Services.

Saigh, P. A. & Khouri, A. (1983). The concurrent validity of the Mathematics Anxiety Rating Scale for Adolescents (MARS-A) in relation to the academic achievement of Lebanese students. *Educational and Psychological Measurement, 43*(2), 633-637. doi: 10.1177/001316448304300237

Sandman, R. S. (1979, April). *Factors related to mathematics anxiety in the secondary school.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco, California.

Secretaría de Educación del Distrito. (2013). *Caracterización del sector educativo de Bogotá D.C. año 2012.* Bogotá: Secretaría de Educación del Distrito. Oficina asesora de Planeación – Grupo de Análisis Sectorial.

Villegas, J. J. & Cornejo M. C. (2010, June). *¿Miedo a las matemáticas?* Paper presented at the Encuentro Regional de Tutoría de la Región Centro Occidente, Guadalajara, México.

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

Wren, D. & Benson, J. (2004). Measuring test anxiety in children: Scale development and internal construct validation. *Anxiety, Stress & Coping, 17*, 227-240. doi: 10.1080/10615800412331292606

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