EFFECTS OF MATH ANXIETY ON STUDENT SUCCESS IN HIGHER EDUCATION

Núñez-Peña, M.I., Suárez-Pellicioni, M. & Bono, R.

Department of Behavioral Sciences Methods, Faculty of Psychology, University of Barcelona, Spain

Institute for Brain, Cognition and Behavior (IR3C), University of Barcelona, Spain

Correspondence to:

Maria Isabel Núñez-Peña

Department of Behavioral Sciences Methodology

Faculty of Psychology

University of Barcelona

Passeig Vall d'Hebron, 171

08035 Barcelona (SPAIN)

Tel. +34 93 312 58 53

Fax: +34 93 402 13 59

E-mail: inunez@ub.edu

ABSTRACT

This study examines whether math anxiety and negative attitudes towards mathematics have an effect on university students' academic achievement in a methodological course forming part of their degree. A total of 193 students were presented with a math anxiety test and some questions about their enjoyment, self-confidence and motivation regarding mathematics, and their responses were assessed in relation to the grades they had obtained during continuous assessment on a course entitled "Research Design". Results showed that low performance on the course was related to math anxiety and negative attitudes towards mathematics. We suggest that these factors may affect students' performance and should therefore be taken into account in attempts to improve students' learning processes in methodological courses of this kind.

KEY WORDS: Mathematical anxiety; Academic performance; Higher education.

1. INTRODUCTION

The negative effect of mathematical anxiety — defined as a feeling of panic, helplessness, paralysis and mental disorganization that arises among some people when they are required to solve a mathematical problem (Richardson & Suinn, 1972; Tobias, 1978) — and of negative attitudes towards mathematics on the performance in tasks requiring the management of numbers has been widely studied (Ashcraft, 2002; Ashcraft, Kirk & Hopko, 2000). Ashcraft and Faust (1994) show that these factors are related to poor performance in mathematics and that the effects get worse with more complex arithmetical problems. These negative effects have been studied mainly in educational contexts, more specifically, in the area of mathematics teaching, a field in which the impact of affective aspects on the process of learning has been studied (Gómez-Chacón, 2000). Inside this topic, McLeod (1988, 1992, 1994) demonstrated that affective aspects play a very important role in the process of teaching and learning mathematics; some of them are deeply rooted and are very difficult to eliminate by instruction (Gómez-Chacón, 2000). Although many investigations have been conducted on primary and secondary education (e.g. Carbonero, Martín & Arranz, 1998; Gil & Guerrero, 2005; Tejedor, Santos, García-Orza, Carratalà & Navas, 2009), very few have focused on the higher education context. The main objective of this study is to examine whether mathematical anxiety and the negative attitudes towards mathematics also affect academic performance on a Research Design course, a second-year course in the degree in Psychology at the University of Barcelona, characterized by a high statistical content and the involvement of numerical reasoning.

As teachers on this course, we have noted that many students have great difficulties in achieving the educational objectives required. These difficulties are accentuated in the case of a small group of students, for whom this course turns into a nightmare, because they feel incapable of passing. These students are mainly the ones that fail the course and have to repeat it the following year. Given the mathematical content of the Research Design course we wondered whether the problem of some of these students might be emotional and related with negative attitudes towards this course. The importance of attitudes as an undeniable factor in the monitoring and assessment of teaching-learning processes is widely accepted by teachers today (Hernández & Gómez-Chacón, 1997). Gómez-Chacón (2000) claims that the high number of students failing mathematics courses at different educational levels might have to do with the emergence of negative attitudes caused by different personal and environmental factors, so the detection of these elements may constitute the first step on the way to effectively counteracting its influence.

As far as we know, only two published articles have studied this topic in the university population. Hunsley (1987) assessed the level of mathematical anxiety in students enrolled on a Statistics course in the degree of Psychology at the University of Waterloo, asking them to answer some questions regarding the grade they expected to achieve, how well prepared they thought they were, how important it was for them to perform well in the exam and how anxious they felt at that moment. The results showed that students with high mathematical anxiety expected to obtain a low grade in the exam, felt unprepared, attached considerable importance to performing well in the exam and showed a high level of state anxiety; finally, they obtained poorer grades in the exam. The second study, carried out by Lalonde & Gardner (1993), found similar results in another group of psychology students enrolled on a Statistics course.

The first objective of our study was to assess whether students' negative attitudes and feelings towards mathematics would affect their performance on the Research Design course. The course has a high statistical and methodological content, and students are assessed on the basis of five group projects carried out during the course and an individual final exam. Our main interest was to study the extent to which negative attitudes and feelings towards mathematics affected students' performance in these group assessments and in the final exam. We expected affective aspects to have a stronger influence on the final exam grade than on the group assessments, given that mathematical anxiety is likely to impair performance more significantly in an exam situation. We assess mathematical anxiety with the *Abbreviated Math Anxiety Rating Scale (sMARS*; Alexander & Martray, 1989) which allows us to separate three different aspects: math test anxiety, numerical task anxiety and math course anxiety.

Our second objective was to examine the relationship between negative attitudes and feelings towards mathematics and the type of itinerary, or syllabus, that the students had studied at high school. Regarding this objective, LeFevre, Kulak & Heymans (1992) identified four factors that influenced the choice of university degrees differing in their mathematical content: mathematical anxiety, genre, arithmetical ability and attitudes and beliefs regarding mathematics. They found the following relationships between these factors: a) Students with higher levels of mathematical anxiety avoided degrees with moderate or high mathematical content; b) Women avoided degrees requiring moderate levels of mathematics, even though they had the same level of arithmetical ability as men; c) Students with higher levels of arithmetical ability choose degrees with higher mathematical content; d) Students with better attitudes towards mathematics tended to choose degrees with higher mathematics content. In our study, in view of the relationship between choice of high school syllabus, mathematical anxiety and attitudes towards mathematics, we expected to find a higher degree of mathematical anxiety and worse attitudes towards mathematics in students coming from the humanistic and social high school syllabuses than in those coming from the scientific and technological options. In the current Spanish education system, scientific and technological itineraries have a high mathematical content, while in the social and humanistic pathways this content is considerably reduced or even non-existent. We also expected the grade on the Research Design course to be related to the type of high school itinerary: students who had followed itineraries with lower mathematical content were likely to present poorer grades.

2. METHODS

2.1. Participants

The study sample comprised 193 students, enrolled on the Research Design course in the degree of Psychology at the University of Barcelona during the 2010-2011 academic year. One hundred forty-nine were women (77.20%, mean age 20.82 years, SD = 3.29, range = 18-43) and 44 were men (22.79%, mean age of 21.20 years, SD = 2.51, range = 19-28). Participants were second-year students who at high school had studied humanistic (25.38%), social (33.67%), scientific (25.38%), technological (6.73%) and other (5.18%) itineraries. All participants gave written informed consent before participating in the study.

2.2. Materials

Participants answered the following questions and paper and pencil tests:

1. Personal and contact data.

2. Question about their high school itineraries. This question included five answer options: a) humanistic, b) social, c) scientific, d) technological and e) others.

3. A three item questionnaire about attitudes towards mathematics, including a question about enjoyment (*How much do you enjoy mathematics?*), other about

motivation (*How much motivation do you have towards mathematics?*) and a last one concerning self-confidence (*How self-confident are you with regard to mathematics?*) was presented on five-point Likert scales from 1 (not at all) to 5 (very much).

4. *Abbreviated Math Anxiety Rating Scale (sMARS*; Alexander & Martray, 1989), recently validated and adapted for Spanish by our research group (Núñez-Peña, Suárez-Pellicioni, Guilera & Mercadé-Carranza, 2012). The sMARS is a 25-item version of the Math Anxiety Rating Scale (MARS; Richardson & Suinn, 1972). This instrument measures the construct by presenting 25 situations which may cause mathematical anxiety. The participant decides on the level of anxiety associated with each item by answering on a five-point Likert scale from 1 (no anxiety) to 5 (high anxiety). The sum of the item scores provides the total score for the instrument (minimum 25 and maximum 125). Three factors have been identified in this scale: 1) Math test anxiety (MTA), which includes 15 items reflecting apprehension about taking a test in mathematics or about receiving the results of mathematics tests (e.g. Thinking about an upcoming math test one week before); 2) Numerical Task Anxiety (NTA), which includes five items reflecting anxiety about executing numerical operations (e.g. Being given a set of division problems to solve); 3) Math course anxiety, which includes five items reflecting anxiety about taking a mathematics course (e.g. Watching a teacher work on an algebraic equation on the blackboard). The scores of the Spanish version of the sMARS have shown strong internal consistency (Cronbach's alpha = .94) and high 7-week test-retest reliability (.72) (Núñez-Peña et al., 2012).

5. *State-Trait Anxiety Inventory (STAI;* Spielberger, Gorsuch, Lushene, Vagg & Jacobs, 1983). The STAI is a 40-item scale used to measure state (STAI-S) and trait (STAI-T) anxiety. Good to excellent internal consistency has been reported for both subscales (Cronbach´s alpha = .86-.95). Adequate 30-day test-retest reliability with high

school students (State: r =.71, Trait: r =.75) and 20-day test-retest reliability with college students has been reported (State: r =.76, Trait: r =.86) (Spielberger et al., 1983). The STAI includes 40 statements describing different emotions, 20 for STAI-S and 20 for STAI-T. Items are answered on a four-point Likert scale. In the STAI-T the answer options go from 0 (almost never) to 3 (almost always) and participants answer by considering how they feel “in general”. In the case of the STAI-S the answer options go from 0 (not at all) to 3 (very much) and individuals answer on the basis of how they feel “right now”.

6. The students’ grades on the Research Design course. This course was continuously assessed, collecting the following evidence of the students’ learning throughout the course: a) Students received computer practical classes in which they carried out statistical analyses of different research designs using the program PASW. Students worked in groups and, at the end of the class, handed in a set of responses about their data analysis results and interpretations. b) The continuous assessment also included an assignment, carried out in pairs and tutored by the teacher, consisting of the analysis of a scientific article and the performance of a statistical analysis with simulated data for each practical case. c) Finally, students performed an individual final exam, giving open answers to both theoretical and practical questions. The final grade of the course was the result of the weighted sum of three assessments: 20% for the computer practical classes (5% for each practical class), 30% for the pair work assignment and 50% for the final exam.

2.3. Procedure

Data were collected during the 2010-2011 academic year, as part of a voluntary activity devised for the classes on the Research Design course. The tests were administered in normal classroom settings. The researchers administered the questionnaires, supervised completion, and provided appropriate support when required. The data were collected by trained researchers who took special care to avoid coercion or other bias in data collection. The data were double-entered by two research assistants, and discrepancies were solved by comparison with the original data.

3. DATA ANALYSIS

First, we studied the relationship between the grouping variable *final grade* and the quantitative variables *level of mathematical anxiety* and *attitudes towards mathematics* (enjoyment, motivation and self-confidence). The grades "good" and "excellent" were grouped together in the same category given the fact that there were very few students with the "excellent" grade[1]. Four *unifactorial analyses of variance (ANOVA)* were performed taking *level of mathematical anxiety* and *attitudes towards mathematics* as the dependent variables and the variable *final grade* as the factor. When a significant effect was found ($p \leq .05$), post hoc comparisons were made using Scheffé's test. Second, we studied the relationship between the *final grade* obtained and the *high school itinerary* chosen by students using a *Chi-square test.* Third, we assessed the differences in the level of mathematical anxiety and the three variables of mathematical attitude according to students' choice of high school itinerary. To study this effect we used *independent sample t tests*, with the variables *mathematical anxiety, enjoyment, motivation and self-confidence* as the test variables and *high school itinerary* as the grouping variable. To determine the relationship between *mathematical anxiety* and *attitudes towards mathematics, trait* and *state anxiety* and *the grades* obtained by the students on the computer practical classes, pair work, and final exam, *Pearson*

[1] The academic grading in Spain consists of: *fail* (below 5), *pass* (between 5 and 6.9), *good* (between 6.9 and 8.9), *excellent* (above 9) and *with honors* (exceptional cases obtaining a 10).

correlation tests were used. Finally, stepwise multiple regression analysis was used to test relationships between the different independent factors and the outcome measure, the final exam grade. We estimated the model twice, using as predictors variables of mathematical anxiety and variables of attitudes towards mathematics in the first case, and only the attitudes towards mathematics in the second.

For data analysis we used the PASW 20 statistical package.

4. RESULTS

4.1. Relationship between final grade, mathematical anxiety and attitudes towards mathematics

In this section we show the results of the analysis of the relationship between the final course grade, the level of mathematical anxiety and the attitudes towards mathematics. The results show a significant relationship between *final grade* and the variables mathematical anxiety ($F(2,180) = 5.03$, $p = .007$, $\eta^2 = .053$), math test anxiety ($F(2,179) = 3.47$, $p = .033$, $\eta^2 = .037$), math course anxiety ($F(2,180) = 6.53$, $p = .002$, $\eta^2 = .068$), enjoyment of mathematics ($F(2,177) = 5.09$, $p = .007$, $\eta^2 = .054$), self-confidence in mathematics ($F(2,176) = 5.92$, $p = .003$, $\eta^2 = .063$) and motivation regarding mathematics ($F(2,175) = 9.25$, $p < .001$, $\eta^2 = .096$). Post-hoc comparisons showed that the students who failed the course had more mathematical anxiety (in general), more math test anxiety , more math course anxiety and a lower level of enjoyment than those students with a grade of good/excellent. The results also showed that the students who failed the course reported a lower level of self-confidence and motivation regarding mathematics than those who passed and, at the same time, students who passed showed lower self-confidence and motivation than those who obtained a final grade of good/excellent. Table 1 shows mean differences between final grade groups (fail, pass and good/excellent) for the four measures of mathematical anxiety and the degree of enjoyment, self-confidence and motivation towards mathematics.

Insert Table 1 approximately here

4.2. ***Relationship between high school itinerary and final course grade.***

This section explores the relationship between students' high school itinerary and their grade on the course. The high school itineraries were grouped together in two categories according to their degree of mathematical content: low content (humanistic and social itineraries) and high content (scientific and technological itineraries). The results of the statistical analysis were marginally significant, showing that students who obtained good/excellent grades mainly came from the scientific and technological itineraries whilst those who failed had mainly studied the humanistic and social syllabuses (χ^2 = 4.63, p = .09). Figure 1 shows the percentage of students from each high school itinerary who failed, pass or obtained a good/excellent course grade.

Insert Figure 1 approximately here

4.3. ***Relationship between high school itinerary, mathematical anxiety and attitudes towards mathematics.***

In this third section we analyzed the relationship between students' itinerary at high school, their level of mathematical anxiety and their attitudes towards mathematics. Students coming from the humanistic and social high school itineraries showed a greater level of mathematical anxiety ($t(164) = 4.38$ $p < .001$), math test anxiety ($t(163) = 3.43$ $p = .001$), numerical task anxiety $t(164) = 4.32$ $p < .001$) and math course anxiety

($t(164) = 3.83$ $p < .001$) than their scientific and technological peers. Regarding attitudes towards mathematics, the students from the humanistic and social itineraries reported a lower level of enjoyment ($t(163) = 7.03$, $p < .001$), self-confidence ($t(163) = 5.20$, $p < .001$) and motivation regarding mathematics ($t(163) = 7.71$, $p < .001$) than the students from the high school itineraries with higher mathematical content. Table 2 shows the means and standard errors for the four measures of mathematics anxiety and for the enjoyment, self-confidence and motivation regarding mathematics according to their high school itinerary.

Insert Table 2 approximately here.

4.4. Relationship between mathematical anxiety, attitudes towards mathematics and the different evidence from students´ continuous assessment.

In this section we show the results of the analysis studying the relationship between mathematical anxiety, attitudes towards mathematics and the grades from the continuous assessments. Table 3 shows that the correlation between the exam grade and the mathematical anxiety global score is negative ($r = -.237$; $p = .002$). Nevertheless, when we analyzed scores on the different subscales of the sMARS we found that this effect was due, on the one hand, to the relationship between the exam grade and the math test anxiety ($r = -.191$; $p = .014$) and, on the other, to the relationship between the grade and the math course anxiety ($r = -.341$; $p < .001$). The results also showed positive correlations between the exam grade and enjoyment ($r = .231$; $p = .003$), self-confidence ($r = .235$; $p = .003$) and motivation ($r = .270$; $p = .001$) towards mathematics. In other words, the students who obtained higher grades showed lower levels of mathematical anxiety (more specifically, lower levels of math test and math course anxiety) and a high degree of enjoyment, self-confidence and motivation regarding mathematics. Those effects were not present when the grades on the computer practical classes or the pair work assignment were analyzed.

Insert Table 3 approximately here

The results also show a negative correlation between the exam grade and trait anxiety (STAI-T) (r = - .164; p = .036). Nevertheless, the correlation index is higher with mathematical anxiety than with trait anxiety, which suggests that the mathematical anxiety is a different construct.

4.5. Relationship between exam grade, mathematical anxiety and attitudes towards mathematics: Regression analysis

We now explain exam grades (EG) using stepwise multiple regression analysis, which lets us control for many of the factors that influence grades. We first analyzed the model with mathematical anxiety, MTA, NTA and MCA, and attitudes towards mathematics, enjoyment (ENJOY), self-confidence (SCONF) and motivation (MOTIV):

$$\text{EG} = b_0 + b_1\text{MTA} + b_2\text{NTA} + b_3\text{MCA} + b_4\text{ENJOY} + b_5\text{SCONF} + b_6\text{MOTIV} + e \qquad (1)$$

where e is the error term, b_0 is the constant, b_i are the unstandardized estimated coefficients in the regression analysis for each of the explanatory variables defined previously. Unstandardized estimated coefficients represent the predicted change in the exam grade for a one-unit change in the explanatory variable when all other explanatory variables are held constant. The estimated coefficients and their associated *t*-statistics of equation (1) are shown in Table 4.

We analyzed a second equation in which we use only attitudes towards mathematics as explanatory variables. We estimate the following equation:

$$EG = b_0 + b_1 ENJOY + b_2 SCONF + b_3 MOTIV + e \qquad (2)$$

As with the prior equation, e is the error term, b_0 is the constant, b_i are the unstandardized estimated coefficients in the regression analysis for each of the explanatory variables. Unstandardized estimated regression coefficients are interpreted in the same manner as in the first equation. Results from equation (2) are presented in Table 4.

Insert Table 4 approximately here

The results show a negative relationship between EG and MCA in equation (1): students with higher levels of MCA have lower exam grades (b_3 = -0.803). In equation (2) the highest levels for motivation correspond to the highest exam grade (b_3 = 2.516). It is worth noting that the first model is better because it explains a higher proportion of the variance with the predictor MCA (R^2 = 0.119, F (1,158) = 21.338, p < .001) than does the second model with the predictor motivation (R^2 = 0.073, F (1,159) = 12.482, p = .001).

5. DISCUSSION

5.1. General discussion

This study demonstrates that mathematical anxiety and negative attitudes towards mathematics can affect the performance of students on the Research Design course. Students who did not pass this course show a higher level of mathematical anxiety (more specifically, of math test and math course anxiety) and a lower level of enjoyment, motivation and self-confidence in mathematics than those who passed it. The lack of relationship between failure on the course and the numerical task anxiety factor is an interesting finding. This factor includes items regarding daily situations in which mathematics might be involved (e.g. Reading a cash register receipt after making a purchase) and four items related to a set of different mathematical problems to be solved. Consequently, the present study shows that the failure on the Research Design course is only related to aspects of the mathematical anxiety that are to do with taking a course in mathematics and being assessed on it. In fact, the stepwise multiple regression results allowed us to conclude that math course anxiety is quantitatively the most influential factor in explaining the lower level in the exam grades of these university students. To sum up, our work supports the previous evidence regarding the negative influence of mathematical anxiety and negative attitudes towards mathematics on students' performance in academic fields with a high mathematical component (Hunsley, 1987; Lalonde & Gradner, 1993), and suggests that these factors have to be considered in order to improve the students' learning processes.

This study also shows that students coming from humanistic or social high school itineraries (both with low mathematical content) have high levels of mathematical anxiety (as reflected in all its three factors). These students also have negative attitudes towards mathematics and obtain low grades in the final exam. These results are in accordance with those reported by LeFevre et al. (1992), who found that students with worse attitudes towards mathematics tend to choose degrees with lower mathematical content and to avoid optional courses that involve mathematics.

In conclusion, the results of the present study show that math anxiety may affect students' success in their higher education studies. This result is relevant because workforce well-qualified in the STEM (Science, Technology, Engineering, and Mathematics) fields is needed in the 21th Century high technological society. Math anxiety does not only impacts on the decisions and career choices of young people today, but also on the achievement of university students when they have to take courses with high mathematical content.

5.2. Recommendations

Although the results of the present study clearly demonstrate that the students' final grade on the Research Design course may be influenced by emotional and attitudinal factors, this study is limited by the fact that no intervention programs for these students were evaluated. In future research it would be interesting to examine the ability of intervention programs to decrease the impact of these factors on students' academic results. Lalonde & Gardner (1993) presented a set of intervention programs for improving the learning processes of students who have difficulty with this type of course. They made three proposals. The first is the incorporation of leveling courses in statistics for students from high school itineraries with a lower mathematical content. The second is that students should carry out small projects during the course which have a very low impact on the final grade; this encourages them to acquire the habit of studying every day and to master the contents of the course gradually, without the pressure of having to perform well on the final exam. Indeed, our results have shown that mathematical anxiety and negative attitudes towards mathematics are associated with the grade in the final exam but not with the small-group assignments carried out during the course. This is because the assignments during the course allowed them to accumulate their total grade gradually, free from the pressure exerted by the presence of the single final exam. It is also widely demonstrated that small-group learning is effective in promoting academic achievement (Springer, Stanne & Donovan, 1999). Nevertheless, these results merit further investigation, since on our course the assignment grades were awarded to the whole group and not for the student individually – a factor that can also explain the lack of relationship between the grades on these assessments and the affective and emotional factors we examined. Lalonde & Gardner (1993)'s third proposal for increasing students' interest in courses with mathematical content involves the carrying out of simple research projects in which they collect their own data and develop their own analysis (see also Garfield, 1995 and Sciutto, 1995).

It is worth highlighting that Jackson and Leffingwell (1999) pointed out that negative experiences in mathematics classes from kindergarten through college may create math anxiety in students. In fact, the role of instructor behavior and teaching mathematics techniques in creating math anxiety have been studied as an underlying cause of math anxiety (Furner & González-DeHass, 2011). Willians (1988) stated that mathematics anxiety has its roots in teaching and in teachers of mathematics, and Tobias (1993) reported that teachers in their classes spread stereotypes concerning that not all students can be good at math because math ability is inborn. Recently, Beilock, Gunderson, Ramirez and Levine (2010) have demonstrated that teachers' math anxiety carries consequences for girls' math achievement by influencing girls' beliefs about who is good at math.

Because teachers can play an important role in creating math anxiety, their role in preventing and reducing the level of math anxiety in their students is also essential.

Furner and Gonzalez-DeHass (2011) suggest that teacher's instructional practice has to be focused on mastery goals instead of on performance goals. If mastery goals are emphasized students will not tend to focus on their ability and will not attribute their lack of ability as a cause for failure (Ames & Archer, 1988).

5.3. Summary

In conclusion, we consider that teachers giving courses with mathematical content at Primary, Secondary and University level should take into account the negative impact of affective factors on teaching/learning processes in mathematics and should incorporate intervention programs in order to mitigate this effect and optimize students' performance.

ACKNOWLEDGMENTS

This research was supported by Consolidated Group for Innovation in Teaching GIDCUB-11/DTI from the University of Barcelona and grants PSI2009-10364, PSI2012-35703, and BES-2010-036859 from the Spanish Ministry of Science and Technology.

REFERENCES

Alexander, L. & Martray, C. (1989). The development of an abbreviated version of the Mathematics Anxiety Rating Scale. *Measurement and Evaluation in Counseling and Development, 22*, 143-150.

Ames, C., & Archer, J. (1988). Achievement goals in the classroom: Students' learning strategies and motivation processes. *Journal of Educational Psychology, 80*(3), 260-267.

Ashcraft, M. H. & Faust, M. W. (1994). Mathematics anxiety and mental arithmetic performance: An exploratory investigation. *Cognition and Emotion*, *8*(2), 97-125.

Ashcraft, M. H. (2002). Math anxiety: Personal, educational and cognitive consequences. *Current Directions in Psychological Science, 11*(5), 181-185.

Ashcraft, M. H., Kirk, E. P. & Hopko, D. (2000). On the cognitive consequences of mathematics anxiety. In *The development of mathematical skills,* ed. Donlan C., 175-196. New York: Psychology Press.

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

Carbonero, M. A., Martin, L. J. & Arranz, E. (1998). Expectativas ante las matemática de alumnos de primer ciclo de Educación Secundaria. *Revista de psicodidáctica, 6,* 69-78.

Furner, J.J., & Gonzalez-DeHass, A. (2011). HOw do students' mastery and performance goals relate to math anxiety? *Eurasia Journal of Mathematics, Science, & Technology Education, 7*(4), 167-182.

Garfield, J. (1995). How students learn statistics. *International Statistical Review, 63,* 25-34.

Gil, N., Blanco, L. J. & Guerrero, E. (2005). El dominio afectivo en el aprendizaje de las matemáticas. Una revisión de sus descriptores básicos. *Revista iberoamericana de educación matemática, 2*, 19-32.

Gómez Chacón, I. M. (2000). La alfabetización emocional en educación matemática: actitudes, emociones y creencias. *Uno, 13*, 7-22.

Hernández, R. P. & Gómez-Chacón, I. M. (1997). Las actitudes en educación matemática. Estrategias para el cambio. *Uno, 13,* 41-61.

Hundley, J. (1987). Cognitive processes in mathematics anxiety and test anxiety: the role of appraisals, internal dialogue and attributions. *Journal of Educational Psychology, 79*(4), 388-392.

Jackson, C. C., and Leffingwell, R. J. (1999). The role of instructor in creating math anxiety in students from kindergarten through college. *Mathematics Teacher, 92*(7), 583-586.

Lalonde, R. N. & Gardner, R. C. (1993). Statistics as a second language? A model for predicting performance in psychology students. *Canadian Journal of Behavioral Science*, *25*(1), 108-125.

LeFevre, J., Kulak, A. G. & Heymans, S. L. (1992). Factors influencing the selection of university majors varying in mathematical content. *Canadian Journal of Behavioral Science*, *24*(3), 276-289.

McLeod, D. B. (1988). Affective issues in mathematical problem solving: Some theoretical considerations. *Journal for Research Mathematics Education, 19,* 134-141.

McLeod, D. B. (1992). Research on affect in mathematics education: A reconceptualization. In *Handbook of research on mathematics teaching and learning*, ed. D. A. Grows, 593. Nueva York: Macmillan: NCTM.

McLeod, D. B. (1994). Research on affect and mathematics learning in the JRME: 1970 to the present. *Journal for Research Mathematics Education, 25*(6), 637-647.

Núñez-Peña, M. I., Suárez-Pellicioni, M., Guilera, G. & Mercadé-Carranza, C. (2012). A Spanish version of the short Mathematics Rating Scale (sMARS). Paper presented at the *V European Congress of Methodology*, Santiago de Compostela, Spain.

Richardson, F. C. & Suinn, R. M. (1972). The Mathematics Anxiety Rating Scale: Psychometric data. *Journal of Counseling Psychology, 19*, 551-554.

Sciutto, M. J. (1995). Student-centred methods for decreasing anxiety and increasing interest level in undergraduate statistics courses. *Journal of Instructional Psychology, 22*, 277-280.

Spielberger, C. D., Gorsuch, R., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). Manual for the State-Trait Anxiety Inventory. Palo Alto, CA: Consulting Psychologists Press. Spanish adaptation of the STAI by TEA Ediciones S.A. (3rd Edition). Madrid, 1988.

Springer, L., Stanne, M. E., Donovan, S. S. (1999). Effects of small-group learning on undergraduates in science, mathematics, engineering, and technology: A meta-analysis**.** *Review of Educational Research*, 69(1), 21-51.

Tejedor, B., Santos, M. A., García-Orza, J., Carratalà, P. & Navas, M. (2009). Variables explicativas de la ansiedad frente a las matemáticas: un estudio de una muestra de 6º de primaria. *Anuario de Psicología, 40*(3), 345-355.

Tobias, S. (1993) *Overcoming math anxiety revised and expanded.* New York: Norton.

Tobias, S. (1978). *Overcoming math anxiety*. Boston, Massachusetts: Houghton Mifflin Company.

Williams, W. V. (1988). Answers to questions about math anxiety. *Scholl Science and Mathematics*, *88*(2), 95-104.

FIGURE CAPTIONS

Figure 1: Percentage of students from each high school itinerary who failed, pass or obtained a good/excellent course grade.

Table 1. Mean differences between final grade groups (Fail, Pass and Good/Excellent) for mathematical anxiety, mathematical anxiety factors and attitudes towards mathematics.

Comparison	sMARS	MTA	NTA	MCA	Enjoyment	Self-confidence	Motivation
Fail - Good/ Excellent	8.7 *	4.7 *	1.5	2.4 *	-.58 *	-.49	-.62
Fail - Pass	2.6	1.0	.27	1.3	-.47	-.53 *	-.73 **
Pass - Good/ Excellent	6.0	3.6	1.3	1.1	-.11	.03 *	.11 *

* $.05 \geq p > .001$; ** $p \leq .001$

Note. sMARS: Shortened Math Anxiety Rating Scale; MTA: Math Test Anxiety factor from the sMARS; NTA: Number Task Anxiety factor from the sMARS; MCA: Math Course Anxiety factor from the sMARS.

Table 2. Means and standard error (in brackets) for mathematical anxiety, mathematical anxiety factors and attitudes towards mathematics depending on the high school itinerary.

High School itinerary	sMARS	MTA	NTA	MCA	Enjoyment	Self-confidence	Motivation
H-So	69.1 (1.5)	48.2 (0.9)	10.3 (0.4)	10.6 (0.4)	2.3 (0.1)	2.5 (0.1)	2.3 (0.1)
Sc-T	57.9 (2.1)	42.3 (1.4)	7.5 (0.4)	8.3 (0.4)	3.4 (0.1)	3.2 (0.1)	3.4 (0.1)

Note. H: Humanistic; So: Social; Sc: Scientific; T: Technological; sMARS: Shortened Math Anxiety Rating Scale; MTA: Math Test Anxiety factor from the sMARS; NTA: Number Task Anxiety factor from the sMARS; MCA: Math Course Anxiety factor from the sMARS.

Table 3. Correlations between the different grades at the course and mathematical anxiety, mathematical anxiety factors, attitudes towards mathematics and state-trait anxiety.

	sMARS	**MTA**	**NTA**	**MCA**	**Enjoy ment**	**Self-Confidence**	**Motivation**	**STAI-S**	**STAI-T**
Exam grade	- .237**	-.191*	-.090	-.341**	.231**	.235**	.270**	- .139	- .164*
CPC	- .065	-.045	-0.40	-.098	.002	.070	.026	- .032	- .001
PW	.008	.034	-.022	-.059	.001	- .070	- .029	.060	.130
Final grade	-.224**	-.189	-.067	-.342**	.213**	.194*	.275**	-.133	- .132

* p< .05 **p< .01

Note. sMARS: Shortened Math Anxiety Rating Scale; MTA: Math Test Anxiety factor from the sMARS; NTA: Number Task Anxiety factor from the sMARS; MCA: Math Course Anxiety factor from the sMARS; STAI: State-Trait Anxiety Inventory, -S: state, -T: trait; CPC: Computer practical classes; PW: Pair work assignment.

Table 4. Stepwise multiple regression results using equations 1 and 2

	Equation 1		Equation 2	
	Estimated		Estimated	
Predictors	coefficient	*t*-ratio	coefficient	*t*-ratio
Constant	37.623	20.146**	22.868	11.235**
MTA	0.056	0.574		
NTA	0.145	1.636		
MCA	-0.803	-4.619**		
ENJOY	0.096	1.162	0.016	0.116
SCONF	0.110	1.336	0.088	0.790
MOTIV	0.127	1.474	2.516	3.533**

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