STEREOTYPES ABOUT MATHEMATICS AND WOMEN: SEX DIFFERENCES IN MATHEMATICS ANXIETY OF COMMUNICATION STUDENTS[1]

ESTEREOTIPOS SOBRE MATEMÁTICAS Y MUJERES: DIFERENCIAS POR SEXO EN LA ANSIEDAD MATEMÁTICA DE ESTUDIANTES DE COMUNICACIÓN

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Abstract

Citizens are required to understand an increasingly datafied reality to perform sensible decision making and be active participants in society. However, our ability to grasp that complexity, especially when it involves data in the form of numbers, is affected by limiting factors such as mathematics anxiety. In the case of women, how they face the reading of content based on data or numbers affects their daily lives, including career choice. Playing a central mediating role in transmitting increasingly datafied information, journalism is an interesting research object. This study examines the notion that journalism students –especially female students– are «bad with numbers» through the measurement of math anxiety of 185 Communication students, looking for correlations with their math competency. Results show that students manifest a low competency in math, paired with high

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math anxiety, which is the factor that best serves as an explanation for competency results. Specifically, only students with medium-low values of math anxiety pass the competency test. However, no sex differences were found in competency, while small differences in math anxiety (with women displaying slightly higher anxiety values than men) were identified. Even if the minor sex differences in math anxiety found in this study are not statistically significant, investigating whether this is also the case in other fields or in a random sample remains relevant, as these results defy previous misunderstandings of women's capacities that are significant to understand the interactions of women with data.

Keywords: data journalism; open data; educommunication; mathematics education; anxiety; digital literacy.

Resumen

La ciudadanía se ve obligada a comprender una realidad cada vez más informatizada para poder tomar decisiones. Sin embargo, nuestra capacidad para captar esa complejidad, especialmente cuando se trata de datos en forma de números, se ve afectada por factores limitantes como la ansiedad matemática. En el caso de las mujeres, la forma en que se enfrentan a la lectura de contenidos basados en datos o números afecta su vida cotidiana, incluida la elección de carrera. Al desempeñar un papel central de mediación en la transmisión de una información cada vez más datificada, el periodismo es un interesante objeto de investigación. Este estudio examina la noción de que al alumnado de periodismo –especialmente a las estudiantes– «se les dan mal los números» a través de la medición de la ansiedad matemática de 185 estudiantes de Comunicación y la detección de correlaciones con su competencia matemática. Los resultados muestran que el alumnado manifiesta una baja competencia matemática, emparejada con una ansiedad matemática alta. En concreto, solo estudiantes con valores medios-bajos de ansiedad matemática superan la prueba de competencia. Sin embargo, no se encontraron diferencias en desempeño entre hombres y mujeres, aunque estas enfrentan un nivel de ansiedad ligeramente más alto. Aunque las diferencias en ansiedad matemática encontradas en este estudio no son estadísticamente significativas, investigar si esto también ocurre en otros campos sigue siendo relevante, ya que estos resultados desafían los malentendidos y estereotipos sobre las capacidades de las mujeres.

Palabras clave: periodismo de datos; datos abiertos; educomunicación; educación matemática; ansiedad; alfabetización digital.

1. INTRODUCTION

Unlike men, women are exposed to stereotype threat when performing any kind of mathematical operations, either in everyday life or in academic contexts (Ganley et al., 2013; Maloney et al., 2013): the feeling that failure is expected makes them more anxious and more prone to performing poorly. Thus, they are considered here forms of antifeminist resistance or «reaction(s) against [gender equality] that seeks to prevent further change from happening and reverse those changes already achieved» (Flood et al., 2021, pp. 394-395). For this reason, it is crucial to examine how these happen and explore strategies to overcome them. This article precisely measures mathematics anxiety and its interaction with mathematics performance of Communication students.

Reality is becoming increasingly complex in what is mistakenly and interchangeably referred to as «knowledge» or «information» society, where ICTs are becoming more and more relevant. Despite their differences, this frequent pairing of information and knowledge can be explained through what is known in the areas of information management systems or information technology as the *hierarchy of knowledge* or *knowledge pyramid*. The knowledge pyramid identifies and describes «the processes involved in the transformation of an entity at a lower level in the hierarchy (e.g., data) to an entity at a higher level in the hierarchy», such as information or knowledge (Rowley, 2007, p. 164).

In this paradigm, participating citizens, who generate social change through their actions, need to reach an understanding of a reality that is increasingly complex; they construct knowledge through complex interactions with their environment, whether by assimilating information transmitted by others or by resorting directly to the source, to data.

Furthermore, with the development of ICT, the connected and always available digital environment has given rise to a «data revolution», defined by two factors: first, «[a]n explosion in the volume of data, the speed with which data are produced, the number of producers of data, the dissemination of data, and the range of things on which there is data»; and, second, «[a] growing demand for data from all parts of society» (UN Secretary-General's

Independent Expert Advisory Group on the Data Revolution for Sustainable Development, 2014, p. 6).

Data availability is constantly increasing and their use for decision-making in all areas is the norm in *data society*. In our digitised era, where all kinds of content, including data, are stored in computer-readable formats composed of bits (or binary digits), transforming data into information generally means data analysis, which refers to the statistical analysis of number-based data sets.

Numbers are, thus, unavoidable: and along with the increase in the existence and availability of these large volumes of data, the need to develop abilities to manage and understand numbers and learn from them grows accordingly (Wurman, 1989, p. 32). This training should be extended to the general public, but is particularly relevant for journalists, given their role as intermediaries and interpreters of reality.

The intermediary role of journalism in this transformative process is at the foundation of the very definition of journalism as a discipline: it must become a «*Sense Maker*, […] put events in context in a way that turns information into knowledge» (Kovach & Rosenstiel, 2014, p. 27). At the same time, journalism retains the task of «verify[ing] what information is reliable» (Kovach & Rosenstiel, 2014, p. 27), and its capacity to perform and verify transformations of data into information is essential. For journalism, «[n] umbers have become as essential as words […] to explain what is happening in our world» (Maier, 2002, p. 507).

Data Journalism (DJ) is presented as part of the response to this requirement, reformulating «precision journalism» (Meyer, 1973); data journalism deals with the access and analysis of datasets, offering them to its audience. It has popularised some of the processes and performance habits that bring some traditional data analysis, computer science and programming roles closer to the newsroom and the area of journalism. In other words, DJ refers to the combination of «the traditional 'nose for news' and [an] ability to tell a compelling story with the sheer scale and range of digital information now available […] at any stage of the journalist's process» (Bradshaw, in Gray et al., 2012, p. 2).

Even though there is a widespread notion that at least a basic numerical ability is required for journalism, the relationship between journalists and numbers has never been easy. What is more, «[m]athematical incompetence among journalists is legendary» (Maier, 2002, p. 507), and the perspective towards the closest future is not propitious if we look at the preferences of upcoming professionals: «[t]eachers of data journalism will be familiar with the complaint from students that 'I'm not good at maths' or, perhaps more worryingly, 'I'm not good with technology'» (Bradshaw, 2018, p. 56).

Given this reputation and negative inclination from journalistic profiles towards numbers and technology, training Journalism and Communication students in these tasks seems complicated. When considering the incorporation of DJ into journalism curricula, the need for the required contents and tools for the exercise of DJ are typically considered. Still, the widespread initial reluctance among students –a symptom of their mathematics anxiety– has not been addressed directly so far.

The construct of mathematics anxiety (MA) offers a reference framework that contributes to the understanding of the reluctance of journalists towards data and everything related to numbers. Appearing for the first time in the academic literature under the term «matemaphobia» (Gough, 1954), MA is generally defined as involving «feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations» (Richardson & Suinn, 1972, p. 551).

People suffering from this kind of anxiety directly avoid exposure to numbers (Ashcraft, 2002; Betz, 1978); in addition, MA is attributed with a strong negative effect on mathematics performance (Dreger & Aiken, 1957; Hembree, 1990). Consequently, insisting on teaching mathematical abilities to journalism students might not have the effect of improving their performance, in the cases where MA interferes.

Specialised literature also indicates that anxiety –along with avoidance behaviours in situations with potential exposure to numbers– and the negative effect of anxiety on mathematics performance, increase in the case of women (Baus & Welch, 2008; Betz, 1978; Dowker et al., 2016; Harriss Dew et al., 1983). Women manifest higher levels of MA in almost every case (Ma, 1999, p. 523), especially among university students (Hembree, 1990, p. 40).

Even though recent studies have largely dismissed the myth that men get higher marks in mathematics, at least in countries where education is equal for both sexes (Devine et al., 2012, p. 5; Spelke, cited in Dowker et al., 2016, p. 7), women continue regarding themselves as inferior to men and expressing higher levels of MA (Devine et al., 2012; Dowker et al., 2016; Hembree, 1990). This higher MA, however, does not seem to result in a proportional effect on performance or mathematics avoidance, which could be explained, according to Hembree (1990), by two hypotheses: it could be that women can manage their own anxiety better than men; or it could also be that women are more likely to manifest their anxiety than men (Ashcraft, 2002, p.45). The stereotype threat theory suggests that it is more common for women to report higher anxiety levels overall (Steele, cited in Baus & Welch, 2008, p. 291); and that they do so even in areas where they are traditionally regarded as more capable than men, such as language learning (Park & French, cited in Dowker et al., 2016, p. 7).

Sex differences in MA could be explained through the stereotyped belief about how women should feel about mathematics, more than through their actual ability or real experimented anxiety. This notion is reinforced by studies showing that, even though women display higher MA as a trait[2] than men, this is not the case (values for both sexes match) when asked about their MA as a state, in real-time, directly before and after a mathematics examination (Goetz et al., 2013). A possible explanation for this is that «girls do not in fact experience so much more mathematics anxiety than boys, but […] due to gender stereotypes they *expect* to experience more mathematics anxiety» (Dowker et al., 2016, p. 8), and thus report higher MA levels.

Women tend to express higher levels of MA than men, but the reasons behind this difference and the potential consequences in performance for both sexes are complex. It is especially problematic in a field like journalism, in which university enrolment has been predominantly female since academic journalism training first emerged (Franks, 2013). Although this sex distribution is not extended to the professional context, the yearly report

2. In psychology, and particularly in studies about anxiety, anxiety as a trait and anxiety as a state are distinguished. Anxiety as a trait is understood as a personality characteristic, has long term effects, and is manifested through behaviour, actions, and emotions. Anxiety as a state, on the other hand, refers to a temporary circumstance in which anxiety is manifested in response to a stimulus; once the stimulus disappears, anxiety disappears accordingly.

of the journalistic profession in Spain for 2017 stated that a more significant presence of women was found in almost all modalities identified as «new professional profiles», including «data journalists», «data and traffic analysts», and «data visualizer» (Asociación de la Prensa de Madrid, 2017, p. 57). MA and its potential relationship with gender are thus of particular interest, more so when there is evidence that MA, especially in the case of women, is not indicative of actual mathematics ability, but has the potential to impair its application, hurt performance, and trigger avoidance behaviours, with the loss of capacities this would imply for Journalism studies and, subsequently, newsrooms.

At the same time, and despite the efforts carried out in the last decades to incorporate women to STEM studies and professional careers, figures do not seem to follow and women are still under-represented (Smith, 2011) both in the academic and professional fields (Moss-Racusin et al., 2021). This has obvious detrimental effects in terms of intellectual inclusivity and global competitiveness in fields of increasing relevance today. To attract and retain women in STEM and have them play active roles in areas such as AI or algorithmic design, MA research might serve as a significant factor in understanding causes for dropout, lower enrolment and in policymaking and curriculum design (Beilock & Maloney, 2015).

Through a case study, this investigation analyses the construct of MA in the context of Journalism studies and the effect of its prevalence in the acquisition and application of the required knowledge and abilities for the exercise of DJ. The case study has gained popularity among the Social Sciences in general and in education research (Álvarez Álvarez & San Fabián Maroto, 2012). It is a technique to «inform about complex education realities, kept hidden by everyday patterns, to understand internal processes and discover dilemmas and contradictions, promoting reflection on practices» and helps «orient decision making around educational problems» (Álvarez Álvarez & San Fabián Maroto, 2012, p. 4).

This case study uses a convenience sample: students of the Communication Degree from the University of Deusto, Spain. The impossibility to generalize research results is one of the most common critiques of case studies, even though in approaches like this one, «it is not so convenient to talk about ‘generalization,’ but instead of ‘transfer’» (Álvarez Álvarez & San Fabián

Maroto, 2012, p. 5). To promote this transferability, both the instruments employed, including the full questionnaires, and the anonymized data and analysis are available through an Open Science Framework data repository (Berasategi Zeberio, 2023).

Through this case study, we identify the interference of MA levels on student performance, a key element to design educational proposals to develop and improve the knowledge and abilities required to perform DJ projects. Some guidelines for this design are also offered so they are transferable to a context like the one studied here. It seeks to respond to the following research questions: Does students' MA interfere in their math performance? Is there any sex difference in either MA or math performance?

The structure of the article is as follows: first, materials and methods used for data collection are specified. Second, collected data are analysed to establish levels of math anxiety and maths performance, as well as the interaction between them, with the aim of identifying potential sex differences. And third, some suggestions for alleviating the harmful effect of math anxiety in mathematics performance are given, relevant to Communication studies, before finishing with concluding remarks. All the tables and figures are designed by the author.

2. MATERIAL AND METHODS

To respond to the research questions, both student MA and mathematics performance were measured. Thus, the effect of MA on the specific aspects of mathematics performance that are most relevant for the exercise of DJ could be established.

MA has traditionally been measured using questionnaires that inquire about situations related to mathematics that could potentially trigger anxiety (Dowker et al., 2016, p.4). The panorama for MA measurement instruments is complex, with multiple questionnaires applied in different studies. However, there is a consensus that «the reliability of mathematics anxiety questionnaires has generally been found to be good» (Dowker et al., 2016, p. 5), and «researchers' decisions on what instruments to use do not seem to affect analytic results found» either regarding MA or its effect on performance (Ma, 1999, p. 534).

This investigation employed the Alexander and Martray's questionnaire (1989), generally referred to as RMARS (or «Reduced Math Anxiety Rating Scale»), for various reasons. First, because it contains a reasonable number of 25 items, which allows for not-too-extended response times; second, because it is the most widespread version in literature for the measurement of MA; and third, given the importance of offering students instruments in their most familiar language, to avoid the need for mental translations and thus overloading their working memory (Dehaene et al., 1999). Because there is a validated translation into Spanish, the language most students chose to answer the questionnaire, it is used directly in this study (Núñez Peña et al., 2013). However, the linguistic reality of our context requires questionnaires to be offered not only in Spanish, but also in Basque. Therefore, along with the Spanish translation by Núñez Peña et al. (2013), a Basque version specifically designed for this study was also used[3].

RMARS is a reduced 25-item version of the «Math Anxiety Rating Scale», or MARS (Richardson & Suinn, 1972), that measures MA by presenting 25 situations that could trigger anxiety. It is generally recognized that it divides into three different factors: «Mathematics examination anxiety», «Mathematics task anxiety» and «Mathematics course anxiety». To complete this questionnaire, the respondents need to use a 1 («not anxious at all») to 5 («very anxious») Likert scale. Students were given 10 minutes to respond to this questionnaire.

The detrimental effect of MA on mathematics performance is established from the very first initial conceptualization in the pioneering works of Gough's (1954) and Dreger & Aiken (1957). However, the measurements methods of mathematics performance employed to establish this effect have been diverse over time (Ma, 1999, p. 526).

Given that this research is focused on journalism, the specific requirements of journalistic dealing with numbers are to be evaluated. Thus, it is necessary to identify an *ad hoc* tool to measure this aspect of mathematics. With that in mind, the *Math Competency Test for Journalists* (Meyer & Poynter Institute, 1998) has been the instrument of choice to measure mathematics performance.

3. All translations by the author.

Developed by CAR pioneer and creator of precision journalism Philip Meyer, the Math Competency Test for Journalists, or MCTJ, is a 25-item test, with four possible answers each, that values the ability to apply basic mathematics (e.g., calculating percent changes) to everyday problems faced by journalists (e.g., communicating the percent change of a salary). It has been used by many universities to evaluate undergraduate and postgraduate students (Maier & Curtin, 2004) and in professional fields as a requirement to hire journalists in newsrooms (Maier, 2003, p. 925).

Compared to a general mathematics performance measure, MCTJ allows measuring MA's interference in areas that are of specific interest to journalism more precisely, specifically when carrying out DJ projects. As with the RMARS questionnaire, the MCTJ questionnaire was offered in Spanish and Basque translations to allow respondents to pick their preferred language. Students were given 20 minutes to respond to this questionnaire.

Participants were offered the options «female», «male», and «other» to verify whether there are any sex differences in either students' MA, or mathematics performance, or the effect that MA might have on mathematics performance.

To explore other variables that could explain MA (and mathematics performance as well), demographic data were also collected through the questionnaire, including baccalaureate itinerary, centre, or centre type where the baccalaureate was studied; town or size of the town where baccalaureate was studied; and degree, year, and language in which they are studying.

To sum up, the specific instruments chosen to collect the data for this study, either in Spanish or Basque (depending on participants' choice), were RMARS by Alexander and Martray (1989) to measure MA, and MCTJ by Meyer and Poynter Institute (1998) to measure mathematics performance, alongside the demographic data.

They were collected over the total census of Communication students at the University of Deusto (274 students), during the 2017/2018 academic year. After signing the informed consent form to participate in the study, the responses were processed for analysis using the statistical computing software R (R Core Team, 2018). The total number of valid responses were 185, representing a response rate of 67.5%.

The age of participants was between 18 and 27, with most of them (75%) between 18 and 21. Regarding gender, 115 responses were by women, 66 by men, and 2 declared other genders (62.2%, 35.5%, and 1.1%, respectively). About languages, 56.8% (105 students) decided to respond to the questionnaire in Spanish and 43.2% (80 students) did so in Basque.

The validity of instruments and their translations was checked by analysing their factor structure (Lê et al., 2008). Translated versions displayed the same factor structure in both languages: therefore, they are considered equivalent instruments, and this allows a joint reading of results, without having to separate the analysis by language.

3. ANALYSIS AND RESULTS

In this section MA and math performance results are shown and analysed.

3.1. Math Anxiety

A MA value for each participant was calculated by the sum of all the values given in each response of RMARS (Alexander & Martray, 1989), with possible values ranging between 25 and 125 points. To facilitate reading these results, they were transformed into a scale between 0 and 100. The statistical summary of the global results of RMARS is shown in Table 1. Responding students displayed an average of almost 45 points out of 100 of MA, with 19.43 points of standard deviation.

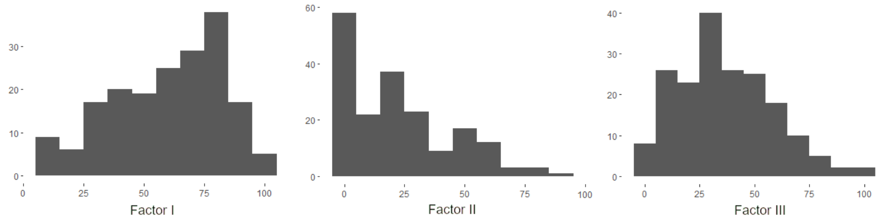
Table 1. RMARS results summary

Min.	Q1	Median	Average	Q3	Max.
4.0	30.0	45.0	44.4	57.0	94.0

Looking at factor analysis allows for greater nuance in these global results for MA, which seem to indicate that students did not display very high levels of MA (with both the average and the median below 50 points over 100). Figure 1 shows the value distribution for the three factors, obtained through factor analysis (Lê et al., 2008) and hierarchical grouping or clustering of variables (Chavent et al., 2011): Factor I, or «Mathematics examination anxiety»;

Factor II, or «Mathematical task anxiety»; and Factor III, or «Mathematics course anxiety».

Figure 1. Value distribution of MA factors

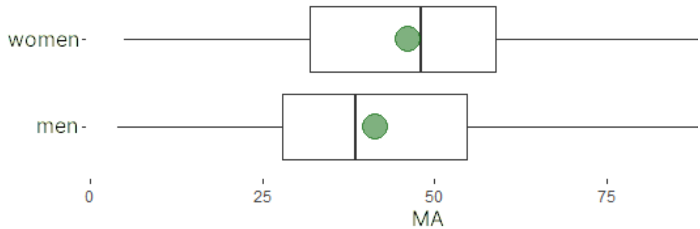


This analysis allows seeing that the global figures shown in Table 1 hide students' anxiety regarding FI «Mathematics examination anxiety», which presents very high values. However, these high values are compensated by the lower values in the other two factors, which considerably moderate the global MA result. Even though global MA gets medium results (with both the average and median at around 45/100 points), this closer reading shows that mathematics examinations trigger high to very high anxiety results.

Thus, mathematics examinations (Factor I) constitute the most significant anxiety-inducing factor for students, with a large difference, with no individuals displaying 0% anxiety and a median placed at around 65 points over 100.

When looking at MA results by sex, average values display minor differences in overall values and in values divided by factors, with women always obtaining slightly higher average values than men. Figure 2 shows a boxplot of the statistical summary of these results. The green dot represents the average, the left-hand end of the horizontal line is the minimum value, and the right-hand end is the maximum value (excluding outliers). The box is drawn from Q1 to Q3, divided by a vertical line representing the median value. These sex differences, as the graphic displays, are not however very significant, with the exception, perhaps, of average values for FI «Mathematics examination anxiety», where women get an average of 7.36 points above that of men.

Figure 2. Boxplot with overall MA results, by sex



Student T-Value calculations for sex and the overall and factor values of MA also corroborate that sex differences in MA results are not statistically significant, except for FI «Mathematics examination anxiety», with a p-value below 0.05 of 0.03848. The main difference is in the median value, with a difference larger than 10 points: women display not only higher average values for FI of MA, but more women present high values than men in this factor as well.

From the analysis of the data displayed in this section, it can be concluded that Communication students display moderate levels of MA, although slightly higher than students from other related disciplines analysed in other studies. The main contributor to their MA is mathematics examination anxiety (or FI). At the same time, slight sex differences can be found only in FI, with women displaying slightly higher values of mathematics examination anxiety, which are barely statistically significant.

3.2. Math Performance

Once the results of MA have been analysed, the second central element of this study is performance in mathematics, measured in this case through the Mathematics Competency Test for Journalists or MCTJ (Meyer & Poynter Institute, 1998). In order to eliminate the effect of randomness on obtained scores, correct answers were scored 1 point; blank answers, 0 points, and incorrect or null answers –0.33 points. 14 students (7.54%) left one-third (9) or more of the answers blank, and 5 questions had 20% or more blank answers. A value for mathematics performance was obtained by the sum of scores in each answer, with possible results ranging between 0 and 25 points.

As in the calculation of the values for MA, to facilitate their reading, MCTJ values were normalised to a scale between 0 and 100.

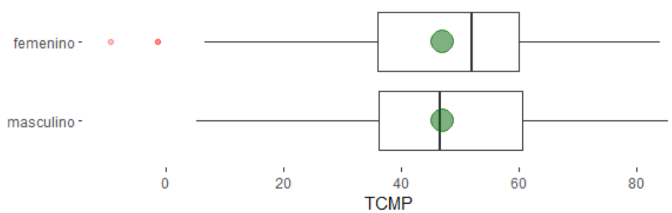
The statistical summary of the global values for mathematics performance measured through the MCTJ is shown in 1. Both the average and the median are below 50 points out of 100, which allows the statement that participants in the study display, overall, a low mathematics performance. Additionally, the minimum value below 0 and the relative position of the average and median values, with the first below the second (with a negative asymmetry) indicate the existence of individuals with extremely low scores. In any case, 50% of obtained results is between 63.00 and 60.00 points, with a standard deviation of 14.7 points.

Table 2. Summary of MCTJ results

Min.	Q1	Median	Average	Q3	Max.
-9.5	36.0	48.0	47.1	60.0	85.3

Results divided by gender are almost identical for both men and women. However, both the median and the minimum value are different, as shown in Figure 3, where the small red dots represent outliers: the minimum score for women students in the MCTJ is determined by outlier values and, in fact, if these outliers are disregarded, results for both genders are even more similar. Both Q1 and Q3 figures are almost identical, and maximum, average, and even minimum values (once outliers are excluded) are very similar.

Figure 3. Boxplot with MCTJ results, by sex



The main difference between genders in MCTJ stands in that, on the one hand, for the group of men, the average and median are very close values while, on the other hand, the average and the median values are more distanced in the case of women. This implies that the results for women display a negative asymmetry, probably caused by the outlier values mentioned before. If these outlier values are excluded, performance results for the group of women are slightly above, overall, those of men, even though women do display a few (although outlier) extremely low scores. The Student T-Value seems to corroborate the fact that gender differences in MCTJ results are not statistically significant.

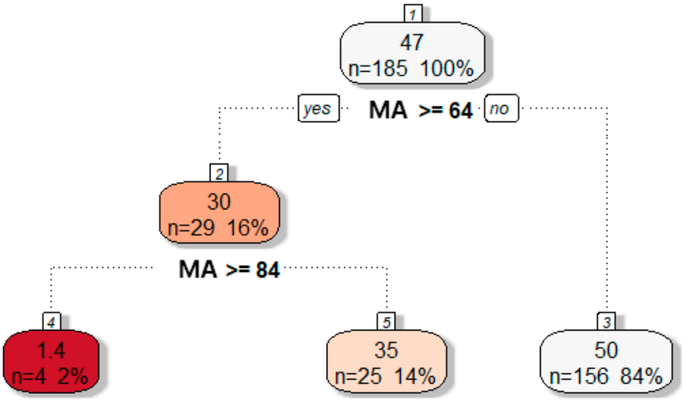
Ultimately, mathematics competency of Communication students who participated in this study is low. It is possible, however, as shown in the literature review, that these low marks in the MCTJ can be explained in large by the MA displayed by students. This aspect is analysed in the following section.

3.3. Explanatory value of Math Anxiety

The hypothesis that MA affects the mathematics performance of Communication students has been explored in this study through regression and classification trees, or CART (Breiman et al., 1984), using the Rpart package for R (Therneau & Atkinson, 2019).

Figure 4 shows the regression tree explaining the mathematical performance score considering all collected variables (including sex and demographic data) and using the overall value as a proxy for MA. When the MA is high (greater than or equal to 63.5 points), performance on average is lower than when the MA is not so high: the average MCTJ score is a failure grade with 30 points for the first group (with high MA), while it is a fair pass with 50 points for the second group (with a not-so-high MA). When the MA is exceptionally high (greater than or equal to 84 points), it has a devastating effect on performance (averaging 1.4 points out of 100 for MCTJ).

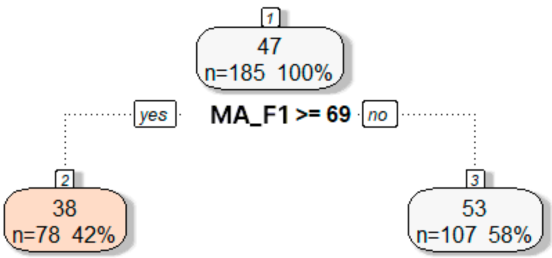
Figure 4. Regression tree for global values of MA



The same regression tree was created, considering all variables collected during the analysis, but using the values divided by factors as a representation of MA instead of its overall value. The objective constructing this second tree was to observe whether MA factors influence the performance outcome differently.

The resulting regression tree contains a single split, using the value of Factor I «Mathematics examination anxiety» as its criterion, as shown in Figure 5: when FI value is high (equal to or higher than 68.75 points), the mean for mathematical performance is a fail result with 38 points, and it is a pass grade otherwise, with 53 points.

Figure 5. Regression tree with factor values of MA



This regression analysis has consistently returned that the explanatory significance of sex, both for MA and MCTJ, is practically inexistent. In other words, as per the data gathered for this study, student sex is an irrelevant factor with a null predictive value of the mathematics performance and MA they display.

In summary, MA showed a predictive value or, in other words, a strong influence on mathematical performance outcomes above any other factor collected through demographic data such as sex, age or language. The data collected confirm that their levels of MA significantly impair mathematical performance of UD Communication students. More specifically, it appears to be mathematics examination anxiety (Factor I) that most clearly divides students who score on average poorly on the MCTJ from those who achieve a pass on average.

4. DISCUSSION

Although this analysis displays no significant sex differences in mathematics performance or MA of Communication students, other studies show that expectations of women's failure may affect their performance. MA and stereotypes might impact women's choices about what to study at university. Scholarship has shown that STEM fields are predominantly male, with lower participation among women (Makarova et al., 2019).

Whereas evidence has long dismissed the myth that men achieve higher results in mathematics, as mentioned earlier in this chapter, this has not diminished the stereotype at the same levels, and women continue regarding themselves as inferior to men in mathematics and other STEM fields, as well as expressing higher levels of MA (Devine et al., 2012; Dowker et al., 2016; Hembree, 1990). These sex differences in MA, then, could be explained through the stereotyped belief about how women should feel about mathematics, more than through their actual ability or real experimented anxiety. Given that avoidance is one of the first and strongest responses to MA (Ashcraft, 2002; Betz, 1978), its effect on the numbers of women enrolling in STEM university studies is clear.

Regarding Journalism and Communication studies, there is no discrepancy: female students of Communication present higher MA levels both than the general population and than students in other similar areas, such as Business studies (Baus & Welch, 2008, p. 298). It is also agreed that high levels of MA result in reduced math ability (Hembree, 1990, p. 34) not by diminishing their real capacity, but by impairing the mental resources necessary to put it to practice efficiently.

Meanwhile, data are omnipresent: incorporation of data journalism into Communication and Journalism curricula is urgent, and MA needs to be considered. To incorporate contents and skills necessary to carry out DJ (e.g., basic mathematics and statistics operation, use of spreadsheets, markup languages such as HTML, basic notions of programming for the web, data visualization, and basic statistical programming), some elements for curriculum design are suggested.

To reduce the impact of FI «Mathematics Examination Anxiety», which has been the main contributor to overall MA value in the case of Communication students, the number of objective tests should be reduced, and assessment should be made through continuous and qualitative tasks (Baus & Welch, 2008; Deieso & Fraser, 2018; Maier & Curtin, 2004). On the other hand, and with the aim of tackling the second predominant factor of students' MA (FIII «Mathematics Course Anxiety»), treatment proposals based on course structuring (Poindexter, 1997), increased exposure to mathematics –specifically through support tasks– (Dowker et al., 2016; Ramirez et al., 2018), and revaluation (Maier & Curtin, 2004; Ramirez et al., 2018) are worth considering.

These suggested techniques for dealing with MA can be shaped in a series of learning strategies that convey the required contents and serve as a method for reducing MA in students at the same time. These would be focusing on tasks rather than tools, so that students understand the underlying concepts and can switch tools with ease (Berret & Phillips, 2016, p. 30); organising content in incremental iterations in which the basic tasks of DJ –retrieval, treatment, analysis and communication of data– are performed repeatedly using techniques and tools of increasing complexity, from spreadsheets to basic visualization tools to statistical programming (Stewart et al., 2009); project-based work in cooperative groups (Bradshaw, 2018); and a flipped classroom approach (Peterson, 2015; Quint, 2015; Wilson, 2013), where conceptualisation occurs outside the classroom and face-to-face time is used to carry out numerical tasks.

Working in cooperative groups and flipped classroom, specifically, offer innumerable occasions to revaluate failure in executing tasks as a normal and necessary part of the learning process, instead of as a sign of incapacity (Ramirez et al., 2018, p. 157). In that sense, watching the efforts and even occasional failures of teachers in carrying out these tasks in the classroom might be of especial value: if the reference figure struggles and needs to put an effort in tasks, and even thus it might be that the result is not the one that is expected, students will probably value their own struggles and failures kindlier in a natural way. This has a clear reductive effect in MA, and thus can directly improve mathematics performance.

5. CONCLUSIONS

To conclude, this study attests that there are no significant sex differences in either mathematics performance or MA of Communication students. The only slight difference was observed in FI of MA, «Mathematics examination anxiety», which is not a very large difference. This mathematics examination anxiety, then, is the only aspect in which a slight sex difference is found, which agrees with findings from academic literature. Careful curriculum design and choice of methodology can help alleviate this specific aspect of MA.

However, it is worth considering that the group analysed in this study is not a representative sample of the general population; they are students of a degree (Communication) which traditionally and demonstrably has been picked by individuals conscious of a certain degree of MA. In other words, students choosing Communication studies at university often do so precisely as an avoidance strategy of exposure to numbers. What is more likely happening in this case is that students of both sexes are self-elected according to specific similar characteristics regarding MA. This does not imply that there are no actual sex differences; it is simply that the group analysed in this study is more homogeneous than the overall population, due precisely to their shared selection of a university degree.

In short, the construct of mathematics anxiety materialises and allows for analysing the widespread but not very precise notion that journalists (and journalism students) are not good with numbers, which constitutes a determining factor in explaining this inability, becoming a sort of self-fulfilling prophecy. The data analysed in this study attest that MA is a reality among Communication students and, therefore, while the incorporation of quantitative content into curricula is urgent, it is imperative to do so considering this trait.

In this way, future journalists will be able to retain their autonomy when transforming data into information to communicate to their audiences without depending on potentially biased third parties or self-interested interpretations. In an increasingly data-driven reality, journalists who are inquisitive with numbers are required; professionals who will not slacken the journalistic rigour they demonstrate in other aspects of their job.

Although the strategies outlined here to alleviate MA have been proposed in the context of Journalism and Communication studies, the under-representation of women in STEM fields seems to suggest that MA can constitute a significant topic for research in those fields as well. With avoidance as one of the most direct consequences of MA, STEM education might be explicitly avoided by women with only moderate levels of MA, thus reducing enrolment in higher education STEM degrees. Once that first hurdle has been overcome, identifying MA in students, and employing alleviation and coping strategies as the ones collected here could help reduce the effect of stereotype threat and dropout, and thus improve the mathematics performance of women in their STEM careers and in the professional field.

Academics and professionals should remain vigilant that mathematics anxiety, and its concurrent avoidance behaviours, do not diminish the presence of women in STEM and the specific areas of journalism requiring advanced management of data. Data literacy is increasingly relevant for understanding reality and, as such, for journalism to fulfil its goal of sense-maker.

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