MATHEMATICS ACHIEVEMENT:  
SEX DIFFERENCES VS. GENDER DIFFERENCES*  

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In this study our aim was to determine if there were significant differences in students’ (12-13 years old) mathematics achievement when differentiating them by sex (boys and girls) and by gender (masculine, feminine, androgynous and undifferentiated traits). 1056 students were given a mathematical test and the Bem Sex Inventory. Results confirm that there are no significant differences when considering sex, but there are significant differences when gender is taken into account. Students (boys and girls) with masculine traits do better. Girls surpassed boys in almost all the gender categories. The sample will be followed up for two more years in order to detect changes in achievement and gender traits.

BACKGROUND

Over the past three decades, a considerable number of studies seeking to determine a relationship between gender and mathematics learning have been conducted in various countries. In recent years research efforts (Fierros, 1999; Zhang and Manon, 2000; Johnson, 2000; Leahe and Guo, 2001; Ericikan, McCreith, and Lapointe, 2005) show no significant differences in achievement between boys and girls as they start getting acquainted with mathematics. Nonetheless, differences favoring male students begin to emerge with time (Campbell, 1995; Mullis y Stemler, 2002). Although these studies address gender-related differences, the distinction is usually made by sex, i.e. considering individuals’ biological characteristics rather than the sociocultural background that shapes their gender identity. However, gender and sex are not synonymous. Gender is a sociocultural construct, a category that sorts and organizes social relationships between human male and female (Lamas, 1986; Bustos, 1991, 1994; Gomariz, 1992; Barbieri, 1996; Scott, 1996). It is, gender is the outcome of a social, historic and cultural process that develops through practices, symbols, representations and social standards and values, and determines appropriate roles for men and women — all of this based on sex differentiation. Gender acquisition develops through a complex, individual social process. Sex, by contrast, refers to anatomical and physiological characteristics deriving from biology.

Since the seventies quantitative research began, where sex was considered as an independent variable that determined the kind of mathematics skills of men and women, based on their achievement, participation, and performance in this area. The results of these studies showed small differences between men and women, which did not allow to explain the reason for the dissimilarity in achievement, participation and performance in higher education, where more advanced math is taught (Atweh, 1995).

In the nineties, the need to consider other theories and methods to examine this fact became apparent. Thus, attention began to be paid to the social and cultural processes that boys and girls are subject to, which affect their math achievement, participation and performance. For example, Leder (1992) emphatically stated that the research paradigm used in reviewing the “women-math” issue should be replaced with “gender-math”, with emphasis on socialization processes and hidden cultural pressures, because female facts cannot be studied in isolation. Gender then emerges in the mathematics domain as an analysis category with a qualitative approach that considers the sociocultural elements in which individuals are embedded. However, when developing gender-maths studies we still very often differentiate individuals by sex (biological characteristics) rather than by gender (socio-cultural characteristics), in spite of the theories and instruments permitting to differentiate subjects by gender.

Since the seventies, as a criticism towards early views on gender roles which sustained that masculinity and femininity were opposite personality characteristics, two new theories began to develop. The gender identity model (Spence & Helmreich, 1978) and the androgyny model (Bem, 1974) promoted masculinity and femininity as separate and independent constructs. Bem contributed to this evolution in the study of gender roles by developing the concept of androgyne, having both masculine and feminine characteristics, and that of undifferentiated, having low masculine and feminine characteristics. In connection with this concept, Bem also developed a tool for the measurement of masculinity, femininity, and androgyny called the Bem Sex Role Inventory (BSRI).

THE STUDY

The study we are presenting is part of a longitudinal research investigating the relationship between mathematics achievement, sex and gender traits. We present here the results of the first phase of the study. Our first purpose was to investigate if there are significant differences when comparing achievement in mathematics’ performance when students 12-13 years old are differentiated by sex (boys and girls) and when they are differentiated by gender (masculine, feminine, androgynous and undifferentiated traits). During the next two years the same sample of students will be followed up. The results will show whether or not the same results are reached when conducting studies based on sex differences or on gender differences.

METHOD

A quantitative study was conducted with 1,056 students (50.7 % females and 49.3 % males) attending the first year of secondary school in Mexico. The mean age was 12.7 years old (d.s.= .53). Students were given two instruments (described below) in order to evaluate their mathematical achievement level and their gender traits.

Instruments

Mathematical knowledge

A 14 multi-choice items questionnaire, already validated and widely used for official testing in Mexico, was employed to test students’ mathematics knowledge. It aims at evaluating mathematics knowledge for students attending the first year of high-school
in Mexico. The items tackle students’ capabilities to work with basic mathematical concepts that students should have acquired during elementary school, and which are reviewed during the first secondary school year (divisors and dividends of numbers, proportion, percentages, addition and subtractions of fractions, simple probability, ratio, pre-algebra, basic data analysis).

Gender identification

To identify students’ gender the short version of the Bem Sex Role Inventory (BSRI) was used: a 30-statement questionnaire in a 5-point, Likert-type format, intended for psychological androgyny empiric research. It provides an independent evaluation of masculine (10 items) and feminine (10 items) traits, and the possibility to categorize those presenting androgynous or undifferentiated traits. Moreover there are 10 filler items. Depending on the score obtained a subject is considered to belong to one of the four gender categories. An individual is considered as androgynous if he/she gets high ratings for both masculinity and femininity, and as undifferentiated if he/she gets low ratings in both categories. Before using it with Mexican students, we verified that the masculine and feminine traits contemplated in the BSRI are the same as socially ascribed in our country. Reliability and validity testing of the thirty-item Spanish version of the Bem scale adapted for the purposes of this study have shown the reliability and validity of this instrument.

RESULTS

When analyzing the BSRI scores, one can immediately realize that it is not the same thing to talk about sex than to talk about gender (Table 1). The great majority of first year secondary boys and girls are distributed into the four categories (masculine, feminine, androgyny, undifferentiated). Two more categories were added, due to the fact that a small number of students got the same score proportion in two categories: masculine and undifferentiated (Masc-Undif) and feminine and undifferentiated (Fem-Undif).

<table>
<thead>
<tr>
<th>Sex</th>
<th>Gender</th>
<th>Masculine</th>
<th>Feminine</th>
<th>Androgyny</th>
<th>Undifferentiated</th>
<th>Masc-Undif</th>
<th>Fem-Undif</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls</td>
<td></td>
<td>10.4</td>
<td>20.7</td>
<td>41.8</td>
<td>20.9</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Boys</td>
<td></td>
<td>25.5</td>
<td>7.1</td>
<td>28.8</td>
<td>33.2</td>
<td>3.6</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Table 1 – Cross matrix table that shows the sample distribution in percentages for each of the categories regarding students’ sex

It is interesting that the majority of girls of this age (12-13) can be found in the androgyny category, that is, they tend to have both masculine and feminine characteristics strongly developed. On the other hand, the majority of the boys show undifferentiated traits, that is they have low masculine and feminine characteristics.
Our longitudinal study (in course) will provide evidence on how gender identity changes over time.

In order to establish the mathematical achievement level of the students, they were classified in two sets: the ones that had more than 60% correct answers in the knowledge test, and the ones that had less than 60%. With this grouping it was evident that only 13.8% of the sample had at least 60% correct answers. When analyzing the data considering students’ sex (Figure 1), there were no significant differences found ($\chi^2 = 2.71$, with $p > .05$ and df = 3), which corroborates results found in recent international research reports.

![Figure 1 – Percentages of correct answers for boys and girls](image)

Nevertheless, when answers were analyzed differentiating by gender (Figure 2), significant differences ($\chi^2 = 19.53$, with $p < .01$ and df = 5) between the different categories appeared, even though the majority obtained less than 60% of correct answers.

![Figure 2 – Percentages of correct answers by gender](image)

In Figure 2 it can be appreciated that masc-undiff students are the ones that get the best marks, followed by the ones with masculine traits. At the same time, students that have fewer correct answers are the undifferentiated ones.
In order to distinguish the different gender traits within each sex, Figure 3 shows the results for girls. Significant differences between the different gender traits ($\chi^2 = 13, 35$, with $p < .05$ and df = 5) were found. In particular, it can be observed that masculine girls and fem-undiff girls are the ones that get the best results. Girls with undifferentiated gender traits are the ones that get less correct answers.

![Figure 3 – Percentages of correct answers by gender considering only girls](image1)

In the boys’ case (Figure 4) differences between genders are also significant ($\chi^2 = 15, 80$, with $p < .01$ and df = 5). It can be noted that masc-undiff boys are the ones that obtained higher scores, meanwhile the fem-undiff boys are the ones with the lowest score. It is important to realize that the differences between categories in the boys case (Figure 4) is stronger than for the girls case (Figure 3).

![Figure 4 – Percentages of correct answers by gender considering only boys](image2)

When comparing the results within each gender category differentiating by sex (Table 2), we find that for the majority of the gender categories there are significant differences between sexes, favoring girls. Several $\chi^2$ tests were used to evaluate if there were significant statistical differences between the percentage obtained by girls and boys in each gender category.
The results were the following:

For fem-undiff students significant differences were found favoring girls ($\chi^2 = 18.8$, with $p < .01$ and df = 1);

For masculine students significant differences were found favoring girls ($\chi^2 = 5.44$, with $p < .05$ and df = 1);

For feminine students significant differences were found favoring girls ($\chi^2 = 8.89$, with $p < .01$ and df = 1);

For androgynous students significant differences were found favoring girls ($\chi^2 = 4.41$, with $p < .05$ and df = 1).

The only gender category for which a significant difference favoring boys was found is the undifferentiated one ($\chi^2 = 8.05$, with $p < .01$ and df = 1).

The category where there no significant difference between sexes was found is the masc-undiff one ($\chi^2 = 2.77$, with $p > .05$ and df = 1). This last result could be due to the low absolute frequency of students corresponding to this category in contrast with the other categories.

**CONCLUSIONS**

This study investigated the mathematics achievement level of 12-13 year’s old students, in order to see if there were significant differences due to sex or to gender traits. The results obtained specifically show that:

1. When variable sex is considered, no significant differences in students’ mathematics achievement is detected, which confirms results obtained in other recent studies.

2. When gender identity (without considering students’ sex) is taken into account, significant differences appear between genders favoring students (both, boys and...
3. When sex is considered within a specific gender trait, significant differences appear between sexes. Girls performed significantly better in four of the six categories (Fem-Undiff, Masculine, Feminine, Androgynous). Boys performed better only when categorized as Undifferentiated. Both sexes performed equally well when gender identity was Masc-Undiff.

Our results stress the importance of doing research in which the socio-cultural issues, which define students’ gender traits, are considered and not only the biological characteristics. Gender traits reveal issues that remain hidden when only sex differences are considered. Following Leder (1992) we want to stress once more that “gender-math”, with emphasis on socio-cultural aspects, should be the new paradigm. The research reports that show no sex differences in students’ achievement should be revisited from this perspective. The issue to be looked at now is how strong socio-cultural influences can affect girls and boys mathematics achievement, and how the social construction of gender traits is gradually influencing their capabilities to learn mathematics.

Recent research reports that when older students are tested, significant differences in mathematics achievement favoring men appear. We question if the population that is favored is the male one or the one that has masculine traits. We base this questioning in the results obtained in this study, that shows that students with masculine traits did better than the others. It might be that with age, due to socio-cultural influences, girls become more “feminine” and boys more “masculine” which will give the idea that men do better than women, and not that students with masculine traits do better. If this is the case, we will assume that gender characteristics can influence the achievement level.

In order to see how gender changes with aging and how this correlates with mathematics achievement we will follow the group of students that has participated in this study during two more years.

References


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