Effects of gender and school type on attitudes towards mathematics

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Abstract. Attitude and perception plays a crucial role in the learning of mathematics. This study was designed to investigate the different attitudes towards mathematics at the secondary school level. The purpose of this study is to find out the students attitude towards mathematics based on their individual genders and their school type i.e. single sex or coeducational school. The sample consisted of 180 secondary school students across three schools. A questionnaire was used to examine the attitudes towards mathematics by asking questions related to self-confidence in doing mathematics and perception about the usefulness of mathematics. Statistical Package for Social Science (SPSS) was utilized to analyze the collected data. The results highlight differences in attitude towards mathematics between boys and girls that are more pronounced when they are in different school types. Moreover, we propose using a fuzzy concept for the measurement of Likert-type scale to measure student attitudes toward mathematics.

1. Introduction
Perception and attitude towards a certain field of study play a crucial role in determining the amount of effort one is willing to exert in learning a particular subject as well as influencing the decision to pursue a career in related fields. There exist a number of students who are qualified intellectually but decided not to study mathematics beyond minimum school requirements. In many developed countries, many more girls than boys are making this decision [1]. Most research [2] conclude that girls in these countries have a relatively negative perception of mathematics and their abilities in relation to the subject.

Previous reports [2] seems to indicate that the opposite is true in Malaysia. In a study on Malaysian 13-14 year old school students [3], girls scored higher both in terms of results and attitudes towards mathematics. It was concluded that perhaps due to maturity, the girls seemed to have a better understanding of the need to seriously learn mathematics. In this paper the focus is on slightly older students and the effect that different type of schools have on these students. It has been said that girls in all-girls school tend to perform better when compared to their counterparts in co-ed schools [4, 5].

Therefore, the aim of this pilot survey is twofold. First, to investigate whether gender is an issue when it comes to doing mathematics by asking questions about confidence and perceptions towards mathematics. Secondly, to ascertain if school types play a role in affecting this perception by asking these questions across three different gender-based school.
Table 1. Respondents from three different schools in Kuching

| School Name                  | School Type   | Girls | Boys |
|------------------------------|---------------|-------|------|
| SMK St. Joseph (SJ)          | All Boys      | 0     | 45   |
| SMK St. Mary (SM)            | All Girls     | 45    | 0    |
| SMK Tabuan Jaya (TJ)         | Co-educational| 45    | 45   |

2. The survey

A total of 180 students (distribution outlined in Table 1) were chosen to participate in this survey. These form four students (16 year-olds) were chosen from Sekolah Menengah Kebangsaan (SMK) St. Mary (SM), SMK St. Joseph (SJ) and SMK Tabuan Jaya (TJ). These three schools are National Secondary Schools (SMK) in Kuching, Sarawak, West Malaysia with good average school grades. For SMK St. Mary and SMK St. Joseph, 45 students are chosen from three different classes such that 15 students are from the pure science stream, 15 students are from the half science stream and 15 students are from the arts stream. These different class types usually differ in terms of mathematical content where the science and half science streams are required to sit down for an additional mathematics paper. As for SMK Tabuan Jaya, the number is doubled as they have both boys and girls. Similarly, these 45 boys and 45 girls were chosen in equal number from pure science, half science and arts stream.

2.1. Content of the Survey

The survey is divided into two portions. The first portion is dedicated to collecting student data. Participants were asked to list their gender, race, spoken language and family income range. The respondents were Malays (35.6%), others (33.9%), Chinese (20%) and Indians (10.6%). The survey was written both in English and Malay to facilitate understanding. The second portion is divided into three sections based on the Fennema-Sherman Attitude scale [1] as shown in Table 2. The Fennema-Sherman Attitude scale was constructed to measure attitudes towards learning mathematics. This scale utilizes a Likert-like scale to measure several affective variables that is identified as having influence on the learning of mathematics.

The questions in this survey are geared towards measuring three affective variables that has been defined by this scale [1]. The variables are Confidence in Learning Mathematics, The Usefulness of Mathematics and Mathematics as a Male Domain. In section A, Confidence in Learning Mathematics is measured by asking questions related to the student’s ability to learn and to perform well on mathematical tasks. In Section B, The Usefulness of Mathematics is gauged by asking questions related to students’ beliefs about the usefulness of mathematics currently, and in relationship to their future education, vocation, or other activities. In Section C, questions are intended to measure the degree to which students see mathematics as a male, neutral, or female domain in the following ways: (a) the relative ability of the sexes to perform in mathematics; (b) the masculinity/femininity of those who achieve well in mathematics; and (c) the appropriateness of this line of study for the two sexes. For each section, there are 6 pairs of questions (6 negative and 6 positive ones), making 18 pairs in total (36 questions).

2.2. Fuzzy Likert Scale

The scale utilized in this survey is based on the Likert Scale and fuzzy measure [6]. For each question (a snapshot of the survey can be seen in Figure 1), a scale of natural numbers from 0 to 10 is given such that the responses (scores) can be roughly divided into four ranges of 0-2.5 (strongly disagree: SD), 2.5-5.0 (disagree: D), 5.0-7.5 (agree: A), and 7.5-10 (strongly agree: SA). To calculate the fuzzy measures [6], the scores are divided by 10 to get values in the [0, 1]
Table 2. Contents of the Survey

| Section | Content                        | Pairs of Question |
|---------|--------------------------------|-------------------|
| A       | Confidence in Learning Mathematics | 6                 |
| B       | Usefulness of Mathematics       | 6                 |
| C       | Mathematics as a Male Domain    | 6                 |

Figure 1. Snapshot of the first pair of questions in Section A, Question 1 (positive question) and its pair Question 7 (negative question).

range. For each pair of question $i$, $i = 1, \cdots, 18$ we get the fuzzy measure of the pair by using the formula

$$
\mu_i = \frac{\mu_i^+ + (1 - \mu_i^-)}{2}
$$

where $\mu_i^+$ is the score obtained from the positive question of the pair divided by 10 and $\mu_i^-$ is the score obtained from the negative question of the pair divided by 10. For example, from Question 1 in Figure 1 we get the fuzzy measure $\mu_1^+ = 0.6$ and from its pair, Question 7, we get that $\mu_1^- = 0.4$. To get the fuzzy measure of the first pair of questions (Question 1 and Question 7) we use the formula in (1) such that

$$
\mu_i = \frac{\mu_i^+ + (1 - \mu_i^-)}{2} = \frac{0.6 + (1 - 0.4)}{2} = 0.6.
$$

We are using summative scales thus measures will be summed together to get the measure for each section. The fuzzy measure for the section will be the average of the fuzzy measure of all pairs of questions. Pairs 1 to 6 are in Section A, pairs 7 to 12 are in Section B and question pairs 13 to 18 are in Section C. Therefore for each section A, B and C the fuzzy measures are

$$
\mu(A) = \frac{1}{6} \sum_{i=1}^{6} \mu_i
$$

$$
\mu(B) = \frac{1}{6} \sum_{i=7}^{12} \mu_i
$$

and

$$
\mu(C) = \frac{1}{6} \sum_{i=13}^{18} \mu_i
$$

respectively for each respondent.
Table 3. Average fuzzy measure for each category

| Category    | Section A | Section B | Section C |
|-------------|-----------|-----------|-----------|
| TJ Girls    | 0.72      | 0.69      | 0.59      |
| TJ Boys     | 0.74      | 0.69      | 0.60      |
| SM Girls    | 0.84      | 0.79      | 0.66      |
| SJ Boys     | 0.72      | 0.67      | 0.57      |

3. Results

For each respondent we shall have one fuzzy measure for each section, giving a total of three measures for each individual. To get a value that is representative of a school or a certain gender in a particular school, the average value of the individual measures is taken. To better illuminate the results we divided our respondents into four categories:

(i) TJ Girls: the 45 girls from SMK Tabuan Jaya
(ii) TJ Boys: the 45 boys from SMK Tabuan Jaya
(iii) SM Girls: all 45 girls from SMK St Mary
(iv) SJ Boys: all 45 boys from SMK St Joseph

For each category we shall have a fuzzy measure averaged over the 45 individuals for sections A, B and C. Table 3 and Figure 2 summarizes the results.

The resulting measure can be interpreted in terms of 0.00-0.25 (strongly disagree), 0.25-0.50 (disagree), 0.50-0.75 (agree), and 0.75-1.00 (strongly agree). Values more than 0.5 indicates agreement (positivity) and less than 0.5 indicates disagreement (negativity) towards statements in the particular section. One can see that the results are generally positive, meaning that most of the respondents agree with the positive statements in the survey. However, it is the students of SMK St. Mary (Category 3: SM Girls) that leads in positivity for all three sections. The SM Girls are the most confident (0.84) in their mathematical ability and strongly agree (0.79) that mathematics is important. Furthermore, the SM Girls agree (0.66) that mathematics is not a male domain.

Another way to view this result is in terms of percentages. One can say that the results of Category 4 (SJ Boys) indicates that on average, a boy from SMK St Joseph is 72% confident in their mathematical ability, 67% convinced that mathematics is useful and 57% percent sure that mathematics is not a male domain. Although the results are still generally positive, the result of these SJ Boys are the least positive out of all four categories.

However, the boys in the co-ed SMK Tabuan Jaya (TJ Boys: Category 2), have a slightly more positive view of mathematics than the girls of SMK Tabuan Jaya (TJ Girls: Category 1). On average, a boy (girl) from SMK Tabuan Jaya is 74% (72%) confident in their mathematical ability, 69% (69%) convinced that mathematics is useful and 60% (59%) percent sure that mathematics is not a male domain.

The overall results for each section averaged over each category shows that generally respondents are 75.5% confident of their mathematical ability. However, they are only 67.75% convinced that mathematics is useful and 60.5% convinced that mathematics is not a male domain.

4. Discussions

In order of most positive to least positive attitudes, the school ranks as SM, TJ and SJ. It can be concluded that SM Girls School has the most confidence in mathematics, strongly perceive that
Figure 2. Results of the survey calculated using fuzzy measures for each section. The results from SMK St. Mary (SM Girls) is the most positive. A simple interpretation of the first category (TJ Girls) can be read as: a girl from SMK Tabuan Jaya is 72% confident in their mathematical ability, 69% convinced that mathematics is useful and 59% percent sure that mathematics is not a male domain.

Even though all three schools are usually considered to be in the same ‘good school’ category, the three schools have slightly different Average School Grade (the less the better) which are 3.75, 3.86 and 4.18 for SM, TJ and SJ respectively. This supports the view that attitudes and performances are positively correlated [1]. However one can also say that, SM as the best ranked school among the three is expected to have the most positive attitude towards mathematics regardless of gender. The difference between the attitude of the boys and girls in the co-ed school TJ is also rather small. This may suggests that all else being equal, gender does not play much of a role in determining attitudes towards mathematics. This could also explain the almost middling respond (0.60 on average) to questions in Section C about mathematics being a male domain. Perhaps the question even perplexed the student as the issue of gender in studying mathematics was never part of the culture. The dominant view is that mathematics is not a male domain in South East Asia [3].

From the overall result, one can say that many of the students are quite confident in their mathematical ability (75.5%) but not very convinced of the usefulness of mathematics (67.75%). This suggests that perhaps the main reason deterring students that are intellectually able from pursuing mathematics as a career, for either boys or girls, is that they do not see how it can
be useful in real life. If this is the case, more effort is needed to convey the usefulness of mathematics, instead of simply teaching rote memorization of formulas.

From these results we get an indication that perception towards mathematics in these schools are not really affected by gender. However, it seems that different types of school do affect their perceptions since SM Girls were much more positive than TJ Girls. The TJ Boys and the SJ Boys on the other hand are not very different. In fact the general concern in Malaysia nowadays are ‘the lost boys’, the boys that either left school early or had low attainment levels. Girls are consistently outperforming boys at every level of education from primary to university (70 percent are females) [4]. This situation is not exclusive to Malaysia and seems to be the trend in a lot of developing countries around the world [2]. It seems that mathematically related work becomes more male dominated as a country gets more developed. Hopefully Malaysia can learn from these studies and not let the negative perception towards mathematics shape the choices of future generations.

There is much more to be done in trying to understand the effects of attitudes and perceptions in studying mathematics especially in relations to mixing or separating gender in the learning process. Future research could include comparing examination scores and attitudes towards investigating if there is a difference between genders in terms feeling confident. Moreover one could also investigate the difference in attitude across class type (science, half-science, arts) pertaining their views of mathematics and the effect that is has on their results. All of these could hopefully be done on a much larger scale.

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References
[1] Fennema E and Sherman J A 1976 Fennema-Sherman Mathematics Attitude Scales: Instruments Designed to Measure Attitude Towards The Learning of Mathematics By Females and Males Journal for Research in Mathematics Education 7(5) 324–326
[2] Charles M 2017 Venus, Mars, and Math: Gender, Societal Affluence, and Eighth Graders Aspirations for STEM Socius: Sociological Research for a Dynamic World 3 1–16
[3] Halimah A and Azina N 2003 Gender Differences in Mathematics Learning in Malaysia (Kuala Lumpur: Penerbit Universiti Malaya)
[4] Curriculum Development Division, Ministry of Education Malaysia 2016 Sharing Malaysian Experience in Participation of Girls in STEM Education (Geneva, Switzerland, UNESCO International Bureau of Education (IBE))
[5] Baker D and Jacobs K 1999 Winners and Losers in Single-Sex Science and Mathematics Classrooms Report of Annual Meeting of the National Association for Research in Science Teaching (Boston)
[6] Bhowmik M and Banerjee B 2013 Fuzzy Measure of Students Attitude Towards Mathematics International Journal of Research Studies in Education 2(2) 21–30