



Exploring Female Students' Perceptions of the Influence of Gender Stereotypes on the Choice of Mathematics at a Secondary School in Zimbabwe.

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ABSTRACT

This study sought to explore the perceptions of female students of a secondary school regarding the influence of gender stereotypes on their choice of mathematics and on prospects of pursuing it at tertiary level after they have successfully completed it at Advanced level. Involving a purposive sample of twenty students (11 Lower Sixth and 9 Upper Sixth) this qualitative case study employed slight quantitative data analysis. Questionnaires, focus group discussions and Interviews were used to collect data. The study established that the majority of students were aware of common stereotypical conceptions that society ascribed to the learning of mathematics by girls. Gender had little impact on the decision to learn mathematics at Advanced and tertiary levels. Although some participants perceived mathematics as being more appropriate for boys than girls most participants indicated that the choice of mathematics at Advanced level and prospects of studying it at tertiary level were not so much about gender as they were about several factors. Recommendations for disabusing students' stereotypical conceptions of the choice of mathematics choice are made from the findings of the study.

INTRODUCTION

A discussion of the choice of mathematics as a science in High school is contextualised in the global realisation of the dearth of participants in the STEM (Science, Technical, Engineering and Mathematics) in general and the gross underrepresentation of females in this critical area of the curriculum in particular. Despite the universal call for gender parity and the legislation for empowering the girl-child and women through creating opportunities for females in all fields of endeavour in most countries of the world, there is an underrepresentation of females in the science, technology and mathematics (STEM) fields. Huhman (2012) states that in the technical industry in USA, only 1 in 7 engineers is female. Reporting that women made up less than 25% of the workers in the engineering field in 2009 in Canada, Fisk (2011) observes that the dearth of women in the STEM fields is attributed to several factors. Together with the lack of innate ability or desire on the part of women, negative stereotypes, i.e. societal beliefs about women's abilities to participate in STEM activities have influenced women's aspirations and career decisions (Fisk, 2011; Powell, 2012). Although Zimbabwe openly encourages young girls to engage in STEM learning programmes by making enrollment into the STEM subjects of mathematics and science in high school open to both boys and girls, there is a disproportionately small number of girls doing mathematics at Advanced Level, i.e. in Lower Sixth and Upper sixth forms at Drundale High School (pseudonym). The gross

underrepresentation of females in the STEM subject curricula of mathematics for five enrolment years is illustrated in Table 1 below.

Table 1: Student Enrolment for Advanced Mathematics at Lower Sixth and Upper Sixth Forms, 2013 to 2017

Year	Lower Sixth		Upper Sixth	
	Males	Females	Males	Females
2013	9	3	8	5
2014	7	3	10	3
2015	10	4	11	4
2016	15	5	15	6
2017	16	7	12	4

Adapted from Drundale School: 2017

This prompted us to probe the students to glean some nuanced insights into the gender issues regarding their choice of mathematics and their perceptions on the prospects of proceeding with their study in it to tertiary level.

LITERATURE REVIEW

The growing concern about the small numbers of women participating in the STEM fields has been documented in the literature and empirical studies with certain perspectives proffered to explain this phenomenon.

The biological perspective of gender in relation to the learning of mathematics

Scholarly accounts that apply the biological perspective to the engagement of women in the STEM fields have detailed the notion that men are naturally better at studying these disciplines than women (The Varsity, 2014). The Varsity (2014) further write that some critics still claim that men have superior 3D spatial and visualisation skills which most girls and women lack, and yet these are crucial in STEM fields. According to Huhman (2012) those who subscribe to this perspective ascribe the gender differences in relation to STEM fields to the notion that biologically, Science and Mathematics are typically male fields, while humanities and arts are primarily female fields. Fisk (2011) also notes that the biological perspective attributes women's lack of confidence in mathematics to a lack of innate abilities in mathematical tasks. Amelink (2012) underscores the role played by the innate capabilities by opining that those students who view mathematics as an innate ability that one possesses or does not inherit at birth are likely to lose interest and confidence in learning it when they experience challenges. Conversely, those students who view mathematics as something that can be developed through study and by additional resources and assistance are likely to maintain an interest and confidence despite obstacles and challenges.

However, it should be borne in mind that research has shown that mathematical skills are easily improved in females over a short period of time and are therefore not necessarily a function of biology (The Varsity, 2014).

Socially constructed stereotypes scare away females from STEM programmes

According to Fisk (2011) the socially constructed meanings that members of a given society assign to the social roles that women play and the social behaviours expected of

them constitute the gender stereotypes that the members make in relation to participation in STEM activities. The typically patriarchal cultural society has often judged men as being superior to women in STEM activities. Referring to "the stereotype threat phenomenon, Powell (2012) argues that if a person is exposed to negative stereotypes about a group to which they belong, they will then perform worse on tasks related to that stereotype.

Scholars further observe that negative stereotypes about women lacking strong mathematical abilities and about men traditionally outstripping them have often subtly influenced females' aspirations and career decisions that involve mathematical and scientific reasoning, thereby funneling them away from participation in male-dominated subjects (Amelink, 2012; Huhman, 2012; Powell, 2012). As observed by Spelke (2005) socio-culturally defined stereotypes in terms of negative views that parents and teachers hold about the degree to which females and males are good at mathematics have all too often resulted in girls internalising them, thereby negating participation in mathematics.

While there exists some empirical evidence that refutes the foregoing claims by way of some studies that have revealed a rapidly shrinking and even non-existent gap in the general performance levels between men and women in mathematics (Spelke, 2005; The Varsity, 2014) the underrepresentation in this area still persists.

Exposure to STEM-related activities

One of the main reasons for women's reluctance to pursue STEM subjects is their limited exposure to STEM-related experiences, especially in their early and middle school life. According to Opsal, Perez, Gibson and Lynch (2011) studies indicate that women's lack of experiences is traceable to experiences outside and inside the classroom, which in most cases are more available to men. The Varsity (2012) states that women seldom avail themselves to certain masculine activities. Male students improve their spatial/visualisation skills through playing with erector sets and 3D computer games, which exposure could also enhance the females' abilities (The Varsity, 2014). This environmentalist conception of gender stereotyping in relation to STEM seems to suggest that if women can improve their skills over time by being exposed to a supportive practising environment, then the claim that their innate abilities matter most becomes irrelevant. The gender differences are therefore more probably a function of gender stereotyping than biology.

PROBLEM STATEMENT

Granted the fact that generally both girls and boys experience perceived difficulties in embarking on mathematics and science subjects at Advanced Level (Opsal, et al., 2011), and the gross preponderance of boys over girls in Mathematics school curricula at Drundale High School we felt that not much is known about what female students think about gender issues in relation to the choice of mathematics as one of the subjects in the sciences combination that they pursue at Advanced level. The purpose of this study was thus to interrogate the Advanced Level students to elicit their views on how they think gender stereotypes frame and shape their choice of mathematics and their choice to study it at tertiary level.

Goals of the study

1. To identify and describe gender stereotypes that Advanced level students know concerning the mathematics subject curriculum which they are studying?
2. To establish whether or not students ascribe their choice of mathematics to gender and their reasons for the choices.
3. To determine whether or not students ascribe the prospects of studying mathematics at tertiary level to gender.

RESEARCH DESIGN AND METHODOLOGY

Largely employing the interpretivist paradigm, this qualitative case study to a limited extent incorporated quantitative techniques, for purposes of triangulation. To gain insights into participants' practical, real lived experiences (students) operating in their practical situations we used the qualitative techniques of focus group discussions and semi-structured interviews which Taylor and Wallace (2007) regard to be the most suitable instruments that, as Creswell (2005) contends, allow participants to ventilate their views. A questionnaire that contained sections with close-ended questions was preferred for its advantage of obtaining information on pre-structured categories that we had conceptualized (Hartas, 2010) to supplement interview and focus group discussion data. We preferred face-to-face, one-on-one semi-structured interviews for their effectiveness in accessing participants' perceptions, meanings, and construction of reality in their own terms (Punch, 2009) and for creating a conversational relation between researcher and participant, providing a richer, deeper understanding of the phenomenon (Hartas, 2010).

Sampling

The study employed purposeful sampling, where participants who were currently studying mathematics and science at the Lower Fifth and Upper Sixth levels were involved. Thus twenty (n=20) female mathematics students who comprised 11 Lower Sixth and 9 Upper Sixth formers were chosen as they displayed a common characteristic of interest (Hartas, 2010), i.e. were all sciences students who were taking mathematics at Advanced Level, and provided an information-rich sample (Hennink, Hutter and Ajay, 2011). Since our aim was not to generalise findings to a larger population but to seek a deeper understanding of the students' perceptions we considered a small sample of one school and 20 students as our cases.

Data analysis procedures

We quantified and analysed questionnaire data using MS excel and presented them on tables of information. Content analysis procedures of open and axial coding of the interview transcripts and the focus group discussions transcripts resulted in the production of a number of initial themes, which were then collapsed and abstracted into fewer broad themes. Along with descriptive statistical presentation of data was conducted a narrative description of the findings.

Ethical considerations

Heeding Creswell's (2008) advice we sought permission to conduct this study by obtaining ethical clearance from the management of Drundale High School. We then sought informed and voluntary permission from the participants to conduct the study, and assured them of anonymity and confidentiality of the findings.

Issues of validation

The credibility of this study was enhanced by field notes of the interviews. The trustworthiness of data was attained through methodological triangulation (Leedy and Omrod, 2008) and detailed narrative descriptions (Creswell, 2007). To enhance the reliability and validity of questionnaire data, we attempted to align our questionnaire questions with the research questions and amended the questions after pilot-testing the instrument for internal consistency.

RESULTS AND DISCUSSION

We conducted a focus group discussion with six (n=6) participants, (3 Lower Sixth and Upper Sixth formers) to collect shared understandings of the focal issue based on a variety of unique perspectives of the participants (Hennink, *et al.*, 2011). This resulted in some key themes depicting the gender stereotypes that students commonly knew in relation to the choice of mathematics. The themes are presented hereunder:

7. Theme: Science and Mathematics are for boys
8. Theme: Boys perform better than girls in Mathematics.
9. Theme: Females are scared of Mathematics.
10. Theme: Males are better than females in learning mathematics at college or university

The results above show that students in this study had an awareness of the presence of gender stereotypes in relation to mathematics. The stereotypes that the participating students commonly knew in relation to the choice of Advanced and tertiary levels mathematics resonate with the work from scholars in this paper (Amelink, 2012; Huhman, 2012; Powell, 2012, Spelke, 2005).

To establish whether or not students ascribe their choice of mathematics to gender and their reasons for the choices, Table 2 below shows the students' perceptions of their choice of mathematics.

Table 2: Data on students' perceptions (n=20)

No.	Item/Frequency	Responses			
		Yes		No	
		No.	%	No.	%
1	Was your choice of mathematics Influenced by your sex?	7	35	13	65
2	Would you say studying mathematics at A level presents challenges related to your sex?	8	40	12	60
3	Would you say you are comfortable to enroll for a course that involves the learning of mathematics at a college or university?	18	90	2	10
4	Would you choose to take up a job that involves using mathematics all the time?	19	95	1	5

Table 2 shows that the majority of students (65%) did not attribute the choice of mathematics to their sex. In the interviews, some of them said they chose this subject on

the basis of an awareness of gender equality, interest in the subject, intellectual capability and self-confidence. Interestingly, a sizeable number of them (30%) confirmed that the choice of this subject curriculum was influenced by one's sex. They cited their reasons for considering their sex as: (a) the fact that science and mathematics are by nature difficult for most girls, demanding powerful reasoning and application of prescribed rules (b) the idea that boys are well-versed and more exposed to spatial experiences. This finding resonates with the literature which underscores the importance of gender differences regarding exposure to mathematical activities that have been traditionally known to be masculine (Spelke, 2005; The Varsity, 2014).

A good majority of the students (60%); (90%); and (95%) felt that the choice of mathematics at A level did not present challenges related to their sex, and that they were comfortable to enroll for a course that involves the learning of mathematics at a college or university and could easily choose to take up a job that involves application of mathematics, respectively. During interviews, all the students confirmed their readiness to do a job that uses mathematical reasoning. These findings suggest that although most of these students were aware of gender stereotypes that society often attach to participation in mathematics and science subjects fields, they did not hold negative gender stereotypes in relation to their choice of mathematics.

Our interest to determine whether or not students ascribe the prospects of studying mathematics at tertiary level to gender is addressed by findings shown in Table 3 below and data from interviews.

Table 3: Data on students perceptions of the influence of gender in studying mathematics (n=20)

Item	Strongly Disagree		Disagree		Notsure		Agree		Strongly Agree	
	No.	%	No.	%	No.	%	No.	%	No.	%
A level Mathematics is for boys	10	50	6	30	0	0	3	15	1	5
Both boys and girls can study mathematics equally well	4	20	3	15	0	0	9	45	4	20
Both boys and girls can pursue mathematics up to college or university.	2	10	3	15	3	15	7	35	5	25
Both boys and girls can do jobs that involve mathematical reasoning	3	15	2	10	0	0	10	50	5	25

Data collected through a closed questionnaire presented in Table 3 above confirms that the majority of students in this study (80%) did not believe that Advanced Level Mathematics is for boys only. Conversely, 65% of the participants agreed to the view that both boys and girls can learn mathematics equally well, while 60% agreed that both boys

and girls can pursue mathematics up to college or university level. A vast majority of the participants (75%) agreed that both boys and girls can end up doing jobs that involve mathematical reasoning equally well. The foregoing findings thus disconfirm the patriarchal view most societies hold that STEM fields and particularly mathematics are naturally and typically for males (Powell, 2012). Thus the participants in this sample held positive perceptions about themselves in relation to the learning of mathematics and expressed the view that girls had the potential to engage competently in studying it at tertiary level. On this score, one student had this to say:

It does not mean to say that girls cannot do mathematics at higher levels. After all is it not that there are some girls that beat many boys in this subject.....? You find that if we both girls and boys get good teachers, enough textbooks and good textbooks that explain how to do mathematics we can all do well.. we can dfo it the same...

Thus factors that can be gleaned from this statement which are ascribed to choice of learning mathematics include one's ability, good teaching and adequate , appropriate learning resources as opposed to gender.

Another student said:

I think both boys and girls can take up mathematics at college and university levels in the same way because if someone has serious interest he or she can do it well. If there are enough resources and books and also help from teachers and good mathematics learners, even girls can do well ..even better than boys.

Thus interview data confirm the little effect that gender stereotypes seemed to have on most students' perceptions of gender issues in relation to the studying of Advanced level mathematics at this school. This point is illustrated by a summary of themes below:

- 11.**Theme: Enrolment at the high school is based on merit.
- 12.**Theme: Ability counts in the choice of learning mathematics at college or university.
- 13.**Theme: The quality of teaching of mathematics counts much in choosing to pursue mathematics at college or university.
- 14.**Theme: Some girls perform better than boys.

This finding concurs with literature which acknowledges a rapidly shrinking and even a non-existent gap in the general performance levels in mathematics tasks (Spelke, 2005; The Varsity, 2014), suggesting that for as long as people stop stereotyping, females are well competent and likely to grow an interest in mathematical tasks. In contrast to the positive perceptions that most students held about female participation in mathematics, 20% (See Table 3 above) of the participants confirmed the stereotype that learning of mathematics at A Level is for boys.

This questionnaire finding is triangulated by interview data themes developed from the participants' views that we present hereunder:

- 15.**Theme: Some girls still think that mathematics and jobs that involve mathematical reasoning are for boys or men.

16. Theme: High school girls lack confidence in studying mathematics and cannot proceed to tertiary level mathematics courses.
17. Theme: Society still underestimates the potential of girls and women in this area, and holds that females cannot do as well as their male counterparts at tertiary level.

This finding resonates with literature which attributes girls' lack of confidence in studying High school and tertiary mathematics to the stereotype threat whereby girls and women tend to perform worse on tasks related to the negative stereotypical judgements that society makes of them (Fisk, 2011; Powell; 2012).

CONCLUSIONS

The mixed perceptions that participants expressed about the gender issues thus underline the complexity that is attendant to the explanation of this subject. The fact that most participants in this study did not perceive gender stereotypes as a key determinant of the choice of mathematics seems to suggest that gender has no impact on the process that some females (in this study) go through when they choose mathematics at Advanced Level. On the other hand, the fact that a sizeable number of participants (35%) (See Table 2), did not agree that both boys and girls can learn mathematics equally well, for example suggests the persistence of stereotypical thinking among some high school students. The implication of this scenario to the teaching and learning of mathematics at this high school is that in the absence of conscientisation of students of the need to transcend stereotypes in relation to this subject curriculum, girls and women may continue to shun fields that involve application of mathematical reasoning.

It can also be concluded that in this study, although most participants displayed a clear knowledge of gender stereotypes in relation to the choice of Mathematics at Advanced Level some participants still held negative stereotypes towards girls. The fact that many students attributed the choice of mathematics at A Level to a person's sex in favour of boys indicates the stereotypical traits that still prevail among some female youth.

Many participating students in this study were aware of the role played by various other factors besides gender, in defining their choice of mathematics at Advanced Level and explaining their prospects of studying it at tertiary level.

The foregoing perceptions in which a majority of students portrayed gender stereotypes in a positive light could probably be interpreted in the light of the global transformation on the girl child's rights to gender parity in education in Zimbabwe, where both boys and girls can enroll for and learn the same science subjects including mathematics up to any level.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

1. As the most strategically positioned significant others, teachers and parents should encourage girls to develop confidence in learning mathematics through exposing them to mathematical reasoning at an early age.

2. Through hands-on workshops schools should provide mixed gender team work which encourages equal participation in which boys and girls engage in solving mathematical problems using tools such as ICTs, to help girls gain confidence.
3. At secondary and tertiary education levels, educators should expose female students to successful female mathematicians and statisticians as role models who talk to them about professions that demand mathematical reasoning.
4. Society should disabuse both males and females of the gender stereotypes by impressing upon them that all human fields of endeavour, including mathematics and science are meant for both the sexes.

While this baseline study provides a rich and comprehensive understanding of the perceptions of students regarding how gender issues shape and frame their choice of mathematics and the decisions to pursue this subject curriculum to tertiary level, the negligible sample places limitations on generalisation of the findings to a larger population of high schools. This therefore renders it difficult to claim representativeness of the findings.

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