

Assessment of First Year Female Students' Experiences in Historically Male Dominated Subjects in Higher Education from a Cultural Capital Perspective

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KEYWORDS Male Dominated Subjects. Higher Education. Female Students. Cultural Capital

ABSTRACT Studies have confirmed that the composition of male and female students in higher education in South Africa is far more equitable than before. Surprisingly, there has not been a significant increase in the number of female students in the historically male-dominated subjects such as science, engineering, and mathematics. This paper was based on a phenomenological study that explored the experiences of first year female students taking science subjects in one University in South Africa. This study was a descriptive survey that employed both qualitative and quantitative approaches. The population for this study was all female first year students majoring in physics, chemistry and mathematics at an institution in higher education. Due to the relatively low numbers of females in these subjects, all were given questionnaires to answer. The findings show from students' ideas and perspectives the main aspects that influence inclusion or exclusion of female students in male dominated subjects like science and mathematics.

INTRODUCTION

None of us needs telling that the higher education landscape is changing and regardless of geographical location, it is also the case that most of us working in higher education have seen growth in terms of the numbers of students entering higher education (Baldwin 2009). South Africa has seen a large increase in the number of students in higher education, often referred to as massification. This is linked with attempts to widen participation towards groups that have not in the past benefited from a college education and this includes women. For this equality to be a reality there is need to ensure retention of female students who enroll in higher education in general and in historically male-dominated subjects such as mathematics and sciences in particular. The gender gap on student participation in class is larger in college than elementary and secondary school and two-thirds of the silent students in college are women (Sadker et al. 1994).

A number of reasons have been put forward as causes of the low numbers of women in the sciences and mathematics. Through a synthesis of 1,300 studies on girls in school and equity for girls, American Association of University Women (AAUW) reported that teachers gave more opportunities to boys than to girls to perform hands-on demonstrations in class (Hazari et al.

2007). According to Dalton et al. (2007), women's lack of interest in mathematics and sciences may also come from parents, or society in general, all of which discourage females from entering traditionally male-dominated fields such as auto-mechanic, electronics and computer technology, and other careers that require mathematics and science backgrounds.

Research shows that despite having an equal aptitude for mathematics and sciences that is equal to or higher than that of males, female students' interest in these subjects decreases during the pre-college years (Gurer 2002). The gender gap on student participation in class is larger in college than elementary and secondary school and two-thirds of the silent students in college are women (Sadker et al. 1994). Gurer (2002) provides statistics that point out elementary school education as the origin of the gap in boys' and girls' scientific learning performance. It is argued that girls are usually neglected or unrecognized for their performance in scientific learning, which accounts for their lower standard. In middle school, the way teachers go about teaching and interacting with students is filled with gender bias where there is a tendency to be more teacher-student interaction for male students while female students do not have half as much questioning and answering time (Wang 2007). Some studies in chemistry, biology and physiology classroom settings found out that male students received

more attention from and opportunities to interact with their teachers while female students were overlooked in science classes (Wang 2007; Madigan 2009). This places female students in a science class at a disadvantage because when there is less interaction, the asked questions are absorbed at lower levels of memory and thinking for female students and at higher analytical and cognitive levels for male students (Gurer 2002).

Theoretical Framework

This study is premised in the social and cultural capital theoretical framework. Access to various forms of capital is associated among others, with gender and ethnicity (Wells 2008). Social and cultural capitals are closely linked although their constructs are different. Social capital includes the social and personal connections or networks that people capitalize on for interpersonal assistance and personal gain, which for youth are often developed in schools in addition to the home (Coleman 1990; Wells 2008). Cultural capital is often inherited from one's family and therefore may sustain socio-economic status stratification based on families passing the torch of societal privilege and advantage (Longden 2004; Tinto 2005). As is apparent, these concepts are closely related and hence hard to disentangle (Wells 2008). Therefore, this study is informed by both cultural and social capital.

Bourdieu's work emphasize how social classes, especially the ruling and intellectual classes, preserve their social privileges across generations despite the myth that contemporary post-industrial society boasts equality of opportunity and high social mobility, achieved through education. In other words, Bourdieu's (1992) main distinction is his belief that social capital operates as a tool of cultural reproduction in explaining unequal educational achievements.

This theory has strong socio-cultural roots which locate the educational experiences of individuals dialectically through their social and material history. These features, in our opinion, render the Bourdieuan perspective on social capital the most scrupulous and constructive approach in the study of disadvantaged learners. Specifically, as a conceptual treatise, Bourdieu's theory proffers socio-cultural explanations for why under-represented groups remain excluded from the educational process (Cloete 2004). It

achieves this by expanding upon an analysis of cultural barriers to participation and relating subsequent investigations to individuals' own lived experiences. Educational participation too, from a Bourdieuan perspective, is thought of as an extension of participation in society at large and is thus contingent on wider political, economic, social, and cultural factors. Accordingly, non-participation is challenged not on individual/cultural deficit terms but in relation to the perceived need to effect societal change. An analysis of social capital cannot therefore be separated from a treatise on social exclusion (Tinto 2005).

According to Bourdieu's theory, lecturers, because of the symbolic power they possess continue to uphold the middle class culture and students who hail from such dominant cultures tend to excel while those from those lower classes tend to be eliminated from the higher education system, thus non completion of programmes or dropping out after either failing or frustrated.

The Problem

The massification of higher education in South Africa has inevitably been a result of a strong political agenda which provides for a 'deliberate attempt to broaden participation in higher education as a means of reducing the highly stratified race and class structure of the country' (Schroeder 2007; Van der Bergs 2006). There has been evidence of a representative participation of students from various racial backgrounds and gender. For instance from 1993 to 2006 the number of women enrolled in Higher Education (HE) rose from 20200 in 1993 to 408718 in 2006 (Van der Bergs 2006). This paper therefore sought to find out cultural *perspectives* that may contribute to reduction of female student participation in historically male-dominated subjects in higher education.

Research Questions

In a bid to assess the experiences of the female students in historically male dominated subjects, the study sought to answer the following questions:

- A) What is the attitude of female students towards science/mathematics as a subject at an institution in South Africa?
- B) What is the perception of female students regarding mathematics/science subjects at tertiary level in South Africa?

METHODOLOGY

This study was a descriptive survey that employed both qualitative and quantitative approaches. According to Babbie and Mouton (2001), qualitative research refers to a generic research approach in social research according to which research takes its departure point as the insider perspective on social action. The method was chosen because it emphasizes the respondents' perspectives and experiences. However, its limitation is that it is subjective in nature and cannot be generalized. The population for this study was all female first year students majoring in physics, chemistry and mathematics at an institution in higher education in South Africa. Self-administered questionnaires with open ended and closed questions were used for data collection. Due to the relatively low numbers (80 in total), of females in these subjects, all were given questionnaires to answer. The questionnaires were administered during the fourth quarter of the year when students had quite a long experience in the first year. Therefore, the number of returned questionnaires were as follows: 12 mathematics, 32 chemistry and 16 physics. In analyzing qualitative data, categories were identified and put into themes for presentation and discussion. For quantitative data, some descriptive statistics including percentages were used.

RESULTS AND DISCUSSION

The data in Table 1 assists in providing critical information on the current situation on the ground in terms of gender enrollment ratios in science disciplines at the institution under study. It is assumed that a fuller understanding of the prevailing situation in terms of statistics (36.36 percent) given will make it easier to better understand the perceptions and experiences of first year female students doing historically male dominated subjects.

Table1: Enrollment of first year science students by gender (2009)

Subject	Males	Percent	Females	Percent
Sciences	140	63.64	80	36.36

Table 1 above shows that there are more first year male students doing sciences than females. The total percentage of males doing sciences (mathematics, physics and chemistry) is 63.64

percent as compared to only 36.36 percent females doing the same subjects. This data gives the impression that historically male dominated subjects are still a male domain area. In trying to identify the experiences of higher education female students taking science subjects as majors, the following themes emerged from the data collected:

- Ø lack of role models
- Ø gender biased attitudes
- Ø lack of self confidence and interest in the subject.

These themes have been discussed in detail in the next section:

Lack of Role Models

Lack of role models was identified as one of the factors contributing to poor persistence of female students in the science and mathematics subjects. Responding to the question on whether science subjects were meant for women too, those who responded saying "No" gave the following reasons: "*Most of the engineers in SA are males and tutors in science subjects are males.*" "*Most of the students who get high marks in my class are males.*" The results confirm the findings by Miliszewska et al. (2006:24) in their studies on "Gender Equity in Computer Science, where it was found out that:

The first year, particularly the first semester of the course emerged as the make or break period especially for female students. Not only was it an important period with respect to adjustment to the course but also it was a period most likely to influence most female students' decisions about quitting the course.

On a similar note, research by Robst and Keil (1996) also confirmed that a significant positive relationship was found between retention and the percentages of science, mathematics and computer science courses taken by female students that were taught women.

This demonstrates that those individuals who are exposed to fewer females who have made it in sciences would find it difficult to convince themselves that they could make it in those subjects. In addition those who find themselves in these subjects would not find it difficult to quit in the sciences if confronted by minor hitches in the subject because they would have entered the programme, not very well convinced that they can make it. Thus, they would not be prepared to persist. Robst and Keil (1996) summarized this

situation as follows: “Women see very few scientists as role models. Very early they get messages that science is not for them. . . . And this discrimination perpetuates itself. The next generation is again faced with a lack of appropriate role models.”

Have (1999) postulates that the scarcity of role models leads to lower expectations for success in science and, like many self-fulfilling prophecies, this expectation is usually met. Many opportunities for establishing successful female scientists as possible role models are missed. For example, the common practice of referring to scientists who have made important discoveries by their last names, as in “Watson and Franklin’s work on DNA” and “Hershey and Chase’s bacteriophage experiments,” leads students to the often false assumption that these individuals are all male (Sonnert 1995; Mullis et al. 2008). The “Great Scientists” series of posters is prominently displayed in many school laboratories and shows only one woman, Marie Curie; unlike the men, she is shown surrounded by her family name (Tremor 2007). Moreover, most books refer to her as “Madame Curie,” thus denying her the individual identity that a complete name (Charles Darwin or Isaac Newton) bestows. In addition, while the vast majority of public school teachers are women, the majority of teachers in the physical sciences are men, according to Klawe (2002). The messages that these facts send to girls is a very simple and strong one that science is not for them.

As reported by Moskal (2002), the 1998 numbers for the United States show 18.6 percent of the 75,058 Bachelor’s degrees, 20.3 percent of the 36,337 Master’s degrees and 12.3 percent of the 7377 PhD degrees going to women. In 1995, women represented roughly 10 percent of the engineering work force in the U.S and world-wide, women account for a small percent of the engineers. When girls read these statistics, they tend to assume that mathematics and science subjects are meant for men and they won’t put much effort in these subjects. Women are under-represented in most areas of science, in most parts of the developing and developed world. Women are not well represented in science, engineering, and technology as students, teachers, professors, researchers or workers (Clewell and Campbell 2002).

Gender Biased Views of Mathematics and Sciences

In order to ascertain gender biased views of mathematics and sciences, respondents were

asked the following question: How do you describe your interest in Mathematics/ Science? The table below illustrates what emerged from the responses given by the participants:

Table 2 indicates that 43.75 percent of the respondents are not interested in Physics, 37.5 percent who are doing Chemistry are not interested at all in the subject and 16.67 percent of respondents enrolled for mathematics have no interest in the subject. It is quite disturbing to note that on average 33 percent of female science students who are still in their first year of study and are expected to be in the system for the next three years are not interested in the career they have chosen.

Table 2: Gender biased views of mathematics and sciences

Subjects	Interested		Not interested	
	N	Percentage	N	Percentage
Physics (N=16)	9	56.25	7	43.75
Chemistry (n= 32)	20	62.5	12	37.5
Mathematics (n= 12)	10	83.33	2	16.67

The responses in this study also demonstrate that the respondents had a biased view of mathematics and science subjects. The reasons given also show stereotypic view of the abilities of males and females e.g. the following reasons given: “*Because males are more intelligent in science fields than women*” “*Males are more dedicated and determined than females*” “*Males are good in calculations.*” “*Some believed that males are more dedicated, focused and more intelligent than females.*” The results show that social and cultural capital is positively significant for persistence in higher education.

The above results demonstrate that respondents have a biased view of the science subjects and did not view women and hence themselves as ‘belonging’ in these subjects. A research in the US where both male and female students were asked to give reasons for their poor performance in engineering, found out that women students attributed their poor performance to lack of ability, while men attributed it to lack of hard work or being treated unfairly (Cunningham 2007). Such responses demonstrate acceptance of defeat on the part of women while the males demonstrate optimism that if they put more effort they could make it. Such students are prone to drop out if they do not get appropriate support. Such characteristics where women are passive

and rarely challenge issues and men being aggressive is common in patriarchal societies. Therefore female students from such backgrounds are likely to have low self esteem and easily accept "defeat" in areas they believe are meant for men. Some studies show that social and cultural capital are positively significant for persistence in higher education (Wells 2008).

Most of the development of children's gender role experiences comes from gender stereotypes that are ingrained in society, families and schools (Longden 2002). On a similar note, a research on women and school headship established that women, even those capable, have a tendency of hesitating to enter previously male dominated positions due to lack of confidence and low self-esteem which emanated from gender role stereotypes (Chabaya et al. 2009). These gender stereotypes could be instilled in social institutions which include the family and the education system. Dalton et al. (2007) point out that gender stereotypes in school textbooks can distort and neglect women's role and experiences and even perpetuate and underpin gender role bias of society.

Gender bias has also been found to exist in teacher-student interaction. Sadker et al. (1994) from their study, point out that gender bias is common in the classroom interaction where teachers allow more thinking time for male students than female and the length of the time affects the level and quality of thinking and answering. As a result learning opportunities are lost for female students who do not have as much thinking time as male students in an interaction process dominated by gender bias. According to the research by Kaino (2002), teachers who received complete training in gender equity education not only can instruct in a more constructive and effective manner, but can also improve teacher student interaction.

However, a sizeable number of respondents believe that mathematics and sciences are for both male and females and were ready to prove to those who think females cannot do sciences. These findings were rather surprising, as they yielded no strong indication of gender bias in the learning environment where participants reported that they did not experience any gender related interaction with their lecturers. It was therefore prudent to investigate the reasons why more females are now taking up subjects that were once regarded as men's territory. In order to ascertain this, the following question was asked:

What are Some of the Factors that Motivate/ Demotivate Females from Taking Up Mathematics and Sciences?

It emerged that most of the respondents showed interest in mathematics and sciences due to reasons such as: *sciences being in demand, sciences having more opportunities, challenging those who think women cannot do it*. In the same vein the participants that were not motivated to study mathematics and sciences gave reasons for not liking the subjects as follows: *"science is not for girls."* One of the respondents asserted that *"even my mother discouraged me. When I first enrolled in college she was opposed for me taking computer science as a major"*. Another respondent indicated that *"some people believe that if you are doing sciences, you would never find a boyfriend."* It was also revealed that *"some young women may turn away from science and technology careers because of a perception that people in those careers spend long hours working alone on esoteric ideas in a laboratory or computer room and no, or not enough, time collaborating with others or making positive changes in the world"*. It also emerged that some of the teachers' actions discouraged girls from developing a positive interest in mathematics and sciences.

Basing on the above perceptions from various respondents, it can be deduced that teachers and some cultural beliefs are believed to influence gender interest in mathematics and sciences. One argument states that the gender separation in the use of technology begins as far back as kindergarten. Boys gravitate toward computer games and mechanical toys (Clewell and Campbell 2002; Klawe 2002). Girls, on the other hand, are more likely to develop interest in dolls or be involved in more social games (Jepson 2007). Teachers may treat boys differently from girls causing differing expectations. For example, boys and girls are often approached differently when dealing with inappropriate physical and verbal attacks on others. Boys involved in pushing or even fist fights may be more accepted than girls involved in the same activities; *"boys will be boys."* Girls are expected to be better negotiators thus preventing the need for physical altercations (Jenkins and Macdonald 1989). This causes girls to lose interest in any activity that is physical (Galpin 2002).

In addition, girls in adolescence tend to

experience weakening self perceptions (Camp 2002). Many girls in adolescence go through changes that negatively affect self image and future choices. As a result, girls often refrain from asking questions and sharing answers (Moskal 2002). Many girls feel inferior to others or wish to mask their leadership abilities and intelligence and decline opportunities to take part in student government, clubs, or challenges that may cause failure (Wardle and Burton 2002). These issues also discourage some girls from taking part in higher track classes in mathematics, science and computer science.

Elementary-age girls exhibited more negative attitudes toward science, and elementary-age students tended to view science as a masculine subject and lose interest in sciences (Jepson 2007; Hazari et al. 2007). These differences escalated during the middle school years, becoming extremely pronounced by age 14, when students were about to begin high school (Barley and Phillips 1998; Havas 1999). Girls at this age repeatedly indicated that they saw the high school science environment as a threatening one, exhibited strongly negative attitudes toward science, and pursued fewer science opportunities. By the end of high school, girls scored considerably lower than boys on measures of mathematics and science achievement (Jenkins and Macdonald 1989). It was also necessary to ascertain the level of the participants' confidence in mathematics and sciences the since about 33 percent of respondents had indicated their displeasure in these subjects, hence the following question was asked:

How Confident are You in Mathematics/ Science Subjects?

Table 3 shows that (a) out of 16 respondents doing physics, 43.75 percent pointed out that they were not confident in the subject (b) out of 32 girls enrolled for chemistry, 37.5 percent said that they were not confident in the subject (c) out of 12 participating students doing mathematics, 50 percent indicated that they did not have confidence in the subject. One wonders how these students are going to make it in their studies given that they already lack confidence whilst they are in their first year of studies. Asked if they sometimes feel like dropping the science subjects, 41.67 percent said yes. Table 4 summarizes this:

It was prudent to ask respondents the reasons

Table 3: Self-confidence in the subject

	Confident		Not confident	
	n	%	N	%
Physics (n=16)	9	56.25	7	43.75
Chemistry (n= 32)	20	62.5	12	37.5
Mathematics (n= 12)	6	50.0	6	50.0

Table 4: Do you feel like dropping the subject: N=60

Yes	%	No	%
25	41.63	35	58.37

why some of them contemplated changing their careers. The main reason for that was repeated failure as one student puts it saying "*I fail even if I put effort.*" Another respondent indicated that "*I am failing even if I try harder than before, I always get disappointed.*" The other participant said "*I just want to change, this subject is frustrating me, and I am regretting having chosen this subject*".

The above responses could be indicators that science, as it exists in education, is a fundamentally patriarchal subject and as a result girls lose confidence in such subjects. Baldwin (2009) and Wells (2008) confirm this by postulating that "—science is usually taught by males and is regarded as the quintessentially masculine intellectual activity". The interpretation that comes into mind is that sex-role stereotyping contributes strongly to the fact that girls view science careers as masculine and, therefore, avoid them. They therefore lack confidence in these subjects (Kaino 2002; Trenor 2007). Perceived traits of scientists, such as high intellectual ability, persistence at work, independence, aloofness, competitiveness, aggressiveness, and dominance, are those most often associated with masculinity (Berger 2000; Braxton 2000). To attract women to science, the pervasive masculinity of science must be eliminated (Kaino 2002; Wells 2008). Girls have lower motivation to achieve in traditionally male areas because of the negative social consequences they perceive (Camp 2002; Moskal 2002).

According to Berger (2000), providing opportunities is important, but women can only benefit from these opportunities if they have the confidence and attitude they need to pursue these opportunities and take advantage of the educational and professional openings that are available to them. Wardle and Burton (2002) assert that too often, girls are not encouraged to develop

the confidence they need to continue in higher level maths and science courses in high school, and in some cases are even actively discouraged from taking advanced courses so their "grades will be better". This puts them a step behind when they get to college, though, and makes it more difficult to move ahead at the college level (Galpin 2002).

A survey of middle-school girls reveals that their self-confidence in mathematics suffers when their parents believe the gender stereotype that holds that mathematics is a male domain and when the parents give unsolicited help with homework (Braxton 2000; Kaino 2002). In support, Sonnert (1995) asserts that there's still a gender gap in mathematics and sciences. Contributing to the same debate, Klawe (2002) is of the view that "It's not a gap about performance or achievement. It's about attitudes. Girls are not as confident about mathematics and science." According to the 2000 National Assessment of Educational Progress in South Africa, 71 percent of eighth-grade boys and 60 percent of eighth-grade girls reported confidence in their mathematics ability but however the gender gap in confidence persists in high school (Camp 2002). National achievement tests and performance in class show that girls have the same mathematics ability as boys," said Berger (2000). "Yet, girls continue to underestimate their ability. I'm interested in what contributes to their lack of confidence" (Berger 2000).

Previous studies show that children's confidence decreases when parents give unsolicited help on homework (Baldwin 2009; Kaino 2002). Green who conducted this study became curious whether parents who endorse gender stereotypes and who give intrusive help on homework unintentionally undermine a child's self-confidence in academic abilities (Galpin 2002). Research shows that when parents endorse the stereotype that mathematics is a male domain, their daughters underestimate their mathematics ability (Trenor 2007).

CONCLUSION

Several factors influence the fact that girls are participating less and show less motivation to take part in science education especially at tertiary level. Some of the reasons are related to differences in ways boys and girls learn and the content of science education reflected in gender-

biased curricula, textbooks, which are not related to women's and girls' concerns and interests. Many of these factors are bound up with cultural and societal influences. The attitude of teachers and parents, classmates as well as the level of confidence of girls in their science skills determine the often observed gender gap in science education.

RECOMMENDATIONS

It, thus, became clear that to achieve gender parity in science, it is important not only to motivate the girls themselves but also to address the surrounding socio-cultural factors.

- Ø National Governments should incorporate "gender and science and technology" analysis into all regular programs, and through redistribution of agency funding priorities, provide increased regular budgetary allocations to gender units.
- Ø Technically based agencies should support adequate staffing of gender experts and require training of all staff in gender analysis to ensure full incorporation of gender into their regular programs.
- Ø States should investigate alternative methods of increasing intra and inter-agency communication in this area by, for example, establishing an electronic network link on gender, science and technology

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