

The Experiences of Ugandan Females in Mathematics

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Abstract- This study reports women's experiences in mathematics. Data was gathered in the years 1996–1999, 2007 and 2011. The aim was to use the experiences of successful Ugandan females in mathematics to establish factors that enhance females' persistence and success in mathematics and those that inhibit them. Participants were a random sample of 99 females ranging from students in senior three to six, college, university and members of the mathematics teaching profession. They were selected from all five regions (central, south, east, north and west) of Uganda. They responded to the researcher's guidelines for describing their experiences in mathematics at all levels of mathematics learning. Many (of 49) respondents simply narrated their experiences in essay form. Their responses revealed support from parents, siblings, teachers and peers; availability of textbooks; their own personal effort (hard work, perseverance and determination) and role models helped them succeed. They also narrated some experiences that discouraged them from doing mathematics. In 2011 April a list of these in form of a questionnaire (see appendix 2) were given to 50 university students from two Ugandan public universities. Respondents ranged from those who did mathematics up to O level to those who did or were doing mathematics at college or University.

Keywords: Women mathematicians; experiences of women; support from parents, siblings, teachers and peers; availability of textbooks; ambitions; hard work; perseverance; determination; role models, God.

Introduction

In 1996 at a Mathematics conference held in Uganda, the issue of gender and mathematics was discussed. Kaahwa (1996a) highlighted the situation in Uganda at the time using a review of a number of unpublished research reports. These were studies such as Adiope (1992), Kisa (1991), Meya Wa'Muya (1991), Ssajjabbi (1992), Chikwakwa (1993), Kaahwa (1996b), Ndimbirwe (1996). In addition studies done elsewhere such as Fennema 1995 and Leder 1992 were reviewed. The studies done in Uganda were small scale each based on one or two districts. Many were surveys which used mainly questionnaires to teachers and other stakeholders, hardly involving girls.

A lot of interventions have been done in the various parts of the country in the 1990s and 2000s based on these. Most prominent of these was Female Educationalists in Mathematics and Science in Africa (FEMSA) an arm of Forum for African Women Educationalists (FAWE) which developed guidelines to promote gender parity on behalf of the ministry of Education and Sports (MoES) task force. The guidelines that highlight gender and Millennium Development Goals (Wikipedia, 2011) were to be pre-tested in one district (Soroti). FAWE developed Regional Gender Responsive Pedagogy for teachers and district education managers to equip teachers of the pilot schools to promote girls' education.

FAWE-Uganda (FAWEU) adapted this pedagogy and procured textbooks to promote girls' access to science based professions. UAUW (Uganda Association of University Women) has also played a role.

The findings in this research can further enhance Ugandan females' participation in mathematics and science. They recount women's experiences in their own words. The number of girls successfully studying mathematics and science though on increase is still small. This is especially the case in poorly resourced districts. Yet the study of mathematics in Uganda is compulsory up to the end of secondary school (O level). Kaahwa (1996b) and other researchers at Mathematics as a barrier to the learning of Science and Technology by girls conference in Ahmedabad, India (Goel and Burton, 1996) have argued that low performance in mathematics can be a barrier to girls' study of science. Within education, mathematics

... has a high prestige and power. It is the subject more than any other that labels differences in perceived overall abilities between students, that separates the 'bright' child who moves on to more mathematics and more education and the child who 'cannot even add' who leaves school at the earliest opportunity for ill or unwanted manual labor (Harris, 1997, p.85).

Today emphasis in Uganda's education system is on science, a key to development. Seventy five percent of Uganda's government scholarships to university education are going to science based courses. They take boys or girls on merit. Carnegie Corporation used to give 100 scholarships to Makerere University for disadvantaged girls (orphaned or too poor to pay for Makerere University education). The project ended in 2006. However it was always difficult to get 60 girls to take up these scholarships. A majority of the girls who do science attends the good and expensive schools in the country and therefore could not qualify for the scholarship program. Besides, generally, female science candidates at advanced level are only 12 -15% of all the science candidates. 60% of the scholarship money was spent on science based careers since these are usually more expensive to fund.

The Problem

Today Uganda needs a population that is mathematically literate for development. Uganda is aware that to educate a woman is to educate a nation. It has placed emphasis on

sciences; 75% of the scholarships are given to science-based courses. But you cannot do sciences unless you have studied mathematics because mathematics is the language of the sciences. There are scholarships specifically earmarked for girls. There is need to find out what supports girls' success in mathematics and what makes them fail so that the nation can take measures.

Aims

The study aimed at finding out females' experiences in mathematics learning and gaining insight into factors that enhance or inhibit their doing mathematics.

Literature Review

Lewis (1991) found that successful women's peers described them as self-reliant, self-confident, persistent, risk-taking and imaginative. However all over the world the girls' attitudes toward mathematics have been found to be negative. (Examples include American Association of University Women (AAUW), 1992, Gill, 1994; Fennema, 2000; Tuyezire, 2008). Clewell and Anderson (1991) said that teachers must help girls of color to bring down the barriers they face by encouraging them to have positive attitudes in mathematics, to enroll and participate in mathematics and science classes. Fennema (2000) reports all Fennema-Sherman studies having found females less confident in learning mathematics.

Hall (2009) reviewed literature which attributed the inferior performance and under-representation of women in mathematics and science to innate biological factors. Other research she reviewed however questioned it, examined other issues and pointed out that no sex differences exist on these grounds. She concluded like Fennema (2000) that differences are not innate, but are linked to societal perceptions. Fennema (2000) says that Peterson and she in 1985 proposed an autonomous model which suggested that because of societal influences and personal belief systems females do not participate in learning activities that enable them to become independent learners. However modern educational research suggests no physical or intellectual barrier to the participation of women in mathematics (Hanna (2003) cited by Hall (2009)). Women are underrepresented because of social and cultural barriers (i.e. stereotypical identifications, media portrayals of women and mathematics, and parental and teacher expectations, views, and treatment of females in mathematics) that do not accord them equal opportunities. Azar (2010) also asserts that culture contributes to men having higher interest and achievement.

External support (supportive relationships such as parental, teacher, sibling or relative and peer) is instrumental in women's study of mathematics (Hall, 2011). Hall (2009) also found that the discipline and the way it is taught may be to blame for women's underrepresentation. The teaching should be connected to different ways of learning which may be connected to gender differences and which are attributable to differences in socialization rather than innate biological characteristics.

Teachers' interactions with students determine students' liking of mathematics. Lewis (1991) found that in America

bad instruction can cause women to run away from the subject. They perceive mathematics as a bag of rules and tricks to be applied quickly and mechanically. They need immediate feedback on their accomplishments and to be recognized as individuals. They do not want competitiveness but co-operate learning. They prefer discussive, discovery modes of learning to the advocacy style. Fennema (2000) reports indications that certain student-teacher interactions, teacher and student behaviors and characteristics of classroom and teaching behaviors facilitated females' learning of mathematics. Women like warm learning environments where there is good student-teacher interactions, a peer support system, and a sense of community (Lewis, 1991). Kaahwa (1996a) reported that some teachers in Uganda hold the view that girls cannot do mathematics. They throw nasty, discouraging and embarrassing comments at them during mathematics lessons to the effect that they can never do mathematics. Kaahwa (2009) recommended that teachers should have positive attitudes towards girls and mathematics.

Ssajjabbi (1992), and Ndimbirwe (1996) and Mulemwa (1987) found that in Uganda in addition to teaching methods, females' study of mathematics is determined by cultural upbringing, lack of careers guidance, lack of role models, textbooks, examinations and assessment methods, peer support. There are few prominent women to act as role models in Uganda and few women teachers (Kaahwa, 1996a). These would be the best role models next to their mothers. Kaahwa 1996a reported that the females are not informed of the numerous careers that the study of mathematics opens to them. Concerning peers, she said that boys harass gifted girls. Kirschner (1981) found that in other countries gifted girls receive less positive attention from their male peers than do other girls. Fortunately this does not appear to be the case in Uganda. Most women mathematicians who participated in this study are married to educated men.

Blevins-Knabe and Musun-Miller (1991) indicated that parents' belief in girls' Mathematics ability affects girls' belief in their own mathematics ability. Women successful in the subject receive encouragement and assurance of their abilities at critical points from parents and instructors (Lewis, 1991). Campbell (1992) found that parents play a crucial role in their daughters' mathematics and science education. She suggests that they foster positive attitudes in them towards mathematics by encouraging their daughters to do mathematics and science and by talking to them about the importance of mathematics and its necessity in certain careers. In Uganda Kaahwa (1996a) said that in most cultures girls are valued in terms of the brides wealth they will bring. They therefore are brought up to be good wives. They are loaded with household chores and restricted in the kind of activities they participate in.

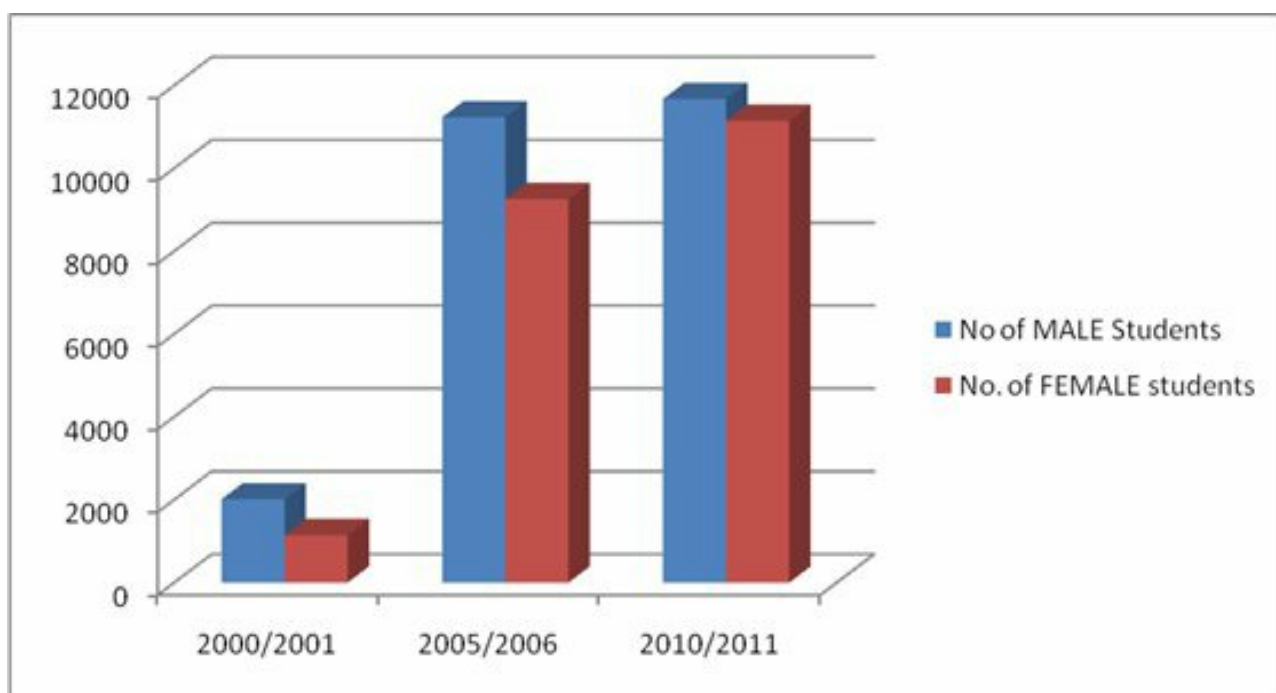
Fennema and her colleagues found that gender differences in mathematics might have decreased but still existed in tasks requiring functioning at high cognitive levels. She reports on the 1990s effective professional development programs that were built on knowledge derived from cognitive science studies (Fennema 2000).

The American Psychological Association found girls to be as good at mathematics as boys and culture to be one of the

factors at play in the gap existing between them (Azar, 2010). Even if girls perform well in the subject they still do not think they can be as good as boys. Girls in lower classes are as good at mathematics as boys. However they are also good at verbal skills. So when they reach time to choose careers they have to choose mathematical career and others. Boys however just choose the mathematical careers (Azar *ibid.*). Cultures are changing and women are being supported in science and mathematics. So when girls see many women in careers like engineering they also opt for them (Azar *ibid.*) Girls like working with people and boys with things. In the classroom girls prefer working with manipulatives and being accurate while boys like being fast and do not care much about accuracy. So the girls do well in earlier classes but their method of learning fails them in higher classes where speed is preferred to accuracy. Boys have an upper hand here (Azar, 2010).

Quinn (2002) says there are situations that implicitly suggest stereotype 'threat'. A stereotype threat is not an explanation based on internalized inferiorization. It is its knowledge that is enough to affect performance in the situation, she explains. It is a particular kind of "social identity threat" (Murphy et al., 2007). "a broad threat that people experience when they believe that they might be treated negatively or devalued in a setting simply because of a particular social identity they hold (p.879). Some stereotype-threats are that girls have inferior mathematics skills and that women score lower than men on tests that are standard (which hinders or even makes girls drop out of mathematics early) (Quinn, 2002). It is part of the reason for women not taking math-heavy courses (Murphy et al., 2007). Lewis (1991) also found that despite excellent performances, many successful women in mathematics are not self confident. He explains that this may be due to the fact that the general public views mathematics as masculine and early on women perceive themselves as being outsiders to the mathematical world. Fortunately in

Graph 1 Showing Student Intake in the Public Universities (Makerere, Mbarara, Kyambogo and Gulu)



It is not a surprise that Ugandan women mathematicians are taking on science courses. Mulemwa (1987) found that women's study of science and mathematics is controlled by social cultural factors among others. Today Ugandan culture is changing and many parents nationwide support girl education. However some cultures still value girls in terms of bride price (Kaahwa, 2009)

Research Question

What are the factors that helped women succeed in mathematics; what are those that discouraged them from doing mathematics?

Methodology

The Research Design

The study was a longitudinal survey type. In the years 1999 and 2007, women wrote narratives of their experiences in mathematics learning guided by questions given by the researcher. The main question asked of women was their experiences in mathematics learning at home, and at nursery, primary, ordinary secondary, advanced secondary school levels. They were also asked to include information on people who helped them at home or school to perform in mathematics the way they did. Did they have enough

mathematics textbooks; did their friends give encouragement to learn mathematics? What were their experiences with mathematic content? Did they have to be coached? They were asked to include as much as they thought should be documented concerning their mathematics learning experiences. In 2011, university women were given a self-report questionnaire made up of responses found out in the 1999 and 2007 narrative survey.

The Sample

Thirty four females who studied mathematics before 2000 randomly selected from all regions (central, south west, east and north) of Uganda participated. The easiest groups to identify were the teachers and students. Thus females from secondary school, teacher training colleges, university and those in the teaching profession participated. Specifically: 8 students of mathematics in senior 5 (advanced level/A level or high school); 5 university students doing education (2 doing postgraduate diploma in education and 3 Bachelor of Science with Education); 7 grade V teachers of varying years of experience; 2 graduate teachers; and 7 mathematicians with masters degree in mathematics and mathematics education. (Three of these women now hold PhDs in mathematics (2) and mathematics education (1). Four of the women who participated studied mathematics up to the end of 2nd year at university. One laboratory technician also participated). Thirteen girls (10 ordinary level/O level and 3 A level) attending a holiday coaching class in 2007 academic year also participated. In 2011, 50 university women participated. All together the sample was comprised of 97 women.

Instruments

Guiding questions were prepared based on factors affecting women's study of mathematics worldwide as described in the literature. These were completed in the years 1996- 1999 and in 2007. From the responses, a self-completed questionnaire was developed and completed in 2011.

Data Collection

Guiding questions were handed out to a random sample of females doing mathematics or teaching it. Some of them were given during workshops and classes. Most participants (except those in workshops) took their time to respond and submit their responses. The distribution of guidelines and collection of responses was done over the years 1996 – 1999. In 2007 these same guiding questions were given to 13 girls

who were in a class on holiday coaching. The responses were analyzed and a self-report questionnaire developed from them. This questionnaire was filled in by a random sample of university women in 2011.

Analysis

The narratives were read through many times as themes were sought and coded. The themes were identified (as per existing factors from literature), frequencies of their occurrences counted and tabulated and their percentages calculated (see tables below). Frequencies of occurrence of these themes or factors were documented for women who filled in the questionnaire in 2011 (see table below)

Results

Themes that emerged as the researcher read and reread through narratives of women before 1999 were taken to be the factors that influence Ugandan women in their study of mathematics. These same themes emerged as narratives of women who studied mathematics between 2000 and 2007 were read through. These factors operated both positively and negatively. The factors that operated positively are shown in table1 and those that were negative are shown in table 2.

Factors with very low percent are included because they mattered to women who mentioned them. Besides, this study was mainly qualitative and descriptive. The percentage being high simply means that more women mentioned the factor thus strengthening its role in their study of the subject. Percentages of the year 2007 are a bit high because the sample size was small.

Most factors reported in this study before 1999 operate at primary and secondary (O and A) levels. This agrees with other research, including Fennema et al. (1998) and Azar (2010) that gender differences do not emerge until early adolescence. At tertiary level peer support (23%) and positive attitude (15%) were reported as most helpful. In 2011, however, positive attitude, hard work, determination and God mentioned by 54% each, coaching mentioned by 36% and self confidence and career guidance mentioned by 27% each were supportive.

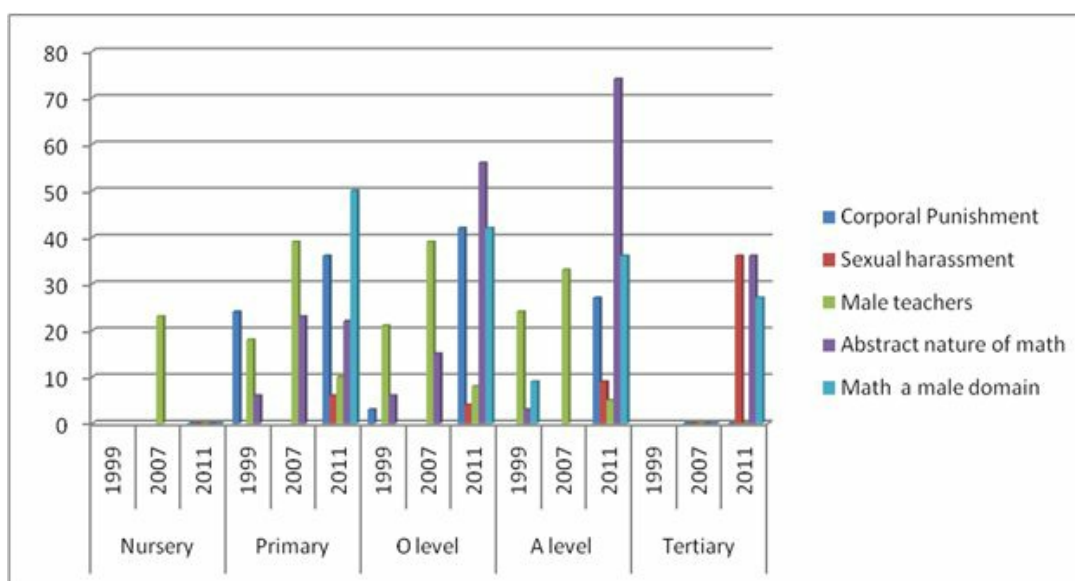
Most women before 1999 mentioned that they were not aware of mathematics at nursery. Many did not get nursery schooling. All respondents after 2000 attended nursery and 62% had positive attitudes, 46% parental support and 77% teacher support. In 2011 nursery schooling was not asked for in the questionnaire.

Table 1 Percentages of factors that positively influenced females in mathematics learning at various levels of education in the years before 1999, 2000- 2007 and 2003- 2011

FACTOR	LEVEL OF LEARNING														
	Nursery			Primary			O level			A level			Tertiary		
	%			%			%			%			%		
	N=16 1999	N=13 2007	N=50 2011	N=34 1999	N=13 2007	N=50 2011	N=34 1999	N=13 2007	N=50 2011	N=34 1999	N=3 2007	N=22 2011	N=26 1999	N=0 2007	N=11 2011
Attitude	19	62	0	50	54	54	47	69	54	41	33	45	15	0	54
Performance	13	8	0	32	46	24	24		24	12		18	7.7	0	18
Self Confidence			0			38	3		36	15	15	36		0	27
Teacher support	13	77	0	50	77	46	59	62	50	38	100	45	7.7	0	
Parental Support	38	46	0	32	69	32	12	85	32	15	100	32		0	9.1
Sibling Support	25	15	0	27	31	6	12	54	2	3	66	9		0	
Textbook		8	0	18	46	40	27	77	40	15	66	32		0	9.1
Peer support	6	8	0	29	15	16	47	85	16	32	66	14	23	0	9.1
No sexual harass			0	9	46		6	54		9	66		3		
Coaching			0	6	23	34		92	30	6	66	41		0	36
Career	6		0	3	8	16	12	8	20	6		14		0	27
Role Model			0	6		8	9	8	16	6		18		0	9.1
Gifted			0	27	8	10	9		2			9		0	9.1
Hard work			0	32	8	50	35	31	56	35	33	50	4	0	54
Perseverance			0			20	9		32	15		23		0	9.1
Determination			0			56		38	70		33	59		0	54
Attributed success to God			0		8	72			78		33	82		0	54

Table 2 Percentages of factors that negatively influenced females in mathematics learning at various levels of education in the years before 1999, 2000- 2007 and 2003- 2011

FACTOR	LEVEL OF LEARNING														
	Nursery			Primary			O level			A level			Tertiary		
	%			%			%			%			%		
	N=16 1999	N=13 2007	N=50 2011	N=34 1999	N=13 2007	N=50 2011	N=34 1999	N=13 2007	N=50 2011	N=34 1999	N=3 2007	N=22 2011	N=26 1999	N=0 2007	N=11 2011
Corporal Punishment			0	24		36	3		42			27		0	0
Sexual harassment			0			6			4			9		0	36
Male teachers		23	0	18	39	10	21	39	8	24	33	5		0	0
Abstract nature of math			0	6	23	22	6	15	56	3		74		0	36
Math a male domain			0			50			42	9		36		0	27

**Graph 2** showing factors that deterred women in the study of mathematics at different levels

At primary level before 1999 the most prominent factors that helped women are positive attitude (50%), teacher support (50%), performance, hard work, and parental support (each at 32%). Peer support (29%), sibling support and being gifted (each at 27%) also played a vital role. Corporal punishment reported by 24% had a deterring effect or even discouraged girl students from study of mathematics. It introduced fear and anxiety in them. It is again reported in 2011 by 36%, meaning it is still the practice in schools today. Other discouraging factors mentioned were male teachers and lack of support from teachers (18% each). In 2011, 22% reported abstract nature of mathematics and, for the first time mathematics a male domain (50%) as negative factors. They overcame them by positive attitude, parental, and sibling support and hard work, determination, perseverance, and faith in God reported in 2007 and 2011.

At O level (secondary school) before 1999, same positive factors were still reported to be helpful. However, teacher support is reported by a higher percentage (59%) as is peer support (47%). These supportive factors at school seem to be more than those at home and personal characteristics (i.e. good performance (24%), positive attitude (47%)). Abstract nature of mathematics and dominant male teachers (21% each), no peer support (15%) and no textbooks (27%) are reported as deterring. Perseverance (9%) is reported for the first time by this group meaning at this level the content is beginning to get tough, women need more support but peers cannot help so there is need for perseverance.

Women in 2007 had all the support as table 1 shows. However dominant male teachers (39%) and abstract nature of mathematics (15%) were negative factors. In 2011 God (78%), determination (70%), hard work (56%), good attitude (54%) and teacher support (50%) were the prominent positive factors reported. More women mentioned role model (16%) and career guidance (20%) as positive factors than in 1999 and 2007. This means that today there is an increased number of visible role models. ('Visible' because Kaahwa (2009) found that girls prefer to have women near them and whom they know to be their role models). Career guidance in schools is also on the increase. Abstract nature of mathematics (56%), mathematics a male domain (42%) and corporal punishments (42%) continue to be negative factors at this level in 2011. This means that today these factors are on the increase which should not be the case.

Before 1999 at A level, women report positive attitude (41%), teacher support (38%), peer support (32%) and hard work (35%) as prominent factors. Perseverance is mentioned by more women (15% compared to 9% at O level and none at primary level). This means the subject becomes harder at this level and that the women that succeeded had to persevere without much external support. They mention male teachers (24%) being dominant, no teacher support (24%) and no peer support (15%) as prominent negative factors. Women report mathematics as a male domain (9%), not mentioned at lower levels, as deterring. At this level they begin to associate the subject with male and the number of women coached rises to 6%. Sibling support also goes very low (3%). Either the siblings have not studied the subject this far or they just cannot manage it. Good performance is no longer an

inspiration to many. All this indicates that mathematics study at this level gets tougher. As already pointed out the percentage that mentions teacher support and lack of it also reduces. Moreover it should be noted that in Uganda mathematics is compulsory up to O level. This would explain why at tertiary level very low percentages of women mention these factors.

In 2007 women were silent about role models, career guidance, giftedness, perseverance and performance. The rest of the positive factors were at play at A level. They were disturbed by Sexual harassment (55%) and dominant male teachers (33%). In 2011 prominent supportive factors are God (82%), determination (59%), hard work (50%), positive attitude (45%), teacher support (45%), coaching (41%), self-confidence (36%), parental support (32%) and perseverance (23%). The highest number that mentioned role model (18%) in the study was here. Abstract nature of mathematics (74%), mathematics a male domain (36%) and corporal punishment (27%) were deterring factors. It was at this level in the study that the biggest number of women reported mathematics as abstract and lowest number reported dominant male teachers (5%) as deterring. None mentioned sexual harassment. This could point to the fact that male teachers teach well and their absence complicates it.

Before 1999 at tertiary level 23% women mentioning peer support and 15% positive attitude as supportive factors are the highest percentages. Discussion groups appear to be the norm at this time. In 2011 God, determination, hard work and good attitude were each mentioned by 54% and career guidance and self-confidence each mentioned by 27% women as positive factors. Sexual harassment (36%) (this was the biggest percentage that reported it in the whole study), abstract nature of mathematics (36%) and mathematics a male domain (27%) were reported as deterring.

Discussions

The factors at play may be categorized into two major categories: social factors (just like Mulemwa, 1987, Ssajjabbi, 1992, Ndimbirwe, 1996, and Hall, 2011) and personal factors which Mulemwa (1987) termed psychological and bio-psychological factors. Under social factors the learner gets external support and under personal factors the individual learner makes deliberate effort or is endowed with natural capabilities. Mulemwa (1987) also found that the nature of science and mathematics were among the factors that affect women's study of science and mathematics, confirmed by this study. She also found the study of these subjects to be controlled by the economic status of the family and poor guidance and counseling as did Ssajjabbi (1992) and Ndimbirwe (1996). Social factors include home support (parental and siblings support), teachers support and peer support. Personal factors are attitudes, hard work, determination and perseverance. This study also found that women attributed their success to God

This study brings out details on how some of these factors helped or deterred Ugandan females in their mathematics study. The women detail ways in which they managed to study mathematics. These are new contributions to literature.

Factors That Helped Women Study Mathematics

Home Support

Families are children's most important educators (Ravitch, 2011). This study has found like other s (e.g. Blevins-Knabe and Musun-Miller, 1991, Campbell, 1992, Lewis, 1991) that home support is crucial to female's study of mathematics. Home support included parental, siblings and relatives support. Parental support included payment for coaching, buying textbooks, teaching, involving in activities such as counting calculations business, encouragement to work hard, prayers, help with homework, counseling, helping to solve numbers. In some cases, both parents helped while in others only mother, or father, helped. In some cases mother or father was a mathematician or even a mathematics teacher.

Blevins-Knabe and Musun-Miller (1991) indicated that parents' belief in girls' Mathematics ability affects girls' belief in their own mathematics ability. Parental support or better still home support acts as a back-up and a stabilizer to the learner. Campbell (1992) found that parents play a crucial role in their daughter's mathematics and science education. When things are not going well at school, learners need to be assured of the sanctuary at home. One woman's experience supports this argument. She recalls starting to hate the teacher for his conduct towards her. She at times dodged his lessons and slowly lost interest in mathematics.

"I always looked miserable at school and at home one day I decided to share it with my mother and elder brother. They advised me not to hate the teacher but to befriend him and explain my problem. I took their advice. To my surprise, the teacher became very concerned and helpful. ...my interest rose again."

Campbell (1992) suggests that parents foster positive attitudes in their daughters towards mathematics, encourage them to do it and science and talk to them about its importance and necessity in certain careers.

It can be said that parental support is heavily dependent on socio-economic status. In most cases parents could only give encouragement. Most of them did not go far with education and so could not help with academics. They could not provide textbooks yet Ssajjabbi (1992) and Ndimbirwe (1996) found their availability to be one of the factors determining females' study of mathematics. Most women who reported text books' availability found them in their schools. Women whose parents could pay for coaching could support them at all levels

Although Kaahwa (2009) found girls in North Western Uganda pressured to get married and Kaahwa (1996) says that some cultures in the country value girls in terms of the bride's wealth they will bring as an economical issue, no indication is given by the women in this study that anybody at home suggested to them early marriage as an alternative to schooling. This points to beginnings of change in culture.

Sibling and relatives help the students to gain interest and encourage them to work hard. The women reported that siblings helped, taught and gave them problems to try out.

One of them pointed out, "my brother reached an extent of drawing for me a timetable". The study however found that these did not help those at higher levels. This might be because the content becomes hard especially for those siblings and relatives who did not go far with the study of mathematics.

Text Books

In this study, apart from women reporting that their parents could or could not afford to buy them textbooks or the school did or did not have any, there was no talk about textbooks. This might be because in Uganda students tend to depend a lot on teachers. Indeed a good percentage reported adequate teacher support. However Ssajjabbi (1992) and Ndimbirwe (1996) found availability of textbooks to be one of the factors determining females' study of mathematics. Everyone should have adequate resources and a balanced curriculum (Ravitch, 2011). With the advent of computers lack of textbooks and adequate resources might cease to be a problem.

FAWE has reported that textbooks are gender biased depicting mathematics as a male domain through examples and content. However none of the women reported any of these which might mean that they are unaware of this phenomenon. In any case in some textbooks such as School Mathematics of East Africa (books 1-4 by Kaahwa and Quinn) for O level it has been addressed. A few women talked of some topics in mathematics being very hard to understand and a number of them say they overcame this by hard work and help of friends (who in most cases were male) and God.

Teacher Support

This study like Ssajjabbi (1992) and Ndimbirwe (1996) found that teacher support and teaching methods determine females' study of mathematics. Teacher support was in form of praise to those who worked hard. It was in form of teaching 'well' that is explaining content well, not being harsh, using various modes of teaching including discussions and a variety of text books; being friendly and giving threats (such as without passing mathematics, no recommendation would be given). Fear of these threats helped women to work hard and love mathematics. Some teachers showed eagerness to help, were caring, showed confidence in the students' abilities and talked to them about it. They showed concern about their performance. Some teachers gave presents to excelling students, told interesting stories about mathematics, and gave quizzes and mental work.

One woman's statement "some teachers encouraged us, others discouraged us that mathematics is for men" summarizes teachers' support. Indeed some teachers were unsupportive. These teachers, though good at teaching, were harsh especially to those who failed. Some teachers used corporal punishments. One woman wrote "the teacher was harsh; he caned us, made us walk on our knees on stones. He also gave other corporal punishments". Being harsh and caning introduces fear in both male and female students. This study found that corporal punishments still exist in Uganda at all compulsory levels and that it deters women as the following quotes portray: "Our teacher in primary was very cruel. He used to beat us whenever we failed. We were scared

most of the time and ended up almost learning nothing". Another woman recalls

"I will never forget the many challenges I went through in primary three... when the teacher introduced the topic on 'division' I could not understand. He was so rude that I even feared to ask questions... He used to give us exercises... whichever number you failed you were punished severely. It was too much, I started hating him"

Unsupportive teachers dodged lessons, didn't mark tests, were drunkards, abusive verbally and boastful. One woman wrote "The teacher ...suggested to me that whether I was doing well in mathematics or not, the end office would be a kitchen, just like my mother".

In some schools the teachers were not enough and others not qualified. One woman recalls; "They used to teach for the sake of teaching" that is, they did not care if students learned. They did it as a job. The unsupportive moves by teachers were unexpected by the students whose view of the teacher was that of one who is kind, helpful, explains well, gives counsel and is patient and understanding. They did not expect to be hated or caned when they failed to understand. Some students did appeal to higher school authorities for change of teachers to which some authorities responded while others ignored. Schools must improve in such a way that everyone has a stable and experienced staff (Ravitch , 2011). Teachers are important in females' study of mathematics (Lewis, 1991; Fennema, 2000). Girls can run from the subject if teaching methods are not conducive (Lewis, 1991).

Peer Support

This study has found like Ssajjabbi (1992), and Ndimbirwe (1996) that females' study of mathematics is determined among other factors by peer support. This is the support given by fellow students and colleagues. This study found it to be mainly in the form of study groups, discussions, advice and encouragement as the following quotes show.

"More boys were interested in mathematics than girls. My only alternative was to befriend the boys, we formed discussion groups".

"I attribute all my practice skills to my classmates. Whenever my friends got a mathematics problem that they could not solve, they would bring it to me. Usually to my surprise I would solve it. That too boosted my morale." "To some extent I did the coaching within myself and my friends who might have understood better... I used to do constant practice especially during the time when I was assisting my friends who used to consult me. This increased my interest in the subject."

Women do not want competitiveness but co-operate learning. They prefer discussive, discovery modes of learning to the advocacy style (Lewis, 1991). They like warm learning environments where there is good student-teacher interactions, a peer support system, and a sense of community (Lewis, 1991). In other words girls like constructivist methods. Constructivists emphasize group work and say it is consistent with the social nature of knowledge (Gupta, 2008).

'... we learn best when we interact and communicate with others. Building upon the social dimensions of learning will increase student achievement, by boosting interrelated factors, such as meta-cognition, memory retention, motivation, and the understanding that with explaining what we think to others'p.5.

Role Models and Career Guidance

A role model may be someone you especially want to emulate or one who offers you encouragement. It can also be someone whose life or profession allows you to see that the role has been played by someone with whom you can identify. One of the women defined a role model as someone she would look at as her example, encourager, and motivator, someone inspiring generally. Someone she would desire to be like, follow the strategies he/she uses to excel in life.

When girls do not have female mathematics teachers they are likely to regard the subject as a male domain (Mathur, 2010). This study in confirmation found that today in Uganda women especially at compulsory levels regard mathematics as a male subject. Female teachers are scarce and where available are unsupportive, too soft or very harsh. Yet research shows that young children are more likely to emulate adults of the same gender (Azar, 2010). Mathur (2010) found that in the USA female teacher's attitude to mathematics affects her female students' performance. The more anxious teachers are about mathematics the lower the mathematics achievement of female students.

Female mathematics teachers can be role models to girls even in Uganda. Mulemwa 1987, Ssajjabbi (1992) and Ndimbiirwe (1996) found this to be so. In this study however role models rarely featured in women's study of mathematics. It might be that the idea is not familiar and there were few female mathematicians visible to them. ('Visible' because Kaahwa (2009) found that girls prefer to have women near them and whom they know to be their role models). Some women before 1999 however mentioned that their mothers were teachers of mathematics and helped them with mathematics. These were few because mathematics in the times of their mothers was not popular and few parents educated girls.

In this study women found male teachers a deterring factor yet they are a majority. Career guidance hardly featured in the narratives of the women in 1999 and 2007 may be because it is lacking in most schools. Only 20% at O level, 14% at A level and 27% at tertiary level in 2011 talked about it as something that inspired them to study mathematics. One can conclude that career guidance is beginning to be addressed. One woman in 1999 mentioned seeing a woman banker and wishing to be a one as something that pushed her on in mathematics.

"in this school there was a bad attitude among students that mathematics is an impossible subject for girls. But one time when I went to the bank to pay school fees, I admired the women who worked there and from then on I aimed at working in the bank... I inquired of what requirements I needed to qualify. My friend told me that

without mathematics I could not work there. So I worked hard at it.”

In 2007, she completed a PhD (in mathematics?) and now holds a lectureship at Makerere University.

Attitude, Hard Work, Determination and Perseverance

Not studying mathematics can hinder girls' study of sciences (Kaahwa, 1996b). Stereotype threat is part of the causes of females not taking on the math-heavy courses (Murphy et al., 2007). However positive attitude, hard work and perseverance can make them press on and succeeded. This study found that positive attitude played a big role especially at primary and secondary levels. A positive attitude indicator was interest in the subject as comment below shows:

One comment I will not forget is from a friend in 3rd year when I was a fresher, who told me that mathematics 'X' was the hardest subject in Makerere University campus. Since I had got used to all these bad sayings about mathematics, this time I took my stand and thought that we ladies who have passed mathematics do not have green blood! I had to work harder since we were always having tests while our friends were most of the time sleeping in their rooms. It was not a smooth way, especially with pure mathematics where my problems at A level still affected me.

Table 1 shows that today hard work and determination play a big role in female's study of mathematics at all levels. Table 2 shows that at these levels mathematics is abstract and that this is a deterring factor. It suggests that the women that succeed have to persevere.

One student in senior 5 in 1999 narrates:

I always find difficulties in mathematics and as such I feel I have no brain for it. I don't understand it at the time it is taught. However later when I make it out on my own, I pick it very well, I think I understand things later.

One woman said: "In primary I used to compete with boys and used to prove better than them in mathematics and this encouraged me to do mathematics". Another said: "I used to make constant practice ... when I was assisting my friends who used to consult me and this raised my interest in the subject. ...It was an incentive to perform better than the boys and help others too"

Thus the support that students got helped them become interested in the subject. Hard work, determination and perseverance resulted in success and good performance which sustained their interest. As the saying goes 'success breeds success'.

Self Confidence

Self confidence is one of the factors inhibiting girls' study of mathematics (Azar, 2010). In support of her finding few women in this study reported self confidence as having supported them in the study of the subject even at university

level. Research has found that lack of self confidence stems from culture (Azar, 2010). Now that women are culturally being accepted in sciences, more are taking on careers traditionally thought of as male. They are seeing opportunities in science and mathematics careers and so are taking higher mathematics in A level. This makes them more likely to pursue those careers. They see more women doing sciences and they also get determined as Table 1 shows.

The more gender equity a country has, Azar reports, the smaller its mathematics gender gap (Gender equity is measured by school enrolment, women's share of research jobs and women's parliamentary representation). This is the case in Uganda today. Before 1999 women were not culturally supported to do sciences but today they are.

Giftedness

Not many women thought they did mathematics because they were gifted. In fact none of them mentioned it. It can only be deduced from their statements. These were mainly at primary level. One recalls; "In my PLE I got a distinction in mathematics. At home I was nicknamed 'great mathematician'" Another recalls:

In primary I got division I results and mathematics was my best subject. I had nobody at home to help me gain interest in it. I did not have to work so hard. Once I learnt a fundamental principle, I found it easy to apply.

Another said:

In primary I used to complete with boys and used to prove better than them in math." "In primary 1-4 I just learnt and did mathematics because it was being taught and since I had the ability it was not a problem to me.

I too (the author) identify with these. At primary my teachers and all the students thought me gifted and bright. Indeed I did well in most subjects, including mathematics with little effort. However the story changed at secondary especially at A level. The subject became extremely hard to understand. I cannot tell why because the teachers tried their best to help me. It could have been the methods used I remember there were no teaching aids The teachers would explain, do some calculations and give exercise. This points to other factors detrimental to women's, and probably men's, study of mathematics. Azar (2010) concludes that we need to look for better mathematics teaching methods for both boys and girls.

God

Many women at all levels claim that God helped them perform well in mathematics. Indeed today Ugandans who succeed in any subject or field make this claim. For Example: 'Hard work, prayers were Amoding's key'p.4; 'Prayers help- Ankuda' p.6 (New Vision, 2011).

Mathematics at University/College Level

Murphy et al. (2007) found stereotype threat to be part of the causes of females not taking on the math-heavy courses. Hall

(2009) interviewed 6 undergraduate women from University of Ottawa and found like earlier feminist research that supportive relationships were key to women's success and that being passionate about and highly skilled in the subject area were essential for one to pursue and persevere in it. In Uganda, Kaahwa (1996a) has listed and expounded on the problems that Ugandan women face at University/college level. These are bisexual environment, lecture method, female to male ratio of lecturers, undermining good female students' performance, time tabling of tests, examination layout, roles aspect, monthly periods and help from lecturers. In this research women did not mention any of these as problematic. This may be due to the absence of prompting. The women in this study however suggested that their own attitudes, lack of self confidence, good performance, teacher support, anxiety, peer support and lack of it, absence of sexual harassment and hard work played key roles in their persistence in advanced study of mathematics. In 2011 54% reported good attitude, hard work, determination and God as having played a key role. 27% also reported career guidance and self confidence as helpful. They talked of sexual harassment and abstract nature of mathematics as deterring.

Factors That Deterred Women in Mathematics Learning

Sexual Harassment

Kasente and Kwesiga (1996) reported that some teachers fear to be misunderstood in their motives to help girls since teachers have been found to harass girls sexually. In this study none of the women in 1999 and 2007 reported sexual harassment although a majority of teachers were male. In 1999, a small percentage simply wrote that they were not sexually harassed. However, sometimes the female students got discouragement from boys. For example they called them names; others called them 'boys'. One lady wrote; "The boys really discouraged me. They advised me to like English more since I was a girl." One woman wrote: "In some cases they [boys] would call me their fellow boy. At first it offended me but later I knew it was a challenge to them, so I tightened". Another wrote: "Most of my classmates sort of discouraged me by calling me names such as 'gender' or 'hermaphrodite'"

Today sexual harassment seems to be on the increase as table 2 shows. It happens most at tertiary level.

Abstract Nature of Mathematics

Today mathematics is abstract and this is mainly at A and O levels. This is deterring to its study by women. It is clear why this so. From graph 2 it appears that the fewer the male teachers the more abstract the subject. For example at tertiary level in 2011 male teachers are not mentioned as deterring however mathematics is reported as abstract. Could it be that mathematics teachers are scarce? Or are there more female teachers now that there women mathematicians and they are effective?? Could it be that the methods they are using are ineffective or inappropriate? There is need for more research.

Mathematics as a Male Domain

Many women before 1999 were not aware of the view that mathematics is a male domain. Only 9% gave a hint of it. It appears that the view was non-existent in this group. However their statements show that male teachers and boy students wanted to rub it in them. Comments such as "some teachers after a student gave a wrong answer at A level would tell the student 'Go for History' as a reward" from the women gave a hint of this. One woman said:

"Generally in my education I was taught by one female teacher. The rest were male and I can say that it appears as though mathematics had been a subject for men but I can now see that both male and female have equal abilities of doing the subject"

Women then were very much aware of their small numbers studying mathematics among many males. Comments from some of them were:

"We were only 2 girls who got D1 in UCE".

"We were 2 girls in a class of 300 students – many students wondered how a girl could like mathematics."

This shows that the circumstances and the environment also gave them such an impression. Lewis (1991) found that women successful in mathematics have been described by their women peers as self reliant, self confident, persistent, risk-taking and imaginative. This is what these women were. Today, despite the fact that there are more women in mathematics, table 2 shows that women think mathematics is for men. Table 1 shows self-confidence reported by 38% at primary level, 36% at secondary and 27% at university which is less than half at every level. This supports Lewis (1991) who found that despite excellent performances many successful women in mathematics, always doubt that they are as good as they are. He explains that this might be because of the general public view of mathematics as masculine. He also says that in earlier levels women perceive themselves as outsiders to the mathematical world.

The view that mathematics is a male domain appears to have caught up with women in Uganda today; 42% reported it in 2011. Mathematics seems to have become harder; 56% reported it as such in 2011. Corporal punishments (42%) reported in 2011 at A level also have gone high.

Conclusions

This study sought to uncover factors that supported women's success in mathematics and those that discouraged them from studying it. The data was through a guided self reporting narrative plus a self reporting questionnaire. The information can be relied upon as authentic. Women in their own words wrote about experiences they remember; incidences that stuck in their minds. For example one of them said: "I will never forget what my friend told me concerning the study of mathematics... she said it was the hardest on the university campus."

The study suggests that if the following social, psychological and psycho-biological factors are optimized, women's study of mathematics might be improved. Good attitude, good performance, self confidence, teacher, parental, peer, sibling and textbook support, no sexual harassment, career guidance, coaching, presence of role models, hard work, determination, perseverance and faith in God. It also suggests that the number of male teachers be reduced and mathematics be made less abstract.

Gender inequity in Uganda does indeed exist but the study shows that the gap between boys and girls is beginning to narrow; there are more women today doing mathematical careers than in 2000. There are more female students doing undergraduate mathematics as seen from the statistics of enrolment at Makerere University (See the graph). The number of women who hold masters degrees and PhDs in mathematics is on the increase. Three women hold PhDs in mathematics and 2 in mathematics education. Holders of masters in mathematics and mathematics education are many more than this. More are aspiring). Fennema (2000) advised that where gender differences exist in mathematics education, feminist research methods be used to get a better understanding of factors at play. A study in APA (2009) said that both boys and girls need mathematics help (Azar 2010). I concur with Azar.

The message in the present study is that for women in Uganda the study of mathematics is possible but challenging. It requires determination, hard work and perseverance. It requires support for the learner especially from teachers, parents, siblings and peers. It is not for the gifted only. Discussions and mutual support in study groups can be key to successful mathematics study. Coaching which is common in Uganda is not essential because few women reported it as having supported them. Caning and verbal abuses frighten learners and adversely affect their performance.

In summary no obstacle succeeded in eliminating the females in this study from the study of mathematics. We can learn from them what helped them succeed. However we cannot know from this study how many other females were deterred from the study of mathematics by adverse conditions beginning at primary school. We would need to learn from others what inhibited their persistence. This therefore points to the need of another study.

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