Students' Views on Learning Environment for Undergraduate Mathematics in Selected Higher Learning Institutions in Tanzania

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Abstract

The aim of this paper is to find out views of students on learning environment for undergraduate mathematics in Tanzania. 303 male and 120 female undergraduate students participated in the study. Data were collected through questionnaire and interview methods. Students' views were positive on lecturers' characteristics, academic relationships, as well as gender sensitivity in the learning environment. However, the students had a concern on the teaching methods for the subject, the nature of tests during their coursework, as well as marking and grading styles. This paper concludes that, among others, contrary to observations in non-mathematics contexts, male and female students hold similar views on many aspects of the learning environment for undergraduate mathematics. However, these views depended on the mode of students' participation in the subject.

Keywords *gender, gender sensitivity, lecturers' characteristics, undergraduate, post-compulsory mathematics*

Introduction

The problem of low female students' uptake of mathematics is reported to be more acute in higher education. For instance, UNESCO (2017) revealed a global average for female students studying university mathematics to be less than two percent. This percentage would rapidly drop for the advanced university mathematics (core-mathematics courses). For statistics courses and applied mathematics, there is literature evidence that the number of female students has been promising although a gender gap is still evident. The underrepresentation of female students in higher education in the areas of mathematics, technology and engineering is very low in developing countries such as those in the Sub-Saharan Africa and some parts of Asia (Kinyota, 2021).

This gender gap in mathematics has long been attracting policy, research and media discussions. For instance, Leder (2019) indicates that the research and policy interests on gender and mathematics may have begun from the 1970s to date. In

recent times, this interest has been intensifying for post-compulsory mathematics. Alcock, Attridge, Kenny and Inglis (2014) argued that, the concern for gender and mathematics is now on the existence of gender gap in post-compulsory mathematics participation, gender differences on experiences of post-compulsory mathematics as well as academic progress in the subject. Likewise, Leder (2019) concluded from a review of the history of research in gender and mathematics that current policy and research interests regarding gender and mathematics are turning towards the advanced mathematics subjects particularly in higher education.

The concern for gender in education, particularly promoting females' access, performance and retention, is not recent in Tanzania. This is illustrated by Posti-Ahokas and Lehtomaki (2014) who reports that the efforts for widening access to schooling for all students and hence retention and performance have been featuring in various educational policies since 1961 to date in Tanzania. Several practical initiatives were undertaken in Tanzania for increasing access to schooling at primary and secondary education. One such initiative included the use of the quota system of separate selection for girls and boys into form one. This reduced the competition that girls had to undergo against the boys for being selected in subsequent levels of education. At the higher education, the most pronounced initiatives for female students' participation in Science, Technology and Mathematics (STEM) fields were the affirmative actions introduced in the 1990s. Studies such as Kilango, Qin, Nyoni and Senguo (2017) and Aggrey, Oliver and Stella (2014), illustrate several affirmative actions for gender balance in Tanzania's higher education. This included pre-entry programmes (PEP) where remedial training were provided to the female students with university qualifications but missed admission points for science and mathematics degree programmes. Another included the Preferential Admision Criteria (PAC) where the females with qualification but had grades below that of the male applicants by 1.0 or 1.5 points were considered for admission into mathematics and the sciences. Female Undergraduate Scholarship Programme (FUSP) was also among the affirmative actions reported to have been introduced for attracting female students into mathematics and science fields.

Despite the existing initiatives, available evidences indicate that the progression of females from one level of education to another is in a decreasing trend and hence a problem yet to be solved (MoEVT, 2014). Data from the President's Office-Regional Administration and Local Government, PORALG (2020), for the students who register for the advanced mathematics national examinations suggest that participation in mathematics decreases rapidly for the female students as the level of education increases. The data suggest that the proportion of the male students is nearly twice that of the female students. Moreover, the data indicate that the uptake of the advanced mathematics subjects by females and males is the least of all the subjects taught at the advanced secondary education level. This

low number of the female students was also observed by Mazana, Montero and Casmir (2020). Consequently the low uptake of advanced mathematics for the female students as well as choices against undergraduate mathematics, and the ratio of males to female students in the subject have increased to over three times. For instance, the males to females ratio for the first year mathematics students in electronics degree programme for the year 2017/2018 at the University of Dar es Salaam (UDSM) was 3:1, for Bachelor of Science with Education was 9:1. For the second year students, the ratio of male to female students was 3:1 and 7:1 for the two degree programmes respectively.

This low progress in mathematics particularly by the female students is partly caused by factors related to the learning environment. Studies report the home environment, especially heavy workloads for girls, as leading to gender gap in performance in Tanzania. Furthermore, the school environment in particular the dominance of male mathematics teachers in schools, as well as inadequate physical facilities such as toilets appears to be among the reasons for gender disparities in mathematics. Chouinard (2017) illustrated that, the link between learning environment, gendered choices and performance follows from the fact that it impacts on students' motivation, self-efficacy and study approaches.

Furthermore, the evidence indicates that the female who progress into Science and Technology disciplines in higher education in Tanzania experience a discriminatory and gender stereotypical learning environment. For instance, the study by Modest (2012) reports aspects of gender discrimination and gender stereotypes regarding grades obtained by females as well as their ability in STEM subjects. This minority environment is described as a chilly climate for the female students or masculine environment. Kinyota (2021) as well as Rukondo and Kinyota (2021) report similar findings of gender stereotypes for the minority females in STEM subjects. Particularly, male students were reported to hold negative gender stereotypes even when female students were the ones outperforming the male students in the sciences.

Research evidence on how male and female students view the learning environment for the individual STEM subjects is scanty in Tanzania. Views on the learning environment are particularly important for undergraduate mathematics courses given that the subject is leading with fewest female students. On the other hand, mathematics at the university level has long been characterized by failure and high attrition rates (Mazana, Montero & Casmir, 2020). For instance, at the University of Dar es Salaam, Mwalimu Nyerere Campus, retrieved results from students Academic Registration Information System, UDSM (2022) indicate high supplementary, carryover cases, and discontinuation from studies for most of the mathematics students. This failure rates as further observed by Mazana, Montero

and Casmir (2020) affects both male and female students despite their previous performance grades. This paper therefore intended to find out views of students on the learning environment of mathematics among undergraduate students.

Theoretical Framework

The term learning environment receives different meanings in the literature. The most common meaning of the term learning environment concerns the physical state of the classroom or the homestead for supporting learning or private studies. This includes temperature, air-conditioning, level of noise, class size and others. A review by Alhija and Levi-Eliyahu (2019) reveals that the most frequently used meaning of the term learning environment in the literature is as a psychological or psycho-social environment. This social and psychological environment of the classroom or school and even home pertains to feelings, comforts, teacher-student relations, and student-student relations. For instance, in the most common scales developed for measuring learning environment, such as that by Hermann, Bager-Elsborg and Parpala (2017), the dimensions include peer support, staff enthusiasm, quality teaching, and alignment of the tasks to course and to goals or objectives. In theories of academic achievement such as educational productivity, the term psychological environment has also been described in terms of classroom climate, meaning the degree of classroom intimacy, social homogeneity and democratic policy.

The common referred framework for understanding the learning environment and its dimension is the Moos (1980) Tri-dimensional Classroom Climate Model. This model, as claimed by Alansari and Rubie-Davies (2020), regards the learning environment as constituted of three dimensions, namely the personal growth dimension, the relationship dimension, and the system maintenance dimension. The personal growth dimension is concerned with how experiences within the classroom or school community support students' academic developments. This pertains to aspects such as task orientation, competitiveness, autonomy and relevance or integration of the learning content. Importantly, the personal growth dimension of the learning environment measures factors related to classroom practices and their contribution to learning gains.

The relationship dimension focuses on the interpersonal relationship in the academic lives of the students. It involves teachers and students academic relationship as well as student-student academic and friendly relationships. Baars et al. (2021) argue that this relationship dimension includes feelings of being affiliated in the group as well as being accepted and supported in that learning community. The system maintenance dimension refers to aspects such as order, control, expectations as well as responsiveness to change (Baars et al., 2021). Furthermore, this dimension

involves also grouping of teachers and students, scheduling of the learning activities and overall regulation of the learning process.

In Tanzania and Africa in general, studies examining views of students on the learning environment for higher education mathematics are generally scanty. However, studies such as Modest (2012), Kinyota (2021) and Rukondo and Kinyota (2021) from Tanzania, found negative experiences of the females with respect to STEM learning environment. These studies report females viewing the learning environment as male dominated and comprised of negative gender stereotypes. Knowledge on how the learning environment for higher education mathematics is viewed by male and female students is important given claims that, views are dependent on the nature of the specific subjects of study (De Clercq et al., 2013) or structure of the degree programme in which the students are enrolled.

Methodology

This study involved a total of 423 undergraduate mathematics students. Among them, 120 were females and 303 were males. The sample size for all students was determined using the Krejcie and Morgan (1970) table for sample size determination followed by systematic sampling. The students were from three university campuses in Tanzania, namely University of Dar es Salaam Mwalimu Nyerere Campus, Dar es Salaam University College of Education (DUCE), and Mkwawa University College of Education (MUCE). 163 (100 males and 63 females) were from degree programmes where mathematics is a compulsory major, while 260 (203 males and 57 females) students were from degree programmes where mathematics is a voluntary major. The campuses were selected based on university degree programmes' capacities outlined in the Tanzania Commission for Universities (TCU) guideline for the year 2018 particularly on the sciences. Tanzania Commission for Universities (TCU) is responsible for quality assurance for higher education institutions and it releases guidelines regarding admission requirements as well as programme capacity for each institution of higher learning in Tanzania. The mathematics students selected for this study were those pursuing Bachelor of Science with Computer Science, Bachelor of Science in Electronics, Bachelor of Science in Meteorology, Bachelor of Science with Education, and Bachelor of Education in Science.

The data collection instruments involved a questionnaire and interviews. All 423 students taking mathematics from the aforementioned degree programmes were provided with the questionnaires in their co-mathematics courses that combine students from various degree programmes. The questionnaire collected both students' background information as well as their perceived learning environment. The questionnaire items were adapted from scales for measuring the learning environment available in the literature such as Herrmann, Bager-Elsborg and Parpala

(2017). The scale for learning environment was comprised of Likert items where a score of 1 represented '*strongly disagree'*, 2 represented '*disagree*', 3 represented '*agree*' and 4 represented '*strongly agree*'. The questionnaire was comprised of four sub-scales: academic support, teaching style, lecturer characteristics, and gender sensitivity in the learning environment. The questionnaire was piloted using first year students at the Mwalimu Nyerere Campus. Cronbach's alpha reliability coefficient for the questionnaire scale for measuring views of the learning environment was $\alpha = 0.761$. The sub-scales for the questionnaire included *academic support* ($\alpha = 0.56$), *teaching style* ($\alpha = 0.68$), *lecturer's characteristics* ($\alpha = 0.74$), and *gender sensitivity* ($\alpha = 0.88$).

Then among the selected students 20 (10 females and 10 males) were purposively selected to participate in face-to-face interviews basing on their previous experience with mathematics including school types attended, grades and also their performance in undergraduate mathematics. The interview guide was constructed to reflect the questionnaire sub-scale of the learning environment. The interviews were conducted around the university campuses in locations selected by the interviewees themselves. Each interview lasted between 45 and 60 minutes and were recorded using a voice recorder and also through note taking. The questionnaire responses were analysed descriptively using tables and charts and also chi-square test of independence and t-tests using SPSS version 20. The chi-square test of independence was used for comparing views of males and females at item level within the questionnaire sub-scales. The t-test was used for comparing the views of males and females at sub-scale levels of the questionnaire. The interviews responses were analyzed thematically. This included transcribing, reading, coding, searching for themes, reviewing and collating themes and writing the description. The presentation of interview responses was done using pseudonyms of letters A1, A2, A3… to represent the participants.

Findings

Analysis of the questionnaires indicated that males and females were different on their background characteristics. As indicated in Table 1, female students on average were of younger age compared to male students. Regarding prior performance, the majority of females had higher performance from both advanced and ordinary level secondary education compared to the males. In terms of school type attended, it was found that majority of females were from private schools at ordinary level secondary education compared to the males. In terms of subject combination at advanced level secondary education, it is indicated that males and females were similar in that Physics, Chemistry and Mathematics (PCM) was the leading combination followed by Economics, Geography and Mathematics (EGM) and then Physics, Geography and Mathematics (PGM) for both male and

female students. Moreover, the female students reported having family members with higher education levels compared to the males.

Table 1*: Background Characteristics of the Male and Female Undergraduate Mathematics Students*

	Males	Females	Total
A-level Performance			
Division one	52.1	65.7	56.0
Division two	43.9	30.6	39.8
Division three	4.0	3.7	4.2
O-level performance			
Division one	37.6	55.7	42.8
Division two	45.9	30.4	41.1
Division three	16.5	13.9	16.1
Age(years)	23 (SD= 2.83)	22(SD=2.23)	23(SD=2.72)
O-level School type			
Government	72.3	34.5	61.4
Non-government	27.7	65.5	38.6
Subjects combination			
PCM	59.2	63.0	60.6
PGM	11.8	12.6	12.0
EGM	29.0	24.4	27.4

Regarding views on the learning environment for higher education mathematics, Table 2 indicates students' percentage responses from the questionnaire. Overall, the students had generally positive views about the learning environment for mathematics regardless of gender. For instance, on the perceived academic support, majority of the participants agreed with the suggested views in the questionnaires. The minimum cumulative percentage for strongly agree and agree responses was 61.1 for the males and 70.6 for the females. For the items on lecturers' characteristics, cumulative percentage responses in agreement with the items were above 70.0 for all the items except that on marking and grading. Regarding teaching style, it is indicated that students were generally positive on the items with exception on the views that the pace of teaching undergraduate mathematics is fast for students to grasp lectures. With this particular item, the cumulative percentage response raises near 50%. When a Chi-square test of independence was run for all the items

in the three sub-scales illustrated in Table 2, statistically significant differences by gender on the percentage responses were noted only on the following two items: *I am comfortable with the methods used for teaching undergraduate mathematics; and Mathematics lecturers are fair in marking and grading.* Females were likely to report being uncomfortable with the marking and grading while males were likely to report uncomfortable with the methods used for teaching mathematics. For these two items, however, the cumulative percentage for agree and strongly agree responses were still above 50% for both male and female students

Table 2: *Males and Females Percentage Responses on the Learning Environment for Undergraduate Mathematics*

Statements	Sex	SD	D	A	SA	χ^2	P-value
Academic support (α = 0.56)							
Lecturers are usually available for supporting me when I have an academic problem in mathematics.	F	4.3	14.8	50.4	30.4	2.42	0.49
	M	8.7	15.2	45.8	30.3		
I fear seeking tutorial support from my maths lecturers.	F	20.9	48.7	22.6	7.8	3.55	0.32
	M	21.8	39.3	27.3	11.6		
My fellow mathematics students are usually supportive to me academically.	F	2.6	7.8	44.0	45.7	0.84	0.84
	M	2.5	10.5	44.4	42.5		
Discussion with my fellow students helps me to improve my understanding.	F	1.7	8.6	38.8	50.9	0.53	0.91
	M	1.5	10.9	38.9	48.7		
I can receive help for mathematics from my fellow students when I need it.	F	0.0	4.5	31.8	63.6	5.39	0.15
	M	0.8	2.5	50.8	45.9		
Teaching style (α = 0.68)							
I am comfortable with the methods used for teaching undergraduate mathematics.	F	6.9	11.2	59.5	22.4	9.25	0.03*
	M	4.0	21.9	47.4	26.6		
The pace of teaching mathematics is too fast for me to grasp lectures.	F	7.1	47.8	34.5	10.6	6.54	0.09
	M	7.7	34.2	42.6	15.4		
Mathematics lecturers are generally organized in presenting contents by following course outlines.	F	1.8	13.2	58.8	26.3	2.26	0.52
	M	4.0	11.3	54.2	30.5		
Mathematics lecturers use different strategies and teaching devices for presenting their lectures.	F	1.7	13.9	59.1	25.2	0.68	0.88
	M	2.2	16.6	55.2	26.0		
Mathematics lecturers generally explain the objectives of their lectures clearly at the beginning of each lesson.	F	4.3	14.7	54.3	26.7	1.40	0.71
	M	3.3	18.5	49.6	28.6		

Lecturer characteristics (α = 0.74)							
Mathematics lecturers are fair in marking and grading tests and examinations.	F	9.1	33.6	49.1	8.2	8.72	0.03*
	M	3.4	25.9	59.7	11.0		
Mathematics lecturers show good relationship with students.	F	5.3	9.7	57.5	27.4	3.63	0.30
	M	1.8	10.7	57.2	30.3		
Mathematics lecturers impose proper discipline and use proper rules.	F	1.8	8.8	58.8	30.7	1.08	0.78
	M	2.9	11.4	56.8	28.9		
Mathematics lecturers are firm and consistent in decision making.	F	0.9	8.7	60.0	30.4	2.11	0.55
	M	0.4	11.2	53.3	35.1		
Mathematics lecturers have appealing personality and sense of humour.	F	6.1	18.4	53.5	21.9	4.98	0.17
	M	2.9	12.5	59.7	24.9		

**Means statistically significant at α = 0.05*

Gender sensitivity was also among the four sub-scales of the questionnaire (α = 0.88). Figure 1 illustrates the items and the responses for the female and male students respectively. High percentage disagreements with these items indicate views that the learning environment was gender sensitive. This was because the items were set to suggest differential treatment between male and female students.

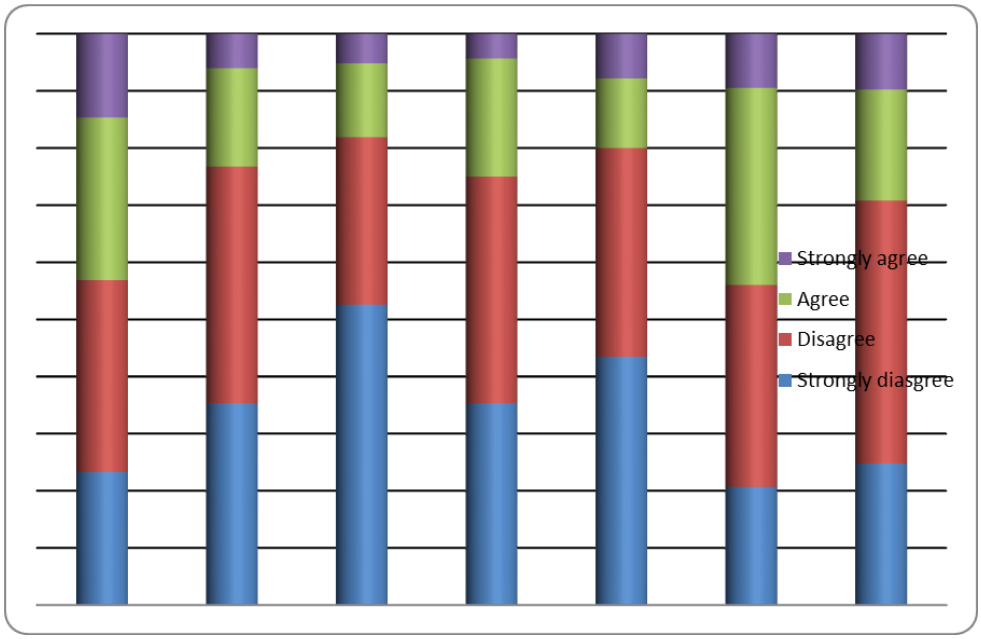

Figure 1. Female students' views on gender sensitivity in mathematics

Figure 1 indicates the percentage responses for strongly agree and agree (green and purple) colours together) are less than 40% for all the items indicating a high disagreement with these items by the female students. The percentages for disagreement for each of the seven items from the male students were above 56%.

These reflect a similar pattern to that of the female students suggesting views that the learning environment is gender sensitive. A Chi-square test of independence supported this similar pattern as none of the seven items showed statistically significant difference on the responses for male and female students.

The analysis of the students' questionnaire responses of males (*N = 303*) and Females (*N = 120*) at sub-scale level, as indicated in Table 3, corresponded with the items' level analysis presented in Table 2. The mean scores for the sub-scales suggested positive views on the learning environment for undergraduate mathematics. This resulted from the fact that the mean scores ranged from 3.04 to 3.11 for the male students (*M1*) and from 3.04 to 3.22 for the female students (*M2*). The mean scores from 3.00 and above indicate agreement because the Likert scale comprised of a score of '1' representing a strongly disagree response, a score of '2' for disagree response, a score of '3' for agree response and a score of '4' for a strongly agree response. Although both male and female students showed positive views, female students were more likely to report availability of academic support than the male students. On the gender sensitive sub-scale, the mean score was 2.20 for male students and 2.12 for the female students indicating disagreement that the learning environment was gender biased. This lower mean score for the female students implies that females were more likely to disagree that the learning environment is gender biased compared to males.

Table 3. *Mean differences by gender and participation mode on the perceived learning environment sub-scales*

	M_1	M_2	*t*-value	*p*-value
Gender (Males Vs Females)				
Academic support	3.11	3.22	-1.98	0.049*
Lecturers' teaching style	3.04	3.07	-0.48	0.630
Lecturers' characteristics	3.05	3.04	0.26	0.800
Gender sensitivity	2.20	2.12	1.25	0.210
Females by mode of participation				
Academic support	3.24	3.2	0.45	0.650
Lecturers' teaching style	2.95	3.21	-3.35	0.001*
Lecturers' characteristics	2.94	3.14	-2.40	0.018*
Gender sensitivity	2.03	2.22	-1.88	0.063
Males by mode of participation				
Academic support	3.14	3.09	0.77	0.450
Lecturers' teaching style	2.87	3.13	-4.00	< 0.001*
Lecturers' characteristics	2.90	3.13	-3.50	0.001*
Gender sensitivity	2.04	2.29	-3.16	0.002*

**Means statistically significant at* $\alpha = 0.05$

Separate analysis of males and females in terms of mode of participation in mathematics, as is further indicated in Table 3, suggested degree programme difference on views on the learning environment for mathematics. The male students ($N = 100$) and female students ($N = 63$) in degree programmes where mathematics is a compulsory major (as indicated by *M1*) were more likely to report negative views on lecturers' teaching styles and lecturers' characteristics.

The findings from the questionnaire nearly corresponded to those from the interviewed mathematics students as presented in the subsequent section.

Academic Relationship with Lecturers

The interviews revealed positive views for most of the male and female students on their academic relationship with mathematics lecturers. It was reported by the participants that mathematics lecturers were generally willing and ready to offer academic support to all students. The interview responses indicated that during lectures, the lecturers often provide their office numbers for students' consultation and encourage the students to visit them for academic help. It was, however, noted that consulting lecturers in their offices was a rare practice among all students taking mathematics regardless of gender as unveiled by C1 (female student):

> Mathematics lecturers are very cooperative but there is low readiness for students to consult them for help. The lecturers insist students to visit them in their offices in case they need help but students rarely utilise this opportunity.

The views in the foregoing quotation regard lecturers as cooperative and tend to encourage students to consult them for academic problems. When the students were further inquired why they do not consult lecturers, several reasons were provided. For instance, consulting lecturers in their offices was illustrated as a last resort because students prefer first to consult each other for academic support. Some reported that consulting lecturers was rare because of the students' own study approaches. Students were reported to study for examination or test such that concentration on studies emerged when the timetables for examinations or tests were released. Moreover, the following quotation from G1 (a male student) indicates that some mathematics lecturers are not welcoming for questions, and others are not available in their offices for consultations.

> There are lecturers who are interested in teaching but there are some who teach but do not want questions. Also, there are those who receive females with a polite language as opposed from how they receive the males. Others do not have time for students.

A few students reported existence of threats from mathematics lecturers. These particular students claimed that sometimes lecturers declare that their courses are difficult, there will be supplementary examinations, or students will carry the course. Although the students took these as threats, they acknowledged that the lecturers did this within the intention of compelling students to engage themselves in their studies. The female interviewees were further asked if they felt affected by the fact that most of the mathematics course lecturers were males. Among their responses was that they were not affected because mathematics teachers being males was something that began from pre-university school level so they were used to it. However, two female students reported of being affected and that was why females rarely visited lecturers in their offices for academic consultation. The following argument from interviewee J1 (female) connotes the view of many responses from these students: "Yes, there is a barrier for majority of mathematics lecturers being males. You just find it difficult to take questions to the lecturers in their offices. I don't know. May be is just nature."

For some of the females, to consult a lecturer immediately after the lecture hour or to attend his office was a matter that needs companionship from fellow students. When the males were asked the same question of the effect of the un-representation of the female students in mathematics, some replied that they did not see any effect of the females being few in mathematics. Some reported that the few females are the ones who more often consult the lecturers immediately after the lectures than the males. Although the females differ in their views, the message is that majority lecturers being males affects female students.

Gender Sensitivity

The findings from the interviews unveiled that mathematics lecturers were generally viewed to be gender sensitive. The female students claimed that, the lecturers often times discouraged gendered pattern of sitting arrangement, insisted on mixed gender group discussions, and planned group assignments with a gender concern. Furthermore, when the female students were asked about whether there is gender bias in classroom, all of them revealed that questions and answer sessions have been fair for both male and female students. The following quotation from a male interviewee A1 reveals a gender sensitive classroom and a positive academic relationship for both male and female students with their lecturers:

> Both female and male students consult lecturers at the end of lectures. Even in class both ask questions and volunteer to solve on the blackboard. This is because there are extra marks awarded for solving a problem on the blackboard during tutorial sessions. Thus, these marks compel students to volunteer solving questions.

The foregoing quotation unveils that some lecturers do use strategies for motivating both male and female students to participate in solving mathematics problems. Furthermore, when the students were asked whether there is any difference in the kind of questions and praises targeted to male and female students by lecturers, they argued to have never witnessed either difficult questions or easy questions targeted to one gender, let alone praises. The students were further asked if they ever witnessed favours through grades particularly to female students from mathematics lecturers. As indicated by the quotation from E1 (female) below, some females indicated an awareness of the existing claims that some female get bonus marks as favour from lecturers. These particular respondents admitted to have heard before joining university studies about the notion of females being favoured through grades. All of the interviewed students, however, reported to have never witnessed cases of favours through scores or grades in mathematics.

> Before joining the university, I heard that you may have a study companionship with someone who never concentrates on studies but keeps passing the course with high grades because she has relations with the course lecturer. But I have never seen such a scenario here.

These interviewed students could not see the possibility of favours through grades in mathematics courses because mathematics is very objective in marking compared to other subjects.

Academic Relationship among Students

The interviewed students were asked about their views on the academic relationship among themselves in higher education mathematics. All of the interviewees viewed that the academic relationship among mathematics students was good because there was academic support among the students, sharing of materials, and the main approach they used for studying mathematics was through group discussion. It was further reported that compared to pre-university school level mathematics, there are no competitions or jealousy among students for grades because the grades are posted in the Academic Registration Information System (ARIS) such that each student is able to view only his or her own grade.

When the female interviewees were asked about the academic relationship between male and female students in mathematics, they viewed it to be generally good. The female interviewees were further asked whether they felt affected by the fact that majority of the students taking mathematics courses were males. The responses were varied as some reported that it was a fact that had begun from previous levels of education. Some of them claimed that they had attended the National Service so they were used to be in the males' majority environments. It was also noted, as exemplified again by the quotation by E1 that follows, that some females regarded

male students in mathematics to be gender sensitive and therefore, females were not affected by being in the midst of the majority male students:

> I do not feel affected because in our class we have built a culture of helping each other. Sometimes you find you are the only female in a group discussion but there is awareness among the males that we need to help each other.

The interviews further revealed a challenge on interaction between males and females when beginning their studies in the first year. Females were reported to isolate and accompany among themselves during the beginning of first year studies. This leads to lack of awareness on what is transpiring among the majority males regarding studies. Some of these females, while reporting that there are other students who isolate themselves based on their former secondary schools, they acknowledged an impact of the late interaction between male and female students academically. The main preconception of some of the female students during this period is mistrust in male students. In their responses, as also illustrated in the selected quotations from A1 and K1 (both females) that follow, it was noted that whereas males may approach females with a need of academic help from them, some of the females may interpret this as an intention for seduction.

> Yaah! That thinking existed. You find a male coming to you asking about issues related to the courses; for example 'How about that assignment….' You ask oneself how comes he did not see other people but only me. That fear was very common at the beginning.

> Interaction between males and females was very difficult at the beginning. For example, as for me when a male approached me requesting for help, I used to ask myself how comes he did not understand? He would go away while he did not really have any other malicious intention apart from academics.

When the male students were also asked about their academic relationship with the female students, the responses were dependent on their degree programmes. For instance, interview with male students from Electronics degree programme indicated that the academic support learning environment is highly dependent on the male students. The male students unveiled that females do follow males for solving mathematics problems but rarely do the males request the same from female students. The following quotation from a male student in Electronics degree programme indicates females only solve mathematics problems when the group has set a plan for everyone to participate:

> Yes they do solve. Most of the time they solve according to their

> groups' plans. We usually plan who is to solve which question during group discussion. However, no female student is often depended upon by the group.

Although the foregoing quotation reveals female students as being depended on males in mathematics group discussion, it suggests also a positive cooperation among students. For the case of females in the Actuarial degree programmes, they were described by fellow males as more committed than the male counterparts. The following view was from a male student from this degree programme:

> Learning should not go by gender but in real life females are more determined. So, in our course you would be lucky if you are paired with females to do a group work. Ladies want everything done in an orderly way. Males just want the job done whereas females want perfection.

These male students' views in the foregoing quotation are similar to those of the male students from Bachelor of Science with Education, where females were overall described as much committed for academics, and they sometimes initiated group discussions for mathematics. This commitment of the females motivates academic cooperation between the male and female students in the subject.

Discussion

This study intended to find out the views of male and female students on the learning environment for undergraduate mathematics. The study found that regardless of gender, students had positive views on the learning environment for mathematics. In particular, gender bias or stereotypes of the females and their grades were found as less common. These findings oppose the claim raised by Modest (2012) that was conducted in non-mathematics contexts. Overall studies such as Kinyota (2021) and Rukondo and Kinyota (2021) reported that female students in STEM degree programmes are usually stereotyped, viewing the learning environment as favouring male students, and undermined as not capable for science subjects. The finding is however consistent with findings from studies conducted in the mathematics context particularly in developed countries. For instance, the study by Piatek-Jimenez (2015) indicates that female students taking mathematics at the undergraduate university level are usually viewed as intelligent and special. One explanation of this observation on how females are viewed is the nature of mathematics. It is reasonable that the common view of mathematics as being a difficult subject make students to have a view that female students in mathematics are the best of the females in the education system and also having a positive academic support including a belief in group discussion for learning the subject. The commonly perceived nature of this subject as difficult and its objectivity in

marking and grading build trust among the students that the female students who choose mathematics are good at it and their grades are genuine.

The findings of female students viewing the environment as stereotype free may be explained from motivation perspective. Studies such as Chouinard (2017) reveal that students' motivation in a subject influences their views of the learning environment. It has also been reported that the females who participate in mathematics at the undergraduate level comprise of the highly performing students and highly motivated and committed in the subject. Consequently, as the female students in this study had higher prior performance than even the males, it can be argued that, their motivation influenced the way they viewed the learning environment. Their experience of similar male-dominated environments for mathematics from secondary school level contributed to this positive view of the environment. Therefore, their motivation and experiences in a male-dominated learning environment might be masking awareness among them on the existence of gender stereotypes and biases. For instance, when the female students were asked whether they feel affected in any way by being in the male dominated environment in terms of mathematics students and lecturers, majority could not immediately cite any impact. This has an implication on research methodologies for studying gender related aspects such as stereotypes in undergraduate mathematics. Particularly, longitudinal and ethnographic studies should be encouraged.

Overall, students relationship particularly academic support for studying mathematics was reported for instance by Judith (2011) that it is an aspect compelled or facilitated by the nature of the subject, degree programme or living in the same hall of residence. The interview responses for this study noted this student-student academic relationship in the study of mathematics to go by degree programme, and also by former school mates. This has an effect as it limits interactions across degree programmes and might be impactful for the students in degree programmes with few mathematics students. While studies reveal building social and academic relationship among students in mathematics to be an overall challenging aspect during the beginning of first year studies, this study found interaction between male and female students as even more challenging at the beginning of first year studies. Moreover, at this time a male student approaching a female student for academic help is likely to be interpreted as intention for sexual relationship. Although this early challenge disappears later as studies become more sophisticated, it affects coursework performance of the students.

The study further found that although gender differences on the views of the learning environment were largely not statistically significant, male and female students who voluntarily majored in mathematics had a more positive view on the learning environment than those who participated in the subject as a result of the

subject being a compulsory learning. The mean difference for students who chose mathematics voluntarily differed significantly from that of the students who majored in mathematics as a compulsory course in terms of lecturers' characteristics and on their teaching styles. This indicates that the views on the learning environment for mathematics depend on specific learning contexts. According to theories of motivation, as De Clercq et al. (2013) argue, students' engagement with mathematics is dependent on the reasons for their choice of subject as well as the nature of the degree programmes of the students. Although gender difference in the learning environment for undergraduate mathematics was not evident, the minority status for females in mathematics is affecting their learning of the subject. This has an impact when and where the academic support from lecturers and male students is accessible for the female students.

Conclusion and Recommendations

This paper concludes that contrary to observations in non-mathematics contexts, male and female students hold similar views on many aspects of the learning environment for undergraduate mathematics. However, these views depended on the mode of students' participation in the subject. Both male and female students in the degree programmes where mathematic was a compulsory major for all students had negative views on the learning environment. This is in comparison with the students who majored in the subject on their own discretion. Mathematics students are more positive on their academic relationship including academic support among themselves. The nature of mathematics and the existing beliefs that cooperation is the best way of learning the subject reinforce positive academic relationship among students. Building this academic relationship between male and female students, however, is a matter that takes time during first year studies before students familiarise among themselves. Moreover, both male and female students are more positive on their academic relationship with mathematics lecturers. However, the students rarely consult lecturers for academic support outside lecture rooms, with female students being more fearful of visiting lecturers' offices. This paper further concludes that the learning environment for mathematics is generally gender sensitive from the perspective of the students. Lecturer's gender awareness is evident from the strategies lecturers use for encouraging cooperation and support among the students. Aspects of gender stereotypes and discrimination are also uncommon among the mathematics student.

Although the views were largely positive on many aspects of the learning environment, the students had a concern on the methods of teaching mathematics, nature of tests, marking and grading of the tests. This study, therefore, recommends more efforts from mathematics stakeholders for promoting gender balance in mathematics education, particularly for attracting and maintain persistence of female students in the subject. Initiatives focusing on reducing the delayed interaction between

male and female students in early first year studies are also recommended. This study further recommends that for undergraduate mathematics researching gender may need more long term field studies such as ethnographies and longitudinal research because the nature of the female students and their experiences of being in male-dominated environments might be masking potential findings useful for addressing gender issues in the subject.

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