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Challenges Confronting Female Undergraduate Students in the Study of Engineering in Nigerian University

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Abstract
This study examined the challenges confronting female students in engineering programmes in Nigerian university (A case study of Rivers State University (RSU), Port Harcourt in south-south zone of Nigeria). Descriptive survey research design was adopted for the study. Forty (40) female undergraduate Engineering students of 2015/2016 Session from seven engineering departments in the university were purposively sampled. Two research questions guided this study and questionnaire was used to collect data. The questionnaire was validated by three experts in the university and using Cronbach Alpha method, a reliability coefficient of 0.85 was obtained. Mean and standard deviation were used to analyse data for the research questions. The study revealed amongst others that, the challenges confronting female students in engineering programmes in RSU include: school factors such as inadequate learning facilities; personal factors such as time management and financial issues. Despite challenges, parental support, career-driven goals, self-motivation, faith, job prospect and future financial independence, amongst others, were used as key motivational factors by female engineering students to help them continue in the engineering programmes. It was recommended that government; school administrators and parents should encourage female enrolment and participation in engineering programmes through positive interactions and creating engineering awareness from early age.

Keywords: challenges, females, engineering, programme, undergraduate, universities

INTRODUCTION

Engineering programmes are highly technical and shows male dominancy but over the years, there has been gradual increase in the number of female enrolment and participation in these programmes. A report showed that women's interest in engineering programmes increased to about 16% compared to seven years ago (Young-Powell, 2014). Over a 10 year period (1997-2006) in Nigerian universities, female enrolment in engineering programmes increased by 77% and by 63% for male enrolment (Aderemi, Hassan, Siyanbola and Taiwo, 2013). In Canada in 2013, women made up 39% of students in Science, Technology, Engineering and Mathematics (STEM) programmes compared to 66% in non-STEM programmes, whereby among the STEM graduates, engineering has 23% of female graduates (Hango, 2015). The increment in female enrolment in engineering programmes indicate that some negative regional stereotyping/beliefs concerning women inability for engineering study are gradually changing and many see the advantages of both sexes in the engineering contributions and achievements in the society. Even though the percentage of female enrolment in engineering increased, the actual number is still considered very low compared to that of males. Many women have positive perception and attitudes towards engineering careers, however most are still unwilling to enrol into engineering programmes. This is because the programmes require high mathematical skills, higher efforts, more time and less distraction which some females believe would not give them ample time for social life and family responsibilities while in some cases women feel uncertain in this male dominated programme which may lead to anxieties, withdrawal from the programme or transfer to non-engineering programmes (Aja-Okorie, 2013; Akinsowon and Osisanwo, 2014). Similarly, most female engineering students have difficulty in coping with necessary manual tasks/activities involve in the practical training and field working engineering programmes; however physical shortcoming do not hinder interested women from completing the engineering programmes and provide intellectual competency that contributes to engineering designs and improvement (Akwei, 2016;Gilmartin, Li and Aschbacher, 2006; Silimand Crosse, 2014).

Over the years, awareness and strategies have been created to address the problem with few women participating in engineering and other technical programmes in order to motivate females to enrol in STEM programmes and also contribute to the engineering creativity and innovations for technological development of the country (Adelakun, Oviawe and Barfa, 2015; Akinsowon and Osisanwo, 2014; Badekale, 2003; Edu and Edu, 2012;

Olatundun, Archibong, Ikutegbe, Ogunmola, and Alege, 2014; Silim and Crosse, 2014). However every discipline has its challenges and for females in engineering programmes, there seems to be additional challenges they may encounter. Consequently the right motivations are crucial for female engineering students to overcome or manage the challenges they face in the programme. Therefore, this study focused on the challenges experienced by female engineering students in Rivers State Port Harcourt, Nigeria. It also identified motivational factors that help female engineering undergraduates to continue in the engineering programmes despite challenges.

Barriers to Female Enrolment and Participation in Engineering

For many centuries the idea of educating women was not a popular one but that idea has gradually changed such that women are encouraged to pursue any career. Encouraging more women to become engineers, according to Stone (2012), begins by addressing the challenges they face in the educational system. There are different barriers– both internal and external – that contributes to the low percentage of female in engineering sector. Few are discussed below;

Lack of Interest

Interest in a particular programme is closely linked to good academic performance. Research showed that interest in mathematics and engineering field is linked to women's decision to choose engineering programme and to participate in activities associated with the programme (Smith and Dengiz, 2009; Stephen and Makotose, 2007). However, negative societal beliefs may greatly affect girls' interest and achievements in engineering, mathematics and other technical programmes such as stereotypes about girls' having poor abilities in mathematics, which may create the mindset that mathematics is extremely difficult (Hill, Corbett and Rose, 2010). Therefore from early age, most females tend to have fear of mathematics and shy away from any mathematics and sciences (Dweck, 2007). With no interest in mathematics and sciences, at tertiary level, most women may lack the fundamental concepts of the engineering and would rather enrol in other non-technical programmes.

Lack of Self confidence

Interest must be supported by ability and self-confidence to achieve a goal. According to Gilmartin, Li and Aschbacher (2006), females with genuine interest in engineering have higher self confidence in their abilities to participate in engineering programmes and to have good/better academic performance. It is well known that females are more prone to low self-confidence leading to anxieties and doubt about their choices in life. Some girls and women have doubt about their ability to good academic scores in the engineering programmes, while others lack courage to venture in to engineering programmes (Adlyn, 2013). Even when discouraged, possessing self-confident can help female engineering undergraduates to excel and persevere in the programme.

Discouragement from family and teachers

Discouragement may manifest in attitudes and unconscious biases of parents, teachers and other close associates of female students. In their research, Stephen and Makotose (2007) reported that 80% of female engineering students indicated they were discouraged by their parents from "venturing into engineering profession" as the parents were convinced that "engineering is not for girls". Furthermore, Stephen and Makotose (2007) observed that 60% of female engineering students agreed that teachers tended to discourage them from getting involve in engineering jobs. According to Akinsowon and Osisanwo (2014), perceptions and attitudes of teachers may be discouraging and can transmit to their pattern of teaching female students especially mathematics and science, and this "end up affecting the performance of the girl child and often makes girls to drop out of school". In addition, Aguele and Agwa (2007) mentioned the "attitudes and expectations of parents and teachers" can create anxieties in young girls and can contribute to the low participation of females in STEM programmes. Therefore females whose parents and teachers are not supportive and unconcerned about their education are less confidence and less likely to enrol in engineering programmes.

Family responsibilities

Generally the socio-cultural beliefs of Nigerians place a woman in her husband's house caring for children and other responsibilities which demand time and energy thus women would prefer a less stressful programme. In most cases family members hold females' responsibilities above career or education hence they may "discourage a woman from STEM programmes" (Aja-Okorie, 2013). The research report by Adlyn (2013) indicated that some unmarried young women choose not to enrol in engineering programmes, because they are afraid that the labour intensity of engineering may prevent marriage proposals and even pregnancy. Family responsibilities of the woman can hinder or slow down career advancement especially when family support is minimal or non-existence (Akinsowon and Osisanwo, 2014).

Lack of role models/mentors

Role models, mentors and counsellors are like guides who can help in career advancement for women engineering. Their activity produces good attitudes or reduces negative stereotypes concerning women in engineering. According to Amelink (2008), such mentor/role-model relationship can help female students on techniques to handle the "feelings of isolation and lack of support among women in STEM

fields" especially engineering. With low female engineers in academia in Nigerian universities, such guidance is insufficient (Udeani and Ejikeme, 2011; Aderemi *et al*, 2013). Due to this uneven gender ratio, it is not easy to find female mentors in STEM fields. With few or no advice from role models, young girls may shy away from engineering programmes and the women who enrol in the programme tend to experience difficulties adjusting to engineering academic life therefore it may take a lot of time (sometimes until their third year) to find balance in academic, family and social lifestyles (Amelink, 2008).

Economic background

Schulz (2005) observed that students' academic performance was linked to their socio-economic status. Engineering is practical-based programme therefore it is more expensive. Minimum income families may not be able to afford textbooks, practical instrument, extra tutorials, field trips and other tools needed learning materials and resources for the best performance of the girls' schooling. Also due to poor financial status, many families can decide to educate the boy-child in programmes that are considered well-paying and prestigious such as engineering, while the girl-child remain uneducated or are pushed into programmes deemed ideal for females (such as administration, nursing, secretarial, teaching programmes) which takes less time, money and effort to complete the programme (Badekale, 2003; Mugo, 2012; World Bank Group, 2014). Typically in Nigeria, females lend on family for financial support in education and other necessities therefore many girls/women opt out of enrolling in engineering programmes to relive financial stress on their families.

Lack of early awareness

There are rarely any early awareness and guidance programmes to prepare female students in primary and secondary levels for careers in highly technical occupations found in STEM and other areas traditionally done by men. According to Olatundun *et al*, 2014), most of 94.47% of female respondents that performed excellently in mathematics and sciences refuse to study engineering because of lack of engineering awareness in pre-tertiary levels of education. Without pre-collegiate engineering classes or awareness, some girls do not possess the interest and/or academic qualifications to enter engineering programmes.

Gender disparity

Gender stereotyping and disparity begins as soon as a child is born. Gender stereotyping has lead to gender disparity in engineering and technical education. The common assumption is that the female role in the society conflicts with the expectations one holds of an engineer. Faculties run and/or headed by woman are slower to gain promotion thus females are less likely to reach the highest academic rank, have lower salaries, and are awarded less grant money than their male colleagues. As a result women represent fewer than one in five faculty members employed in engineering and mathematics thus gender segregation accounts for the majority of gender wage gap in workplaces (National Academies of Science, 2006; Udeani and Ejikeme, 2011). In addition, according to Adlyn (2013), female students gave opinions that the lack of interest and their poor attitude to engineering subjects can be traced to gender stereotyping".

Learning environment

According to Widnall (2000), a hostile climate greatly affects how a woman learns. Hostile climate can refer to any situation that threatens the woman's quest for education. Situations such as unstable education system, political instability or an unsupportive environment where her ability and efforts are underrated, amongst others, can hinder some women pursuit and zeal for engineering**.** Mugo (2012) posits that the learning environment such as the teaching pattern, school facilities and resources can also affects women's career choice and academic performance. The curricula and procedures of engineering programmes in Nigeria have heavy workload so most women find the programmes too demanding to handle (Aguele and Agwa, 2007). In addition, provision of modern training facilities is hardly achievable due to the poor state of most universities in Nigeria (Adelakun *et al*, 2015). Some women do not enrol or participate in engineering programme because adequate training environment are not available for them to get the best form their schooling.

Statement of the Problem

In general, engineering is viewed as elite field dominated by males thus females are uncertain about their future in engineering sectors. Though female engineers have contributed immensely to the growth of the society, many women are still unwilling to enrol into engineering programmes. Strong beliefs that engineering programmes are too complex and hard for females to handle still prevails in parts of Nigeria (Badekale, 2003; Olatundun *et al*, 2014; Silim and Crosse, 2014). According to Edu and Edu (2012), traditional and western educational systems in Nigeria have not encouraged or make provision for equal opportunities for women to enter into and fully participate in vocational and technical fields including engineering. Also in Nigeria, the availability and accessibility to accurate information about engineering, its benefits and challenges are lacking in most schools, thus students are ill-equipped to make the right career choice. In most cases, some female students lack unawareness that engineering careers are options for them and others are not properly prepared for the challenges they would have to overcome in order to earn an engineering degree. Therefore, this study is designed to identify challenges confronting female engineering

students and to identify motivational factors that help them overcome challenges in the engineering programmes.

Research Questions

1. What are the challenges that female engineering students face in the study of engineering programmes?
2. What factors keep motivating female students to continue in engineering programmes despite challenges?

MATERIALS AND METHODS

A descriptive survey research design was used to conduct the study in Rivers State University (RSU), Port Harcourt in south-south geographical region of Nigeria. The university has seven engineering programmes to make up the Faculty of Engineering. Purposive sampling technique was used to select a sample of forty (40) female undergraduate students in the programmes. The study was guided by two research questions on which a structured questionnaire of 63 item five-point Likert scale type titled "Challenges of Female Engineering Students Questionnaire" (CFESQ) was used for data collection. The 5-point Likert format comprised Strongly Agree (SA) = 5, Agree (A) = 4, Neutral (N) = 3, Disagree (D) = 2 and Strongly Disagreed (SD) = 1.The CFESQ instrument was validated by three experts in Technology Education. To determine the reliability of the CFESQ, 10 copies were administered to 10 female engineering students who were not part of the sample and a reliability coefficient of 0.85 was obtained using Cronbach Alpha Coefficient method. All the 40 copies of the CFESQ given out to the respondents were completely filled and returned, given rise to 100% return rate. The data collected were analyzed using statistical mean and standard deviation. The decision rule was based on real limits of numbers of 4.50- 5.00 (Strongly Agree), 3.50 – 4.49 (Agree), 2.50 – 3.49 (Neutral), 1.50 – 2.49 (Disagree), 0.50-1.49 (Strongly Disagree) were used. Therefore, each questionnaire item having mean value greater than or equal to 3.50 was accepted, while any item that had mean value range of 2.50 to 3.49 was neutral and item with mean value less than or equal to 2.49 was rejected. Standard deviation values close or wide apart was used to determine the homogeneity in opinion among the respondents

RESULTS

Research Question 1

What are the challenges that female engineering students face in the study of engineering programmes?

Table 1: Means and standard Deviations of Challenges of Female Undergraduates in Engineering Programme in RSU

S/N	Item statement	$\bar{x}$	SD	Remark
1	I have no financial support	2.40	1.35	Reject
2	I have insufficient financial support	3.53	1.32	Accept
3	It is difficult to sponsor myself (self sponsorship)	3.00	1.26	Neutral
4	Discouragement from father	1.75	0.74	Reject
5	Discouragement from mother	1.70	0.72	Reject
6	Discouragement from friends	1.70	0.72	Reject
7	Discouragement from male lecturers	2.18	1.15	Reject
8	Discouragement from female lecturers	1.90	0.87	Reject
9	Engineering poor job prospect	1.90	0.78	Reject
10	The programme is too long	2.53	1.09	Neutral
11	Engineering is too competitive	2.53	1.24	Neutral
12	Physical disability	1.48	0.82	Reject
13	Lack of suitable infrastructure for the physically disable	2.13	0.94	Reject
14	Health challenges	2.03	1.14	Reject
15	Mental disability	1.63	0.90	Reject
16	Emotional instability	2.00	1.18	Reject
17	Physical harassment	1.93	1.35	Reject
18	Sexual harassment	2.10	1.35	Reject
19	Poor security in school	2.78	1.58	Neutral
20	I feel insecure in class	2.33	1.37	Reject
21	I get overlooked because of my gender	2.00	1.11	Reject
22	Male students dominate everything	2.70	1.45	Neutral
23	I feel my efforts are overlooked by lecturers	2.25	1.28	Reject
24	I feel my efforts are overlooked by course mate	2.38	1.17	Reject
25	I get special treatments	2.15	1.19	Reject

S/N	Item statement	$\bar{x}$	SD	Remark
26	Time management is my problem	3.60	1.45	Accept
27	I feel overwhelmed by academic workload	3.08	0.97	Neutral
28	I feel overwhelmed by my social life	2.50	0.96	Neutral
29	I feel overwhelmed by my parents' expectations	2.40	1.17	Reject
30	I feel stressed by the expectations of my friends	1.88	0.65	Reject
31	I have no academic counsellor	2.50	1.11	Neutral
32	I have no family support system	1.90	0.93	Reject
33	I do not have friends support system	2.38	0.93	Reject
34	Poor practical facilities	3.60	1.55	Accept
35	Poor classroom learning facilities	3.18	1.50	Neutral
36	Books are not readily available	3.58	1.39	Accept
37	Too many students in my class	2.65	1.29	Neutral
38	Poor learning environment	2.78	1.39	Neutral
39	Lecturer-student interaction is limited	2.78	1.44	Neutral
40	Poor interaction with non-academic staff	2.95	1.08	Neutral
41	The courses are really hard	2.48	0.91	Reject
42	I do not understand most of my lecturers	2.90	1.45	Neutral
43	Online course registration	3.53	1.38	Accept
44	Late upload of results	3.63	1.39	Accept
45	Semester is too short to meet up with my study	2.63	1.17	Neutral
46	Lack of background knowledge	2.85	1.25	Neutral
47	I find engineering courses boring	2.03	1.19	Reject
48	Family problems	2.43	1.06	Reject
49	My ability is underrated	2.45	1.22	Reject

Table1 shows the data analysis on challenges faced by female engineering undergraduates in RSU. Items 2, 26, 34, 36, 43, and 44 have mean scores above 3.50 thus these items were accepted as challenges in their engineering programme. The respondents had neutral views on item 3, 10, 11, 19, 22, 27, 28, 31, 35, 37, 38, 39, 40, 42, 45 and 46 (mean scores range of 2.50 – 3.49), while the rest of the items (mean scores range of (0.50 – 2. 49) were rejected. The standard deviation values ranged from 0.65 to 1.58 shows that the responses from the respondents were far from each other.

Research Question 2

What factors keep motivating female students to continue in engineering programmes despite challenges?

Table 2: Means and standard Deviations of Factors Keeping Female Students Motivated in Engineering Programme in RSU

S/N	Item statement	$\bar{x}$	SD	Remark
50	Parents	4.43	0.75	Accept
51	Family members	3.88	1.09	Accept
52	Career goal	4.40	0.78	Accept
53	Friends	3.33	1.23	Neutral
54	Counsellor	2.73	1.26	Neutral
55	Self motivation/self confidence	4.40	0.96	Accept
56	Curiosity	3.68	1.38	Accept
57	Enjoy a challenge	3.75	1.17	Accept
58	Easy path	2.40	1.01	Reject
59	Cannot turn back	2.68	1.44	Neutral
60	Faith	4.18	1.03	Accept
61	Endurance till graduation	3.55	1.54	Accept
62	Financial security	3.35	1.35	Neutral
63	Job prospect	3.85	1.03	Accept

In Table 2, the data analysis showed that nine items (50, 51, 52, 55, 56, 57, 60, 61, and 63) were accepted by the respondents as factors that keep them [females] motivated to continue in the engineering programme in RSU. The respondents had neutral opinions on items 53, 54, 59 and 62 while item 58 only was rejected. The standard deviation indicates that the respondents were far apart on their response with values range from 0.75 to 1.54.

DISCUSSION

The data presented in Table 1 show that the challenges faced by female engineering students in RSU were mainly focused on financial issues, poor learning environment and facilities, delayed ICT services, and time management. This finding is consistent with that of Schulz (2005), that students' performance is linked to their socio-economic status as females with good financial support do well in their academic performance especially in mathematics and sciences. Also in support of this finding are the reports of Adelakun, Oviawe and Barfa (2015) and Mugo (2012) that females find engineering demanding due to inadequate learning facilities. Some respondents do experience discouragements from parents and/or lecturers but they are not swayed from the programmes, while most respondents do not experience such negative attitudes and thus tend to have good academic performance. This finding indicated low gender segregation in the engineering programmes in RSU which is in line with the report of Adelakun, Oviawe and Barfa (2015) that support from school staff can reduce the gender disparity in STEM programmes. So far, the findings for research question one showed that the challenges identified by the female engineering students in RSU were not unique to them because both female and male students in other faculties of the university may experience such challenges.

The findings from Table 2 revealed that the respondents agreed that their choice of engineering programme is not an easy path to take and also dedication in academic work is required to complete the programme. This finding is in line with the report of Tully and Jacobs (2010) that females in engineering developed stronger commitment to pursue a non-traditional career. Although each respondent had different combinations of motivational factors, the results showed that the respondents agreed that parental support, self-motivation, career achievement, faith and job prospect are the most influential factors that motivate them [female engineering students] to continue in the engineering programme. This is in agreement with the reports of Shehab, Walden, and Wellborn (2015) that parental support, career-driven goals and self confidence are strong factors that help students pursue their goals until attainment; and Mugo (2012) who maintained that engineering is a well-paying and prestigious career that attracts and motivates female students. The belief of getting financial stability from engineering jobs is a strong incentive for female engineering students. Amongst other things, these key factors identified in the study help the female engineering students to overcome challenges and boost their self confidence and academic performance.

CONCLUSION

From the findings of the study, it can be concluded that female engineering students encounter a number of challenges that need to be addressed. The challenges are diverse and rise from a number of sources; however gender segregation is quite low in the faculty of engineering in RSU. Most of the challenges indicated by female students in engineering programmes are not necessarily unique to them; those challenges may be affecting male engineering students as well as students from other faculties of the university. The study also confirmed that female engineering students are motivated by certain factors that enable them continue in their engineering programmes. In particular, the findings showed that discouragement from people have little effect on the determination of female engineering students in RSUST.

RECOMMENDATIONS

The following recommendations are made by the researchers based on the research findings:

i. Teachers, school administrators and other stakeholders should provide funds to develop and support engineering programmes in schools in order to help women develop interest engineering. This will help females make easy transition to STEM and to prepare for potential challenges.
ii. Women in engineering bodies in Nigeria should visit schools to be role models and counsellors to equip female students with knowledge to deal with challenges in engineering programmes. Interactions with successful women engineers could help female students identify factors needed for career development and arouse interest in staying engineering field.
iii. Parents and relatives should not discourage the ambitions of female wards from pursuing science courses which may lead to a study of engineering in higher institutions. Regular discussions between parents and children would increase confidence, reduces anxieties and thus improve academic performance of the children.
iv. There is need to create programmes for engineering awareness from pre-tertiary levels through guidance and counselling services functional in all educational levels to ensure students get enough information to make the right career choices for themselves. This will create positive perception of engineering careers in the mindset of girls and women
v. Government to improve the learning environment with engineering facilities to execute activities such as include investigative learning, laboratory experience field trips and collaborative work for real life projects, which are important to help engineering students to understand abstract theories and mechanisms related to engineering.
vi. Finally educational policies and laws needs to be implemented to remove gender disparity and to

ensure equal opportunities for females and males in engineering and other STEM fields.

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