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Promoting female enrolment in engineering education for diversity, equality and inclusiveness in the South Pacific Islands

Olanrewaju M. Oyewola†‡, Olusegun O. Ajide‡, Ibukun S. Osunbunmi* & Yemisi V. Oyewola*

Fiji National University, Suva, Fiji†
University of Ibadan, Ibadan, Oyo State, Nigeria‡
Utah State University, Logan, Utah, United States of America*

ABSTRACT: Females have always been found to play a significant role in decision making. Therefore, encouraging their enrolment in engineering would boost gender friendly participation in engineering disciplines. However, there is a paucity of information on this subject especially in the South Pacific Islands. This present work focuses on the female enrolment distribution in engineering disciplines for a period of five years in one of the universities in the South Pacific Islands. Descriptive and Mann-Whitney U test analyses were carried out on data obtained on engineering students' enrolment from the College of Engineering, Science and Technology of the university in order to carry out quasi-experimental research on female enrolment. Results show that females are underrepresented in engineering disciplines. The outcome strongly indicates that the male distribution in the engineering disciplines is significantly different from the female distribution during the period considered. Appropriate strategies are hereby suggested to improve enrolment of females in engineering disciplines in order to promote diversity, equality and inclusiveness (DEI) especially in the South Pacific Islands. This will in turn help in national resource planning and formulation of policies capable of promoting DEI in engineering education.

Keywords: Female enrolment, engineering disciplines, on-parametric statistical test

INTRODUCTION

Engineering can generally be described as the practical applications of the knowledge, principles, theories and laws of science in the design, modelling, modification, construction, operation and maintenance of engineering systems and structures (machines, aircrafts, ships, buildings, road networks, etc) for the benefit of mankind through utilisation of available materials and resources in the most economic and safe manner. Engineering education is pivotal for nation building and development. No wonder, it has evolved over the years from fundamental to application-based programmes. However, recent reports have shown that there is a continuous wide gap between what engineering education presently offers and the world of engineering practice [1]. The practices of integrated skills are crucial to students' experience for their professional practice in engineering [2].

As responses to the rapid growth of technologies, knowledge, competencies and skills required from future engineers are rapidly changing [3], it has been well established that engineering students are the key agent of change in a long-term future [4]. Hence, several studies have been carried out on enhancement of student learning in engineering programmes [5-12].

With the advent of Industry 5.0, where creativity is the main aspect, there is a strong conviction that the higher education sector will have a robust impact. In the present age, the industry is in need of fresh engineering graduates that are well fortified with digital transformation tools [13]. In the foregoing, the monumental role of engineering as the bedrock of technological innovation, industrialisation, economic growth and nation building has been well emphasised. To guarantee enlistment of more personnel and experts in this field, there is a need for enrolment of more students from all genders into engineering education and training.

As at today, the enrolment of males in engineering education and practice is exceedingly domineering. Engineering is traditionally considered as a male-dominated profession with a gender bias. This is unacceptable in the present era where issue of diversity, equity and inclusiveness (DEI) is given a due attention in all socio-economic endeavours of human lives. Some studies have identified some of the reasons for this monumental disparity between male and female enrolments in engineering education.

In the work by Madara and Cherotich, it was reported that harassment from teachers (as well as male counter parts), and other gender-based issues are part of the challenges confronting enrolment of females in engineering education [14].

In his article, Dos Santos presents his attempt that was made to study factors that motivate females in pursuing an engineering course [15]. The author considered the experiences and challenges faced by women in engineering. Although Australian communities regarded female engineering students and professionals as critical assets for national development, the author found dearth of relevant resources as hitches, and therefore suggested that adequate attention should be paid to resources planning by all stakeholders of engineering education in this regard for the benefit of having active skilled engineering practitioners in the country's workforce [15].

Gender bias against female professionals in the engineering field is no doubt a significant problem. Despite more than a century of progress in women's rights pursuit, engineering is still considered a male-oriented profession, where women are under-represented, and as such has been a source of grave concerns in the recent time [16-20]. To realise sustainable development goals (SDGs), addressing gender inequality and equity in engineering education is critical [20][21].

It should be noted that females have always been found to play a significant role in decision making. Encouraging their enrolment in engineering disciplines would boost and catapult the disciplines to a greater height. However, there is a paucity of information on this subject especially in the South Pacific Islands. Sequel to the foregoing, there is a need for more studies on the present status and pattern of female enrolment in engineering educational institutions. Therefore, the objective of the present work is the study of female enrolment distribution in engineering disciplines for a period of five years in one of the universities in the South Pacific Islands with a view of providing appropriate strategies that can help improve their participation in engineering disciplines. This will in turn help in national resource planning and formulation of policies capable of promoting DEI in engineering education and practice.

METHODOLOGY

In this present study, the research methodology is quantitative such that data on engineering students' enrolment from the College of Engineering, Science and Technology (CEST), which comprises of the School of Building and Civil Engineering; the School of Electrical and Electronics Engineering; and the School of Mechanical Engineering in one of the universities in the South Pacific Islands, were obtained for a period of five years in order to carry out quasi-experimental research on female enrolment. In addition, overall students' enrolment data for the whole CEST were also obtained for the basis of comparison. Descriptive analysis and non-parametric analysis using the Mann-Whitney U test were carried out on the samples. It should be noted that all the statistical analyses carried out were based on the two research questions drawn for this study.

- Research question 1 (RQ1): What are the trends of female participation in engineering programmes in the last five years?
- Research question 2 (RQ2): Does enrolment distribution in engineering programmes differ among males and females in the last five years?

RESULTS AND DISCUSSION

In order to have better understanding of the enrolment pattern of a typical university in the South Pacific Islands, the results for various engineering disciplines are presented and discussed for a period of five years based on the two research questions drawn for this study. Figure 1 suggests that male enrolment is far more than female enrolment in the School of Building and Civil Engineering. However, Figure 2 suggests that there is an upward trend in the percentage of female enrolment in the school over the period considered, although the percentage increase is minimal.

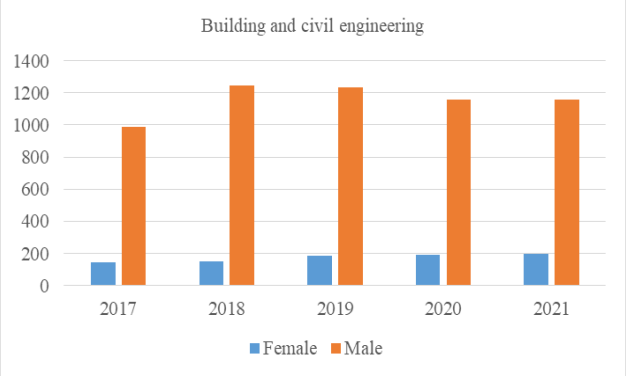

Figure 1: Enrolment of male and female students in the School of Building and Civil Engineering.

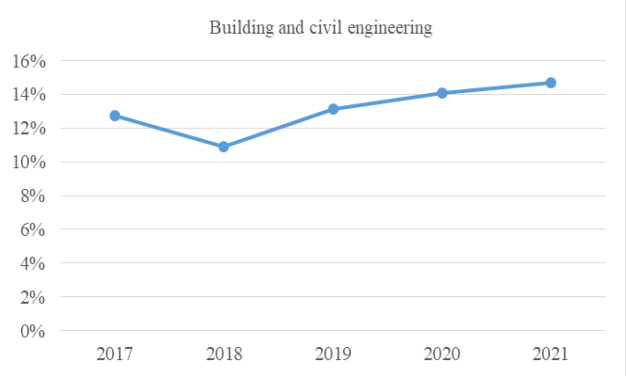

Figure 2: Proportion of the female students enrolled in the School of Building and Civil Engineering.

Similarly, while Figure 3 suggests that male enrolment is far more than their female counterpart in the School of Mechanical Engineering, Figure 4 reveals that there is a somewhat downward trend in the percentage of female enrolment from 2018 in the same school. However, the percentage decrease is minimal. The implication is that there is a need to improve on this female enrolment in order to meet up with SDGs on education, and thereby create DEI in the programme.

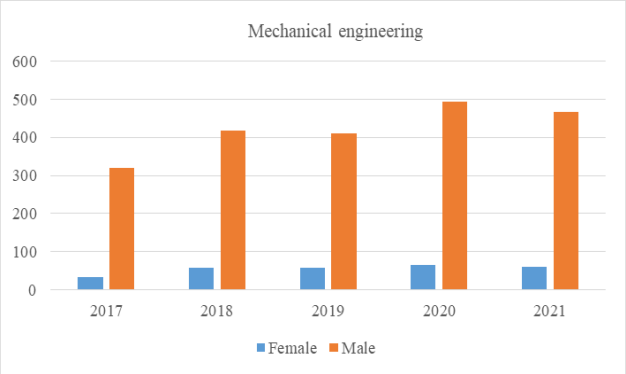

Figure 3: Enrolment of male and female students in the School of Mechanical Engineering.

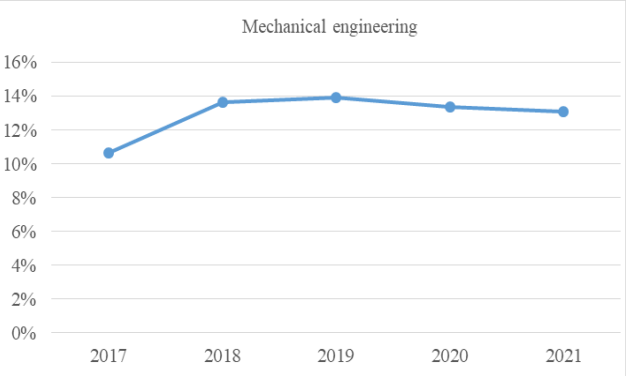

Figure 4: Proportion of the female students enrolled in the School of Mechanical Engineering.

Moreover, there is no difference in the distribution of the enrolment pattern in the School of Electrical and Electronics Engineering (Figure 5) as observed in other schools. However, there is a wavy trend in the percentage of female enrolment in the school (Figure 6). While there is a sharp drop in the year 2020 similar to the School of Building and Civil Engineering, the School of Mechanical Engineering also experienced mild change in the female enrolment in the same year. This is not surprising; it might reflect the effect of the Covid-19 pandemic.

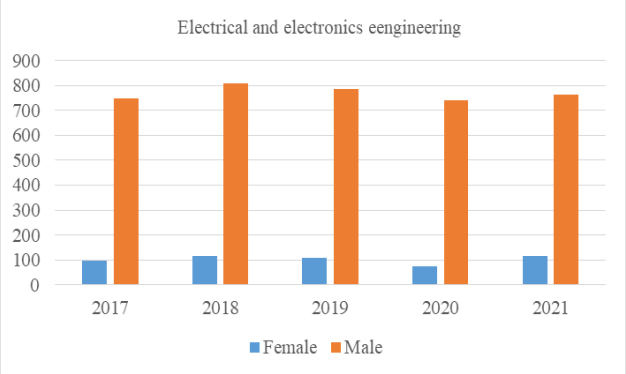

Figure 5: Enrolment of male and female students in the School of Electrical and Electronics Engineering.

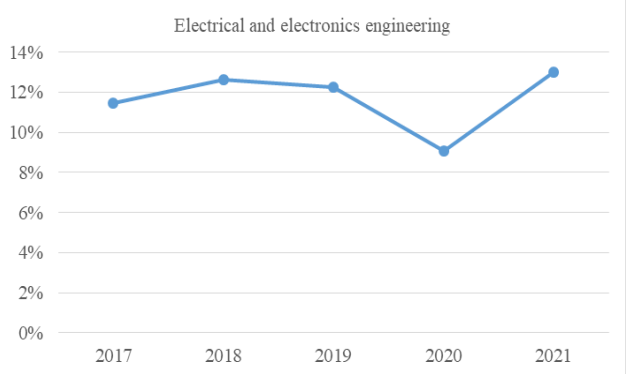

Figure 6: Proportion of the female students enrolled in the School of Electrical and Electronics Engineering.

Figure 7 to Figure 10 show the overall enrolment patterns in the CEST with reference to the School of Building and Civil Engineering, the School of Electrical and Electronics Engineering, as well as the School of Mechanical Engineering.

Generally, the figures show that the male enrolments are significantly higher than female enrolments albeit, female enrolments in the CEST show some appreciative upward trends over the period considered (Figure 8).

Furthermore, while the enrolments of the females in the CEST are higher than those of individual schools (Figure 9), the male enrolment is opposite (Figure 10) suggesting that females have a tendency and flair for other disciplines in the CEST than engineering. This corroborates the argument that engineering is being seen as a masculine programme rather than feminine. This ascertion has to change in order to reflect DEI.

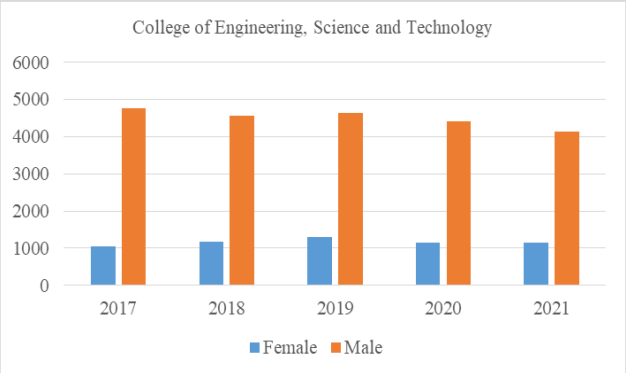

Figure 7: Enrolment of male and female students in the College of Engineering Science and Technology.

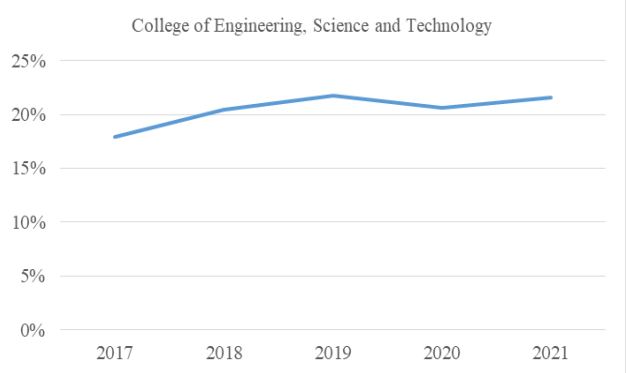

Figure 8: Proportion of the female students enrolled in the College of Engineering Science and Technology.

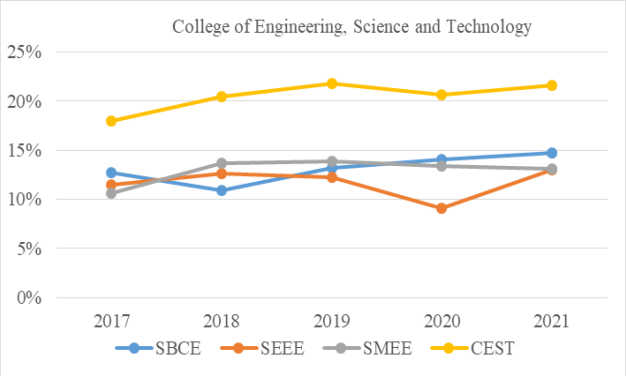

Figure 9: Female enrolment trends of the various schools of engineering and the College of Engineering Science and Technology.

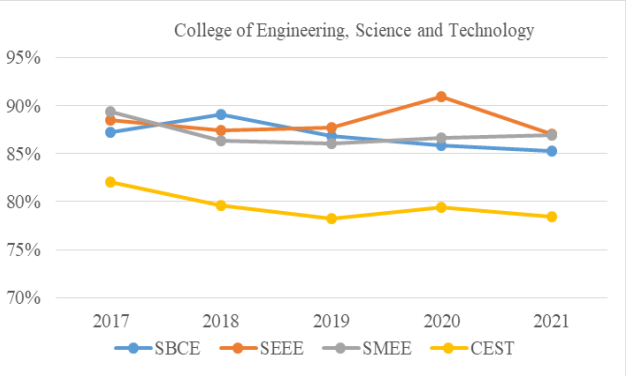

Figure 10: Male enrolment trends of the various schools of engineering and the College of Engineering Science and Technology.

Overall, the results pictured in the figures suggest that there is a need for timely intervention in female enrolment in engineering disciplines in order to promote DEI. Hence, it would lead to boosting of engineering education to a greater height.

Inferential Statistics

In order to check whether the distribution of the enrolment of males significantly differ from the females, a null hypothesis is set as follows:

H_0: the distribution of total enrolment in the School of Building and Civil Engineering, the School of Mechanical Engineering, as well as the School of Electrical and Electronics Engineering is the same across categories of sex.

It can be inferred from Table 1 that the Mann-Whitney U test with *p*-value of 0.008 at z-value of 2.611, which is less than *p*-value of 0.05 indicates that the male distribution in engineering disciplines is significantly different from female during the period considered. Hence, the null hypothesis is rejected. This implies that effort have to be made to improve the statistical differences.

Table 1: Mann-Whitney test summary of male and female enrolment in the engineering programmes.

Independent-samples Mann-Whitney U test summary	
Total N	10
Mann-Whitney U	25.000
Wilcoxon W	40.000
Test statistic	25.000
Standard error	4.787
Standardised test statistic	2.611
Asymptotic sig. (2-sided test)	0.009
Exact sig. (2-sided test)	0.008

STRATEGIES TO IMPROVE FEMALE ENROLMENT IN ENGINEERING DISCIPLINES

The aforementioned results and discussion showed that female enrolment is at disadvantage taking into consideration the available data presented. Therefore, there is a serious need to improve the enrolment of females in engineering disciplines in order to pave a way for related job opportunity and availability, thereby promoting DEI in the workplace. Some of the strategies that can be employed are as follows, but not limited to:

1. Changing of perception that engineering disciplines are of masculine nature. This can be done through advertisement that involves females as the main focus, as well as featuring the successful females in high positions both in industries and other parastatals.
2. Boot camps for high schools which feature more female than male counterparts.
3. Creating a unique welcome classroom that is attractive and comfortable, as well as heterogeneous in nature.
4. Providing special incentives to encourage participation.
5. Redesigning of curriculum to accommodate diversity, equality and inclusiveness.
6. Robust support and mentoring programmes should be specially designed for female engineering students, and such should be embedded in the curriculum of institutions offering engineering disciplines.
7. Protection of engineering female students through strict regulations on sexual harassments/assault and active institutions' agenda on gender mainstreaming.

8. There is a need for national resource planning and formulation of policies capable of promoting DEI and females' participation in engineering education.

CONCLUSIONS

Data were obtained on engineering students' enrolment from the College of Engineering, Science and Technology, which comprises of the School of Building and Civil Engineering, the School of Electrical Engineering and Electronic Engineering and the School of Mechanical Engineering in one of the universities in the South Pacific Islands for a period of five years in order to examine the significance of female enrolment.

It was found that females are underrepresented across engineering disciplines. Similarly, this is also confirmed in the outcome of Mann-Whitney U test with *p*-value of 0.008 at z-value of 2.611, which strongly indicated that the male distribution in the engineering disciplines is significantly different from the female distribution during the period considered. Therefore, there is a strong conviction that if the appropriate strategies highlighted in this article are implemented, significant enhancement in the enrolment of females in engineering disciplines will be attained. This will no doubt promote diversity, equality and inclusiveness, and thereby, boost engineering education especially in the South Pacific Islands.

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BIOGRAPHIES

Olanrewaju Miracle Oyewola received the degree of Doctor of Philosophy (PhD) in Mechanical Engineering from the University of Newcastle, Australia, in 2004. He is currently a Professor in the School of Mechanical Engineering at Fiji National University, Suva, Fiji, as well as in the Department of Mechanical Engineering at the University of Ibadan, Ibadan, Nigeria. He has published one hundred and sixty-five articles in reputable journals and international conference proceedings.

Olusegun Olufemi Ajide is currently a Senior Lecturer in the Department of Mechanical Engineering and Sub-Dean (Postgraduate) in the Faculty of Technology at the University of Ibadan, Nigeria. He obtained his PhD in mechanical engineering from the University of Ibadan, Nigeria, in 2016. Dr Ajide has published over eighty articles in reputable journals and conference proceedings.

Ibukun Samuel Osunbunmi is a postdoctoral research associate in the Department of Engineering Education at Utah State University, Logan, USA. He holds BSc and MSc degrees in mechanical engineering from the University of Ibadan, Nigeria. His research interests include student engagement, design thinking, designing an effective learning environment, evidence-based pedagogy, e-learning, broadening participation in STEM education, sustainable energy and material characterisation.

Yemisi V. Oyewola is a doctoral research scholar in the Department of Engineering Education at Utah State University, Logan, USA. She holds a BSc in computer engineering from Obafemi Awolowo University, Nigeria, and an MSc in information science from the University of Ibadan, Nigeria. She has versatile experience in computer coding and software applications. She has a few publications in engineering education.