EXPLORING THE SELF-EFFICACY OF ENGINEERING STUDENTS: FINDINGS OF A LONGITUDINAL STUDY RELATING TO STUDENT RECRUITMENT, DEVELOPMENT, RETENTION AND SUCCESS

A. LOURENS
NELSON MANDELA METROPOLITAN UNIVERSITY

Abstract

Engineering is regarded as a scarce and critical skill in South Africa, and the shortage of South African engineers represents a capacity and scare-skills crises for the country. A further problem facing the country is the shortage of woman engineers. Further to encouraging and supporting women entering the field of engineering, a South African university established the Women in Engineering Leadership Association (WELA) in 2011. In 2013, WELA embarked on a longitudinal study to establish the impact of the association on WELA members, and to determine the differences in self-efficacy between male and woman engineering students. The research instrument used for the purpose of the study was an adapted version of the Longitudinal Assessment of Engineering Self-Efficacy as developed by Marra and Bogue from the Assessing Women in Engineering (AWE) project. The findings presented in this article are the results of the first round of questionnaires, which highlighted findings relating to student recruitment, development, retention and success. The results of the first round of the study identified that co-curricular interventions were important to prepare students for the world of work, that international partnerships played a potentially powerful role in developing students, that role models were important especially to female engineering students and that technology was an important tool to recruit students. The aim of this article is to assist engineering faculties to understand possible gender differences and self-efficacy issues that could influence course selection, success, development and retention rates of male and woman engineering students. The study also envisions that other universities concerned with student development, success and retention would be able to duplicate some of the findings described.

Keywords: Engineering; student development, student success and retention; self-efficacy; women in engineering

1. INTRODUCTION

The Women in Engineering Leadership Association (WELA) was launched in 2011 by the merSETA Chair in Engineering Development and the School of Engineering at the university where the study is situated. The goals of WELA were to focus on the academic, professional and personal development of women engineering students (WES) at the university (Lourens & du Plooy, 2014).

The programme commenced with workshops that focussed on academic and personal development to achieve one of the project's main aims, namely, to provide WELA members with a reliable social network to support them as they faced the challenges of working in the field of engineering.

Further aims of WELA were to establish engineering as a desirable career-aspiration field for women as well as to develop retention and growth strategies for women already studying in the field of engineering. In 2013, the WELA Leadership Development Programme (LDP) was registered as a formal university short-learning programme and incorporated collaborative efforts with stakeholders within and outside the university (Lourens & du Plooy, 2014).

The design of the WELA LDP included a consideration of the university's values, graduate skills required by industry, input from women engineers, WES and other national and international leadership development programmes (Lourens, 2013). However, the underlying premise of the WELA LDP was to improve the feelings of self-efficacy of WES (Lourens, 2014).

Self-efficacy is defined as a self-evaluation of one's competence to execute successfully a course of action necessary to reach desired outcomes (Bandura, 1977, 1982, 1986, 1991). Self-efficacy is also an important dimension in understanding student satisfaction, achievement, and, ultimately, retention in engineering programmes. As it was necessary to determine if the WELA LDP was reaching its intended goal of improving the feelings of self-efficacy of WES, a longitudinal study commenced in 2013. This study was intended to address questions regarding the self-efficacy of WES in South Africa and, specifically, for engineering students at the university. It further aimed to understand whether specific inputs, as provided by the WELA LDP, made a difference to the ultimate success of WES.

Upon investigating the first set of results from a survey conducted in February 2013, it was discovered that the findings not only provided data on the self–efficacy of male engineering students (MES) and WES, but it also yielded valuable information regarding attracting, developing and retaining engineering students.

2. PROBLEM STATEMENT

In 2010, the Council for Higher Education (CHE) noted that “students entering university do so from positions of extreme inequality, most obviously in schooling, but also in terms of financial and other resources” (Fisher, 2011:18). The CHE (2010:6) also observed that institutions needed to be mindful of the influence of teaching and learning practices, students' readiness, socioeconomic factors, lecturers' pedagogical resources and the institutional environment to produce different academic results to positively influence retention and throughput (Fisher, 2011:18).

An ECSA briefing document of 22 March (Fisher, 2011:6) also identified the impact of schooling, representivity and student throughput in engineering in the following statement:

> *South Africa faces a shortage of high-level engineering skills and there is an ongoing need to transform the profession to ensure greater representivity. Currently the pipeline of qualified candidates from the school system into science, engineering and technology (SET) fields in higher education is constrained by the poor quality of schooling, and many entering students, although in the top decile of their cohort, are academically under-prepared and financially disadvantaged.*
>
> *Currently fewer than a third of all engineering students in Bachelors programmes graduate within the regulation time, and under two thirds graduate within six years. For African students, in particular, and for a range of reasons, throughput and graduation rates are even less satisfactory. Just under a third of African students graduate in five years, as opposed to 64% of white students.*

Based on these concerns by the CHE and ECSA, it became evident that Higher Education institutions need to be aware of and implement measures to attract more students to the engineering field in addition to developing measures and interventions to assist underprepared students to successfully complete their engineering studies. As a result, the aim of the paper was to assist engineering faculties to understand possible gender differences in engineering students, to disseminate information regarding attracting students, particularly WES, to the engineering field and to create a better understanding of factors that could possibly influence retention and development of engineering students.

3. THEORETICAL FRAMEWORK

The underlying premise of the WELA programme was to improve feelings of self-efficacy (Lourens, 2013). The definition of self-efficacy as a determining factor of student success and the link between self-efficacy and engineering students are discussed in the sections below.

3.1 Self-efficacy

An extensive body of research has shown that academic self-efficacy is positively associated with grades in college (Bong, 2001; Brown,Hackett, Betz, Casas & Rocha-Singh, 1992; Lent, Brown & Larkin, 1984) as well as with persistence (Lent, et al, 1984; Zhang & Richards, 1998). Bandura (1993) posits that self-efficacy beliefs affect university outcomes by increasing student motivation and persistence to master challenging academic tasks and by fostering the efficient use of acquired knowledge and skills.

Self-efficacy beliefs are based on four primary sources of information, namely, mastery experience, vicarious experience, social persuasion and physiological reaction (Bandura, 1997; Gist & Mitchell, 1992; Pajares, 2005). Mastery experience refers to previous task experiences and performance, which provide opportunities to learn and practice the rules and strategies necessary to perform a task effectively. Mastery experiences provide confirmation of whether a person has the capability to succeed. Usually, a successful outcome will boost self-efficacy whereas failures will lower it (Rittmayer & Beier, 2009).

Vicarious experience refers to learning through observing others performing tasks (Rittmayer & Beier, 2009). Research suggests that vicarious experience is a particularly powerful determinant of girls' and young women's SET self-efficacy (Seymour, 1995; Zeldin & Pajares, 2000). Social persuasion refers to others' judgements, feedback and support. Positive feedback and encouragement, especially from influential others (for example, parents and teachers), can enhance self-efficacy whereas negative feedback diminishes self-efficacy (Rittmayer & Beier, 2009).

Physiological reactions are experienced when people interpret their emotional and physical states to determine their self-efficacy beliefs. For example, if nervousness and a fear of failure occur during task preparation, a person is likely to doubt his/her ability to succeed. In addition, the increased nervousness is likely to have a negative effect on performance (Rittmayer & Beier, 2009).

3.2 Linking self-efficacy and engineering students

Women are generally under-represented in engineering classrooms and in the engineering profession (Chubin, May & Babeo, 2005; Gowen & Waller, 2002; Sadker & Sadker, 1994). In addition, self-efficacy has been found to be an important factor in the success of women studying engineering (Blaisdell, 2000; Marra, Schuurman, Moore & Bogue, 2005). Bandura (1986) defines self-efficacy as the "belief in one's capabilities to organise and execute the sources of action necessary to manage prospective situations". Although efficaciousness applies to any situation, it is particularly important when choosing and executing constructive actions in situations that are perceived as negative or a barrier to success. For example, lack of a meaningful role in a team project, negative stereotypes, active discouragement by peers or faculty, or scoring poorly on an exam. A strong sense of efficacy could thus assist women in engineering courses to persist in difficult situations (Marra & Bogue, 2006).

Literature about the self–efficacy of women in engineering frequently shows that a general pattern of loss emerges throughout their engineering education.

Although women often enter engineering report high levels of self-confidence and self-esteem (O'Hare, 1995), their self-confidence declines precipitously during the first year. Self-confidence begins to elevate during their studies but it never again reaches the same heights (Brainard & Carlin, 1998). During this time, women often compare themselves unfavourably to their male peers and judge themselves more harshly than the men judge themselves (Hawks & Spade, 1998).

Women are aware of their tendency to judge themselves critically and identify low self-confidence as a major barrier to completing their engineering degree (Brainard, 1993). Women who leave engineering consistently express less confidence in their abilities than the men and women who stay, regardless of the fact that their actual performance is the same or better than their peers who do not leave (Brainard & Carlin, 1998; Jackson, Gardner & Sullivan, 1993). The discouraging nature of low self-confidence is reflected in the fact that women faced with actually failing a course are likely to leave the engineering programme altogether, while their male peers are more likely to repeat the course and continue to pursue their engineering degree (Marra & Bogue, 2006).

Previous studies have found various gender differences regarding engineering self-efficacy. For example, Bradburn (1995) found significant differences in self-efficacy, partially owing to differences in negative persuasion (for example, statements indicating that women could not do certain things) and anxiety signals. A narrative analysis by Zeldin and Pajares (2000) revealed that men perceived mastery experiences as critical to their self-efficacy beliefs, while women valued verbal persuasion and vicarious experiences, For example, experiencing a task or activity “second hand” through someone else's accomplishment of it.

A longitudinal study conducted by Marra, Rodger, Shen and Bogue (2009) found that “positive” statistically significant differences for coping, mathematics and success factors. Marra, et al (2009) postulated that these differences could be attributed to most of the respondents being active participants in women in engineering programmes. Further to the research findings of Marra, et al (2009), it was decided to conduct a similar longitudinal study to establish the impact of the WELA programme on WELA participants. Accordingly, in round one (conducted at the beginning of the 2013 academic year) of the study aimed to compare the self-efficacy scores of WES and MES and round two (conducted at the end of the 2013 academic year) would compare the self-efficacy scores of WELA members, non WELA members and MES,

4. METHODOLOGY

Permission was obtained from Barbara Bogue, Director of the AWE Project, to make use of the Longitudinal Assessment of Engineering Self-Efficacy (LAESE) instrument for the purpose of the WELA longitudinal study. Authorisation was also attained to make adaptations to the questionnaire to suit the South African context.

4.1 The instrument and pilot study

The LAESE is a survey consisting of forty-eight questions designed to measure self-efficacy of engineering students, their feelings of inclusion, outcomes and expectations (AWE, 2007). The questionnaire consisted of six constructs and questions were asked in a Likert-type format where participants indicated their level of agreement with each statement and the importance of the statement in terms of the respondent completing an engineering qualification. A zero indicated strong disagreement and the maximum rating indicated strong agreement. The instrument also included items on the respondents' participation in academic preparation activities and their self-reported plans to persist with their endeavours (Marra, et al, 2009). A pilot study, making use of the LAESE instrument, was conducted with a sample of the 2013 first-year engineering student intake. For the purposes of a descriptive and explorative study, the pilot study results indicated that the face validity and reliability of the adapted LAESE were regarded as acceptable for the six self-efficacy subscales measured by the LAESE instrument (Lourens & Pannell, 2013).Table 1 provides a description of the constructs and the responding alphas.

Table 1: Constructs of pilot questionnaire

Construct number	Number of questions/items	Description	Cronbach alpha
Construct 1	7	Engineering career success expectations	.91
Construct 2	5	Engineering self-efficacy I	.83
Construct 3	6	Engineering self-efficacy II	.94
Construct 4	40	Feelings of inclusion	.79
Construct 5	6	Coping self-efficacy	.89
Construct 6	3	Mathematics outcome expectations	.82

4.2 Administering Round 1

The first round of questionnaires was administered during February 2013. The participants were 250 first-year engineering students of varying races and academic backgrounds from the five different engineering courses, namely, Industrial, Mechanical, Electrical, Civil and Mechatronics.

The first-year students completed the questionnaires at the beginning and at the end of their academic first year as the aim was to measure changes in the self-efficacy scores of MES and WES and, specifically, WES who had joined the WELA programme.

In total, 465 first-year engineering students were registered across the five engineering disciplines in 2013. Two hundred and fifty engineering students responded to the questionnaire, which yielded a representative sample of 54%. Table 2 illustrates the number of registered MES and WES in the study.

Table 2: Number of registered engineering students and respondents

	Registered 1st year students	%	Respondents	Response rate (% of total)
MES	354	76	180	51
WES	111	24	70	64
Total	**465**	**100**	**250**	**54**

From Table 2 is it evident that MES represents the majority (76%) of enrolled first year engineering students. Of the total number of first year engineering students, two hundred and fifty students (54%) took part in the study by completing questionnaires. Of the two hundred and fifty engineering students who completed the questionnaire, one hundred and eighty (72%) were MES and seventy (28%) were WES. For the study, the participants were required to complete the questionnaire at the beginning and end of the academic year. In this way, the self-efficacy scores would be compared to detect changes over the first academic year. It was anticipated that the research project would run from 2013-2015, with the self-efficacy findings published in the latter part of 2014.

Further to exploring the differences in MES and WES self-efficacy scores after the first round of questionnaires, other significant findings regarding student recruitment, development, retention and success became evident.

5. FINDINGS AND RECOMMENDATIONS

The findings from the first round of the LAESE revealed a specific emphasis on WES that could assist universities and engineering faculty in student recruitment, development, retention and success.

5.1 Recruitment of engineering students

The findings suggested possible important sources and methods of recruiting Engineering students.

5.1.1 High School Learners

The majority (86%) of the first-year WES attended high school prior to enrolling at the university, 7% of MES and only 1% of WES were in full-time employment in the year prior to enrolling for their engineering studies. Therefore, it is recommended that recruitment efforts be focussed on high school learners.

Most responses from WES indicated that they made use of university open days to make their decision concerning which engineering course to pursue. Therefore, open days presented a valuable opportunity to recruit WES. Furthermore, it was clear that students made use of the internet/websites to gain information. WELA could use this information and keep their website interesting, exciting, and current, for example, regular updates about activities, latest news and reasons to be proud.

5.1.2 Career influences

Nearly a third of the WES responses specified that they considered the opinion of “other family members” when they decided which engineering course to follow. A possible explanation for this could be that positive role models in their families influenced WES. International research (Aluede, Imahe & Imahe, 2002) also identified social support as one of the strongest factors influencing the decision of women to pursue studies in a technical field. However, a quarter of the WES (26%) also indicated that their high school teachers assisted in their choice of which engineering course to pursue. It thus seems to be beneficial to the Engineering Faculty to ensure that high school teachers have all the necessary information concerning the university's engineering courses and the career opportunities, especially for women in engineering. Regular contact should be made with STEM teachers to ensure that engineering staff were regarded as approachable and could be contacted with questions and learner referrals.

Parents, as a source of information for assistance with decision-making, also seemed to be significant for both MES (23.23%) and WES (21.49%). In order to make use of this recruitment source, the Engineering Faculty could attempt to communicate with parents by providing information sessions (for example, evening sessions that parents could attend with their children). This also related to the indication from most students that open days and school visits were used to make decisions regarding which engineering course to select. By making it possible for parents to be involved in the decision-making process of scholars, the Engineering Faculty would not only assist scholars with their study and career choices, but also tap into an invaluable recruitment opportunity (Lourens & Pannell 2013).

Once engineering students had been recruited, it would be important to ensure that they were developed and supported to assist in retaining them so that they could be successful in their studies and in the workplace.

5.2 Development, retention and success

Diversity and teamwork, confidence and the gender gap, course satisfaction, the role of engineering staff, persistence and role models were also considered as dimensions influencing student development, retention and success.

5.2.1 Diversity and teamwork

Given the ethnic distribution of engineering first-year students, which is a representation of the national ethnic distribution, it could be expected that engineering students would represent different races and cultural backgrounds. This distribution was similar to what the students would eventually encounter in the workplace. Table 3 illustrates the ethnic distribution among engineering students in the Engineering Faculty.

Table 3: Ethnic distribution in engineering faculty

	Black	White	Coloured	Chinese	Indian	Inter-national (Africa	Inter-national (Asia, USA, Europe)	Total
MES	105	47	13	2	6	5	0	178
WES	52	5	10	0	0	1	2	70
Totals	**157**	**52**	**23**	**2**	**6**	**6**	**2**	**248**

Therefore, to assist engineering students to increase their cultural awareness and knowledge regarding different identity groups and to promote better teamwork, it was recommended that engineering students attended courses on diversity training. Not only would such training sensitise them to other ethnic groups, but also MES to women studying and working in the engineering field. In addition, Engineering Faculties could assist engineering students to become more culturally aware through specialised workshops on emotional intelligence, problem solving, and communication and study practices. These essential life skills would not only assist students with team-related problems whilst studying, but also help them to work in teams, once qualified. This training should also have a positive impact on the self-efficacy of students. Furthermore, students would learn efficient ways to study, understand how to communicate effectively, and how to manage their own emotions and those of team members (Lourens & Pannell, 2013).

It is also recommend that the current agreement with the university's international office is expanded to allow more engineering students the opportunity for overseas exchange programmes to practice their teamwork and interpersonal practices. This supports the research of Graham, Crawley and Mendelsohn (2009) who proposed that one of the trends for engineering leadership education in the future includes global engineering and the need for an increased focus on students' ability to operate in complex, international and multi-disciplinary teams with a strong awareness of cultural differences in their approach to engineering problems.

5.2.2 Confidence and gender gap

When the engineering students were asked about their experiences of the work required in high school classes, the respondents could select “easy to get grade I wanted”, “easy to get grade, but few exceptions”, “had to work some”, or “had to work hard”. The majority (58%) of WES indicated that they had to work hard and 46% of MES responded that they had to work hard to obtain the grades they wanted.

This difference of 12% could be attributed to the confidence gap between MES and WES. The confidence gap is defined as gender differences in belief in math and science abilities between male and woman students. According to Watt (2006) and Pajares (2005), the confidence gap exists despite comparable prior accomplishments for men and women, such as STEM grades. The confidence gap could be contributed to the gender gap, which is a sizeable difference in the number of women and men studying engineering and other STEM disciplines. The gender gap develops with high school maths and science course enrolment and grows at each successive stage. Because of this gap, and contrary to expectation based on high school STEM parity, American women earn only 29.1% of mathematics and computer science degrees and 24.7% of doctorate degrees in mathematics and computer science, and hold 27% of professional mathematics and computer science positions (American Association of University Women, 2008).

Linking with the level of work the participants had to apply as high school learners the average cumulative Admission Point Score (APS) result for WES was 41 points in this study, which was 2.98% higher than MES (38 points). This result ties in with the 2011 South African study that showed that in both mathematics and science, girls outperformed boys although, this difference was not statistically significant (Human Sciences Research Council, 2011). Research also shows that young women and girls who receive high grades in STEM are generally modest, while young men and boys who score similarly high in STEM are generally self-congratulatory (Schunk & Pajares, 2002).

It is also important to note that high STEM self-efficacy is a stronger predictor of vocational choice for girls than for boys (Larose, Ratelle, Guay, Senécal & Harvey, 2006). This could possibly explain why WES with a higher APS chose to study engineering.

To support WES to achieve their academic goals, engineering faculties could assist with providing extra tutorials, support classes, and ensure that students had a knowledge of available resources. Study-skills and time-management workshops could also be considered (Lourens & Pannell, 2013).

5.2.3 Course satisfaction

Most of the MES (94%) and WES (77%) were either very satisfied or satisfied with their current specific engineering course choice. However, it was noticeable that 17% more MES than WES were either very satisfied or satisfied with their selected engineering course. It was possible that WES did not have enough information regarding the specific differences between the five engineering courses; additionally it was also possible that a perception existed that girls who performed well in maths and science needed to follow an engineering career.

To ensure a higher percentage of satisfied and very satisfied WES, general information and individual course information sessions for high school learners could assist prospective WES in making the correct choice concerning specific engineering courses or the suitability of enrolling for an engineering course.

The majority of respondents (both sexes) indicated that they were not exploring other courses for their university degree. However, 6% more WES than MES indicated that they were exploring other courses for their studies. There was also a difference between the scores of MES and WES indicative of possible uncertainty in their completion of the engineering course. Only 3.89% of MES indicated that they were not confident in completing their degrees (all of these students indicated that there was a 50% chance of their not completing their studies), while 15.72% of the WES indicated that they were not confident that they would complete their studies. Their answers ranged from 50% chance to not at all confident. Additionally, more WES (15%) than MES (9%) indicated that they were exploring other courses for their studies. As previous studies have shown (Betz, 2001; Blaisdell, 2000; Lapan, Boggs & Morrill, 1989; Marra, et al, 2005; Nauta, Epperson & Kahn, 1998), this could be an indication of a lack in engineering self-efficacy for these WES.

5.2.4 Engineering Academic staff

The majority of the MES and WES indicated that they would talk directly to a lecturer if they experienced problems with a specific class. Knowing that first-year students felt that they could talk to lecturers about course-related problems, the Engineering Faculty should ensure that the trust students had in them was justified. In order to achieve this, lecturers could, for instance, maintain an open-door policy and have regular meetings with students. Such involvement with students should increase trust levels within the Engineering Faculty. Furthermore, engineering lecturers should be sensitised about the unique challenges that WES faced. Woman lecturers affiliated with WELA could ensure that WES knew that lecturers were accessible and willing to assist students. This interaction should improve the self-efficacy of WELA students through improving their feelings of inclusion and their coping self-efficacy.

Seeking assistance from friends was also a popular choice amongst WES. In order to help WES to cope with problems, the Engineering Faculty should strive to create a safe, friendship-based haven for WES. This finding reinforced the need for the WELA home room. This would be a venue within the engineering school where WELA members had exclusive access to meet, study and have formal and informal gatherings. The findings also pointed towards the need for a 'buddy' system where senior WELA participants could act as WELA mentors to one or more first-year students. The mentors could attend a basic mentoring course, to make sure that they had the necessary skills to help younger WELA participants and also had the knowledge to know when they should refer them. This would also add to the skills set of older WELA participants and should also increase their self-efficacy. By ensuring that WES felt and knew that they would be able to receive assistance with problems within the WELA fraternity, WELA could make sure that WELA participants received appropriate assistance, when needed.

Furthermore, the results revealed that WES would seek help on campus. The Student Counselling department would be the most obvious option in this regard. It was, therefore, important to ensure that the student counsellors on campus were aware of the unique challenges that WES faced. Regular contact between Student Counselling and WELA members would be advantageous for students.

5.2.5 Persistence

When the frequency of the "giving-up" option/s (as only choice or as a first option of action to consider) of the scenario items were compared between MES and WES, the following findings emerged

- 14.16% of MES indicated that they would opt for one of the "giving-up" options as a first-choice response to a problem encountered, while only 7.22% of WES indicated the same.

It appeared as if WES were more willing to find a solution to a problem to allow them to continue with their choice of subject/course. The assumption could be made that at the beginning of their first year in their chosen engineering course, WES experienced a positive feeling of self-efficacy, specifically about engineering career success expectations, engineering self-efficacy and coping self-efficacy. More WES (6%) than MES strongly agreed that they could persist in engineering during the current academic year.

However, it was also notable that 14.2% more MES than WES strongly agree that they could succeed in obtaining an engineering qualification. While 46.37% of WES indicated that, they slightly agree and agree that they would be able to obtain an engineering qualification; only 35.96% of MES chose these “less confident” options. It thus seemed as if MES felt more confident that they would be able to obtain an engineering degree than the WES.

5.2.6 Role models

The significance of role models was emphasised by the fact that 6% more WES than MES indicated that they expected not to feel part of the group once they entered an engineering job. Role models are especially influential when they are perceived as similar to the observer, suggesting that interaction with woman faculty members and senior students in engineering would positively affect the self-efficacy of woman STEM students (Rittmayer & Beier, 2009). This was especially important given that 10.77% more MES than WES expected to feel part of the group once they entered an engineering job.

Ensuring exposure to positive role models would facilitate positive vicarious experiences, thereby contributing to improved feelings of self-efficacy of WES. It is proposed that women, to a greater degree than men, considered supportive persons, including role models, as important. Zeldin and Pajares (2000) also found that women valued persuasion (direct encouragement) and vicarious experiences (seeing a person similar to oneself succeeding) as opposed to men who valued mastery experiences as critical to their self-efficacy beliefs (Marra, et al, 2009).

Therefore, WES should visit companies and factories so that participants could engage with women engineers in the field and appreciate the work of qualified woman engineers in the different engineering fields. Qualified woman engineers could also be invited as guest speakers to the university. This would not only make it possible for WES to have access to qualified engineers who could give them practical answers to their questions, but also possibly increasing their self-efficacy with vicarious experiences.

6. CONCLUSION

This study highlighted measures that can be used to attract prospective engineering students and possible interventions that can be developed and implemented to assist underprepared students to successfully complete their engineering studies. Based on the findings of this study, it appeared as if technology played an important role in attracting prospective engineering students. As a result, engineering faculties should make use of technology applications and social media to inform and educate prospective students, parents and teachers about the various engineering fields, study requirements and prospects in each field. Personality traits and preferences linked to an engineering career field to facilitate better study field choices and more satisfaction with choice of study should also be included. The important role of teachers and parents as decision makers and a major influence should also be recognised and nurtured.

In addition, special emphasis should be placed on creating awareness in young girls of the suitability and possibilities represented by a career in the engineering field. As findings also indicated that women role models were important to WES, it would be important to expose current and prospective engineering students to women employed in the engineering filed. The findings also indicated that special interventions should be developed to enhance WES's self-efficacy and self-confidence even if the results indicated that their grade 12-school results were better than MES.

The findings of the longitudinal study to measure self-efficacy of engineering students emphasised that co-curricular interventions such as diversity training, emotional intelligence, problem solving, communication skills, and study skills were important to prepare engineering students for the world of work. Furthermore, in an effort to enhance diversity exposure, teamwork, and the global aspects of engineering, it would be beneficial for Engineering Faculties to actively pursue and encourage international university partnerships.

As the study findings indicated that engineering students valued a relationship with academic staff, it was important to nurture an open-door policy and regular interaction with students. It was, therefore, also advisable that academic staff made a concerted effort to understand the unique circumstances and backgrounds of engineering students. Furthermore, engineering lecturers should be sensitised about the unique challenges that WES faced as studying and working in a male-dominated field.

Even though the objective of the longitudinal study was to learn more about the self-efficacy of engineering students at the university, the research brought to light findings that could be used to not only attract more WES, but also MES.

In addition, the findings emphasised measures and interventions that can be considered by engineering faculty to develop and retain engineering students to assist them to successfully complete their engineering studies. The finding discussed in the article was based on the first round of questionnaires conducted at the beginning of the academic year. The second round of the study intends to compare WES and MES self-efficacy scores at the beginning of the year with scores at the end of the academic year, and will be the focus of a future publication.

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