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Self-Efficacy of Engineering Students at a South African University—Findings from a Longitudinal Study*

ANN S. LOURENS and LIESL S. PANNELL
Nelson Mandela University, Gardham Ave, Summerstrand, Port Elizabeth, South Africa. E-mail: ann.lourens@mandela.ac.za, liesel@panlila.co.za

Internationally and nationally, governments, professional body organisations and higher education institutions and are launching initiatives to attract and retain women in Science, Technology, Engineering, and Maths (STEM) fields. This article reports on the fourth phase in a longitudinal study aimed at determining the levels of self-efficacy of first-year engineering students at a South African university. It further reports on the impact of co-curricular interventions, presented as a leadership development programme (LDP), that was developed to assist women engineering students (WES) belonging to the Women in Engineering Leadership Association (WELA) to improve their feelings of self-efficacy. It was proposed that these interventions could contribute to WELA members outgrowing their perceived insecurities and negative perceptions and result in well-balanced, self-assured and effective WES, and, in turn, women engineer employees. Participation in and completion of the LDP could thereby improve the retention of women in the field of engineering. To measure the self-efficacy of engineering students, the Self-Efficacy Instrument for Engineering Students (SEIES) was developed. The instrument measured students' perceived motivation and confidence relative to nine identified subscales. The findings of the study indicated no significant differences in the self-efficacy of male engineering students (MES), WES and WELA members, even though the results indicated that WELA members scored slightly higher on most of the subscales measured. Based on this study, it became evident that specifically-designed developmental programmes such as WELA could have a positive influence on the self-efficacy of WES. It is envisaged that this particular research study could lead to further research in the field of WES, with the aim of developing, supporting and retaining women in engineering fields.

Keywords: women engineering; self-efficacy; measurement; retention

1. Introduction

Nationally and internationally, the fields of science and engineering face major challenges in producing the necessary workforce for the future. The first major challenge is recruiting students, especially women, to these fields, and the second challenge is retaining those registered until they have completed their qualifications [1]. Studies by Network Engineering [2] have also identified a third challenge, namely, the retention of working women engineers. They found that 70% of South African women engineering graduates left the sector after they started their careers as they felt isolated in their jobs. This finding supports the continued need for professional South African women engineers to overcome traditional stigmas in this male-dominated industry [2].

1.1 Background to WELA

STEM intervention programmes have proliferated at colleges across the USA in response to the demand for engineers and scientists [3]. These programmes are designed to broaden participation of under-represented students in STEM fields and include a focus on attracting and retaining women in addition to cultivating student self-efficacy within their fields. In the UK, many state-funded and third sector projects have been established to encourage girls to enrol for STEM subjects and engineering [4]. An Australian study proposed that education strategies that provided development and support by means of short courses, a culture change in engineering workplaces, and part-time work for women in engineering faculties could eliminate some of the barriers for women entering and remaining in engineering fields [5]. Implementing these measures could, by definition, also improve the self-efficacy of WES. In South Africa, the same need to support WES in engineering is recognised nationally. For example, Women in Engineering and the Built Environment (WiEBE) [6] at the University of Johannesburg and SAWomEng, a non-profit, volunteer organisation founded in 2006, aimed at attracting, developing and nurturing the next generation of women engineering leaders [7].

In an effort to support, develop and grow WES and working women engineers, WELA was established in 2010 at the university where this study is situated. It is one of five projects supported by Manufacturing, Engineering and Related Services sector education training authority (MERSETA) to develop engineering in the province. The goals of WELA are to focus on the academic, professional and personal development of both WES at university and working women engineers. WELA also

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aims to establish engineering as a desirable career-aspiration field for women and to develop retention and growth strategies for women already studying in the field of engineering. Furthermore, WELA aims to provide its members with a reliable social network to support them as they face the challenges of working in the field of engineering. In 2013, the WELA Leadership Development Programme (LDP) was registered as a formal university short-learning programme. Its design considered the university's values, graduate skills required by industry, input from women engineers, WES and other national as well as international leadership development programmes. The underlying premise of the WELA LDP was to improve the feelings of self-efficacy of WES and to contribute to their feeling of belonging and inclusion, which should positively influence retention of WES in the engineering field.

1.2 Background to the study

This research discusses the findings of SEIES as it measured students' perceived motivation and confidence relating to nine identified subscales. The development of SEIES, the nine subscales and scoring has been discussed in a study [8], however, this article discusses the development of SEIES to provide a context and deeper understanding of the SEIES findings.

The investigations into the self-efficacy of first-year University engineering students commenced in February 2013. Permission was obtained to use the Longitudinal Assessment of Engineering Self-Efficacy (LAESE) instrument and 253 students of varying races and academic backgrounds from the five engineering courses offered at the university were assessed. This instrument is a tested and validated survey designed to measure the self-efficacy of WES, their feelings of inclusion and their outcome expectations [9, 10]. The February 2013 study investigated the differences in self-efficacy of MES and WES before the introduction of WELA initiatives aimed at improving self-efficacy amongst WES belonging to WELA.

The results of the February 2013 study suggested that there were no significant differences between the self-efficacy of the MES and WES at the start of the 2013 academic year. This proved true for all six of the self-efficacy constructs as measured by LAESE. To determine if WELA indeed had an effect on the self-efficacy of WELA members, the participants of the February 2013 study were assessed again in October 2013 using the LAESE instrument. The participants for the October 2013 study consisted of 139 students of varying races and academic backgrounds from the five engineering courses offered at the university. In this research, it was possible to compare not only the self-efficacy of MES and WES, but also differences between WELA and non-WELA members, MES and WELA members and, finally, MES and non-WELA members.

The October 2013 results indicated the same outcomes as the February 2013 research, as there were no significant differences indicated between MES, WES, WELA members and non-WELA members for any of the self-efficacy constructs. However, the results of the October 2013 study indicated that WELA members were more resolute in persisting with their engineering degree than non-WELA members. This was considered a distinctly positive outcome of the 2013 WELA programme, which supported the input and guidance given to WELA members. After using the LAESE instrument in 2013, it was decided to develop another research instrument (SEIES) to obtain deeper knowledge on engineering students' self-efficacy in a South African context. SEIES would thus provide data on engineering students' perceived self-efficacy in terms of their confidence and motivation. In addition, the content and subscales of the LAESE instrument were to be reviewed and revised for SEIES [8].

The aim of both LAESE and SEIES was to investigate the self-efficacy of engineering students and to determine if programmes and interventions such as WELA could positively influence the self-efficacy of WELA members. It was important to establish, by means of a quantitative research instrument, whether the WELA programme could be viewed as a success, and that it created a sense of inclusion, belonging and support, leading to an improved sense of self-efficacy amongst WES, thereby contributing to the retention of WES and working women engineers. As the development of the SEIES research instrument was discussed by Lourens and Campher [8], this article reports on the findings of the 2014 SEIES study.

2. Theoretical framework

Bandura [11, p.3] defined self-efficacy as ''the belief in one's capabilities to organise and execute the course of action required to produce given attainments''. Self-efficacy is a critical factor contributing to academic success and thus retention [12].

A landmark report by the American Association of University Women (AAUW, 1991) [13] showed that girls' confidence in their academic abilities dropped dramatically from elementary to high school. The decline is particularly significant in girls' and young women's confidence in their maths and science abilities [14]. This ''confidence gap'' [15] refers to gender differences in belief in maths and science abilities, which is partly responsible for the shortage of women in science, technol-

ogy, engineering and mathematics classes as well as related careers [16]. It is also important to note that high STEM self-efficacy is a stronger predictor of vocational choice for girls than for boys [17].

Self-efficacy beliefs are based on four primary sources, namely, mastery experience, vicarious experience, social persuasion and physiological reaction [9, 18].

1. Mastery experiences, also referred to as performance outcomes or experiences are the most important source of self-efficacy [18]. Both positive and negative experiences can influence a person's ability to perform a given task. If someone has previously performed a certain task well, then he/she is more likely to feel competent and perform well at a similar task [18].
2. People can develop high or low self-efficacy vicariously through other people's performances. Therefore, if people see someone similar to themselves succeed, it can increase their self-efficacy [18].
3. Self-efficacy is also influenced by encouragement and discouragement. Positive verbal or social persuasion can lead people to work harder at certain tasks; therefore, they have a greater chance of succeeding [11].
4. Physiological feedback or reaction happens when a person experiences bodily sensations. How they perceive this emotional stimulation can influence their beliefs of efficacy [18]. For example, certain tasks can cause agitation or anxiety that can lead people to believe that they are less capable and lower their self-efficacy [19].

2.1 Self-efficacy and retention

Academic self-efficacy and contextual support is critical to retention [20]. Generalised contextual support, as offered by the WELA programme, was found to be particularly important to women and appeared to serve as an inducement to stay in engineering. Marra, Rodgers, Shen and Bogue [21] found "engineering climate and belonging" to be a potential barrier to the retention of students in engineering courses. The perceived "climate" in engineering programmes adds to students' feelings that they fit in and belong, and these can be either damaging or beneficial to their retention in those programs. Classroom climate focuses on the interactions within classroom settings among students and between students and faculty. The term "chilly climate" [22] has been used to illustrate educational practices and environments that treat women and men differently and that have an obstructive impact on women and others in engineering. For all students, student-to-faculty interactions are an important facet of climate and, ultimately, student success. A study in student-faculty relationships found that "distant" faculty relationships lowered self-efficacy and academic confidence [23], all of which could influence student retention. Group work in activities such as problem-solving could play a positive role in four sources of self-efficacy [12]. Furthermore, traditional engineering curricula focused less on softer skills and focused rather on core engineering competencies. However, it is often the soft skills that includes communication, teamwork and leadership that is sought in industry [24].

The theoretical foundation of SEIES was that people with higher self-efficacy are more likely to undertake, and be successful in managing themselves as engineering students and in managing their study performance. Furthermore, study accomplishments are believed, in turn, to increase self-efficacy through a feedback cycle tying successful performance to improved self-efficacy beliefs. In an attempt to be as comprehensive as possible, SEIES not only gathered information regarding the confidence engineering students had of their ability to be successful in certain activities, but also how motivated they were to succeed in these measured activities. The development of SEIES and the nine subscales, namely, engineering self-efficacy, mathematics self-efficacy, learning, problem-solving, coping, inclusion, organisational culture, teamwork, role expectations and culture have also been reported on in studies [8]. The aim of this article is to discuss the results of the 2014 SEIES study.

3. Research design

SEIES, a quantitative research instrument, comprises of questions that would provide an individual score relating to motivation and confidence as well as an overall self-efficacy rating. The processes and procedures followed in conducting the research are discussed in the following sections.

3.1 Administration

SEIES was administered by using a standard paper and pencil format. Respondents were advised that the instrument consisted of 49 questions per section (perceived motivation and confidence) and referred to a range of activities associated with engineering studies [8].

3.2 Subscales and scoring

SEIES featured nine subscales and 98 questions to be answered on an 11-point Likert-type scale with response options ranging from 'No confidence at all' to 'Very High confidence' and 'No motivation at

Questionnaire extract

No confidence OR no motivation at all					Moderate confidence OR motivation					High confidence OR motivation
0	1	2	3	4	5	6	7	8	9	10

all' to 'Very High motivation' [8]. Scoring was done by calculating the mean responses per item and per subscale as indicated by the 0–10 scale. An average of all of the items was calculated to obtain the overall score. The extract from the questionnaire (shown above) illustrates the total continuum of possible responses on the scale provided [8].

The 98 items in SEIES were organised into nine subscales and an overall composite score. The number of items corresponding to each of the nine subscales is illustrated in Table 1.

3.3 Pilot study

Based on a literature review, a large number of items were produced as indicators of the nine identified subscales. These were presented for 'judge analyses' in terms of face and content validity. Data was collected and analysed using item/reliability analysis and estimates of internal consistency to validate the appropriate items for each of the nine engineering self-efficacy subscales [8].

The selected items (questions) were submitted for content analysis using expert judges in the broad field of study-based learning, psychology, statistical consultancy and engineering. Judges were requested to fit each item into one of the nine subscales and items identified as not suitable for a specific subscale were either eliminated from the questionnaire or changed. When this procedure was complete, 98 items (49 items each in the motivation and the confidence sections) were retained [8].

A pilot study to test the adequacy, reliability and validity of SEIES was conducted with a sample of 82 of the 2014 first-year engineering students at the university. Descriptive statistics, namely, Mean, Median, Minimum, Maximum, Standard Deviation and Skewness were calculated. The inventory was also subjected to an Item/Reliability Analysis, which included Inter-Item Correlations, Item-Total Correlations and Cronbach's Alpha [8]. The instrument consistently showed itself to be highly-reliable with Cronbach's Alpha in the range of 0.75 to 0.89 for the confidence Form and 0.83 to 0.92 for the motivation Form. Therefore, the internal reliability of the pilot study was high and this suggested that self-efficacy of university students could be measured by SEIES.

Table 2 illustrates the means and standard deviations for each of the subscales and the overall scale score. The overall scale score and the subscale score means were obtained from the original 0–10 scale [8].

The nine subscales contained items that were congruent with each specialised concept, and the

Table 1. Nine subscales

Sub-scales	Number of questions/items
Engineering Self-Efficacy Motivation and confidence in being successful as an engineering student.	8 items
Maths Self-Efficacy Confidence in being successful in the maths requirements for the engineering course and the motivation to be so.	4 items
Learning Self-Efficacy Motivation and confidence in being able to learn productively as an engineering student.	6 items
Problem-Solving Self-Efficacy Motivation and confidence in effectively solving problems as an engineering student.	6 items
Coping Self-Efficacy Motivation and confidence in being able to cope with different issues relevant to being an engineering student.	7 items
Inclusion Self-Efficacy Motivation and confidence to be included in the group as an engineering student.	4 items
Organisational Culture Self-Efficacy Motivation and confidence to effectively scope out and manage organisational politics and traditions as an engineering student.	5 items
Teamwork Self-Efficacy Motivation and confidence in working well within a team environment as an engineering student.	4 items
Role Expectations Self-Efficacy Motivation and confidence to perform and understand the role(s) allocated to engineering students.	5 items
Overall Engineering Student Self-Efficacy **49 items each in the confidence and motivation sections, therefore, 98 items in total**	**98**

Table 2. Means and Standard Deviations for SEIES Pilot Study

		Valid N		Means		Standard Deviation	
	Subscales	**Confidence Form**	**Motivation Form**	**Confidence Form**	**Motivation Form**	**Confidence Form**	**Motivation Form**
1	Coping SE	81	80	8.07	8.46	1.45	1.42
2	Engineering SE	81	80	8.69	8.87	1.20	1.35
3	Inclusion SE	80	80	8.36	8.65	1.37	1.38
4	Learning SE	80	81	8.22	8.74	1.30	1.38
5	Maths SE	80	80	8.45	8.72	1.57	1.61
6	Organisational Culture SE	81	80	7.97	8.64	1.61	1.43
7	Problem-Solving SE	80	80	8.27	8.60	1.22	1.37
8	Role Expectations SE	81	81	8.55	8.80	1.46	1.47
9	Teamwork SE	80	80	8.43	8.70	1.21	1.43
	Factor All	**81**	**81**	**8.30**	**8.68**	**1.27**	**1.32**

Table 3. Cronbach Alpha Values for Subscales and General Self-Efficacy of SEIES Pilot Study

	Alpha		
Sub-scales	**Confidence Form**	**Motivation Form**	**Items**
Engineering Self-Efficacy	0.89	0.92	8 questions
Maths Self-Efficacy	0.88	0.88	4 questions
Learning Self-Efficacy	0.75	0.85	6 questions
Problem-Solving Self-Efficacy	0.86	0.88	6 questions
Coping Self-Efficacy	0.80	0.83	7 questions
Inclusion Self-Efficacy	0.76	0.83	4 questions
Organisational Culture Self-Efficacy	0.80	0.84	5 questions
Teamwork Self-Efficacy	0.72	0.80	5 questions
Role Expectations Self-Efficacy	0.85	0.86	5 questions
Overall Score	**0.98**	**0.99**	**All the Above**

reliability of each of the nine subscales was robust, featuring Cronbach Alphas ranging from 0.72 to 0.92. These reliability estimates are illustrated in Table 3. The reliability estimate for the full scale preliminarily results implied that the scale might be used as a uni-dimensional broad instrument appraising student self-efficacy as a construct in itself [8].

The full SEIES survey thus contained 98 questions (49 per section) arranged into nine subscales as well as 13 biographical and background questions. During March 2014, the instrument was administered for the first time to 339 first-year engineering students representing the five engineering departments at the university. In October 2014, SEIES was administered again to the same group of first-year students to compare the beginning and end of year scores [8].

Although the development of the SEIES research instrument has been discussed [8], the aim of this article was to discuss results and findings of the March and October 2014 studies.

4. Results

In October 2014, the students that participated in the March 2014 study were requested to complete SEIES again**.** Of the original 339 first-year engineering students in 2014, 237 students from the five engineering schools completed the questionnaire (see Table 4).

The following sections report on the results of nine subscales measured by SEIES. Only descriptive statistics was shown in cases where no significant differences between the groups (MES, WES, WELA members) were found.

4.1 Subscale 1: engineering self-efficacy

Results of the March 2014 and October 2014 studies indicated no significant differences in the confidence score of the engineering self-efficacy subscale between MES and WES. In March 2014, there was a small practical significance in the motivation score between MES and WES on this subscale with WES scoring higher than MES. The

Table 4. Respondents

Respondents October 2014	**WELA**	**Non-WELA**	**MES**	**Total**
Number	30	44	163	237
%	13	18	69	100

Table 5. Descriptive Statistics Engineering Self-Efficacy Subscale

Breakdown Table of Descriptive Statistics

	Engineering SE confidence			Engineering SE motivation		
Group	**Means**	**N**	**Standard Deviation**	**Means**	**N**	**Standard Deviation**
WELA	8.00	30	1.45	8.55	30	1.45
non-WELA	7.91	43	1.31	8.02	44	1.76
MES	7.81	162	1.59	8.03	163	1.58
All Groups	7.85	235	1.52	8.10	237	1.60

Table 6. Descriptive Statistics: Maths Self-Efficacy

Breakdown Table of Descriptive Statistics

	Maths SE confidence			Maths SE motivation		
Group	**Means**	**N**	**Standard Deviation**	**Means**	**N**	**Standard Deviation**
WELA	7.71	30	2.08	8.60	30	1.61
non-WELA	7.76	43	1.51	7.91	44	1.94
MES	7.57	161	1.79	8.00	163	1.67
All Groups	7.62	234	1.78	8.06	237	1.72

October 2014 results did not show a significant difference in the motivation rating to complete the required portions of an engineering degree between WES and MES.

Table 5 shows the results of the October 2014 study, indicating that there were no significant differences between the three groups for both the confidence and the motivation rating of the engineering self-efficacy subscale.

Table 5 also shows that no significant differences were observed between WELA members and non-WELA members on both the confidence and motivation ratings of the engineering self-efficacy subscale.

4.2 Subscale 2: Maths self-efficacy

The results of the October 2014 study were similar to those of the March 2014 study, which indicated that there was no significant difference in the confidence rating score of the maths self-efficacy subscale between MES and WES. Although WES were significantly more motivated than MES to complete the math requirements of their engineering degree in March 2014, no difference was observed in the October 2014 results (see Table 6).

From Table 6, no significant differences between MES, WELA members, and non-WELA members were reported for both the confidence and motivation ratings of the maths self-efficacy subscale. Similarly, no significant differences between WELA members and non-WELA members were reported for both the confidence and motivation rating of the maths self-efficacy subscale.

4.3 Subscale 3: Learning self-efficacy

The results of the March 2014 and October 2014 studies indicated no significant difference in the confidence rating score of the learning subscale between MES and WES.

In the March 2014 study, a small practical significance was shown in the learning motivation rating score between MES and WES, with WES scoring higher than MES. Although the October 2014 results were not practically significant, it is noteworthy that WES again scored higher than MES on this subscale. It can, therefore, be deduced that WES are perhaps more motivated to learn efficiently and develop their skill-set than MES (see Table 7).

Table 7. Gender T-test

T-tests. Grouping: Gender

	Mean	Mean	t-value	df	p	Valid N	Valid N	Stand. Dev.	Stand. Dev.	Cohen's d	Pract. signif.
	MES	**WES**				**MES**	**WES**	**MES**	**WES**		
Learning: confidence	7.55	7.69	0.66	233	0.5131	162	73	1.59	1.45	n/a	n/a
Learning: motivation	7.88	8.28	1.67	235	0.0956	163	74	1.66	1.81	n/a	n/a

Table 8. Descriptive Statistics: Learning Self-Efficacy

Breakdown Table of Descriptive Statistics

	Learning SE confidence			Learning SE motivation		
Group	**Means**	**N**	**Standard Deviation**	**Means**	**N**	**Standard Deviation**
WELA	7.91	30	1.33	8.71	30	1.46
non-WELA	7.54	43	1.53	7.98	44	1.97
MES	7.55	162	1.59	7.88	163	1.66
All Groups	**7.59**	**235**	**1.55**	**8.00**	**237**	**1.72**

Table 9. Tukey test

Tukey HSD test; Variable: Self-Efficacy Learning motivation

	{1}	{2}	{3}
WELA {1}			0.51 (M)
non-WELA F {2}	0.1644		
MES {3}	***0.0357***	0.9305	

From Table 8, no significant differences were observed between MES, WELA members and non-WELA members in the learning self-efficacy confidence subscale.

Table 9 illustrates the differences observed between the groups and a medium practical significant difference in the learning self-efficacy motivation subscale was observed between WELA members and MES, with WELA members scoring higher. WELA members were thus more motivated to learn productively than MES.

There were no significant differences in both the confidence and motivation rating on the learning self-efficacy subscale between WELA members and non-WELA members (see Table 10).

4.4 Subscale 4: Problem-solving self-efficacy

Both the March 2014 and October 2014 results indicated no significant difference in the confidence rating score of the problem-solving self-efficacy subscale between MES and WES.

In March 2014, there was a small practical significance in the motivation rating score between MES and WES on this subscale, with WES scoring higher than MES. In the October 2014 study, the motivation rating on this subscale did not indicate any significant differences between MES and WES.

Table 11 shows that there were no significant differences between the three groups in the problem-solving self-efficacy confidence and motivation ratings. No significant differences were observed in both the confidence and motivation ratings of the problem-solving self-efficacy subscales between WELA members and non-WELA members.

4.5 Subscale 5: Coping self-efficacy

The results of the October 2014 study, as in March 2014, indicated no significant differences in the

Table 10. T-tests WELA and Non-WELA Members

T-tests. Grouping: Group

	Mean	Mean	t-value	df	p	Valid N	Valid N	Std. Dev.	Std. Dev.	Cohen's d	Pract. signif.
	WELA	**non-WELA**				**WELA**	**non-WELA**	**WELA**	**non-WELA**		
Learning: confidence	7.91	7.54	1.05	71	0.2966	30	43	1.33	1.53		
Learning: motivation	8.71	7.98	1.73	72	0.0880	30	44	1.46	1.97		

Table 11. Descriptive Statistics Problem-Solving Self-Efficacy

Breakdown Table of Descriptive Statistics

	Problem-Solving SE confidence			Problem-Solving SE motivation		
Group	**Means**	**N**	**Standard Deviation**	**Means**	**N**	**Standard Deviation**
WELA	7.62	30	1.64	8.52	30	1.27
non-WELA	7.53	43	1.44	7.75	44	1.87
MES	7.37	162	1.55	7.83	163	1.66
All Groups	**7.43**	**235**	**1.54**	**7.90**	**237**	**1.67**

Table 12. Gender T-test

T-tests. Grouping: Gender

	Mean MES	Mean WES	t-value	df	P	Valid N MES	Valid N WES	Std. Dev. MES	Std. Dev. WES	Cohen's d	Pract. signif.
Coping: confidence	7.40	7.56	0.70	233	0.4873	162	73	1.58	1.63	n/a	n/a
Coping: motivation	7.61	8.01	1.67	235	0.0970	163	74	1.70	1.83	n/a	n/a

Table 13. Descriptive statistics: Coping Self-Efficacy

Breakdown Table of Descriptive Statistics

	Coping SE confidence			Coping SE motivation		
Group	**Means**	**N**	**Standard Deviation**	**Means**	**N**	**Standard Deviation**
WELA	7.94	30	1.58	8.61	30	1.25
non-WELA	7.29	43	1.63	7.61	44	2.05
MES	7.40	162	1.58	7.61	163	1.70
All Groups	**7.45**	**235**	**1.60**	**7.73**	**237**	**1.75**

Table 14. Tukey test

Tukey HSD test; Variable: Self-Efficacy Coping motivation

	{1}	{2}	{3}
WELA {1}		0.56 (M)	0.61 (M)
non-WELA {2}	***0.0392***		
Male {3}	***0.0099***	0.9999	

confidence rating score of the coping subscale between MES and WES (both WELA and non-WELA members).

With regard to the motivation rating score of this subscale, a small practical significance was observed in March 2014, with WES scoring higher than MES. Although not a significant difference, results in October 2014 again indicated that WES were possibly more motivated than MES to cope with pressure as engineering students (see Table 12).

The October 2014 results illustrated in Tables 13 and 14 below also indicated that there was a medium practical significant difference between the Self-Efficacy Coping Motivation rating of WELA members and MES, with WELA members scoring higher than MES. In addition, a medium practical significant difference was also shown between WELA members and non-WELA members for the Self-Efficacy Coping Motivation rating, with WELA members scoring higher than non-WELA members.

Based on the results illustrated in the tables above, it can thus be concluded that WELA members were more motivated to cope with different issues relevant to being an engineering student than both MES and non-WELA members.

From Tables 14, no differences were observed between the coping confidence rating of WELA members and non-WELA members.

A medium significant practical difference between WELA members and non-WELA members was shown in the motivation rating of the coping subscale (see Tables 15). Accordingly, WELA members were more motivated to cope with different relevant issues as engineering students than non-WELA members were.

Table 15 indicates that, WELA members were more motivated to cope with different relevant issues as engineering students than non-WELA members were.

4.6 Subscale 6: Inclusion self-efficacy

The results of the March 2014 and October 2014 studies indicated that there were no significant differences in the confidence score of the inclusion

Table 15. T-test: WELA and Non-WELA

T-tests. Grouping: Group

	Mean WELA	Mean non-WELA	t-value	df	p	Valid N WELA	Valid N non-WELA	Std. Dev. WELA	Std. Dev. non-WELA	Cohen's d	Pract. signif.
Coping confidence	7.94	7.29	1.69	71	0.0945	30	43	1.58	1.63	na	na
Coping motivation	***8.61***	***7.61***	***2.37***	***72***	***0.0203***	***30***	***44***	***1.25***	***2.05***	***0.56***	***Med***

Table 16. Descriptive Statistics: Inclusion Self-Efficacy

Breakdown Table of Descriptive Statistics

	Inclusion SE confidence			Inclusion SE motivation		
Group	**Means**	**N**	**Standard Deviation**	**Means**	**N**	**Standard Deviation**
WELA	8.00	30	1.53	8.45	30	1.31
non-WELA	7.61	43	1.69	7.71	44	2.03
MES	7.60	162	1.75	7.70	162	1.67
All Groups	**7.65**	**235**	**1.71**	**7.80**	**236**	**1.71**

subscale between MES and WES. In March 2014, a small practical significance was observed in the motivation score between MES and WES on this subscale, but in the October 2014 study, no difference was observed.

No significant differences were shown for the Inclusion confidence and motivation ratings between MES, WELA members, and non-WELA members (see Table 16).

4.7 Subscale 7: Organisational culture self-efficacy

No significant difference in the confidence rating score of the organisational culture subscale between MES and WES was indicated in the March 2014 and October 2014 study. In March 2014, a small practical significance was observed in the motivation rating on this subscale. It was shown that WES were more motivated than MES to scope out and manage the politics and traditions of the Engineering School. However, in October 2014, no differences were observed (see Table 17).

From Table 17, results of the October 2014 study showed no significant differences between the three interest groups for both the confidence and the motivation ratings of the organisational culture subscale.

In addition, no significant differences were observed for the confidence and the motivation rating of the organisational culture self-efficacy subscale between WELA members and non-WELA members.

4.8 Subscale 8: Teamwork self-efficacy

As with the March 2014 study, results in October 2014 indicated that there were no significant differences in the confidence score of the teamwork subscale between MES and WES. In March 2014, there was a small practical significance in the motivation score between MES and WES on this subscale, with WES scoring higher than MES. According to these results, WES were more motivated than MES to work well within a team environment. In October 2014, the results were not practically-significant, but again indicated a higher motivation rating amongst WES.

From Table 18, there was no significant difference between WELA and non-WELA members on the confidence rating of the teamwork self-efficacy subscale. A medium significant difference was found between WELA members and non-WELA members for the motivation rating of the teamwork self-efficacy subscale..

Based on the results in Table 18, WELA members were consequently more motivated to work well within a team environment than non-WELA members.

4.9 Subscale 9: Role expectations self-efficacy

The results of the March 2014 study indicated that there was no significant difference in the confidence rating score of the role expectations subscale between MES and WES. Although not significant, there was a notable difference on this subscale in the October 2014 study, with WES scoring higher than MES. This indicated that WES were possibly more confident than MES about understanding and fulfilling expectations of their roles as engineering students.

Table 17. Descriptive statistics: Organisational Culture Self-Efficacy

Breakdown Table of Descriptive Statistics

	Organisational Culture SE confidence			Organisational Culture SE motivation		
Group	**Means**	**N**	**Standard Deviation**	**Means**	**N**	**Standard Deviation**
WELA	7.39	30	1.84	8.12	30	1.51
non-WELA	7.23	43	1.76	7.66	44	1.89
MES	7.24	162	1.59	7.55	163	1.72
All Groups	**7.26**	**235**	**1.65**	**7.64**	**237**	**1.73**

Table 18. Descriptive statistics: Teamwork Self-Efficacy

Breakdown Table of Descriptive Statistics						
	Teamwork SE confidence			Teamwork SE motivation		
Group	Means	N	Standard Deviation	Means	N	Standard Deviation
WELA	8.22	30	1.64	8.66	30	1.33
non-WELA	7.48	43	1.54	7.81	44	1.67
MES	7.57	162	1.60	7.74	162	1.73
All Groups	**7.64**	**235**	**1.60**	**7.87**	**236**	**1.70**

Table 19. Gender T-test

T-tests. Grouping: Gender											
	Mean	Mean	t-value	Df	p	Valid N	Valid N	Std. Dev.	Std. Dev	Cohen's d	Pract. signif.
	MES	WES				MES	WES	MES	WES		
Role Exp: confidence	7.60	8.05	1.92	233	0.0556	162	73	1.72	1.50	na	Na
Role Exp: motivation	7.93	8.33	1.67	235	0.0964	163	74	1.72	1.74	na	Na

Table 20. Descriptive statistics: Role Expectation Self-Efficacy

Breakdown Table of Descriptive Statistics						
Group	Role Expectation SE confidence			Role Expectation SE motivation		
	Means	N	Standard Deviation	Means	N	Standard Deviation
WELA	8.26	30	1.60	8.85	30	1.28
non-WELA	7.90	43	1.42	7.98	44	1.92
Male	7.60	162	1.72	7.93	163	1.72
All Groups	**7.74**	**235**	**1.66**	**8.06**	**237**	**1.73**

In March 2014, there was a small practical significance in the motivation rating score between MES and WES in this subscale, with WES scoring higher than MES. In October 2014, there was no practical significant difference in the scores between MES and WES. It should be noted that WES, again, scored higher than the MES. This could imply that WES continued to be somewhat more motivated than MES about understanding and fulfilling the role expectations of engineering students (see Table 19).

Table 19 illustrates that the confidence rating of the role expectations self-efficacy subscale did not render any significant differences between MES, WELA members and non-WELA members.

A medium significant difference was observed on the motivation rating of the role expectation self-efficacy subscale between WELA members and MES. WELA members were thus considerably more motivated than MES to perform and understand the role(s) allocated to them as engineering students.

Although not significant, the difference in the motivation rating of the role expectation self-subscale between WELA members and non-WELA members is worth mentioning. It can be concluded that WELA members were somewhat more motivated than non-WELA members to perform and understand the role(s) allocated to them as engineering students (see Table 20 and 21).

Table 21. Tukey test

Tukey HSD test; Variable: Self Efficacy Role Expectation motivation			
	{1}	{2}	{3}
WELA {1}			0.56 (M)
non-WELA F {2}	0.0786		
Male {3}	***0.0181***	0.9845	

From Table 21, there was a medium significant difference between the motivation ratings of the role expectation self-efficacy subscale. This confirmed that WELA members were more motivated than non-WELA members to perform and understand the role(s) allocated to them as engineering students.

5. Discussion

The results of the October 2014 study indicated that there were no significant differences in the confi-

dence or the motivation ratings on the SEIES between MES and WES. Although no practical significance was indicated, WES scored higher in the confidence and motivation ratings on all nine of the subscales measured by the SEIES. It can thus be concluded, that self-efficacy of first-year WES at the university was higher than that of their male counterparts, albeit only slightly. When a comparison of results was made between MES, WELA members and non-WELA members, the following was noted:

1. Medium practical differences between the three groups were only found in the motivation rating of the SEIES. These were:
   (a) Learning: a medium practical significant difference between MES and WELA members, with WELA members scoring higher.
   (b) Coping: a medium practical significant difference between MES and WELA members, with WELA members scoring higher AND a medium practical significant difference between WELA members and non-WELA members, with WELA members scoring higher.
   (c) Role Expectations: a medium practical significant difference between MES and WELA members, with WELA members scoring higher AND a medium practical significant difference between WELA members and non-WELA members, with WELA members scoring higher.
   (d) Teamwork: a medium practical significant difference between WELA members and non-WELA members, with WELA members scoring higher.
2. Although the difference is not significant, non-WELA members scored higher in the confidence rating of the maths subscale than both WELA members and MES.
3. WELA members scored higher than MES and non-WELA members in both the confidence and motivation ratings in all the subscales, apart from the confidence rating of the maths subscale. While most of these differences are not big enough to be deemed statistically-significant, it is noteworthy that WELA members scored higher on SEIES than both MES and non-WELA members in all but one instance.

The results of the October 2014 study thus indicated that the WELA programme certainly has had a positive effect on the self-efficacy of their members. However, the difference in the nine subscales used to measure self-efficacy was not big enough to be deemed statistically-significant. However, the fact that their scores were constantly higher than that of MES and non-WELA members, except in the confidence rating of the maths subscale, must signify the constructive influence the WELA programme has on self-efficacy.

The results of this study underlined the conclusion concerning the difference in the self-efficacy of MES and WES made in the March 2014 report. Therefore, it becomes evident that the self-efficacy was similar for MES and WES first-year students at the university, both in 2013 and in 2014. In other words, the confidence levels that the students had in their competence to execute successfully a course of action necessary to reach their desired goals were similar. In October 2013, the number of WELA participants was too small to draw statistical conclusions about the self-efficacy of WELA members, and no accurate comparisons regarding the self-efficacy between MES, WELA members and non-WELA members could be made. In October 2014, this was not the case and, as noted before, the self-efficacy of MES, WELA members and non-WELA members, with the exclusion of some motivation ratings, was yet again not significantly different.

6. Conclusions, further research and recommendations

The goal of the study was to reassess the original subjects of the March 2014 study in October 2014 to establish whether belonging to WELA affected the self-efficacy of its members. Although the premise of this study was to compare the self-efficacy of MES and WES to assist WELA in enhancing WELA members' self-efficacy, it became apparent that no significant differences existed. The conclusion could thus be made that self-efficacy, the belief students have in their competence to execute successfully a course of action necessary to reach their desired goals, of MES and WES of the 2013 and 2014 first-year students at the university were similar. A further conclusion is that the 2013 and 2014 first-year WES at the university had progressed and overcome gender barriers and that the confidence they had in their ability to perform successfully an array of activities associated with engineering studies was similar to that of MES.

Results indicated that WES, and especially those who took part in the WELA programme, held a similar belief as their male counterparts in their ability to be successful. Whilst the continuous importance of developing self-efficacy is undeniable, it appears that self-efficacy could have been sufficiently developed in the WES partaking in this study.

In future studies, the academic results of MES and WES (WELA and non-WELA members) will be compared in an attempt to answer the following question: If WES are just as confident as and more motivated than MES, does it follow that they are

just as or more successful than MES in tangible performance outcomes? Another aspect open for future research is to determine whether the feelings of self-efficacy of WES diminish over time towards the end of their academic studies and again as working women engineers. It is recommended that the benefits of WELA be promoted to attract more WES to join the association. Furthermore, the results of this study indicated a need for co-curricular interventions and support for not only WES, but also MES.

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Ann Lourens, PhD obtained her undergraduate qualifications in Operations Management followed by MBA (Cum laude) and Doctor of Business Administration (DBA) at the former Nelson Mandela Metropolitan University in South Africa. Prior to a career in academia she worked in various manufacturing industries in operations related positions. As an academic, she has lectured a variety of modules on Operations Management, Industrial Engineering and MBA programmes and has a keen research interest in student (particularly women engineering students) development and retention. To this end, she has developed and managed several co-curricular interventions, since 2011. One such project has been the design and management of the Women in Engineering Leadership Association (WELA) focusing on developing, supporting and mentoring women engineering students. As a member of the Industrial Engineering team at Nelson Mandela University, close links are maintained with industry and several short learning programmes have been designed to develop employees representing various industries in and around the Eastern Cape.

Liesl Pannell completed her undergraduate qualification in Psychology and History in 1988 and Honours Degree in Counselling Psychology in 1989 at the University of Stellenbosch. She obtained her master's Degree in Counselling Psychology at the former University of Port Elizabeth in 1992. She is registered as a Counselling Psychologist with the Health Professions Counsel of South Africa. She is a qualified Assessor and Moderator. She started her career as a psychologist with the Department of Correctional Services in 1992 where she was stationed at the St. Albans Maximum

prison. She also had a Private Practice from 1996 to 2008. In 2007 she joined Panlila Consulting where she mostly concentrated on the administering of psychological tests and inventories to both groups and individuals; the evaluation thereof and the compilation of psychological profiles that were used, amongst others, for court testimony. In this process she has tested in the region of four thousand people and conducted hundreds of therapy sessions. Tests administered, at the Department of Correctional Services, in private practice and for Panlila Consulting, have included the MMPI, Rorschach, LPCAT, DAT, TRAT, JAT, SAT, 16 PF, SAWAIS, SAIS, Otis, Vocational Rank Order, Kodus Interest Questionnaire, SDS, CDQ, Neo, Jung Typologies, Integrity Assessments, PAW, Role Plays, In Baskets, EQ and others.