Education and Skills Development

THE DEPARTMENT OF SCIENCE AND TECHNOLOGY'S YOUTH INTO SCIENCE STRATEGY

Contributing to the Development of Engineering Service Capacity through Experiential Learning

Vijay Reddy

Andrea Juan

Fabian Arends

Sylvia Hannan

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Acronyms

BSTEP	Black Science, Technology and Engineering Professionals
CATI	Computer Aided Telephonic Interviewing
DST	Department of Science and Technology
EEL	Engineering Experiential Learning
NSFAS	National Student Financial Aid Scheme
P1	Practical One
P2	Practical Two
STEM	Science, Technology, Engineering and Mathematics

Prologue: The Youth into Science Strategy

The Department of Science and Technology launched the Youth into Science Strategy: Nurturing Youth Talent for a Stronger National System of Innovation (YiSS) in 2006 to enhance participation, performance and awareness of science and science based careers of school-going youth and undergraduates in Science, Technology, Engineering and Mathematics (STEM). YiSS was expanded in 2010 to include programmes which facilitated work place experience and work placements for post school youth (near and under-graduates) in the areas of STEM.

The YiSS initiative responds to key government priorities and strategies:

- Presidential Priority Outcome 1 to improve the quality of education and Presidential Priority Outcome 5 for a skilled, capable and inclusive workforce;
- National Development Plan which recognises that education, training and innovation are central to South Africa’s long term development; and the
- DST Strategic Plan which aims to build a SET human capital pipeline to ensure increased availability of researchers and innovators for South Africa's competitiveness.

YiSS, aims to increase the quality and quantity of SET graduates from the schooling system by improving science and technology awareness and literacy and recruit more school-going youth and under-graduates to pursue careers in STEM. YiSS also aims to attract young people to STEM based studies at tertiary institutions; to facilitate the completion of tertiary studies and entry into appropriate jobs in the labour market.

The **school focused programmes** aim to improve participation and performance in mathematics and science at grade 12 level and to increase the interest and career orientation in STEM. The projects include the: (i) Talent Development Programme; (iii) Adopted Dinaledi Schools Project and (iii) Science Capacity Building Initiative.

The p**ost-school programmes aim** to provide workplace opportunities for unemployed graduates and almost graduates. The projects include: (i) National Youth Service: Unemployed Science Graduates and (ii) Engineering Experiential Programme.

The **Public Awareness programme,** the National Science Week, aims to improve the science awareness and interest.

This report provides an assessment of the impact of the Engineering Experiential Learning Programme.

1. Introduction

The pervasive problem of skills shortages in South Africa is particularly felt in the engineering sector. This shortage is hampering the infrastructural development of the country (du Toit & Roodt, 2008). There is thus an urgent need to produce more qualified engineers in the country. Ironically, the Department of Science and Technology (DST) found that the qualification of prospective engineers is, to a certain extent, hampered by students' failure to secure industry placements for their compulsory experiential learning. The DST Engineering Experiential Learning programme sought to remedy this phenomenon through collaborating with relevant stakeholders in creating places in the engineering industry to offer South African engineering students at universities of technology opportunities for experiential learning.

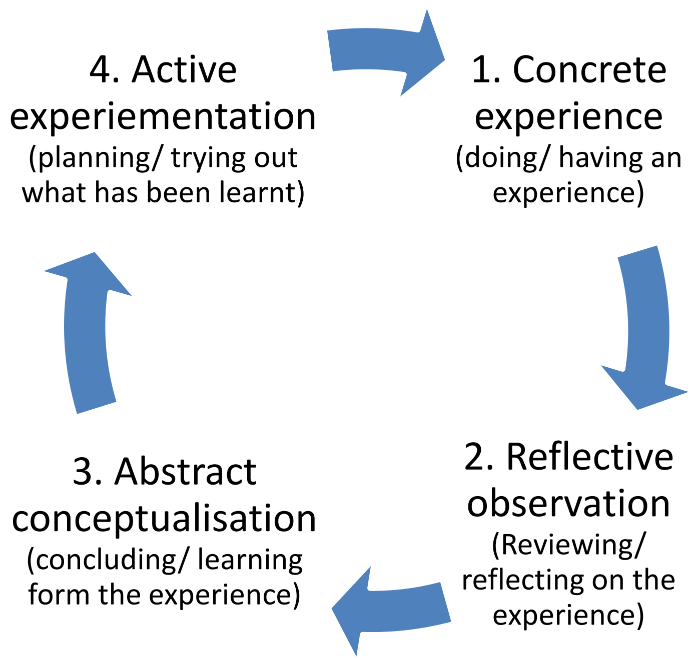
Places created by this project are funded by the DST and employers were expected to accommodate students for experiential learning. The placement of participants is facilitated by Black Science, Technology and Engineering Professionals (BSTEP), a non-profit organisation. The intended outcome of this project is to contribute to the general increase in the numbers of engineering graduates from universities and universities of technology; as well as to create a pool of National Diploma (and undergraduate degree) graduates who can proceed to postgraduate engineering studies in the trajectory towards Science , Engineering and Technology research careers.

This report provides an assessment of the impact of the Engineering Experiential Learning Programme across three cohorts of beneficiaries. From this information we can ascertain whether the programme intervention reached the intended target population. We are also able to map out the post-intervention pathways of these participants to determine the effect of the Programme.

2. What is Experiential Learning?

Before an assessment of the Engineering Experiential Learning programme can take place, it is important to first review what exactly experiential learning is and how it is manifested in the universities of technology in question. By definition, experiential learning is the process of making meaning form direct experience. In other words it is learning from experience. This is contrasted with rote or didactic learning (Kolb, 1984). Experiential learning theory argues that there are four interrelated stages of the experiential learning process. The stages are: abstract conceptualisation, active experimentation, concrete experience and reflective observation (Figure 1).

Figure 1: Stages of Experiential Learning



Source: Kolb, 1984

This study will focus on the first two of the stages: concrete experience and reflective observation. During the concrete experience stage, participants are exposed to "real-world" or simulated work experiences. This work centres on the application of knowledge gained from course work. The experience must also be supervised. During this time participants' work must be evaluated. The next stage of the experiential learning process concerns the participant reflecting on the experience and learning from that experience. The thrust of this theory is that experiential learning must be purposeful and go beyond a mere activity. This theoretical framework was used to aid the questionnaire development and will be used as a framework with which to interrogate the data gathered.

The development of engineering skills and capabilities in South Africa (i.e. a skilled workforce) takes place mainly at universities and universities of technology. Studying towards an engineering qualification at any of these institutions includes compulsory experiential learning through practical experience. The duration of experiential learning varies with programmes. Box 1 sets out the three typical processes of gaining a national diploma in engineering. There are usually two periods of experiential learning. Each period is commonly referred to as P1 (practical one) and P2 (practical two). Computer engineering students have a full year of experiential learning and refer to it as an internship.

Box 1: The three alternative processes of gaining an engineering National Diploma

Lectures (12 months)→ P1 (6 months)→ Lectures(12 months) → P2 (6 months)

Lectures (24 months)→ P1 and P2 (12 months)

Lectures (24 months)→ Computer engineering Internship(12 months)

In addition to the variation in the process of gaining a National Diploma, there is variation in how the experiential learning is carried out. Some experiential learning periods are divided into two blocks of 12 weeks each. The first 12 weeks are spent in a training centre and the last 12 weeks are spent in a working environment. Other experiential learning occurs solely in the workplace.

3. Key research questions

The broad research objective is to evaluate the impact of the Engineering Experiential Learning Programme. The key research questions are as follows:

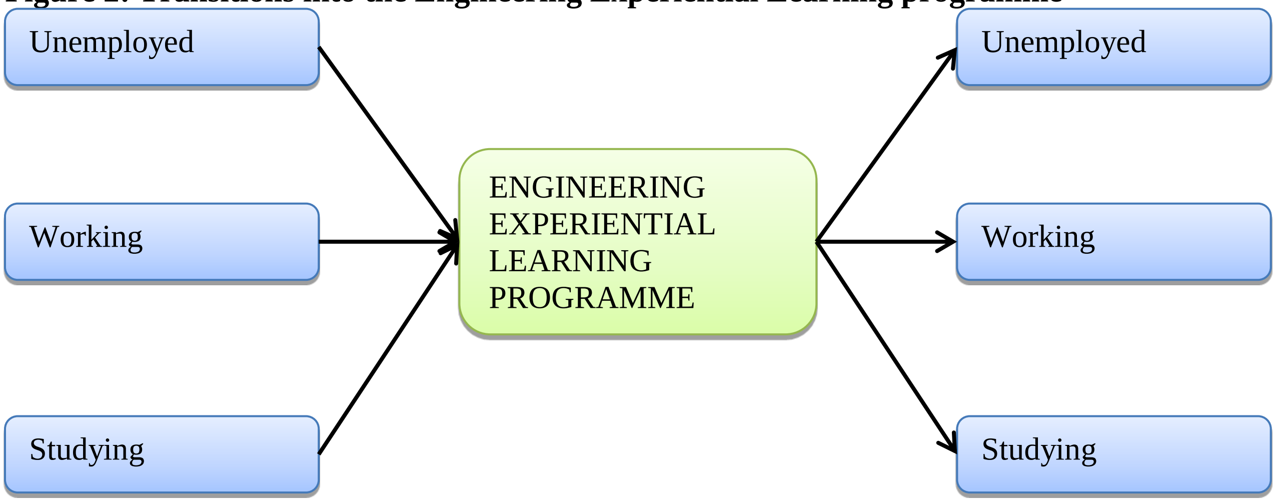
1. Who are the participants in the Engineering Experiential Learning Programme?
2. What are the pathways of the participants into the Engineering Experiential Learning Programme?
3. What are the students' experiences of the Engineering Experiential Learning Programme?

    a. Nature of programme
    b. Quality of programme
    c. Relevance of programme
4. Are graduates who have undergone Engineering Experiential Learning Programme pursuing or intending to pursue further studies?
5. What are the labour market and/or educational outcomes of participants who have exited the programme?

4. Methodology

The study uses a pathways framework. As such, information was collected on participants' educational and labour market transitions into the Engineering Experiential Learning programme. This is done with a view to examine the overall trajectories of this cohort through a subsequent tracking study. This framework allowed for the detailing of participants' transitions between studying, working, unemployment and then moving into the programme. Figure 2 illustrates the three possibilities that exist for the last transition into the programme. The complete transitions are mixture of studying, working and unemployment that eventually led to the Engineering Experiential Programme. Once the programme had been completed, the participants could transition into the same three labour market possibilities. A successful outcome of the programme would be to find that a majority of the participants were working or studying after the completion of their experiential learning.

Figure 2: Transitions into the Engineering Experiential Learning programme



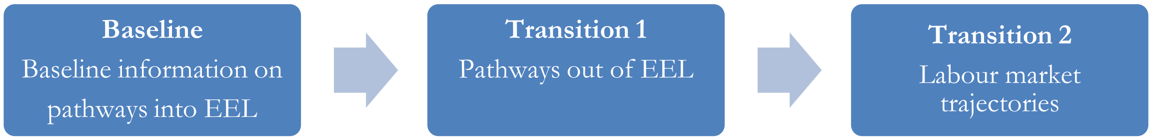
When the survey was conducted, participants were at different stages of the programme: some were placed in "real-world" environments; some were still in the lecture room environment while others had exited the programme. Thus the web-survey was used as a computer aided telephonic interviewing (CATI) tool used to administer the questionnaire depending on situation of the participants. The data from the questionnaire was captured electronically and analysed.

A contact database of participants was provided by BSTEP, containing the contact information of current and exited participants of the Engineering Experiential Learning Programme for all three cohorts. The contact database included information on the participants: gender, age, field of study, higher education institution and host companies. It must be noted that this database was incomplete and in some cases contact information was out-dated. Where details were incomplete, participants who were in the same host company were asked for contact information from their colleagues.

4.1 Tracking the participants

We collected baseline information for Cohorts 2011, 2012 and 2013 and each of the cohorts were followed in the subsequent years to determine their educational and labour market trajectories (Figure 3).

Figure 3: Tracking plan for each cohort



To date, three cohorts of EEL participants have been surveyed and the numbers are displayed in the table below:

Table 1: Participants and respondent in the Engineering Experiential Programme 2011-2013

	Cohort		
	2011	**2012**	**2013**
No. of participants	57	170	57
No. of respondents	55	137	46
Tracked 1 year later	44	98	-

5. Who are the Engineering Experiential Learning Programme participants?

This section describes the demographic and educational backgrounds of those who have accessed the program. Where possible the contact database was used to examine the full cohort. Table 2 sets out the demographic characteristics of each cohort.

Table 2: Demographic characteristics of Engineering Experiential Learning participants

Cohort	Age	N (%)	Race	N (%)	Gender	N (%)
2011	21-25	37(67%)	Black/African	45(82%)	Male	50 (88%)
	26-30	15(27%)	Indian	8 (15%)	Female	7 (12%)
	30+	3(5%)	White	2 (4%)		
2012	21-25	105 (82%)	Black/African	155 (91%)	Male	113 (66%)
	26-30	18 (14%)	Indian	14 (8%)	Female	57 (34%)
	30+	5 (3%)	White	1 (1%)		
2013	21-25	105 (82%)	Black/African	54 (95%)	Male	26(33%)
	26-30	18 (14%)	Coloured	1 (2%)	Female	18 (66%)
	30+	5 (3%)	White	2 (3%)		

The ages of the participants ranged from 21 to 38 years. Across the cohorts, we see that a majority of participants are aged between 21 and 25 years old. The vast majority of participants are Black (82- 95%). This is an over representation of Black participants. As the programme seeks to address the problem of student struggling to find placement for experiential learning, this finding could signify that Black students find it more difficult to find experiential learning placement. This finding will be discussed later in reference to the problems experienced by participant in finding placement.

There is an oversubscription of male participants in all three cohorts. This may relate to the low number of females studying in the engineering field in the country overall. du Toit and Roodt (2009) observed that enrolment and graduation of female engineers is lower than that of their male counterparts. Females constituted approximately 20% of the engineering student population and only 10% of the engineering workforce in 2007.

5.1 Educational backgrounds

In order to determine the pathways followed into the Engineering Experiential Learning Programme, it was necessary to demarcate a point from which to track these pathways. The year after the participants matriculated proved a rational choice for this. Table 3 sets out the years in which the participants matriculated.

Table 3: Year of participant matriculation

Year of Matriculation	2011	2012	2013
2004 or prior	15	24	4
2005	19	12	2
2006	8	19	1
2007	13	40	5
2008	-	35	15
2009	-	9	17
2010	-	-	2
Total	**55**	**137**	**46**

It is noteworthy that 43 of the participants matriculated in or before 2004. This implies rather lengthened educational pathways into the programme.

The subjects that the participants took in their matric year may have bearing on the length of the pathway into the Engineering Experiential Learning Programme. Students who did not take appropriate science-related subjects at the matric level may need to complete a bridging course in maths and science before pursuing a qualification in engineering. Table 4 sets out selected subjects that the participants took in their matric year.

Table 4: Subjects taken in matric by participants

Subject Area	Subject	2011[1] (N=54)	2012 (N=137)	2013 (N=46)	TOTAL (N=237)
Science, Technology, Engineering, Maths related	Physical Science	53	104	45	202
	Agricultural Science	6	12	5	23
	Biology	41	53	13	107
	Computer Science	6	16	3	25
	Geography	18	47	14	79
	Maths	53	116	45	214
	Technical Subjects[2]	10	22	17	49
Languages	English	54	125	46	225
	Afrikaans	28	49	15	92
	African Language	27	97	41	165

1. 1 partial response was omitted
2. Technical subjects include motor mechanics, technical drawing, electrical technology and engineering graphics and design

Table 4 shows that not all of the participants took Physical Science or Mathematics in Grade 12. This was, however, a minority of participants. The discussion is deepened by examining the types of passes achieved by the participants in matric. Those with lower pass levels may face more challenges in accessing a higher education.

The majority of survey respondents (76%) achieved passes that would qualify them for entrance into a university, while 18% achieved a pass that would allow entrance into a university of technology . Table 5 sets out the matric performance of the participants. This suggests a relatively high level quality of student entering the post-schooling sector.

Table 5: Matric performance

Level of matric pass	2011	2012	2013	Total
Distinction Candidates will qualify for a Senior Certificate with Distinction if they achieve an aggregate of 1680 marks (80%) and above	2 (4%)	4 (3%)	0 (0%)	6 (2%)
Merit Candidates will qualify for a Senior Certificate with Merit if they achieve an aggregate between 1260 and 1679 marks (60% - 79%).	11 (20%)	28 (20%)	3 (7%)	42 (18%)
Exemption Candidate has obtained a Senior Certificate that fulfils basic requirements for entry into tertiary studies. To qualify for Endorsement, Candidates must offer a combination of certain subjects and grade levels, and must achieve an aggregate of at least 950 marks	24 (44%)	31 (23%)	5 (11%)	60 (25%)
Senior Candidates will qualify for a Senior Certificate with an aggregate of at least 720 marks	15(27%)	18 (13%)	0 (0%)	33 (14%)
Bachelors Candidate has obtained a pass which fulfils basic requirements for entry into a bachelor's degree.	-	44 (32%)	30 (65%)	74 (31%)
Diploma Candidate has obtained a pass which fulfils basic requirements for entry into a national diploma.	-	5(4%)	5 (11%)	10 (4%)
Missing	2(4%)	4 (3%)	0 (0%)	6 (3%)
Don't know	1 (2%)	3 (2%)	3	5 (2%)
Total	**54**	**137**	**46**	**237**

5.2 Migration

The migration of participants was examined in order to give insight into movement of participants in search of higher education. Table 6 illustrates the migration of the respondents (from as far afield as Malawi).

Table 6: Migration pattern of participants across cohorts

Province	Primary school			High school			Living in		
	2011	2012	2013	2011	2012	2013	2011	2012	2013
Eastern Cape	5	6	3	5	6	3	2	4	0
Gauteng	3	16	6	3	19	7	14	65	27
KwaZulu-Natal	35	21	1	35	21	0	38	19	0
Limpopo	7	54	20	7	52	19		14	5
Mpumalanga	3	15	4	3	15	5	1	19	2
North West	1	9	4	1	8	4	0	1	1
Western Cape	0	6	0	1	6	0	0	11	1
Northern Cape	0	2	0	0	3	0	0	0	0
Free State	7		7	0		7	0	0	9
Not in South Africa	1	1	0	0	0	0	0	0	0
Missing	0	7	1	0	7	1	0	40	1
Total	**55**	**137**	**46**	**55**	**137**	**46**	**55**	**137**	**46**

The participants are currently concentrated in KwaZulu-Natal and Gauteng. These provinces are economic hubs, however the conclusion that participant have migrated to economic hubs cannot be drawn. This is because of the bias created by the location of the tertiary institutions.

5.3 Tertiary education

Initially there were three universities of technology at which the participants studied, this number grew to eight and seven for the 2012 and 2013 cohort respectively. This indicates a greater reach of the programme. BSTEP facilitates the Engineering Experiential Learning Programme through partnerships with these institutions. Table 7 contains the breakdown of the institutional registrations.

Table 7: Higher education institutions at which participants are registered

Institution	2011	2012	2013	Total
Durban University of Technology	23	23	2	48
Mangosuthu University of Technology	20	3	-	23
Tshwane University of Technology	14	99	33	146
Central University of Technology	-	-	13	13
Cape Peninsula University of Technology	-	12	1	13
University of Johannesburg	-	11	4	15
UNISA	-	3	1	4
Walter Sisuliu University	-	3	-	3
Vaal University of Technology	-	16	3	19
Total	**57**	**170**	**57**	**284**

Source: Contact database

The participants in the Engineering Experiential Learning Programme come from various schools within the field of engineering. The largest proportion of the participants are completing qualifications in Mechanical (26%) and Electrical (21%) engineering (Table 8). The other engineering field combined constitute the remaining 53%. This may suggest that student in these fields particularly find it difficult to find experiential learning placement perhaps due to the paucity of placements available.

Table 8: Participants' field of study

Field of study	2011	2012	2013	Total	%
Analytical Chemistry	-	4	6	10	4%
Building	-	2	-	2	1%
Chemical Engineering	4	32	3	39	14%
Civil	3	7	-	10	4%
Computer Engineering	4	10	6	20	7%
Electrical Engineering	26	33	2	61	21%
Industrial Engineering	1	38	20	59	20%
Mechanical Engineering	19	37	17	73	26%
Metallurgy	-	7	3	10	4
Total	**57**	**170**	**57**	**284**	**100%**

Source: Contact database

The discussion now moves to the pathways that the participants of the Engineering Experiential Learning Programme have followed into the programme.

6. Pathways into the Experiential Learning Programme

The pathways into the Engineering Experiential Learning Programme were mapped by asking respondents what their primary activity was for every year since matriculation. The participant could have either: worked, studied, neither worked nor studied or entered into the Engineering Experiential Learning Programme. The year 2003 was used as a cut off for the nine participants that matriculated before 2003.

We were able to clearly map out 221 of the 238 respondents pathways into the Engineering Experiential Learning Programme. The other respondents were omitted due to poor data. The pathways of the respondents are presented in Figure 4 below. Each transition is represented by a different colour: green denotes studied, orange, worked and blue signifies neither working nor studying. For example 13 participants made three transitions before entering the programme. In the first and second transitions all 13 studied, in the last transition 10 participants continued studying while three began working.

Figure 4: Nature and Number of Transitions (years) made going into the Engineering Experiential Learning Programme (cohort 2011)

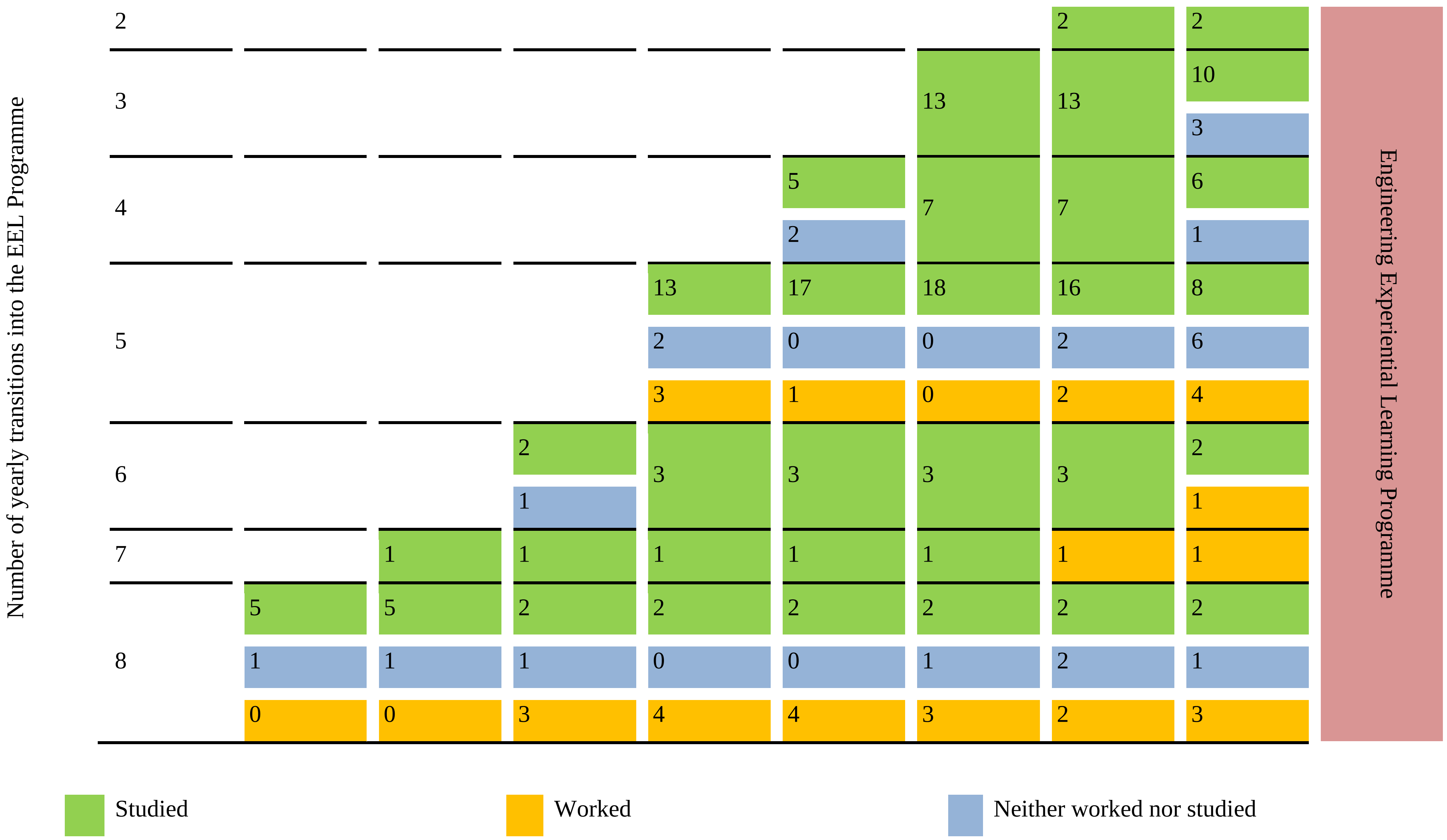


Figure 5: Nature and Number of Transitions (years) made going into the Engineering Experiential Learning Programme (cohort 2012)

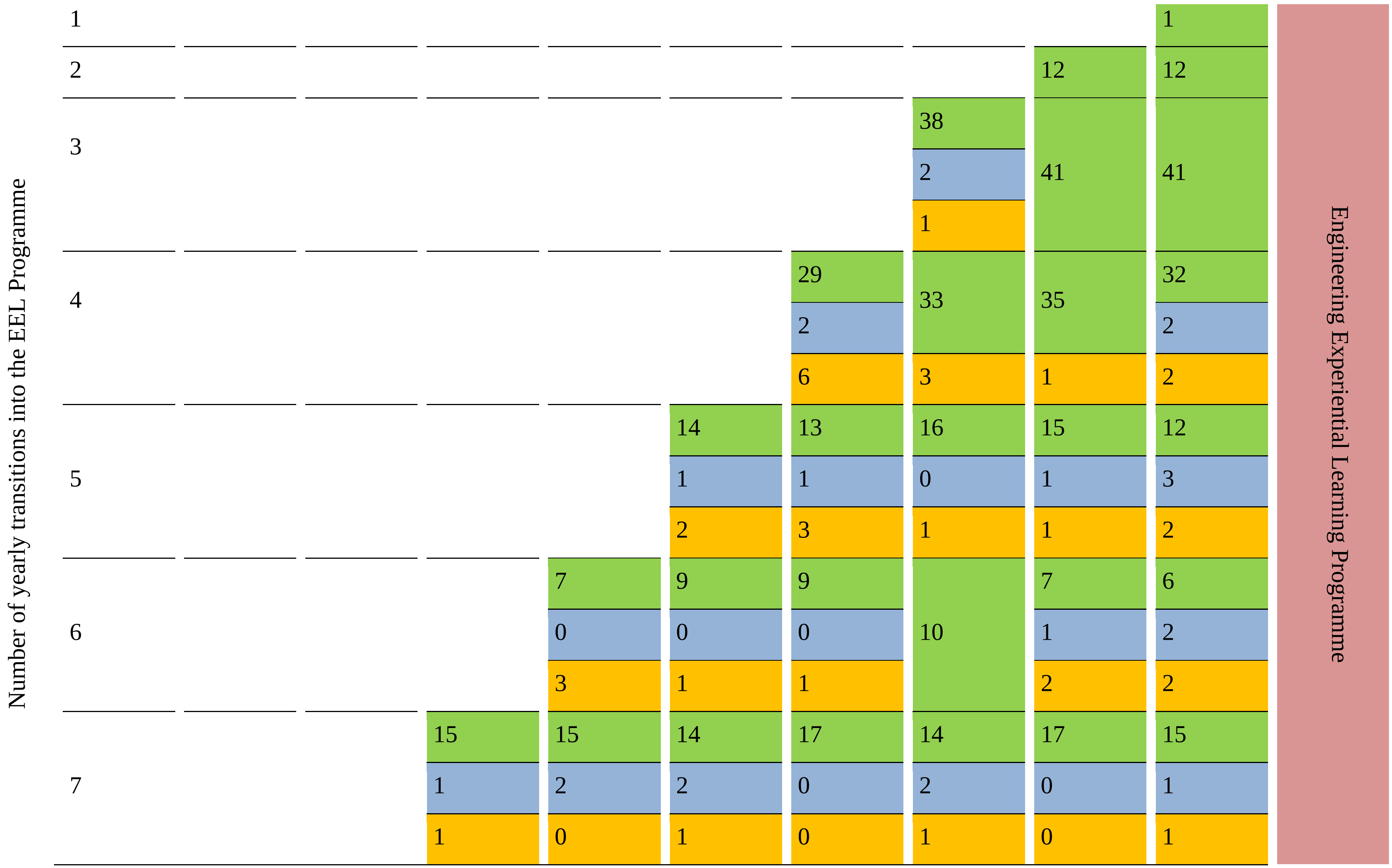


Figure 6: Nature and Number of Transitions (years) made going into the Engineering Experiential Learning Programme (cohort 2013)

It is evident that only 17 of the respondents made smooth (expected) transitions into the Engineering Experiential Learning Programme. That is, the respondents made two transitions before entering the Engineering Experiential Learning Programme. In each transition these respondents studied engineering at a university of technology. At the bottom of the figure it can be seen that six respondents entered the Engineering Experiential Learning Programme after eight transitions.

In 2011, the majority of participants (18) entered the programme after five transitions. This indicates that the participants of the Engineering Experiential Learning Programme, on average experience interrupted and prolonged pathways into the programme. It is not evident, however, that these interrupted pathways are as a result of the participants' inability to find suitable experiential learning placement. This was not the case with the other two cohorts, as a majority of these participants entered the programme after only three transitions. This may indicate that the programme is acting as one of the placement opportunities for these participants, not necessarily targeting those who cannot find placement.

To investigate this further the six participants who had made at least eight transitions into the programme are viewed in greater detail in Figure 7.

Figure 7: Individual transitions of six participants with eight transitions (cohort 2011)

Participant number								
1	Unable to find a job	N3	Diploma Electrical eng	Continuing diploma	Continuing diploma	Completed course work	Unable to find EL placement	Unable to find EL placement
2	Diploma-Electrical eng	Completed course work	Unable to find EL placement	Work somewhat related to studies	Work somewhat related to studies	Work somewhat related to studies	Work somewhat related to studies	Work somewhat related to studies
3	Diploma-Electrical eng	Completed course work	Unable to find EL placement	Work somewhat related to studies	Work somewhat related to studies	Work somewhat related to studies	Work somewhat related to studies	Work somewhat related to studies
4	Diploma-Mechanical eng	Completed course work	Unable to find EL placement	Work not related to studies	Work not related to studies	Work not related to studies	Unable to find EL placement or job	Work not related to studies
5	Bridging course	BSc Constructio n	BSc mechanical eng	Continuing BSc	Continuing BSc – failed this year	Was not looking for a job	Diploma-Mechanical eng	Completed course work
6	FET course electrical eng-completed	Unable to find a job	Unable to find a job	Work not related to studies	Work not related to studies	Diploma-Electrical eng	Continuing diploma	Completed course work

Engineering Experiential Learning Programme

Studied — Worked — Neither worked nor studied

Figure 7 maps out the individual transitions of six of the respondents with at least eight transitions[1]. It can be seen that some pathways are interrupted because the respondent failed their courses, others could not find suitable placement. For example participant number three completed their course work in their first two transitions, then due to failure to secure experiential learning place entered the labour market. This participant waited six years to find placement.

The findings suggest that the length of the pathway can be a result of the participants' inability to find suitable experiential learning placement. Here we see that the DST intervention is reaching some of its target population as four of the six participants in question were unable to find suitable experiential learning placement for a number of years. We contacted two of these respondents to understand his pathways into the Experiential Learning Programme in greater detail.

Stephens* Story

Stephen's long road into the Engineering Experiential Learning programme started before he matriculated. He felt that his teachers did not provide any career guidance and worse did not have any confidence in his academic capabilities. As a result he was forced not to take physical science and maths as subjects in matric. In order for him to pursue his intended career as an electrical engineer, he first had to enrol at a technical college to complete and engineering bridging course, which included physical science and maths. While at the technical college he completed his N5, (equivalent to a higher certificate) in electrical engineering. Even with this qualification he was not able to find employment for almost two years.

Stephen decided to take matters into his own hands and start his own business to generate a income. He did this by starting a cell phone business. Through this business he was able to save enough money to enrol at a university of technology where he completed all the course work for a diploma in engineering. After this he was found it very difficult to find placement too complete the practical part of his qualification (P1 and P2). He was eventually guided to

[1] Transitions were mapped as far back as 2003. Nine participants matriculated before 2003 and thus would have more transitions.

a training centre by the cooperative education office at his university of technology. The training centre in turn told him about the BSTEP programme which he applied to.

In 2012 Stephen was employed as a consultant for the local municipality as a network designer. As his contract was coming to an end, he decided to pursue a BTech in electrical engineering to further his qualifications. Although he achieved an average of 63% for his diploma (which is above the required 60%), his application was unsuccessful due to the high volume of applicants at the university of technology. This setback has not stopped Stephen, as he says he will continue trying to enrol for his BTech.

*Pseudonym

Milton's* Story

Milton is one of five children. His parents are not affluent and so when he matriculated his family did not have enough money to send him to study further. The family felt that his sister was smarter and had more potential to excel at university. As a result Milton sacrificed his education for that of his sister.

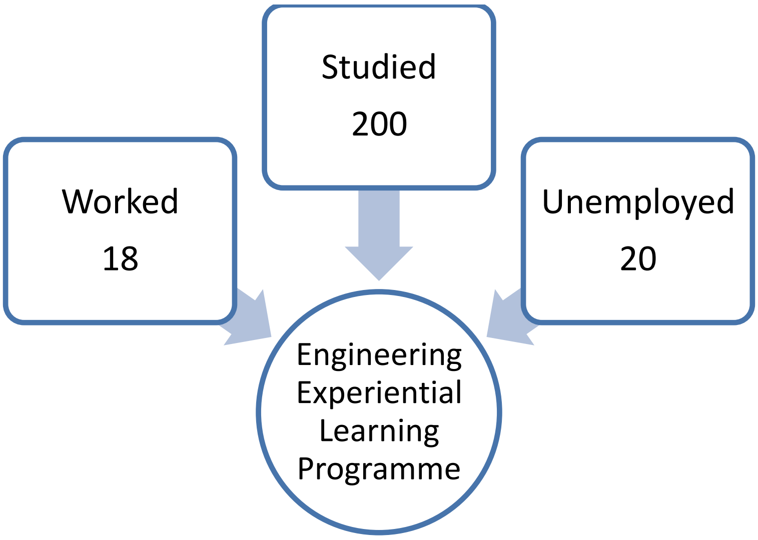
After matric he tried to look for a job but was unable to find one. In 2004 he enrolled at a Further Education and Training College to complete his N3, with a view to increasing his chances of studying for a diploma in electrical engineering. At this time his studies were funded by the National Student Financial Aid Scheme (NSFAS). Once he had completed his N3 qualification he enrolled at a university of technology to complete a diploma in electrical engineering. Milton completed this qualification four years later, due to failing a few courses.

After completing his diploma, he was unable to find experiential learning placement for almost two years. During this time he applied to many companies for apprenticeship. He was called a few times to Richard's Bay to undergo aptitude tests, but was unsuccessful. Milton eventually became aware of the BSTEP programme through the Cooperative Education office at his university of technology and along with 5 friends applied to join the programme.

*Pseudonym

To further interrogate whether the programme is reaching the intended targets (those struggling to find placement) the last transition made before entering the programme is examined. We see that a majority of the participants studied prior to entering the programme. This may suggest that the programme is acting as one of the many avenues of placement in an experiential learning programme rather than targeting those students who failed to secure industry placements for their compulsory experiential learning. While the pathways into the programme may have been interrupted and prolonged for various reasons, the last transition shows that a majority of students (84%) are transitioning from studying into the programme. The remaining 16% of participants had completed their coursework and were either working (8%) or unemployed (8%) while waiting for experiential learning placement. Figure 6 illustrates this last transition.

Figure 8: Transition before entering the EEL Programme



The findings presented in Figures four, five and six lead to the conclusion that the participants in the Engineering Experiential Learning Programme on average have experienced interrupted pathways into the programme. One of the causes of this is that these participants could not find suitable experiential learning placement, however this is not the only cause. That being said, the DST intervention is reaching some of the intended target population. The discussion now moves to the perceived problems finding experiential learning placement.

6.1 Problems experienced finding experiential learning placement

While a majority of participants moved directly from studying into the Engineering Experiential Learning Programme, they did report experiencing problems finding experiential learning placement. This may not be reflected in the pathway information, as the pathways reflect time and do not report on the amount of effort put into finding experiential learning placement. programme. Table 9 shows at of the 284 respondents 153 only received an experiential learning offer from this programme.

Table 9: No. respondents receiving any other offers for experiential learning placement

	2011	2012	2013	Total
No	42	83	28	153
Yes	12	52	18	82
Missing	1	2	0	3
Total	55	137	46	238

The 153 respondents not receiving other offers were asked what they perceived to be the reason for the lack of placement offers. The perceived reasons (appearing in table 11) have been grouped by category. The reason may be due to discrimination against a particular demographic characteristic, socio-economic or situational issues, personal attributes, academic ineptitude or lack of awareness of placement opportunities.

Participant cited not knowing where to look for experiential learning programmes most frequently. This was followed by the perception that employers did not value the participants' qualifications. Situational and socio-economic reasons were also frequently mentioned. Discrimination due to the demographic characteristics of gender and race was mentioned a relatively few number of times. The five participants who listed racial discrimination were Black, while the two participants that found gender discrimination were male. The average age of the participants feeling that they were discriminated against because of their respective ages was 23.7 years and ranged from 22 to 26. This may suggest that prospective host companies prefer older interns with in assumption of having more experience in the field.

Table 10: Perceived reason for lack of experiential learning offers

Perceived reason	Specific reason	2011	2012	2013	Total
Demographic characteristics	Because of my gender	2	6	4	**12**
	Too young (Age)	9	6	0	**15**
	Race	5	8	7	**20**
Personal attribute	Lack confidence to approach employers	1	6	2	**9**
Situational and socio-economic reasons	There are no experiential learning programme opportunities where I live and I was not prepared to move	10	16	8	**34**
	Transport problems	10	5	12	**27**
	Because I could not afford to look and apply for experiential learning programmes	12	7	5	**24**
Academic reasons	Course work results were too low	2	11	4	**17**
	University I studied at is not valued by employers	6	6	2	**14**
	Because employers do not value the type of qualification I have	13	15	9	**37**
Awareness of placement opportunities	Because I didn't know where to look for an experiential learning programmes	15	22	18	**55**
	There are no suitable experiential learning programmes anywhere	3	20	14	**37**

The finding that the highest referenced reason for lack of experiential learning offers was that the participants did not know where to look for placement. This reflects negatively on the Co-operative Education units within the universities of technology. These units are expected to act as: liaison between the respective University of Technology, employers, professional bodies, professional societies and other relevant organisations. With specific regard to experiential learning, the Co-operative Education units are supposed to facilitate the process of experiential learning placement. In fact BSTEP partners with these units at the universities to provide placement. The problem is highlighted in Table 11 which looks at the application routes of the participants. While most participants did apply through their universities of technology, 39% applied privately.

Table 11: Application routes of participants

Method of application	2011	2012	2013	Total
Private application	21	47	24	92 (39%)
Through University of Technology	33	73	22	128 (54%0
Approached by company	0	7	0	7 (3%)
Other	0	7	0	7 (3%)
Missing	1	3	0	4 (2%)
Total	55	**137**	46	238

7. Experiential Learning Placement

The discussion now turns to findings regarding the eventual placement of the participants in organisations. This is the "concrete experience" to which Kolb (1984) refers. It is here where participants are exposed to "real world" or simulated working experiences. This gives the participant the opportunity to apply knowledge gained during their studies at the respective higher education institutions. Table 12 sets out the distribution of participants at the various host companies.

Table 12: Placement of participants

Type of organization	N	%
Private company Matla – Infotech, StarChem Manufacturing, Vodacom, Dolphin Bay Chemicals, Exar Development & Construction, Faurecia, Feltex Automotive Trim, Inergy Automotive, Jurgens, IPR Consulting, Metal Casting Testing, Mohwiti Technologies, NC2 Trucks Southern Africa, PD Naidoo & Associates, Raven Solutions, Rely IntraCast, Schenellecke-SA, Suntank, Walro Flex, Yenza Manufacturing, Yaetsho Projects, Ally Electrical, DJP Power Services, Munasi Consulting, Sappi, SC Johnson, Thandela Consulting, Vermont Leathercraft Manufacturers, Walro Flex, Zinchem	115	40
Training Centre Institute for Advanced Tooling, Tekmation Training Institute Research Composite Centre, Product Development Technology Station	77	27
Municipality Msunduzi, City of Cape Town, Makhado	35	12
Quasi-Governmental CSIR, NECSA, SAATCA, SAQI	44	15
Laboratory Mintek, Cytotouch Metallurgical Testing Labs	13	5
Total	**284**	**100**

Source: Contact database

We see that the largest proportion of participants (40%), were placed in private companies. It is encouraging to see the private sector is buying into such an initiative by the government. The second largest proportion of participants were placed in training centre who specialise in providing experiential learning to students.

8. Experiences in Experiential Learning

A crucial aspect of experiential learning is that the participant must be able to reflect on his/ her experiences. This allows the participants to internalise their experiences. Participants were asked if they had engaged in any reflective practices (table 13).

Table 13: Reflective experiences in experiential learning placement

	2011*	2012	2013
I wrote about my work experiences in a personal journal	45	92	19
I kept a work log book	51	116	43
I kept a portfolio of my work	46	101	36
I spoke to my mentor or supervisor about the work I was doing	53	114	46
I spoke to colleagues about the work I was doing	53	119	45
I made written reports to my mentor or supervisor	49	98	33
I made oral (spoken) reports to my mentor or supervisor	43	94	27

*1 partial response was omitted

Table 13 shows that a majority of the participant engaged in the reflective activities. In fact all of the participants had engaged in at least one of these activities. This means that the participants have been given the opportunity to process their practical experiences and thereby grasp the new information.

The next set of findings refers to the nature, quality and relevance of the EEL programme. Participants were asked to rate the extent to which the programme enhanced specific skills on a scale of 1 (no enhancement of skills) to 7 (greatly enhanced skills). Table 14 presents the average scores for each skill.

Table 14: Average score for skills acquired form experiential learning

Potential skills acquired	Average score (out of 7)		
	2011	2012	2013
Technical skills	6.0	5.5	5.6
Ability to work in teams	6.2	5.8	6.2
Interpersonal skills	5.9	5.8	6.0
Ability to manage	5.7	5.4	5.8
Ability to communicate in the workplace	6.4	6.0	6.4
Science, engineering and technology related skills	5.9	5.5	5.6

In general, participants felt that the programme contributed substantially to the development of these skills with the scores ranging from 5.5 to 6.4. This is a positive outcome as the participants perceive that their experiences in the programme have enhanced their employability. The skills acquired go beyond technical, engineering skills to "soft" skills such as the ability to work in teams.

9. Intention to study further

A secondary aim of the Engineering Experiential Learning Programme is to promote further study in the Science and engineering field among the participants. While we cannot report on whether all participants have studied further after the completion of their experiential learning, it is possible to report on intentions to study further (Table 15).

Table 15: Intention to study further

Intention to enroll for another qualification in future	N	Type of qualification intended to pursue	N
No	20	BTech	150
Yes	209	BSc	12
Missing	9	Masters (Engineering)	4
		Other	24
		Missing/ unsure	19

A majority of participants (209) expressed this desire to further their qualifications. Of these participants, 150 intended to pursue a BTech degree in Engineering. Four participants intend completing master's degrees in the engineering field. It is important to note the various blockages that may thwart the intentions of these participants.

10. Pathways out of the Experiential Learning Programme

This section presents the pathways out of the programme for the 2011 and 2012 cohorts which were tracked subsequent to exiting the programme. Of the 192 participants who responded to the baseline survey, 142 were successfully tracked one year later. A hundred and nine of these participants had completed their experiential learning and had exited the programme. One hundred of these respondents had completed their qualifications and graduated.

The purpose of tracking these individuals is to determine the labour market outcomes of the exited participants. A year later the 2011 participants were tracked again. Of the 44 participants tracked in 2012, 40 were successfully tracked in 2013. Of the 40 participants, one was still in the programme and one had left the programme. We were thus able to map the remaining 39 participants' pathways out of the programme. Table 18 sets out the transitions of the cohorts out of the Engineering Experiential Learning Programme.

Table 16: Activity of Participants Post Experiential Learning Programme

	Working	Studying	Working and studying	Unemployed
2011 cohort, n=44 (1 year post EEL)	49%	12%	7%	33%
2011 cohort, n=40 (2 years post EEL)	58%	2%	5%	30%
2012 cohort, n=98 (1 year post EEL)	56%	17%	1%	25%

Table 16 shows that the largest proportion of respondents had found employment after exiting the programme. This is a positive finding; however the significant proportion of unemployed respondents is cause for concern.

11. Final evaluation

To evaluate the Engineering Experiential Learning Programme, it is important to return to the objective of the programme set out by the DST. In this regard, the programme did create a pool of National Diploma and undergraduate degree graduates. This was a direct result of the programme. These graduates are now able to proceed to postgraduate engineering studies. The high number of participants who intend to pursue further studies is also a positive outcome.

A positive outcome of the DST Engineering Experiential Learning Programme is that a majority of the participants that were tracked were either: working, studying or working and studying across both years (68% in 2012 and 70% in 2013). This may fall short of being an outright success as approximately a third of the participants could not find employment or further their studies post- programme.

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