Work Integrated Learning in Electrical Engineering at a Distance Education Institution: Opportunities and Challenges

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Structured Abstract

BACKGROUND
The University of South Africa (UNISA) is an open and distance learning (ODL) institution. All diplomas offered by the School of Engineering at UNISA include a compulsory period of Work Integrated Learning (WIL) in industry. The WIL component consists of one year's training at an approved workplace. The Engineering Council of South Africa (ECSA) is the accrediting body for all engineering courses in South Africa. A student's WIL work plan is determined according to predefined standards set by ECSA. Recently, ECSA has set new standards prescribing alternate methods of implementing WIL.

PURPOSE
The main aim of the study is to determine how Electrical Engineering students at UNISA and the development of UNISA Electrical Engineering modules would be impacted by new ECSA standards set for WIL. It is our objective to discover how the alternate approaches to WIL may be integrated with the current Electrical Engineering tuition model at UNISA. It is also necessary to analyse student demographics in order to establish what the preferred approaches to WIL for UNISA Electrical Engineering students should be. The information will be used to identify possible challenges and opportunities.

DESIGN/METHOD
The new standards set by ECSA with regards to what is considered to be acceptable WIL practice are investigated. The effects of these alternate methods of implementing WIL on UNISA's current Electrical Engineering tuition model, assessment and WIL practices are explored. Changes required to be made to the aforementioned are identified. Student demographics, especially with respect to employment profile and geographical location, are statistically analysed.

RESULTS
Results include: UNISA Electrical Engineering student profiles; identification of ECSA prescribed WIL methods most suitable to ODL students in Electrical Engineering at UNISA; integration of ECSA approved alternate WIL approaches into UNISA's current Electrical Engineering tuition model', assessment and WIL practices; implementation timeline.

CONCLUSIONS
The opportunity to include additional types of WIL, as approved by our accrediting body, in our new qualifications will resolve some of the challenges that open and distance learning pose. Student demographics will be used as a guide to finding the most appropriate approached to WIL.

KEYWORDS
Work Integrated Learning, Electrical Engineering and Distance Learning.

Introduction

All diplomas offered by the School of Engineering at UNISA, an open and distance learning institution, contain a theoretical as well as a practical component within each module and a compulsory period of Work Integrated Learning (WIL) in industry. The WIL component consists of one year's training at an approved workplace where the student applies the theory learnt. Assessment consists of evaluation of the student portfolio, which comprises of the work experience gained by the student. A log book kept by the student, mentoring of the student and lecturer visits to the student's workplace also form part of the assessment procedure. The student's work plan is set up according to standards set by the Engineering Council of South Africa (ECSA). ECSA is the accrediting body for all engineering courses in South Africa. ECSA has accords worldwide, which ensures that students meet the required international standards. Recently, ECSA has set new standards prescribing alternate methods of implementing WIL. Such alternate approaches may be integrated with the current Electrical Engineering tuition model at UNISA to the benefit of students. Information about students' geographical location and demographics may be used to identify possible challenges and opportunities in this regard.

Electrical Engineering Qualifications at UNISA

The purpose of the National Diploma and BTech Engineering qualifications is to develop the necessary knowledge, understanding and skills required for students' further learning towards becoming competent practicing engineering technicians (ECSA 2002). It is intended to subsequently empower candidate engineering technicians to demonstrate that they are capable of applying their acquired knowledge, understanding, skills, attitudes and values in the work environment in South Africa. A student must obtain 360 credits in order to qualify for a three-year National Diploma in Electrical Engineering at UNISA. These credits are secured by passing twenty 12-credit subjects, each consisting of a theoretical and practical component, with an additional 120 credits being awarded on completion of one year's suitable work experience, i.e. WIL (Department of Education 150, 1997). A student unable to complete the WIL component cannot be awarded the qualification, even though the student might have passed all required academic subjects.

Work Integrated Learning (WIL) in Electrical Engineering at UNISA

The various National Diplomas in engineering are recognised internationally as ECSA is signatory to the Washington, Sydney and Dublin Accords (International Engineering Alliance, 2012). Engineering students who complete WIL and obtain the National Diploma are recognised internationally as competent engineering or technical staff, this being one of the main reasons for completing WIL. In Electrical Engineering at UNISA, WIL consists of the student and mentor / training manager together drawing up the appropriate WIL training programme in consultation with a UNISA representative. The first six months of WIL learning is finalised once 10 modules have been completed successfully. During this first WIL training period, generic training areas that are relevant to all areas of specialisation are dealt with (Unisa 2012 & Unisa 2014). The student may register for the second six months of training after successful completion of 15 modules. This second period of WIL training is specific to the student's area of specialisation, be it computer systems, clinical engineering, electronics and electronic communication, power engineering, process instrumentation or mechatronics.

UNISA modules are offered by open and distance learning. A student therefore receives study material either by post or downloads it from the university website, MyUnisa. The following WIL assistance is available to the student on MyUnisa:

- logbook forms;
- examples of good reports;

- examples of acceptable engineering work for technicians, technologists and certified engineers, respectively;
- discipline-specific guidelines;
- policy on continued professional development; and
- application forms for ECSA registration as technician or technologist.

As qualifications are offered by open and distance learning, there is a need to make use of technology like the MyUnisa platform to provide students with their study guides, tutorial letters and examples of portfolios and to communicate with the students. As bandwidth improves it will be possible to upload video clips and podcasts to assist students with their portfolios for WIL.

Logbooks are used by the student to record all learning that has taken place during the respective learning periods. In each logbook, the employer must certify that all learning aspects have been completed. On completion of each learning aspect, the student's progress must be evaluated by their mentor. The evaluation is to be discussed with the student and signed off by both the student and the mentor. It is the student's responsibility to ensure that the logbook is kept up to date and signed by the employer. The logbook serves as documented proof of learning received or progress made and should always be available. On successful completion of the student's learning periods, the student must submit the logbook together with a covering letter, in which the employer attests to the student having completed all practical requirements satisfactorily, to the Electrical Engineering WIL co-ordinator. The student must identify a suitable mentor at the workplace. A *curriculum vitae* of the proposed mentor is submitted to UNISA for approval. It is preferable to use ECSA registered mentors where possible. Once the mentor has been approved, the student can commence with compiling the required documentation. The guidelines for employers and mentors are documented in "Work integrated learning, policies, procedures and guidelines."(UNISA 2011) This document is supplied to the mentors, employers and other interested parties. A UNISA representative will visit the student and the mentor at the workplace at least once for each of the student's WIL subjects (UNISA 2011).

The design, monitoring and evaluation of WIL in engineering disciplines, as well as the visits to industry for WIL, are structured to meet the requirements as set out in the purpose of the qualification, the required outcomes and the criteria used by the accrediting body, ECSA. Strict guidelines exist that need to be adhered to if full accreditation is to be achieved and maintained.

Profiles of Electrical Engineering WIL Students at UNISA

Student profiles are changing, with an increasing diversity of students by age, ethnicity, employment status, family responsibilities and educational background producing a need for greater flexibility and variety in educational offerings and degree courses (Hay, Foote & Healy, 2000). The careful compilation of student profiles may help to better understand students and their personal circumstances (Nel & Wilkinson, 2001) while serving as an early warning system of vulnerable students who require appropriate interventions (Stephens & Myers, 2013).

In order to establish what the preferred approaches to WIL for UNISA Electrical Engineering students should be, it is necessary to analyse student demographics, especially employment profile and geographical location. What does the student profile reveal about engineering students who registered for their WIL component at an ODL institute (UNISA) over the past 5 years? Such a student profile was compiled by making use of the statistics from UNISA's internal student database system and is reflected in the table and figures to follow:

Table 1: Number of 2014 WIL students by province

Gauteng	103
Kwa-Zulu Natal	36
Western Cape	23
Eastern Cape	10
Northern Cape	8
Mpumalanga	13
Limpopo	5
North West	8
Free State	7
International	6
Unemployed	28
Total	247

Figure 1: UNISA Regional Centres in South Africa (UNISA 2013)

- Most WIL students reside and are employed in the Gauteng province of South Africa. Unemployed students also reside mostly in Gauteng.

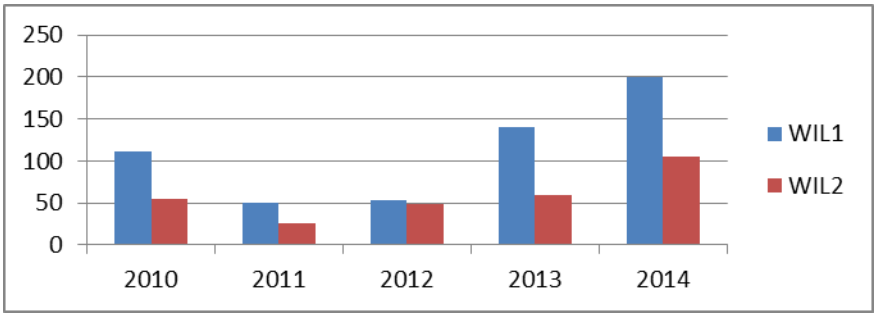

Figure 2: Number of students registered for WIL from 2010 to 2014

- There has been a significant increase in the number of WIL students for 2014.

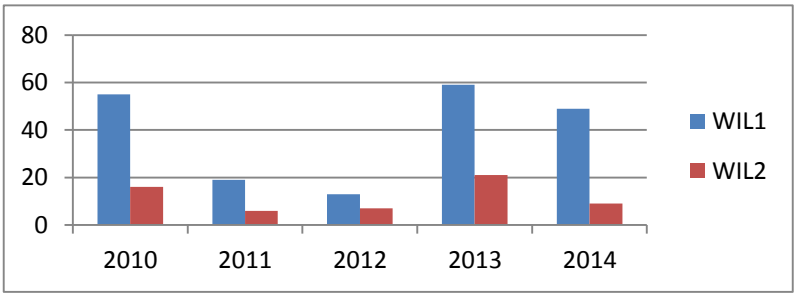

Figure 3: Number of students cancelling registration of WIL from 2010 to 2014

- A lot of students have been cancelling their WIL studies. There seems to be a slight decrease of cancellations from 2013 to 2014 but the 2014 academic year has not been completed yet.

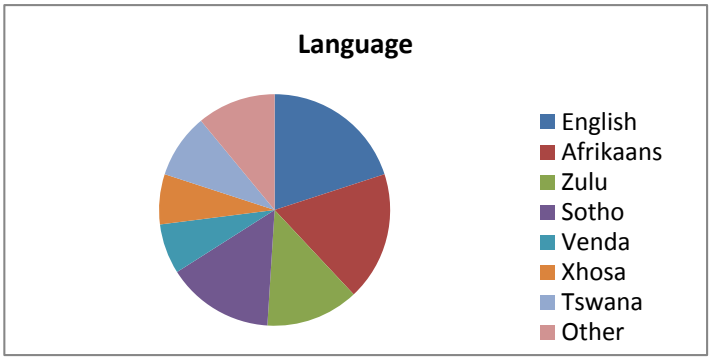

Figure 4: Languages spoken by students registered for WIL in 2014

- UNISA's language of tuition is exclusively English for electrical engineering. Most students therefore receive tuition in a language other than their mother tongue.

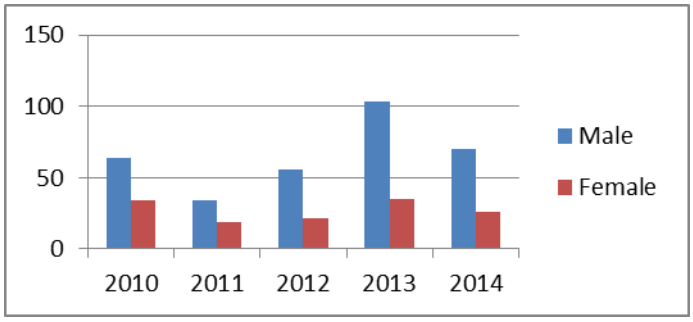

Figure 5: Number of students by gender registered for WIL from 2010 to 2014

- From 2010 to 2014 more than twice as many male students compared to female students have registered for WIL.

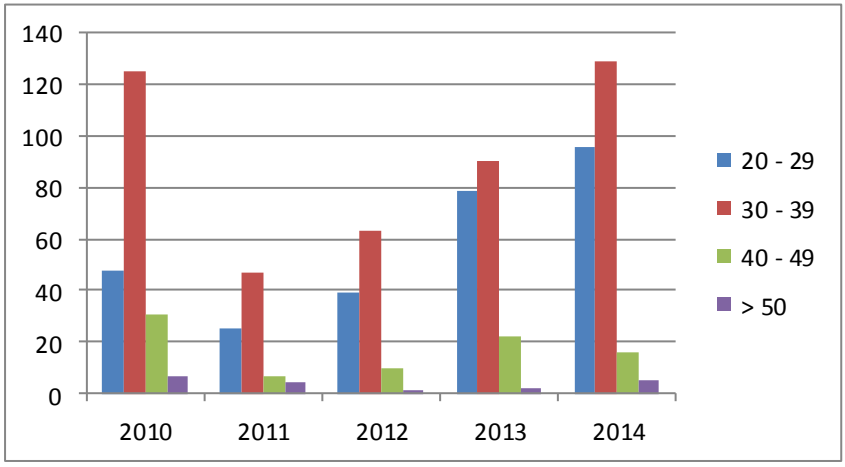

Figure 6: Number of students by age group registered for WIL from 2010 to 2014

- Students registered for WIL from 2010 to 2014 mostly fall in the age group 30-39 years old. Students from the age group of 20-29 years old have been on the increase though.

A total of 305 students enrolled for WIL in electrical engineering at UNISA for 2014. At this stage, 58 students have already cancelled registration for WIL.

New ECSA Standards for WIL

According to the Council on Higher Education (2011:4):

> *WIL is primarily intended to enhance student learning, and to this end several innovative curricular, pedagogical and assessment forms have developed in response to concerns about graduateness, employability and civic responsibility.*

and:

> *The term WIL, then, specifically describes an approach to career-focussed education that includes classroom-based learning and workplace-based forms of learning that are appropriate for the professional qualification.*

ECSA subsequently published the new standards required for WIL for the new diploma in engineering in March 2014. According to these new standards (ECSA 2014), the following are seen as acceptable WIL:

- work-directed theoretical learning;
- problem-based learning;
- project-based learning;
- workplace learning; and
- simulation.

Whereas previous ECSA standards was set at one years' relevant WIL experience, equating to 120 credits, the new standards require only 700 hours (~ 6 months) of WIL but equates to only 70 credits. The student will be able to graduate but will not be able to register as a professional technician without completing additional WIL.

Opportunities and Challenges

Previous ECSA standards for WIL required that the student be employed at some stage in the course of studies by an employer able to offer the relevant and necessary WIL. If the student was not able to complete the WIL, the National Diploma would not be awarded, even though the student might have passed all the required academic subjects. The new ECSA standards for WIL allow for more flexibility. With one of the newly approved types of WIL, work-directed theoretical learning, which is already contained in the theoretical component of studies, a student need no longer be physically employed in order to graduate. The advantage of being able to graduate is that the student can now search for employment and, once employed, can proceed to complete the remaining WIL required for registration as a professional technician.

Considering the other new types of WIL, such as problem- and project-based learning as well as simulation, together with the student profile:

- Existing laboratories can be used. Students' location will determine whether a project is feasible in terms of accessibility to equipment and support. Most of the current WIL students reside in Gauteng where UNISA's Electrical Engineering laboratories are located. Students from other provinces can find assistance at a centre in their province.
- The problem or project may be selected to be relevant to the industry of the region, e.g. for students from the Eastern Cape, an automotive project may be chosen. Such projects, set up in consultation with a local industry, could have the further advantage of employment for students.
- A project (project-based learning) may be broken up into smaller units (problem-based learning), reducing continuous time spent at a support centre for assistance.
- The flexibility offered by the new types of WIL should encourage increasing enrolment, hopefully also for female students, and a decrease in cancellations,

especially where cancellations are due to students not being able to find work placements. More staff and equipment will be required. More suitable support centres and testing stations will have to be put in place. Depending on student location, a major increase in student numbers would preclude using the type of WIL centred on a specific location.

- Most students are not studying in their home language. Effective communication is lacking. Making use of regional centres to support students with WIL projects has the added advantage of students being assisted in their mother tongue.
- An increasing number of students from a younger age group are registering for WIL. Such students might not have secured employment yet. These students would therefore have little or no prior industrial experience and would need more exposure to industry-based tasks and more of the basics would need to be covered. Younger students requiring employment would also encourage reliance on alternative types of WIL.
- Making use of simulation software would address a host of problems experienced with current WIL. The variety of simulation software packages available would make it possible to set up projects that are diverse and relevant, covering all areas of specialisation. Students can visit regional centres for assistance with installing and using software. There is a countrywide need for Programmable Logic Controller (PLC) training but such training would require supervision by suitable, approved mentors. Having access to appropriate resources, such as Personal Computers (PCs), Internet and bandwidth, might prove problematic at first but could be catered for at regional centres. Simulations could also be used to support work-directed theoretical learning.
- Following appropriate safety measures remains paramount.
- Site visits will still form a major, expensive and time-consuming part of WIL assessment, especially with a possible increase in student numbers. However, students engaged in alternative types of WIL could be grouped together at regional centres for visit.

Proposed Guidelines for New WIL Project

Having considered the new ECSA standards set for WIL, the outcomes required for students to register professionally with ECSA, the skills required of graduates by industry as well as the student profile and the opportunities and challenges presented, it was decided to continue with the workplace method as primary WIL method in Electrical Engineering at UNISA. However, optional WIL methods will be harnessed to create a 70-credit project for those students unable to obtain work placements. If completed successfully, this project will enable students to graduate. Additional work experience will be required to register as a professional technician with ECSA. Due to limited equipment, the 70-credit project option will only be available to students at the Florida campus in Gauteng. Only unemployed students that have completed the theoretical part of their studies will be eligible. Required work may also be completed at suitably identified training centres. The project is to consist of the following:

1. **ORIENTATION**
   Basic conditions of employment act
   Machinery and occupational safety act
2. **SAFETY AND FIRST AID**
3. **BASIC HAND SKILLS**
   Correct and safe use and maintenance of hand tools as applicable to electrical engineering

Soldering, welding and brazing techniques

4. **ELECTRICAL/ELECTRONIC COMPONENTS AND EQUIPMENT**
   Component identification, testing and use of a data book
   Wiring of domestic appliances and premises
   Single-phase circuits
   Three-phase circuits
5. **CIRCUIT DIAGRAMS AND APPLICABLE DRAWINGS**
   Drawing and interpreting of circuit and schematic diagrams
6. **MEASURING INSTRUMENTS**
   Correct use, maintenance, connection in circuit (as applicable) and storage of instruments
7. **PROTECTION, PROGRAMMABLE DEVICES**
   Safety and warning systems on electrical control equipment
   Programmable control and operational systems
   Application-system programming as applicable to a particular industry
   Sensor
8. **GENERAL ADMINISTRATION AND REPORT WRITING**

Once students have completed the above modules, they will be required to complete a capstone project in which they will have to apply all theory and practical learnt. Required outcomes as specified by the ECSA standards as well as alternative methods of WIL are covered in the project.

A working process plant will have to include the following:

- literature study;
- detailed design, including safety, specifications and calculations;
- software written for PLC, Variable Speed Drive (VSD), Human-machine Interface (HMI) and Supervisory Control and Data Acquisition(SCADA); and
- commissioning and ensuring all equipment communicates with each other.

Up to now, students have worked separately with the PLC, variable speed drive, HMI and SCADA simulation software. In this project, equipment and software will be used together in order for students to verify the correct operation of their design. The practical part or laboratory work now involves downloading their program to an actual system and observing its operation in an industrial scenario. Software used is state-of-the-art as employed in industry. Students receive a copy of the software to use on their own computers. Some software has a time limit of 1 hour per session to ensure that software is not being used to illegally run a plant. The final report and presentation are submitted in bound format. Drawings are to be done making use of (Computer Aided Design) CAD and documentation is to be compiled making use of a word processor. Final assessment by a neutral moderator will follow.

Conclusions and Recommendations

WIL is an essential component of any engineering programme. The balance of theory, practicals and work experience makes the diploma in electrical engineering a popular qualification with students and employers. To ensure that UNISA's electrical engineering programmes are relevant, keep abreast with modern technology, meet local and international standards and fall within the university's strategic plans, require that our department work closely with industry, accrediting bodies and other stakeholders. New qualifications are being developed according to the above. Workplace learning will remain the primary method for students to apply their knowledge. As part of the new qualifications, a programme will however be developed for students unable to find suitable work placement. The project is to

consist of 70 credits (700 hours) of acceptable WIL as described in the new standards set by ECSA.

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