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A proposed framework for designing an online based (E-learning) Work Integrated Learning (WIL) module for the Diploma in Biotechnology

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Abstract

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Current Work Integrated Learning (WIL) programmes at the Tshwane University of Technology (TUT), for Biotechnology Diploma students is based on students being appointed at companies that are relevant to their training. Lately, the cut in jobs, especially in the current covid-19 situation has resulted in the industry not being able to employ as many students for the WIL opportunities. This creates a problem of students who cannot complete their studies because of the lack of WIL opportunities.

The goal of this study was to develop a framework, which will be used to design an e-learning WIL module for the Biotechnology students. There are many models of e-learning courses design, but very have been used to develop an e-learning (online) WIL module. In this work, the author has looked into the process of developing a framework that will be used to create an online based WIL module, which will allow students to do their WIL in Biotechnology even when they are not employed in a company.

In order to achieve the goals of the study, the research was undertaken by conducting a literature and an empirical study, plus the use of an action design approach. In addition, for data collection, the author used the mixed methods data collection approach, which considers both, the secondary and the primary data. The ADDIE model was followed to develop the e-WIL module framework and it consists of the analysis, design and development of courses for e-learning systems and its application.

MyTutor, an LMS platform used at TUT was identified as the platform which will be used for the Biotechnology e-WIL module. This e-module will be a fully online instruction consisting of three main activities namely; Program Orientation, Learning Activity and Evaluation.

Due to the time constrains, it was not possible to implement the developed plan, assess the performance and usability of the framework.

Keywords
Online learning, E-learning, Work Integrated Learning (IL), LMS, MyTutor, ADDIE model

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Abbreviations

CHE	Council on Higher Education,
DHET	Department of Higher Education and Training
FAO	Food and Agriculture Organization of the United Nations
LMS	Learning Management System
RAENG	The Royal Academy of Engineering.
TUT	Tshwane University of Technology
WIL	Work Integrated Learning

1 INTRODUCTION

In this increasingly connected world, it is clearly evident that technology has the potential to revolutionize education. Just as workforces around the world are being transformed by devices and the cloud, so too is the delivery of education. Institutions around the world have taken up the use of technology in their teaching and learning strategies. The positives of technology on education includes anytime-anywhere learning, access to quality professional and educational resources for all, increased learner autonomy, self-paced learning, peer learning and knowledge sharing (Kumar, 2017). E-learning is that process which uses technology to enable people to learn anywhere and anytime. Generally, the purpose of a successful e-learning platform is that it creates a robust learning experience that feels like a classroom experience, offering the traditional classroom characteristics (like instructor-student interaction, Q&As, discussion, games, collaborative projects, quizzes, etc.) but either online or through a device (e.g. a laptop, desktop, tablet or mobile (e-Learning Platform, 2020). These important learning environments are achieved through a learning platform features and tools that create the level of interaction and engagement students need (Beetham & Sharpe, 2013; Drlik & Skalka, 2011).

Over the years, e-learning platforms have been created for many modules but very few modules have been created for a Work Integrated Learning (WIL) programme. Current WIL programmes offered at Tshwane University of Technology (TUT) requires students to be appointed in relevant industries to undertake educational activities that integrate academic learning with practical application in the workplace. Biotechnology Diploma students are registered in the Department of Biotechnology and Food Technology. In the Department WIL is embedded as a formal component of the two offered Diploma qualification, viz Diploma in Food Technology and Diploma in Food Biotechnology (both previously called National Diplomas). It is a requirement for every student to undertake WIL as part of their academic programme.

The limited employment opportunities of WIL students in the industry has prompted the university to explore other ways of undertaking the WIL modules. This has lately been exacerbated by the Covid-19 situation which has led into a lot of companies being shut down and some companies working on limited number of staff members which meant that most of the university's WIL students did not find any employment opportunities. The university is now looking into other ways of undertaking successful WIL programmes.,

including the use of project-based WIL whereby students will be able to learn more skills by working on projects and supervised by both the academic staff members and industry expertise. There is also a possibility of e-learning WIL (e-WIL) module.

In order to develop a good and successful e-WIL module, it is important that a correct process is followed. This process should be formalised and packaged as a framework that could be followed and used on many occasions. TUT has a Learning Management System (LMS) called MyTutor that is an e-learning platform used to deliver many e-learning content and resources offered in the university. However, currently, there is no online WIL module in the whole of TUT. It is therefore important that a business process for an e-WIL module should be presented in order to complement the currently existing work of migrating to digital learning.

1.1 Research objectives

1.1.1 Research outcomes

The purpose of this study is to design framework that can be used for the development of an e-WIL module for Biotechnology students. Therefore, the outcomes of this study are expected to be:

- Identification of key project team members required in the development of an e-WIL module.
- Development of a target audience analysis tool for Biotechnology students.
- Creation of a guideline to assist during the development of the structure of the Biotechnology e-WIL module.
- Identifying real work skills needed to be incorporated into the Biotechnology e-WIL module.
- Identification of digital techniques, tools, and tactics available to support the e-WIL module.
- Determination of the media and resources to be used to support the e-WIL module.

1.1.2 Research questions

The primary research question of this research is “What are the fundamental elements to consider for ensuring the successful development and implementation of e-WIL module?” and it was encapsulated in the following secondary research questions:

- What is the project team required to be involved in the development of an e-WIL module?
- What tools can be used to assess the current nature of WIL for TUT Biotechnology students?
- What can be the possible structure of the Biotechnology e-WIL module?
- Which digital techniques, tools, and tactics exist currently?
- Which media and resources will be used to support the e-WIL module?

Answering these sub-questions, the author was able to produce the outcomes expected and produced an effective framework to be used for the development of an e-WIL module for Biotechnology students.

1.2 The research scope and structure

The research scope and structure of this project is made up of six chapters:

Chapter 1: Introduction

- Introduces the importance of e-learning and the need to design an e-WIL module for the Biotechnology Diploma students. It also includes the objectives and research questions.

Chapter 2: Literature review

- This chapter presents the literature review on the related work that has been done in the area of the development of e-learning material, particularly e-WIL modules, objectives and research questions of the study.

Chapter 3: Research Methodology

- This chapter presents the research approach and analysis methods applied in this study.

Chapter 4: Results and discussion

- The results of this study are presented and discussed as they answer the research questions posed in this work.

Chapter 5: Conclusions and recommendations

- This chapter includes the reflection and learning experienced during this research project and then the conclusions and recommendations and thereby concluding this work.

2 LITERATURE REVIEW

This chapter introduces the concept of e-WIL and most relevant models that are used for the development of e-learning modules.

2.1 The professional education system

Generally, in South Africa and most parts of the world, the overall training towards a profession is made up of three different fields –the academic field, the education field and the professional field (Maidment, 2017). The academic field provides the scientific basis for the profession. For example, biotechnology is based on the scientific disciplines of Life Science and Microbiology. Lecturers then select and sequence knowledge from the academic field to create the education field, where they develop a curriculum, implement various teaching and learning strategies and assessments. The professional field is when the students graduate and become professionals. Figure 1. provides a schematic representation of the knowledge system of the professions:

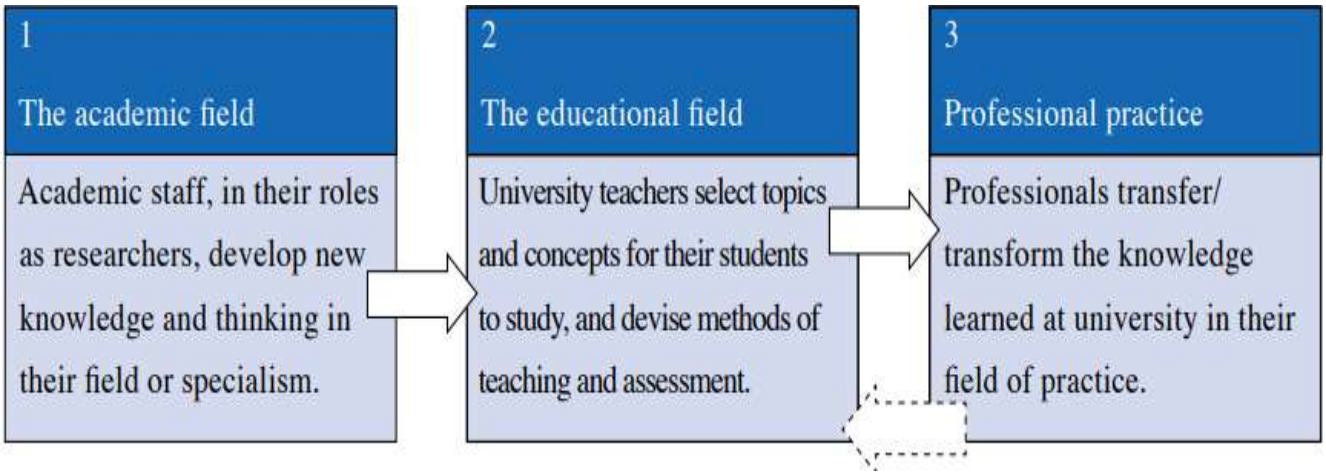

Figure 1. A traditional professional knowledge system (CHE, 2011)

2.2 Work integrated learning (WIL)

2.2.1 WIL background

Historically, the South African higher education landscape consists of main stream universities and university of technologies (former technikons). Universities offers undergraduate and postgraduate education. The courses offered on the mainstream university mainly focus on academic, rather than vocational training. On the other hand, Universities of Technology mainly offer career-oriented diploma qualifications, although they also offer some degrees and postgraduate studies. In universities of technologies, students start with theoretical work, followed by practical training, which was originally known as experiential learning, and now of lately, known as Work integrated learning (Maidment, 2017). Work Integrated learning (WIL) is therefore the term given to educational activities that integrate academic learning of a discipline with its practical application in the workplace. WIL can also be defined as a holistic approach to learning in which the learner is actively involved in the learning process by means of concrete experience, abstract conceptualisation, observation and reflection as well as active experimentation.

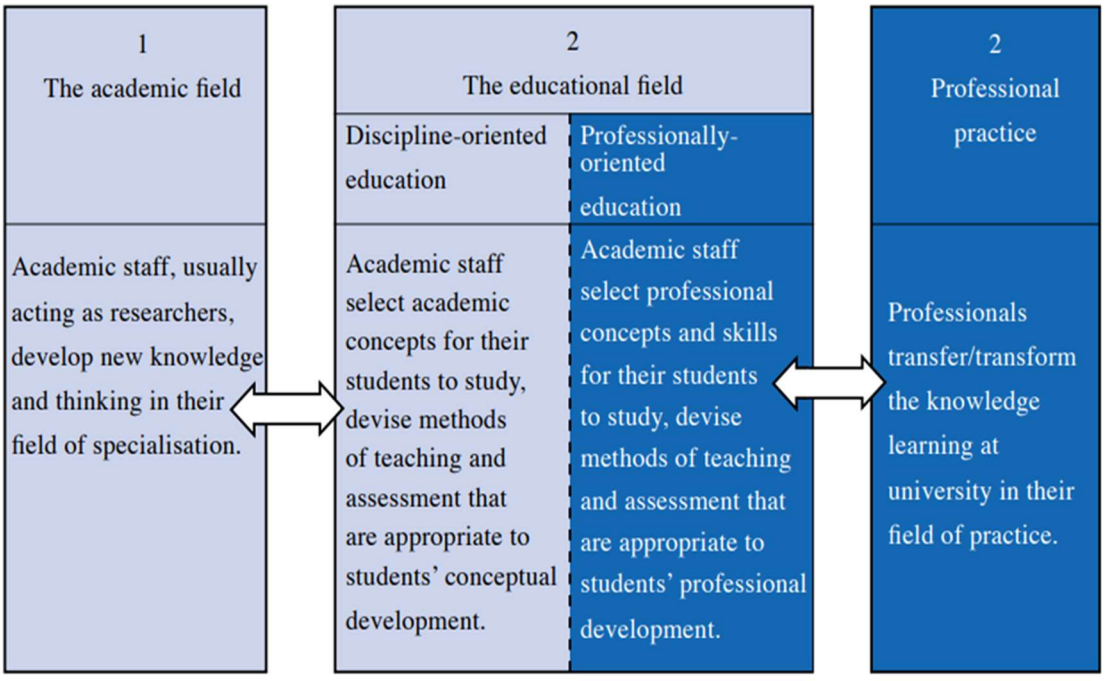

Figure 2. A professional knowledge system in a WIL approach (CHE, 2011)

The WIL approach seeks actively to build linkages between the world of teaching and learning, and the world of professional practice. Figure 2. shows how the three worlds can be brought into alignment; the dotted line suggests that there is not a rigid separation between the academic and professional elements of WIL (CHE, 2011).

The WIL program is driven by the training institutions, the industry and the government represented by the respective sector. The layout of the current framework implemented in South Africa with respect to work readiness which includes apart from the WIL other training programs for work readiness is presented in Fig. 3., which shows that there exist various training programme in South Africa such as cooperative education, WIL, work based learning and experimental learning just to name few. WIL is the programme utilized by most tertiary institutions for the fulfilment of the NDip and is the focus on Fig 3. In South Africa, the need for a good WIL programme is supported by the Council on Higher Education (CHE) (CHE, 2011), which states that qualification programmes need to promote students' successful integration into the world of work after their studies and should enable students to make meaningful contributions as future employees. HEIs are therefore compelled to implement innovative curricular, teaching, learning and assessment practices to ensure that students are suitably prepared for the workplace. Programmes that include WIL offer opportunities for students to prepare and learn from the workplace, to transfer discipline-based theory and a wide variety of skills learned in their formal education to an authentic context as a colleague and employee, with all the responsibilities and expectations such a role entails (CHE, 2011).

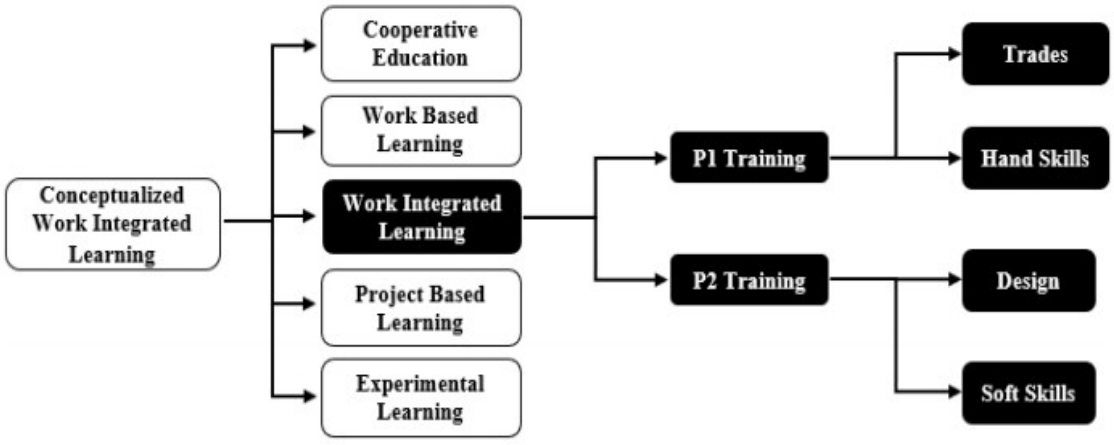

Figure 3. Various training programmes in South Africa

2.2.2 Benefits of WIL

Work integrated learning (WIL) has been widely discussed worldwide for the benefits of the graduates. During the WIL training, students are exposed to new skills, knowledge, capabilities and mastering the skills considered essential to their respective qualification. These skills acquired on the field, cannot be learnt in a formal classroom environment (Orrell, 2004). He also argues that students should therefore be exposed to the everyday practice of the workplace of the particular profession/vocation.

During WIL, students must be exposed to practical work and soft skills. The practical work is dedicated to skills relevant to the qualification, while the second part focuses more on soft skills including problem solving, team work and project management (Maseko, 2018). WIL programs are considered a key strategy for developing employability capabilities in students (Freudenberg, Brimble & Cameron 2011; Helyer & Lee, 2014) and boosting employment outcomes for graduates, particularly for those areas not traditionally linked with employment outcomes. The impact of WIL on student career development or employability capability development has emerged as a dominant theme within the literature (Hall, Pascoe & Charity, 2017; Messum, Wilkes, Peters, & Jackson, 2017), supporting recent developments in the evaluation of WIL initiatives and programs (Lloyd *et al.,* 2015). However, the experience of WIL alone does not guarantee employability outcomes for students and graduates.

2.2.3 Challenges of WIL programmes

Currently, WIL is a compulsory component for the National Diploma students as required by DHET (Helyer, 2014). Many students have been unable to graduate due to a lack of training opportunities offered in the industry even though they have completed all their theoretical subjects. The incomplete qualification of these students relates to the inability of the industry to absorb and provide mentorship and professional exposure to the students. This situation incurs governmental subsidy loss to the training institution as a result of the non-completion of a program of study by the students. Should the student complete the program, this subsidy is payable to the training institution (Tamin *et.al.,* 2018). It is therefore factual that many students are still unable to complete their WIL component, as placement in companies is difficult as full time WIL opportunities are limited. Because of the dynamics of daily life, some students leave the universities to seek

employment to support their families. In this situation, some find work in their areas of training where they can complete their WIL, while those who are unlucky find work in areas different from their basic training. Although they help their families financially, it becomes very difficult for them to align daily tasks with their logbooks. It becomes therefore difficult to these students complete the required WIL credits to graduate (Helyer, 2014; Tamin *et. al.*, 2018).

2.2.4 Current WIL for Biotechnology students

In TUT, WIL has a history of implementation as part of the formal teaching strategies at South African Universities of Technology (UoTs). However, existing WIL programmes are often somewhat amorphous and lack significant evidence of success in terms of contributing towards students' preparedness and development to enter the workplace. Currently in the department of Biotechnology and Food Technology, WIL is embedded as a formal component of the two offered Diploma qualification, viz Diploma in Food Technology and Diploma in Food Biotechnology (both previously called National Diplomas). It is a requirement for every student to undertake WIL as part of their academic programme.

In the department, WIL placement is facilitated by the WIL coordinator who is a technologist in the department. The WIL coordinator conduct workshops with students on CV writing, interview manners and preparations, work ethics, appropriate industry behaviours, etc. He also assists the students with distribution of CVs to various companies. In addition to students being absorbed by companies, the department also employs students as laboratory assistants. Most of the students that are employed by the department were unable to secure employment in industry or still had an outstanding subject and therefore are required to be on campus to attend classes. Students based in companies always benefit from financial gains in a form of a stipend that the company pays them to participate in the programme. It is not always the case with the university-based students. Therefore, the university-based WIL is not the first choice for students, but mostly find themselves there due to the explained circumstances (Annexure A).

The current WIL period in 1 year, divided into WIL1 and WIL2, both for six months. Students have to finish WIL1 before proceeding to WIL2. Both WIL1 and WIL2 students are assessed on a continuous assessment basis. There is an agreement of skills competencies that WIL students must complete during their training. There is therefore an agreement between the

industry appointing the student and the department. The competency profile of WIL students include discipline-specific knowledge, skills and attitudes, as well as workplace generic cognitive, behavioural and technical skills and attributes (Department of Biotechnology and Food Technology, 2019). These competencies are continuously assed by the student's supervisor on a monthly basis using a monitoring and evaluation form, which is signed by both the student at the supervisor.

During the WIL period, students are also required to compile and develop a report/ portfolio of evidence (POE) on work and skills learned, giving an authentic account and reflection of the WIL experience. At the end of each semester, the final assessment includes a presentation of the knowledge and skills learned made to the staff members in the department followed by a question and answer session. The panel members are also are at liberty of questioning the students whether the experience has met their expectations or if they have enhanced any personal attributes, or how they did they cope in a rapidly changing world of work. It is also pivotal to assess if the experience has enhanced employment prospects (if the student will be absorbed in the company or not) in addition to building a network of contacts (McLennan & Keating, 2008; Orrell, 2004).

A study was done prior to this work as development research was able to provide insight into the Biotechnology WIL programme. The study was able to conclude that students that were based in the industry learned more technical skills than students based in the department, the industry-based students had a more pleasant experience compared to the students based at the department and that being placed in the industry provides better employable prospects than being placed at the university. The study recommended that in order to have consistent training of students, an advanced WIL programme could be designed in such a way that the work skills are also taught within an academic programme. It also further recommended that the department needs to develop strategies for monitoring students in a way that their work skills can be enhanced. Another recommendation was that the department must consider the introduction of project-based WIL whereby students will be able to learn more skills and take more responsibility and accountability of the work that they will be responsible for and that this will also enable them to learn more work skills like project management.

It has been shown that technology can expand the range of authentic learning experiences exponentially and presents opportunities to employ powerful cognitive tools that can be

used by students (Joncka, 2014). However, available e-learning technologies are not optimally utilised within existing WIL programmes to improve the learning outcomes. In an attempt to address the mentioned shortcomings experienced in the department of Biotechnology and Food technology's WIL programme, and guided by the CHE's position on the significance of WIL, this project will explore the possibility of using e-learning as a tool to facilitate WIL. This type of work is also supported by Buzzetto-More & Alade, (2006) who stated that the use of information technologies can provide efficient and effective means of integrating theory and experiential learning. WIL that is offered on an e-learning platform can also augment instruction and conventional assessment to allow students to work with course content in ways that would encourage authentic learning.

2.3 Multimodal-blended learning at TUT

During lockdown, TUT has introduced a multimodal-blended learning approach to facilitate teaching and learning. The concept of multimodal-blended learning is a combination of the multimodal learning approach and the blended learning approach. The multimodal learning approach means teaching using multiple channels of content (text, pictures, video, audio, images, interactive elements), whilst blended learning is a learning approach that combines the use of both formal (traditional classroom) and non-formal methodologies (online learning), to boost teaching and learning (Nouri, 2019 & Picciano, 2009). By using a multimodal-blended learning approach, TUT recognizes that the student population represents different generations with different personality types and different learning styles and therefore lecturers and instructional designers must use multiple approaches and online technologies to meet the learning needs of the wide spectrum of students (Picciano, 2009). This approach also allows students to experience learning in ways in which they are most comfortable, while also challenging them to experience and learn in other ways. Like many other universities worldwide, TUT also has a learning platform to deliver courses to learners and to manage online activities. A learning platform is a set of interactive online services that provide learners with access to information, tools and resources to support educational delivery and management (E-learning platform, 2020). Learning platforms are usually referred to as a learning management system (LMS) or a learning content management system (LCMS), terms which often are used interchangeably (TUT, 2020).

TUT is making online resources available to students either to use online (Microsoft Office Live with free storage) or to download to personal devices such as Office 365 for computer, Mac or handheld devices. TUT also provide access to free internet using students' TUT4life credentials to access myTUTor, student email account (TUT4life), Eduroam (TUT Wi-Fi) and other online resources. The Directorate Teaching and Learning with Technology (TLwT)'s myTUTor service desk provide students bringing and using their own computers and devices to make it more accessible within the TUT teaching and learning environment. Students are advised to download the Blackboard App to access and communicate with fellow students and staff online. All detailed information on how to use these APPs are available in the e-Book provided by the university (TUT, 2020). There is an online discussion tool within myTUTor another online tool – Collaborate, to link students' devices to the lecturer's presentation. Students can therefore fully engage from any place with the lecturer while he/she is presenting. This gives students immediate access to presentation material, ask questions and participate in polls in the classroom. This platform also enables students to book a computer in an Electronic Resource Centre (ERC) in advance without having to que to register or book a computer (TUT, 2020).

2.4 The concept of e-WIL

In today's world of high technology and different communication mediums, it is surprising that several reports have pointed to the continuing reliance on traditional lecture-style of teaching, especially in developing countries. Universities are urged to seize the opportunities open to them through technology to provide deeper and more exciting education. In this context, there is arguably a strong case to be made for exploiting the opportunities that e-learning technologies provide to enhance the learning experience (Drlik & Skalka 2011; Lahn, 2004; Michaliski, 2013). E-learning has mainly been used in the normal theory-based courses and subjects that are registered at the university with a lot of theory and assessments.

The establishment of an E-learning WIL programme has been reported by other universities but it is not yet a very popular concept. An e-learning WIL programme (e-WIL) can benefit both students and the Universities in many ways. These include, enabling universities to support additional students and improve personalisation and mentoring–thus reducing isolation, employability and employer engagement as features of many of the e-learning developments. It can also increase opportunities for formative assessment, contributing to

enhanced motivation and learning of students. A Royal Academy of Engineering published a study, which showed improved performance of students using an e-learning based module with practical and interactive lessons (RAENG, 2016). The benefits included encouraging cooperation among students and encouraging contact between students and staff. E-learning therefore presents potentially huge opportunities to enhance both the effectiveness and the efficiency of education. E-WIL modules are usually short instructions and aim to educate students about technical methods, ethics, quality standards and security rules. Similar to the industry-based WIL modules, implementation of an e-WIL module should be mostly focused on handling equipment and solving technical problems (Hardeker, 2014). An e-WIL module needs to emphasize both theory and practice, mixed with on-place lectures and e-learning technologies available to the students. It should also include interaction and learning technologies for distribution and communication of learning content. such as an LMS, web-meeting systems, discussion forums, chat, social media etc. and, digital learning content as instructional video, tutorial guides, wikis, 3D-applications, etc.

In order to implement a suitable e-WIL programme, it is important to further examine learning approaches and design as an integrative process between different learning cultures (Singh and Hardaker 2014). The challenge of designing this e-WIL module for the Biotechnology students will then be to integrate the workplace Biotechnology knowledge needs with the university academic learning traditions into work-integrated e-learning (e-WIL) courses. This research will design a course that emphasize both theory and practice, target for groups of learners mixed with on-place lectures and e-learning technologies available in the workplace or at home (or mobile). This includes interaction and learning technologies for distribution and communication of learning content as LMS, web-meeting systems, discussion forums, chat, social media and digital learning content such as instructional videos, tutorial guides, wikis and 3D-applications.

2.5 Development of an e-WIL module

Good design and planning, while crucial for every type of training programme, are even more important for e-learning projects. In traditional training, the largest effort is in the delivery of training sessions, while in e-learning, it is in the design and development of structured materials which must be self-contained and able to be used multiple times without making ongoing adjustments (Govindasamy, 2002). The purpose of this project therefore was to identify the factors that should be considered for the successful

development of an e-learning course framework for WIL students in the department of Biotechnology and Food Technology. The focus of this research was therefore to develop a process that will be used to design a WIL module using myTUTor as the university's Learning Management System (LMS).

This research was based on the ADDIE model, which consists of linear phases of development from one stage to the next. The last phase of the ADDIE model is the evaluation process, used to review and revise the previous phases.

2.6 Conceptual framework

2.6.1 The ADDIE Model

E-learning development methods can be divided into traditional and agile methods. Instructional Systems Design (ISD) is the traditional approaches to developing educational and training systems. An instructional design model can be used to define the activities that will guide e-learning development projects. There are many instructional systems design models, most of which are based on popular ones such as the ADDIE model (Fig 4) (Ghirardini, 2011). The ADDIE model is one of the most used traditional models in the development of e-modules. The ADDIE model includes five stages: Analysis, Design, Development, Implementation and Evaluation.

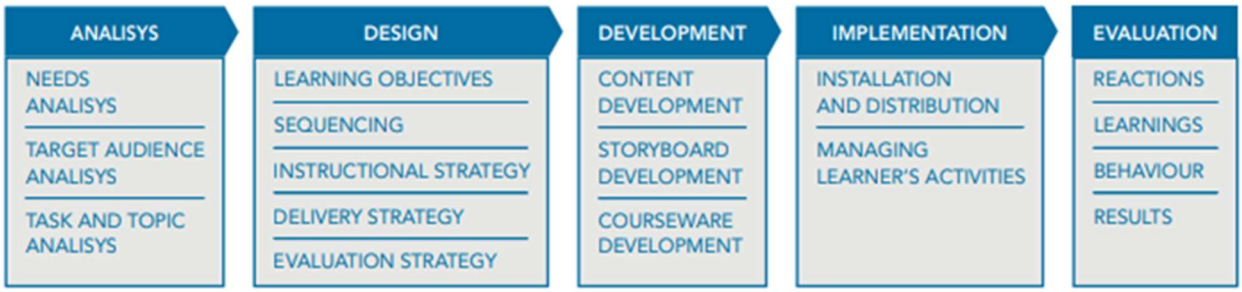

Figure 4. The ADDIE model for E-Learning instructional design (Ghirardini, 2011)

This conceptual framework will guide the development process of a framework that could be used for the creation of the Biotechnology students e-WIL module. The e-WIL module development framework for this study has been developed based on the ADDIE model. In order to deliver on this stage, specifically for designing and development of an e-WIL

module, the ADDIE model, shown in Fig 4. for e-Learning Instructional Design will be used, (Ghirardini,2011).

Analysis

A needs analysis should be conducted at the start of any development effort to determine whether:

- training is required to fill a gap in professional knowledge and skills;
- e-learning is the best solution to deliver the training.
- What are the university/department's goals in offering the training – in other words, what problem(s) that the organization has identified will be solved within the training?
- What skills or knowledge do the students already have, to avoid duplication or redundant information?
- Also, what skills and knowledge they need to have prior to taking the course, in order for it to be effective?

The information above is already contained in the module descriptors of the WIL subject and in the Development research report that the researcher has written. After the above tasks have been concluded, then the researcher will:

- Establish the links between the learning objectives and real work concepts from the work environment to ensure that the students retain a maximum amount of information and work skills.

Design

In this phase of the design process, the goal is to plan and specify the course objectives, each topic within it that will be reviewed, what media and resources will be used to support the e-learning effort, the actual content of the course, and finally, how the students and the effectiveness of the course itself will be evaluated. Essentially, this section includes course development, where the content will be packaged and laid out in a detailed fashion (Ghirardini, 2011).

Development

This is the phase where the actual development of what was planned in the Design phase takes place. Assuming that e-Learning is the platform through which the course will be delivered, the bulk of the development phase centres around the actual production of the course itself.

- All the resources and materials will be collected including instructional aids, resources, tools and so on
- The content and the various resources, tools and evaluation methods will be combined into a cohesive presentation.
- The content will be evaluated at this stage to ensure that it is meeting the organization's goals that were identified in the Analysis phase.
- In addition to resources collected, some parts of the course content or the resources / aids / materials will need to be created so that they specifically reflect the objectives of the course and the needs of the students.

The development of multimedia interactive content is comprised of three main steps being:

- Content development: writing or collecting all the required knowledge and information,
- Storyboard development: integrating instructional methods (all the pedagogical elements needed to support the learning process) and media elements. This is done by developing the storyboard, a document that describes all the components of the final interactive products, including images, text, interactions, assessment tests; and
- Courseware development: developing media and interactive components, producing the course in different formats for CD-Rom and Web delivery and integrating the content elements into a learning platform that learners can access.

The content can vary considerably, depending on the available resources. For example, e-learning content may consist of only simpler materials (i.e. those with little or no interactivity or multimedia, such as structured PDF documents) which can be combined with other materials (e.g. audio or video files), assignments and tests. In that situation, storyboard development and the development of media and electronic interactions would not be conducted.

Implementation and evaluation

Implementation is quite literally the phase where the course is launched and made available to the students identified as requiring the information provided. However, given the time and availability of students, for the purpose of this research it was not possible to implement and evaluate the actual use of the framework. Following the implementation of the course, an online system of feedback/evaluation will be designed to ensure that the e-Learning module has met the needs of the department, the university, the students, and has been presented as effectively and with all the necessary tools and aids.

3 RESEARCH METHODOLOGY

3.1 Research paradigm

In this chapter the research methodology used in the study is described. The study design and the population and sample are described. The instrument used to collect the data, including methods implemented to maintain validity and reliability of the instrument are described.

There are three research approaches or research paradigms. These include quantitative, qualitative and mixed method research. (Denscombe, 2008.) Qualitative research has its purpose in developing a better understanding of a particular phenomenon in detail, focusing upon the issue of what is happening, rather than why it is happening (Leedy & Ormrod, 2010). Quantitative on the other hand, refers to those studies in which the data concerned can be analysed in terms of numbers. Mixed method research combines both quantitative and qualitative methods in one or different stages of the research including sampling strategies, data collection and analysis, findings synthesis, and integration and reporting. The data collected, analysed and synthesized can be numerical, but also textual /visual/ multimedia data (Leedy & Ormrod, 2010).

In this study, a qualitative research design was used whereby an understanding was sought on what are the critical factors that should be followed in order to develop an E-WIL program. Furthermore, the nature of investigation in this research will be of a developmental nature, which describes the situation using the Biotechnology WIL programme as a case study. This research had a combination of both the quantitative and qualitative methods applied. The qualitative approach was used during the collection and analysis of non-numeric data such as words and images whilst the quantitative approach was used when gathering and analysing numeric data such numbers, graphs or statistics.

Another aspect that is important for the approach to this research is that this research is focused on the development of a framework that will be used for Biotechnology students' e-WIL module. Although the work is done within TUT as whole, the focus is on one department, the department of Biotechnology and Food Technology, which is real life

context of one particular programme. Therefore, as a research strategy, the case study research approach was chosen.

3.2 Data collection and analysis

This study focused on a sample of 60 Biotechnology Diploma students that were trained between June 2019 and June 2020. The students were not directly involved since this was a document study approach research which required the analysis of departmental staff members' oral presentation reports, written reports and portfolio of evidence (PoE) submitted by the students and the reports submitted by supervisors. This research also considered the data that was originally collected for use in the Development project. In addition to this data, another set of secondary data was collected through the use of internet search engines. This study therefore employed a combination of primary and secondary data.

Document analysis was undertaken using the triangulation approach. In order to extract the information required from the reports, the process to analyse the data combined elements of content analysis and thematic analysis. Content analysis allowed the researcher to organise information into categories related to the central questions of the research. Content analysis provided crude overall picture of the material being reviewed. The researcher could also identify pertinent information and to separate it from that which is not pertinent in a systematic process that led arrangement of information in a manner that was used to do thematic analysis. In this study, thematic analysis was used to establish pattern recognition within the data. It involved a careful, more focused re-reading and review of the data.

3.3 Use of the ADDIE model

Identification of the team members required to develop the e-WIL module (preparation phase)

It was important that the creation of the development framework start with the identification of the team that will implement the framework. This part also forms part of the development framework, however, it falls outside of the ADDIE model, and it was therefore termed, the

preparation phase. The approach used here was to identify different team members who will be involved in the implementation of the development framework, identified according to the different process steps.

Throughout the undertaking of the research, coding and category construction was always based on the alignment with the ADDIE development method. The predefined themes were a section of the ADDIE development process explained in the ADDIE model (Figure 4), which are Analysis, Design and Development, now shown in Figure 5.

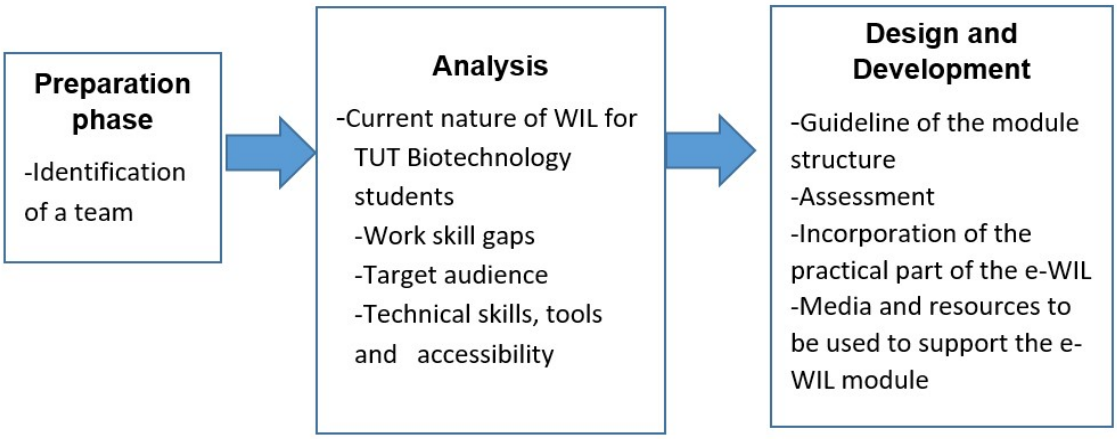

Figure 5. A section of the ADDIE model used in the methodology

Analysis: Current nature of WIL for TUT Biotechnology students

The analyses were conducted by collecting data from the WIL students' report, the departmental WIL reports, the university survey reports on the use of technology and the supervisors' reports.

Work skills gap

The purpose for this analysis was to show what kind of approach could be used to identify the work skills gap. The researcher did this as part of the development project, where she analysed the reports of the Biotechnology WIL students, the Department's reports and the reports from their supervisors to identify the dominant. This approach could be used to analyse the work skills gap, using the ten skills sets to guide the process.

Target audience

The researcher wanted to shown a possible approach to the assessment of a target audience, which could be included in the framework. In order to do that, she looked at different literature, which showed how other people framed their questions when doing the target audience analysis (Shiftlearning, 2019).

Technical skills, tools and accessibility

The report of the TUT student survey that was undertaken in 2020 during the hard lock down, was used to get data in this part of the study. This was done in order to see what kind of questions could be asked to understand the level of the technical skills of the student, and their access to learning tools. The questions asked in that report were modified to develop the questions that could be incorporated in the framework for developing a Biotechnology e-WIL module (TUT, 2020)

Design and development

Guideline of the module structure and assessments

In this phase, the current Biotechnology WIL study guide, the Biotechnology curriculum and the required outcomes of Biotechnology WIL subject were analysed in order to assess if it will be possible to use these kind of documentation to design and develop the e-WIL module. The actual development of the module was not done in this research.

Incorporation of the practical part of the e-WIL module

The current practical sessions which could be incorporated into a e-WIL module were looked at by looking at literature that talks about the use of modern virtual technologies to undertake Biotechnology practical sessions.

Media and resources to be used to support the e-WIL module

The different media sources were looked into (the ones currently being used at TUT and the others), In order to advice the details of the framework.

Implementation

Since the goal of this research was to develop the framework which would be used for the development of the Biotechnology e-WIL module, the actual implementation was not undertaken to evaluate whether the development framework will wok or not.

Evaluation

Since there was no implementation by putting the use of the framework on a trial, it was therefore impossible to evaluate the use of the framework.

3.4 Reliability and validity

In this study, the triangulation approach was used, whereby other sources of data (lecturer reports, departmental reports, etc) were collected (Leedy & Ormrod, 2010). To ensure that this research was valid and reliable, the researcher probed the data collected in depth. Although this research is focused on the particular phenomenon at the specific department (Case study), the framework that will be developed in this study will not be very different not for any other e-WIL module offered in other departments operating in the same university. The research findings should be replicable at least for the department under research and this will add to this study being reliable.

3.5 Ethical issues

There was no ethical clearance required in order to render the study ethical. There were no issues of ethical standards such as, informed consent, anonymity and confidentiality and informed consent required for this study

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4 RESULTS AND DICUSSIONS

4.1 Introduction

The data in this chapter will be presented according to the questions that the study addressed. For ease of reference the research questions are:

- What is the project team required to be involved in the development of an e-WIL module?
- What tools can be used to assess the current nature of WIL for TUT Biotechnology students?
- What can be the possible structure of the Biotechnology e-WIL module?
- Which digital techniques, tools, and tactics exist currently?
- Which media and resources will be used to support the e-WIL module?

4.2 Areas of responsibility for key roles

The areas of responsibility for key roles were allocated according to the development process outlined in the ADDIE model. The different stages of the ADDIE development model include Analyze, Design Development, Implement and Evaluation.

Important key members who would be involved in the development of an e-WIL module. Since the aim of this work was not to develop the module but to rather provide framework for the development of a module, the researcher communicated mainly with the instructional designer and the WIL specialist. Especially because most of the work done in this work involved more reference to reports and documentation available in TUT. However, Table 1. shows all the team members that will be required to develop a fully-fledged Biotechnology e-WIL module.

It is also important to note that the researcher was the course developer/the subject specialist/the content provider. As a lecturer and the head of the department of Biotechnology and Food Technology, the researcher was key member to the team, as she had access to all the necessary document required for this study. The instructional designer will play a very important part in this project.

Table 1. The key team members for the e-WIL module development project

ROLES	PROCESS STAGE	TASKS
- [1]Researcher	Analyse	- Surveys
- [1]Instructional designer - Subject specialist/ Content Provider	Develop	- Content input - Interactive Content - Analysis of Content
- Instructional Designer - Subject specialist - WIL specialist - ICT specialist	Design	- Design documents - Storyboard - Creating Standard
- Instructional Designer - Subject specialist - Content Provider - Media Developer - ICT specialist.	Design and evaluation	- Page Design, - Graphic Design - Flash Development - Sound & Video recording - Checkpoint reviews
- Reviewers	Evaluation	- Design - Editorial and Subject Matt integrity - Review
- Instructional Designers - Technical Specialist	Implementation	- Import to LMS -

[1]The course developer is also the researcher

Developing an online course is significantly different from preparing to teach a face-to-face course, both pedagogically and technologically. This instructional designer is the point of contact to help in developing module materials, to troubleshoot issues, and make updates, for as long as the course is offered online. Instructional Designers can assist by helping to set a timeline and project plan, develop course materials, create assessments, offer recommendations for integrating active learning, and ensure the course meets the quality standards for online courses.

4.3 Current nature of WIL for TUT Biotechnology students (Analysis)

4.3.1 Work skills gap

To understand the nature of WIL for TUT Biotechnology students and skills gaps, a needs assessment must be undertaken. The researcher undertook this as part of the development project (Appendix 1). The results of the development report done prior to this study identified the needs as the three main skills gap being Molecular biology techniques, the project management skills and research skills. This results shows an example and the approach that can be used to assess what skills should the e-WIL module cover, in addition to the skills that the current WIL is covering.

Table 2. Work skills gap analysis tool

	Work skill gap	**Provided in the current WIL**	**Not Provided in the current WIL**
1	Laboratory safety	**X**	
2	Microbiological analysis	**X**	
3	Microbiological media preparation	**X**	
4	Molecular biology techniques		**X**
5	Chemical analyses	**X**	
6	Equipment operation and maintenance	**X**	
	Soft skills		
7	Time Management	**X**	
8	Project Management		**X**
9	Team work	**X**	
10	Research skills		**X**

These results are in alignment with the introduction of these aspects into the new theoretical modules, dealing with three these three aspects. Two new subjects, Molecular Biology and Professional Development modules have been introduced into the new Diploma in Biotechnology since 2019. This means that theoretically, these gaps have been filled but it is also important that the gasp are also filled on the e-WIL module.

4.3.2 Target audience

Understanding the target audience is one of the cardinal points that will help with shaping the framework in a way that will most likely resonate with them. Also, having a thorough knowledge of the audience before the preparation of the modules, will help the module designer to choose the appropriate informational material, figure out the most effective instructional strategy, select the right media to transmit the message, and create an e-learning module development framework which will make students feel supported.

Table 3. Questions to ask students during target audience analysis

	Questions
1	Why are the learners taking this training?
2	What are they looking for in the eLearning course?
3	Is the course mandatory or voluntary?
4	If there was no obligation, will the audience still take the course?
5	How do they expect this course to resolve their workplace concerns?
6	How do they expect this course to help them achieve their professional goals?
7	What do they expect they will be able to do at the end of a course

4.3.3 Technical skills, tools and accessibility

TUT undertook a survey for all their students title “Survey Report on the Students’ Experiences of the Remote Multi-Modal Teaching And Learning”. The survey was undertaken in order to monitor and evaluate the remote multimodal teaching, learning and assessment Strategy (TUT, 2020). This report gives a guideline of what type of questions should be asked in order to establish the technical support that will be required to be offered to the students. The report showed that there were challenges experienced with the educational provisioning during the multimodal teaching and learning. Some of the identified challenges are

- Some either did not receive the data and / or did not have enough data to last the whole month.
- Lack of cellular network coverage/connection problems.

- Electrical power cuts, which affects network connectivity, in which sometimes happens when students need to attend classes and in some cases in the middle of the session.
- The university did not provide laptops for students who don't have them although they were promised that they will get the laptops so that they could access online learning.
- Using phone comes with problem of typing assignments.
- During tests online there is always a problem with the time. The System always logs you out and you can't go back again.
- Students mentioned that assignments sometimes are not appearing on myTUTor when using the phone but when using a computer they appear.

The results of the survey therefore assisted the researcher to develop questions that should be asked to the incoming students before the e-WIL course could begin. This has to happen every time at the beginning of the module because the needs of students differ annually.

Table 4. Questions to ask students during technical skills and accessibility analysis

	Questions	YES	NO
1.	• Are you able to access the TUT online platform (MyTutor)? Give reasons……		
2.	• What device are you using to access MyTuTor r hand-held mobile devices? - Laptop - Cell phone - Tablet - Other (specify)		
3.	• From where do you access MyTutor? - In your residential place - At the university residential area - At the computer laboratory room at the university		
4.	• What network bandwidth will be available to the learners? - Vodacom - MTN - Cell C - Telkom - Other		

The questions shown in Table 4. could be used to analyse the technical skills and the accessibility of students. This exercise will give the researcher information on the technology that is available to students.

4.4 Developmental elements (Design and development)

In order to ensure the successful development of the Biotechnology e-WIL, it was necessary to consider the different developmental elements.

4.4.1 Example of the module structure

A typical module structure will look like the one shown in Figure 6. The theoretical part of the module is well covered. However, the practical part is partly covered, the objectives of the modules are also not very well captured in the current structure.

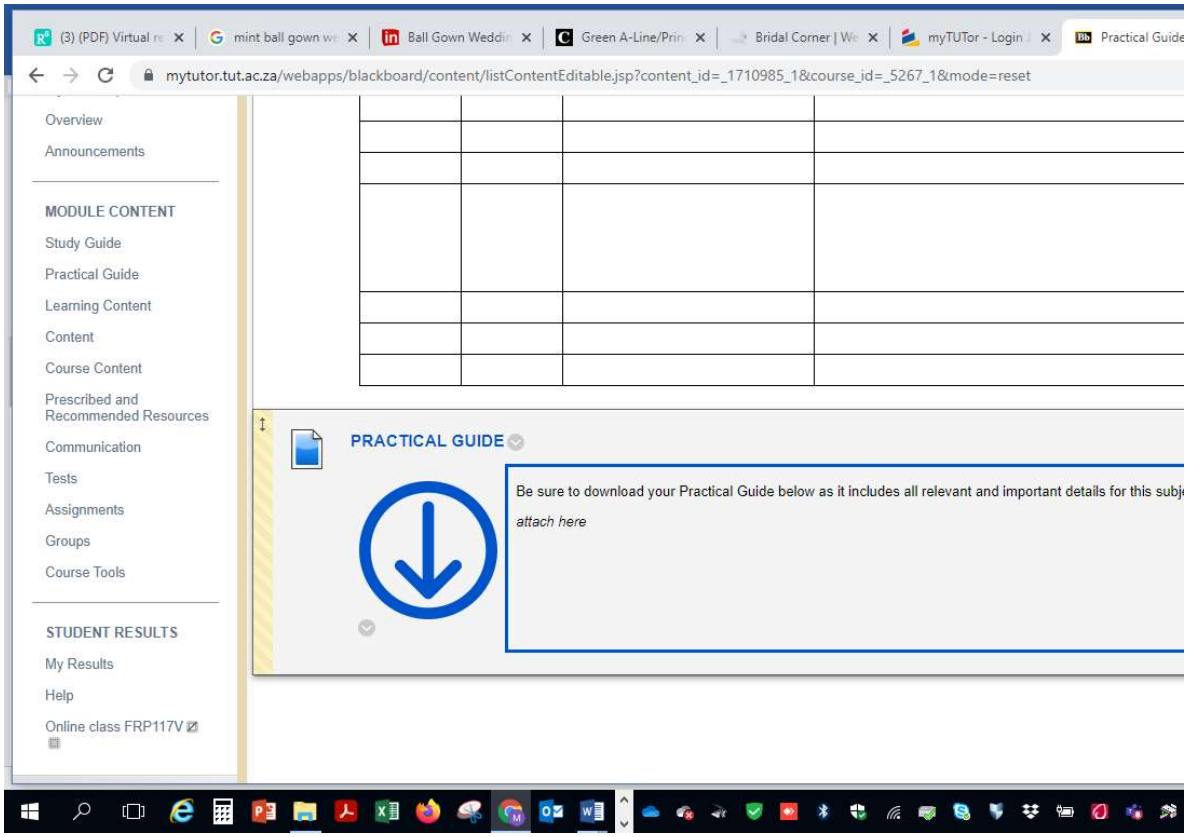


Figure 6. Example of a module content on MyTutor

In order to create relevant learning objectives, an approach that is used to develop SMART objectives was used. By using the SMART criteria, the learning objectives should be specific, measurable, achievable, relevant and time sensitive.

- Specific: Are the learning objectives addressing the needs?
- Measurable: Can we measure/observe the progress of the objective?

- Achievable: Can the objectives be achieved? This means setting realistic goals for realistic timeframes and available resources.
- Relevant: Good objectives are necessary and will ensure the success of the task.
- Time-sensitive: Can learners accomplish this by the end of the course?

It is therefore important that the development of learning objectives is done as part of the development of a guideline of a module structure, which also incorporates the time required to complete the lessons and the module (Table 5). The example of the module structure was based on the data obtained from the previous course curriculum, the subject descriptors and the skills that the students are required to learn during the WIL programme. It was easy to adapt the specific needs to match the learning objectives required ensure that the need it met. However, flexibility is needed to select and adapt a model to a given group of students.

Table 5. A guideline of a module structure

Unit Number	Learning objectives	Lesson duratio (hours)	Completion Time (weeks)
1	Programme orientation	3	0.5
	Technical skills		
2	Laboratory safety	4	1
3	Microbiology laboratory equipment and techniques	12	4
4	Molecular laboratory techniques	12	4
5	Chemical analysis	12	4
6	Individual project	12	4
7	Team project	6	2
	Soft skills		
8	Report writing	12	4
9	Presentation skills	3	1
10	Module evaluation	2	0.5
TOTAL		**78**	**25**

The module structure is divided into Program Orientation, Technical skills, Soft skills and evaluation whilst the actual learning activity consists of eight activities. It must be noted that the new Biotechnology Diploma qualification only has a 6 months WIL programme as opposed to the one-year programme that existed in the old National Diploma programme. Therefore, the total tuition time is six months (25 weeks) as depicted in Table 5. The

development of the new e-WIL programme will be implemented in the second semester of 2021.

The development of the module structure provided an insight into the different study areas which will be used as learning objectives and the real work concepts required to be incorporated into an e-WIL module. However, currently, the department of higher Education and training (DHET, 2020) stipulates that students are required to produce proof of "employment" by a company before registering for WIL in their respective institutions, including TUT. This is based on the fact that the purpose of WIL is to expose the student to as many techniques and industrial experience as much as possible in order to further prepare the student for employment. The e-WIL course outline therefore also has to include a practical component approach, which will support the competency-based training. The practical component will be supported by the theoretical training which the students obtained in the earlier parts of their studies based at the university.

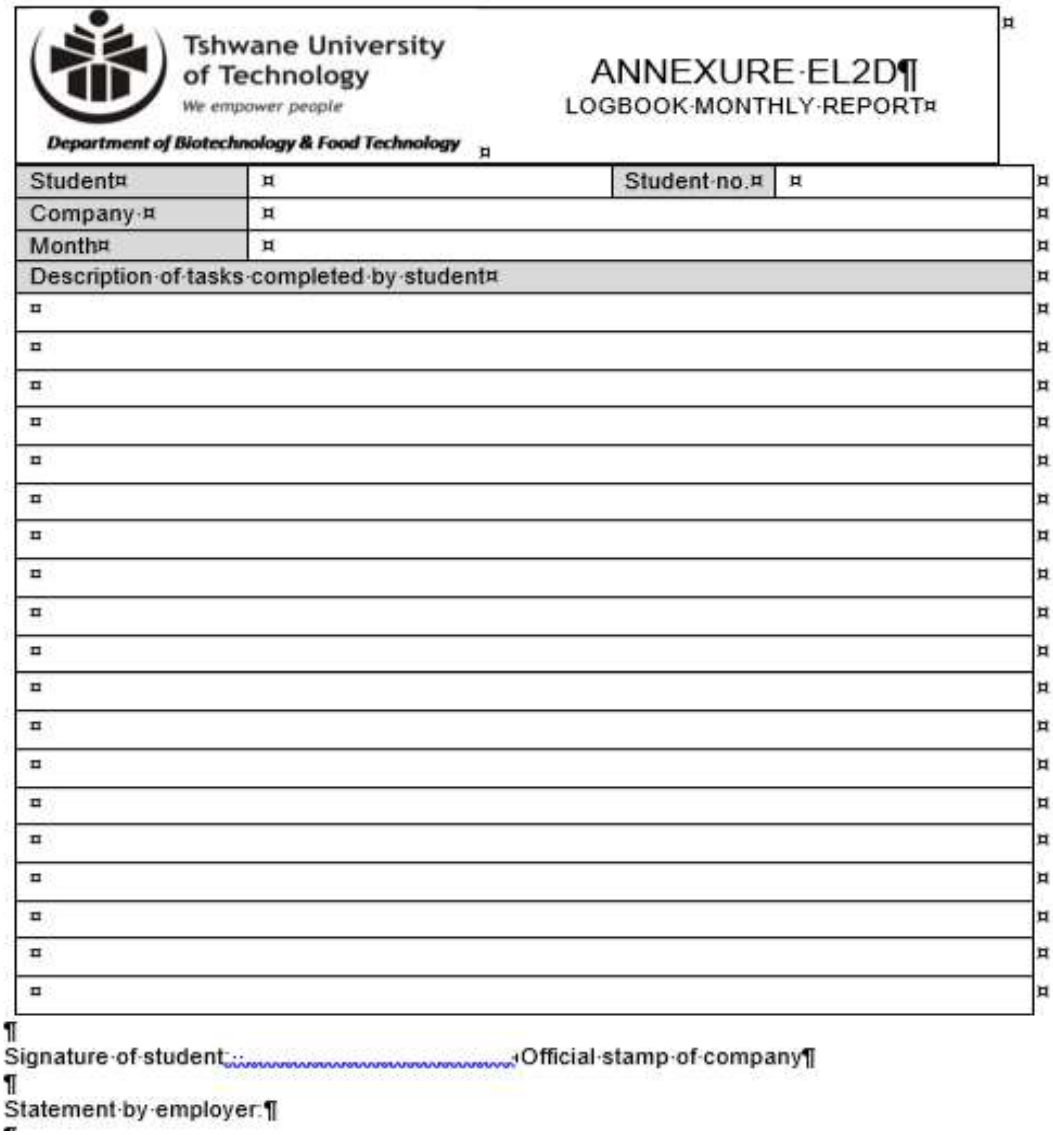
As it is, the industry is struggling to accommodate all our Biotechnology WIL students. This situation worsened during the hard lock down in South Africa, whereby students were not able to access the industry. Therefore, in addition to students being absorbed by companies, the department also employs students as Laboratory assistants. The development study undertaken prior to this work has shown the different experiences of students based in the industry and students based on campus for WIL. Most of the students that are based on the campus showed inadequacies in more areas that the students that were based in the different Biotechnology companies. The development of an e-WIL module will also assist in the current problem that the students are facing in order to complete their WIL.

4.4.2 Assessments

Assessments are a very important part of any module offered at the university. It is important to provide multiple forms of assessment in the e-WIL module and carefully consider all the characteristics of each type of assessment. Currently, the university LMS supports two types of assessment types being the sit down exams and continuous assessment.

Continuous assessments allows the use of assignments to form an important part of the assessment process. However, many lecturers have experienced problems with monitoring of the assignments. The plagiarism guideline is not very clear on the undergraduate in terms

of assignments. It is therefore difficult to establish if the student has really learned the work. Therefore, this type of assessment has shown that it can create problems if not well monitored. Students often use resources to their disposal to look or answers. Another problem with the continuous assessment are tests which are given to students virtually, to write from wherever they are. The lecturer normally gives the time when the test must be returned through email or WhatsApp. Students normally just use resources at their disposal and score very high marks. The final test of the continuous assessment is the formative tests where students are required to sit down and write tests, whilst being monitored. The differences in the results of the virtual tests and assignments vs the summative tests have shown that the students have not learned the material that they have submitted as their work. The virtual work marks were on average, are 70%-80% higher than the sit down test.



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ANNEXURE EL2D
LOGBOOK MONTHLY REPORT

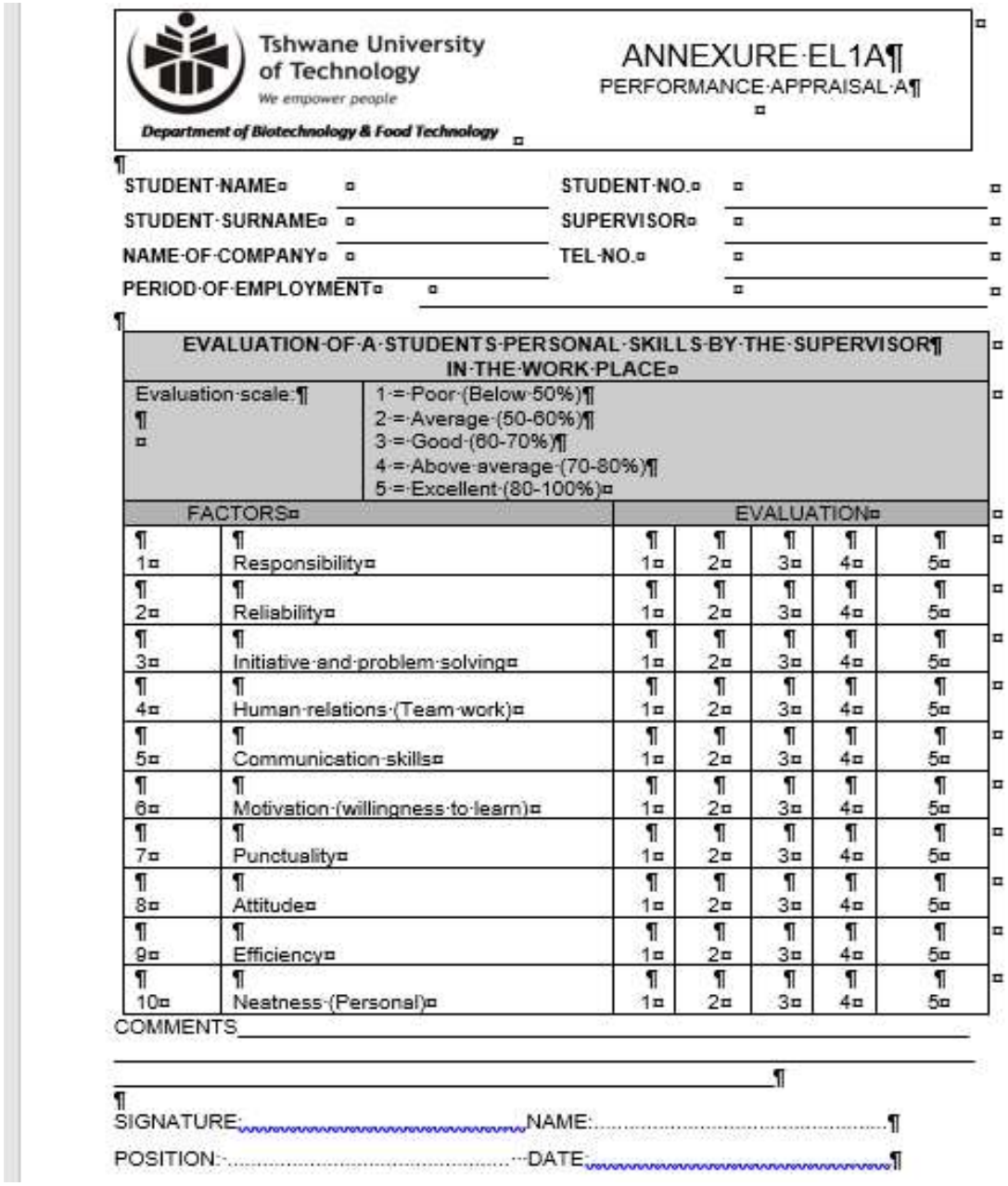
Student		Student no.	
Company			
Month			
Description of tasks completed by student			

Signature of student: ..... Official stamp of company

Statement by employer:

Figure 7. A log form filled by the student

The current WIL assessment is based on a different form of a continuous assessment, whereby the student fills in log forms on a weekly basis to indicate the work that is being done daily. The log book is signed by the supervisor and that is submitted to the department (Figure 7). The student is also expected to give a presentation according to the outline that will be provided to them and give an oral presentation to the staff members so that they can evaluate if the techniques written in the report were really performed by the student. and the work supervisor also evaluating the student through a form (Figure 8 and 9).



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ANNEXURE EL1A
PERFORMANCE APPRAISAL A

STUDENT NAME: _____ STUDENT NO.: _____
STUDENT SURNAME: _____ SUPERVISOR: _____
NAME OF COMPANY: _____ TEL NO.: _____
PERIOD OF EMPLOYMENT: _____

EVALUATION OF A STUDENTS PERSONAL SKILLS BY THE SUPERVISOR IN THE WORK PLACE

Evaluation scale:
1 = Poor (Below 50%)
2 = Average (50-60%)
3 = Good (60-70%)
4 = Above average (70-80%)
5 = Excellent (80-100%)

FACTORS		EVALUATION				
1	Responsibility	1	2	3	4	5
2	Reliability	1	2	3	4	5
3	Initiative and problem solving	1	2	3	4	5
4	Human relations (Team work)	1	2	3	4	5
5	Communication skills	1	2	3	4	5
6	Motivation (willingness to learn)	1	2	3	4	5
7	Punctuality	1	2	3	4	5
8	Attitude	1	2	3	4	5
9	Efficiency	1	2	3	4	5
10	Neatness (Personal)	1	2	3	4	5

COMMENTS _____

SIGNATURE: _____ NAME: _____
POSITION: _____ DATE: _____

Figure 8. Evaluation form used by the supervisor to evaluate soft skills

The experience with student assessments and evaluations is that they fill in the same thing every month. Some supervisors delegate junior staff members to sign off the forms and they don't check if what their signing truly reflects the work of the student. In most cases, the soft skills experience is easy for the supervisors to assess because it addresses the issues that she/he might have experienced with the student. It also becomes an opportunity for the supervisor to praise the student if she/he did well.

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ANNEXURE EL1B
PERFORMANCE APPRAISAL B

STUDENT NAME ____ STUDENT NO. ____
STUDENT SURNAME ____ SUPERVISOR ____
NAME OF COMPANY ____ TEL NO. ____
PERIOD OF EMPLOYMENT ____ ____

EVALUATION OF A STUDENT'S WORK SKILLS BY THE SUPERVISOR IN THE WORK PLACE

Evaluation scale:
1 = Poor (Below 50%)
2 = Average (50-60%)
3 = Good (60-70%)
4 = Above average (70-80%)
5 = Excellent (80-100%)

	FACTORS	EVALUATION				
1	Safety awareness	1	2	3	4	5
2	Theoretical knowledge	1	2	3	4	5
3	Practical skills	1	2	3	4	5
4	Report writing	1	2	3	4	5
5	Quality of work	1	2	3	4	5
6	Quantity of work	1	2	3	4	5
7	Neatness of work/ workplace	1	2	3	4	5
8	Knowledge of techniques	1	2	3	4	5
9	Efficiency	1	2	3	4	5
10	Initiative in the workplace	1	2	3	4	5
11	Willingness to learn new techniques	1	2	3	4	5

COMMENTS _____

SIGNATURE: _____ NAME: _____

POSITION: _____ DATE: _____ Page Break

Figure 9. Evaluation form used by the supervisor to evaluate technical skills

Supervisors have also shown to be fair when assessing this element of the student's training. The only problem comes when the student has not actually did the work that they were supposed to have done, in terms of the agreement with the company.

The units shown in Table 5. must be broken down into subunits or topics and further down to how they will be assessed. The two assessments that could be used for this e-WIL are the written assignments, written reports and oral presentations which could be done virtually.

Written assignments and reports

Written assignments (e.g. essays, reflections, research papers, technical documents) are an excellent way to assess student learning. Currently, the TUT Blackboard provides several effective tools for providing students the feedback that is critical to the assessment of their progress, improvement and learning. There are also tools available that will allow one to detect academic misconduct such as plagiarism. Students will therefore be required to be ready to submit their written assignments and/or reports, virtually by posting their reports on the MyTutor platform or even writing a report online.

Oral presentations

In our experience, having the WIL students present their work at the end of their WIL term, and as a form of assessment is a powerful learning experience which allow them to demonstrate their mastery of content, express creativity within the domain, build their communication skills, and provide an opportunity for peer-to-peer teaching and learning. Using Blackboard Collaborate or Microsoft Teams, students can present work live just as they would in your face-to-face classroom. The supervisors will still need to evaluate the students, however, it will be the responsibility of the students to make sure that their supervisors fill in their assessment forms, which they will be able to load online. In cases where there is a problem with accessing the online platform, then emails could be used to send documents to learners, receive information from learners and communicate with the lecturer.

4.4.3 Media and resources to be used to support the e-WIL module

Different tools can be used to produce e-learning content, depending on which file formats will be used and the nature of the desired final product. Analysis into what type of media is currently used at TUT showed that the following are the mostly used media

- Microsoft word documents are used to create simple learning resources like a presentation or a tutorial.
- Power Point presentation with or without voice overs are used
- Web Conferencing

In order for one to implement a successful e-WIL module, more sophisticated tools are required for the creation of interactive content (See & Clark.,2005). These tools should be able to add text, graphics and other media, but also provide a framework to organize lessons for reliable navigation and linking to the relevant practical and technical sessions, where necessary. To create media components, authoring tools need auxiliary software (e.g. Adobe Photoshop for bitmap graphics, Adobe Illustrator for images or Adobe Flash for animations) and other tools for video and sound creation and compression (Rusli, 2018).

In addition to the media tools that are currently used in TUT for the delivery of online modules, the following could be added to expand on the current tools.

- Electronic mail for delivery of course materials, sending in assignments, getting/giving feedback, using a course listserv, i.e., electronic discussion group. Emails could be used to send graphic and textual information to learners, receive information from learners, and communicate with a personal tutor.
- Live webinars or real-time interactive conferencing. These are scheduled live meetings with students through online tools such as Blackboard Collaborate or Microsoft Teams
- Interactive Media (Simulation, games, virtual reality) .
- Bulletin boards/newsgroups (for discussion of special topics),
- Interactive tutorials on the web,
- A videoconference or teleconference can be used by individuals or groups of learners for a discussion or forum and enables them to see the presentation of educational or

- Teleconferences can be video- or audiotaped for later reference or use.

- Desktop videoconferencing, also known as online classes or electronic seminars, is solidifying as a technology. It encourages exchanges and interactions among individuals as well as with the instructor. Students from diverse backgrounds formed groups and personal relationships interacting altogether

4.4.4 Incorporation of the practical part of the e-WIL module

However, the e-WIL module must also make plans to incorporate the real-life work experience without compromising the quality of skills and expertise that the students are

expected to learn. As it is the case with the current WIL registration requirements, in order to register for this module, the student must already know where they will do their practical components. In addition to that, the university will have planned sessions with clear outcomes to address specific learning outcomes. Students based in the industry will also have the opportunity of undertaking practical sessions that their industry is not addressing and the university will have to make provision for this opportunity. For the practical component of the e-WIL module. It is important that the use of interactive media be strengthened. The following are some of the tools that the university can adapt to ensure maximum training.

Virtual laboratories/simulations

The tools that the university could look into are simulations, virtual or augmented reality. With virtual laboratories, students are able to undertake their experiments according to the instructional video, and doing every step as instructed (Figure 10). Virtual reality can also mean that the students get access to a computer-generated simulation in which a person can interact within an artificial three-dimensional environment using electronic devices, such as special goggles with a screen or gloves fitted with sensors (Figure 11). In this simulated artificial environment, the user is able to have a realistic-feeling experience.

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Figure 10. The picture of virtual laboratories (Labster, 2020)

Figure 11. The picture of an augmented reality using special goggles (shutterstock, 2020)

Many universities and research institutes from developed nations have realized the potential of this concept and have already launched their own virtual laboratories on the web, which are accessible to people around the world. It has already been established that the Virtual Lab enables the students to understand the underlying principles and the theory behind laboratory experiments. The procedure for operating an analytical instrument can be simulated by a mathematical and/or empirical model (de Jong, Sotiriou & Gillet, 2014; Iberdola, 2020).

Experimental kits

Simple experimental kits like one shown in Figure 11. can be purchased and given to students to perform individually or as groups, from wherever they are. A good example is the DNA extraction kit could be performed by students wherever they could be. Students will be required to submit a report of the results obtained after undertaking the experiment.

Figure 12. Example of a DNA extraction kit (Amazon, 2020)

This section on media and answered a question about the type of media resources that are used at TUT and those that could be incorporated into the new Biotechnology e-WIL module. Currently online courses at TUT are presented on a Learning Management System (LMS) using blackboard platform named MyTUTor. The media and resources part of the framework must be accessible, user friendly for teaching and learning.

4.5 The developed framework and its implementation

The results obtained in this section were then used to create a framework (Table 6) that could be used for the development of an e-WIL module. Although the framework was developed using the ADDIE model, there are differences between the components ADDIE model. The developed framework consist of phases, which will help the developer to always be aware of which phase she/he is in. The duration is also important because it gives the developer and opportunity to plan appropriately.

Table 6. A framework for the development of the Biotechnology e-WIL module

PHASES		TASKS	DURATION	PERSONS RESPONSIBLE
Phase 1: **THE PREPARATION PHASE**	1	- Formation of a project team - Holding the initial meeting to allocate responsibilities	2 weeks	- The Instructional designer
Phase 2: **THE ANALYSIS PHASE**	2	- Reviewing current content - Conducting comprehensive needs analysis of the students' learning needs - Reviewing current technical resources - Linking the needs analysis and required content	4 weeks	- The Instructional designer - Departmental WIL coordinator - Facilitators/ Subject specialists/Content developers - ICT specialist.
Phase 3: **THE PLANNING PHASE**	3A	- Prepare a study guide with a module overview, purpose statement and learning objectives - Prepare teaching and learning material - Prepare the assessment plan and documents	4 weeks	- Facilitators/ Subject specialists/Content developers

	3B	- Prepare a practical workbook - Identifying practicals that needs to be undertaken, where and how? - Buying of necessary consumables for the practicals that will be undertaken at the university	4 weeks	- Facilitators/ Subject specialists/Content developers
Phase 4: BUILDING PHASE	4	- Uploading the module and configuring the learning management system - Allocation of the facilitators on myTUTor TUT LMS - Insert the banner of the module landing page - Create a welcome statement (text and video)	2 weeks	- The Instructional designer - Facilitators/ Subject specialists/Content developers

		- Upload a headshot picture, add lecturer details and consultation time		
	4B	- Building the course itself on the LMS - Upload the study guide - Upload content for all the study units - Upload all the module content documents - Upload all the multimedia used in the module - Uploading all the assessment tools including assignments, presentations and submission dates	3 weeks	- The Instructional designer - Facilitators/ Subject specialists/Content developers
Phase 5: TRIAL	5	- Launch the module and perform a trial run with the students that are registered on a normal WIL and some staff members	4 weeks	- The Instructional designer - Facilitators/ Subject specialists/Content developers - ICT specialist.

		- Link the participating students and staff members on LMS - Present a unit of the module, request for an assessment to be loaded - Request the participants to do a practical and send back the report via myTUTor -		
Phase 6: **REVIEW, AND REVISE**	6A	- Request for feedback from participants - Meeting of the team members to discuss the feedback on the module design - Implement modifications that are needed - Fix the glitches and errors/mistakes before final deployment.	4 weeks	- The Instructional designer - Facilitators/ Subject specialists/Content developers - A few students and staff members ICT specialist
Phase 7:	7A	- Full running of the module	6 Months	- The Instructional designer

IMPLEMENTATION				- Facilitators/ Subject specialists/Content developer - Students - ICT specialist
Phase 8: **EVALUATION AND REPORT**	8A	- A full evaluation and report on the implementation of the module	2 Weeks	- The Instructional designer - Facilitators/ Subject specialists/Content developer - Students - ICT specialist

Table 7: A time-frame (schedule) for the implementation of the developed framework

PHASE	May				June				July					August				September					
	1-8	9-15	16-22	23-29	31-05	6-12	13-19	20-26	27-03	4-10	11-17	18-24	25-31	1-7	8-14	15-21	22-28	29-04	05-11	12-18	24-25	26-02	
Phase 1																							
Phase 2																							
Phase 3A																							
Phase 3B																							
Phase 4A																							
Phase 4B																							
Phase 5																							
Phase 6																							
Phase 7																							
Phase 8																							

NB: Some of the phases or parts of the phases can run simultaneously.

Therefore the GANTT chart (shows the actual time that the development of the module can take. The assumption is based on the project starting in May 2021

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Personal reflection and lessons learned from the project

During the process of this study I have learned that TUT has developed many online modules but no one has the business process of the actual steps to follow for doing it. As a result, there is no way of measuring who followed which process and whether it works or not. Therefore monitoring is not being undertaken, which means that there is no improvement of the processes and quality. I have also learned that planning the development of a 100% theoretical module is not completely the same as planning the development of a module which has a big practical component. Therefore, the framework designed in this study is basically the project management template or the business process for the incorporation of the practical component in the development of the Biotechnology e-WIL module. Using this framework will ensure that the module is suitable for students.

I have also realised that it is evident that that remote learning will continue to gain popularity over the years. The difficulties that were experienced in 2020 with placing WIL students in the industry due to financial constrains will still be prevalent. Moreover, more companies are also getting into virtual platforms of doing business. It is therefore important that the university must invest in accommodating advanced techniques into teaching and learning, including the offering of e-WIL modules.

It is my believe that like other online learning platforms, the e-WIL mode of learning will create a rich learning environment that will lead to better learning for students. My opinion is that the work done in this research reveals that e-WIL is a possibility and that it can be incorporated into TUT's already existing online learning platform, MyTutor. However, I have also observed that it will be easier to incorporate the theoretical aspect of the e-WIL module into MyTutor whilst the experimental or practical part of the e-WIL module could require some adjustment to MyTutor, in order to allow students to partake in different practical activities.

Another observation that I made is that having clear-cut objectives and knowing your audience are very important aspects in the process of developing an online module. It was

surprising to see that the currently, the instructional designers at TUT do not put much emphasis on the analysis part at the beginning of the process to develop the online e-WIL modules. It is therefore important to have a discussion with the team that will be involved in the development of the e-WIL module, to emphasize the importance of two elements, defining the goals/objectives and understanding the target audience. Although this work was more to develop a framework, looking at how some of these exercises will be undertaken made me to feel like I was already developing a module. I learned that understanding the objectives and knowing your audience will clearly assist in defining what outcomes are expected through learning objectives; thus, associating the module with producing the required results. Secondly, they could also establish the relevance of the course to its intended audience. Knowing the context of your intended audience also makes the course relevant to your learners, and more effective. Lastly, I believe that having a detailed plan in the form of the framework that has been developed in this work provides a clear business process for the institution and a better way of monitoring the process.

5.2 Conclusions

The following conclusions can be made:

- It was possible to identify the team members that will be required to develop a Biotechnology e-WIL module. The areas of responsibility for the team members were allocated according to the development process outlined in the ADDIE model.
- The framework for the development of the e-WIL module was developed using the ADDIE development model, mainly using 3 of 5 main activities (categories) because only analysis, design, development were applied in order to create the framework for the development of an e-WIL module. The learning objectives, outcomes and real work skills needed to be incorporated into an e-WIL module were identified and the assessment approaches were also included. Furthermore, resources that are available and those that could be used to support the e-WIL module like digital techniques, tools and media were included as an important part of the framework.
- The Implementation and review sections of the ADDIE development model could not be undertaken in this work. However, they have been accommodated in the developed framework.

- This study resulted in the designing of a framework that will be used for the development of a Biotechnology e-WIL module. Nevertheless, this framework can also be implemented on any subject to develop any online WIL module.
- The use of the ADDIE development method provided the basis for the approach of the research but this work also included additional steps that were added to the ADDIE development method. The developed framework also incorporated the practical part of the WIL. It should therefore be noted that the framework designed in this project is a modification of the ADDIE development method.

5.3 Recommendations

Some ideas gathered in the course of this study, which could serve as recommendations are as follows:

- It is recommended that a proper design models or design templates should be developed by the university for more academic departments to implement e-WIL modules.
- In order for this framework to be of use, the university must approve a range of possible practical strategies for students to undertake WIL remotely across the university, making the use of the technologies available.
- It might be a good idea for the university to support the combination of practical sessions into condensed blocks for completion once lockdown restrictions are sufficiently lightened (while, yet again, remembering that such an eventuality might not come about within an academically convenient timeframe);
- The university must purchase simulation software which will be made freely available and accessible to students.

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Appendix 1: Results of the development project

5. RESULTS AND DISCUSSION

5.1. New technical skills learned

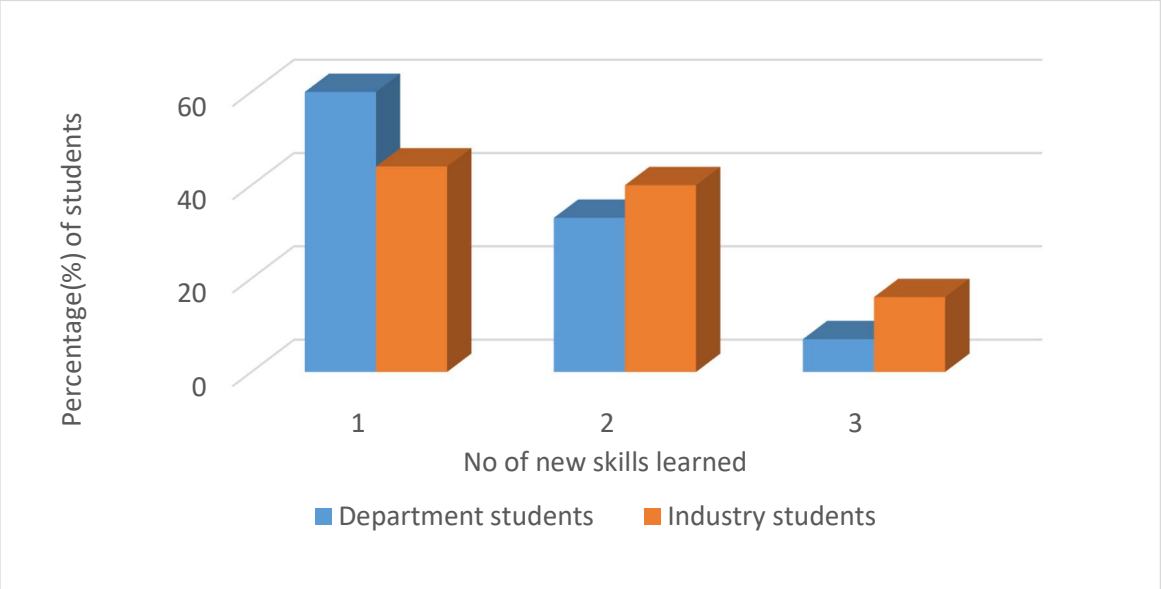

Figure 3. The number of technical skills learned by the students

In terms of the new technical skills learned, more students from the department group (60%) learned 1 new skill as compared to the 44% from industry. The industry-based students learned more new skills (16%) as compared to department based students (7%). This observation makes sense because the students based in the industry will have prior knowledge but are required to relearn most industry specific technical skills based on the industry in which the technique is applied. On the other hand, students based at the department are required to assist mostly with the techniques that they have already been exposed to. It was interesting to observe that 33% of the students in the Department have actually learned 2 new skills and that 16% have learned three. This mean s that there is a possibility of training students to add on their technical skills set even in the environment that they have been previously exposed to.

5.2. Work skills learned

The work skills assessment shown in Table 3 indicated that that both the industry based and departmental students scored a 3 in the first three work skills shown in

table, namely the safety awareness, theoretical knowledge and practical skills, although there was a higher number of students who scored 4 than a 3 of the industry students. This can be because the safety aspects of a new industry might have been challenging for students. The majority of students scored a three for theoretical knowledge. This is because students often do not make an initiative to go and revise theoretical work to complement the technical skills. Students scored very similar in the other parameters except for time keeping and efficiency, in which industry students scored much better than the department students.

Table 3. The scoring of students (%) on the work skills learned

	Percentage of students Ratings (1-Poor); (2-Average); (3-Good); (4-Above average) and (5-Excellent)						
Work skills		1	2	3	4	5	Total
Safety awareness	Industry	0	18	68	14	0	100
	Department	0	21	64	15	0	100
Theoretical knowledge	Industry	0	13	46	38	3	100
	Department	0	16	43	41	0	100
Practical skills	Industry	0	14	43	38	5	100
	Department	0	13	40	44	3	100
Knowledge of techniques	Industry	0	13	33	53	1	100
	Department	0	18	27	55	0	100
Report writing	Industry	0	15	43	42	0	100
	Department	0	12	40	48	0	100
Time keeping	Industry	1	10	44	44	1	100
	Department	5	23	51	21	0	100
Quality of work	Industry	0	13	34	50	3	100
	Department	0	15	47	38	0	100
Efficiency	Industry	0	18	53	29	0	100
	Department	0	20	41	39	0	100
Neatness of work/workplace	Industry	0	12	38	48	2	100
	Department	0	18	32	50	0	100
Initiative in the workplace	Industry	5	22	26	44	3	100
	Department	7	24	40	29	0	100
Team work	Industry	0	10	49	41	0	100
	Department	0	10	44	44	2	100
Willingness to learn new techniques	Industry	0	23	40	33	3	100
	Department	0	25	41	33	2	100

Overall, the industry based students scored higher on the work skills compared to the department students although the differences are very high on specific skills.

The reason might be the fact an industry set up is very different from University set up. In industry, there are strict rules and regulations that guide most behaviour of employees and this is also closely monitored by the supervisors. These findings are in line with similar studies conducted by Orrell (2004), McLennan and Keating (2008), Freudenberg, Brimble and Vyvyan (2010) and Cooper, Colin and Gordon (2010) who state that students derive several work skills benefits from WIL experiences, namely, development of relevant discipline specific skills, personal attributes, and communicative abilities.

5.3. Overall experience where they were placed

The overall WIL experience by students based in the department and in the industry is shown in figure 4. The majority of students from both groups rated their experience as pleasant with the industry students scoring higher (80%) for the good experience compared to the department students (64%). The students who rated the experience as average were higher (36%) for the department students as compared to the industry students (22%). These results are in an agreement with studies that have shown that industry based WIL does improve students employability opportunities (Brauns 2013 and Jonck 2014,).

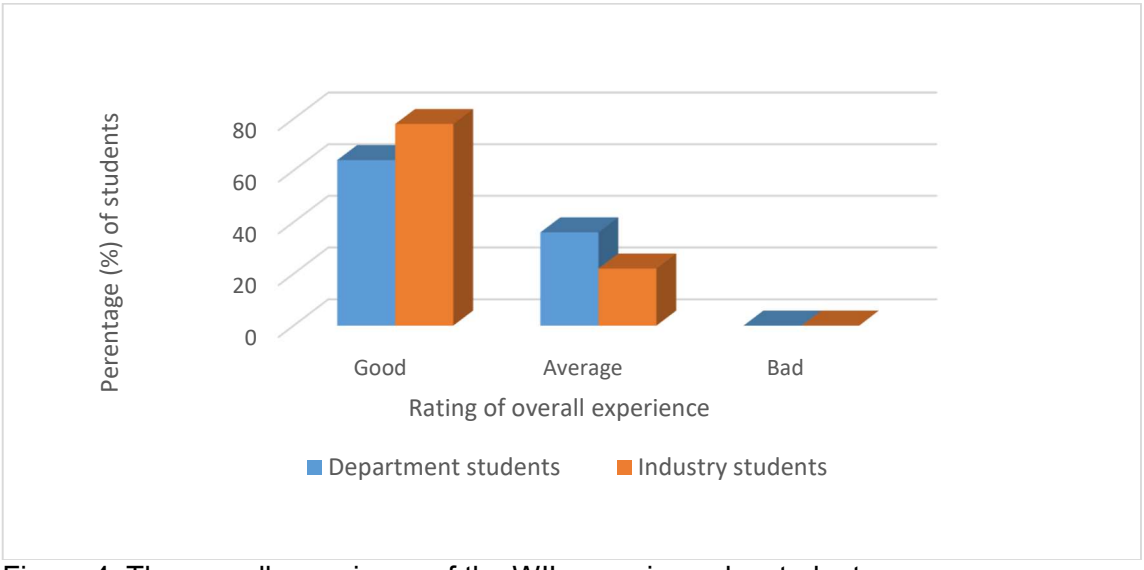

Figure 4. The overall experience of the WIL experience by students

The reasons for the high scores are shown in Figure 5. Getting a salary in a form of a stipend was rated by the students as being the main reason for good experience. Students based in the department did not get a monthly stipend, but received the

lump sum of a combined 12 months stipends at the end of the contract. Technical skills learned came up as the second reason for the industry students whilst it was the main reason responsible for good experience for the department students. The study undertaken by Meerseta, 2015, also indicated that getting a stipend is an influential aspect towards the enjoyment of a WIL experience, especially since most of the students are from poor families whereby the ability to just make it to work depends on the stipend that they receive.

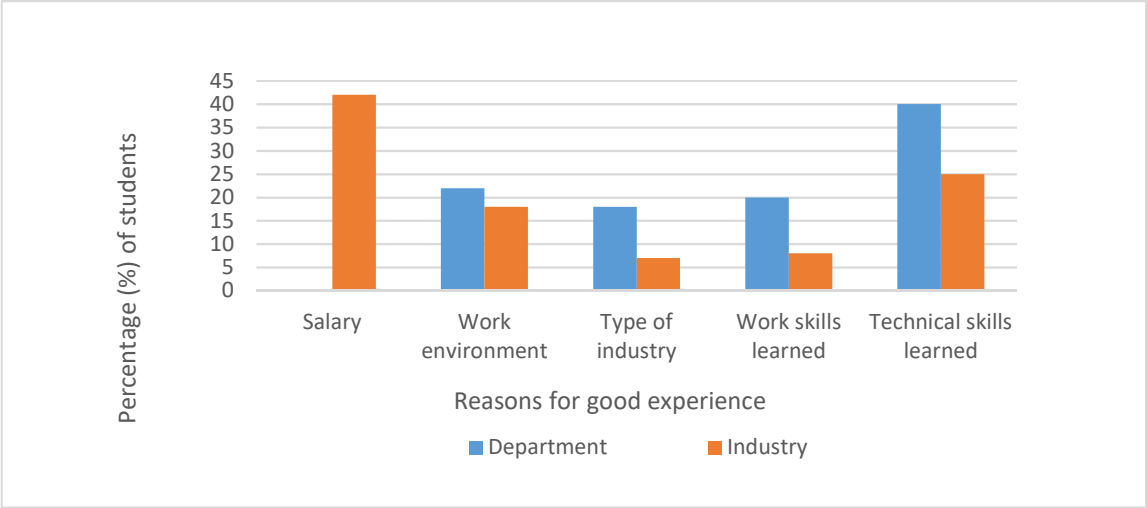

Figure 5. Reasons given for the good experience during WIL

5.4. Future prospects

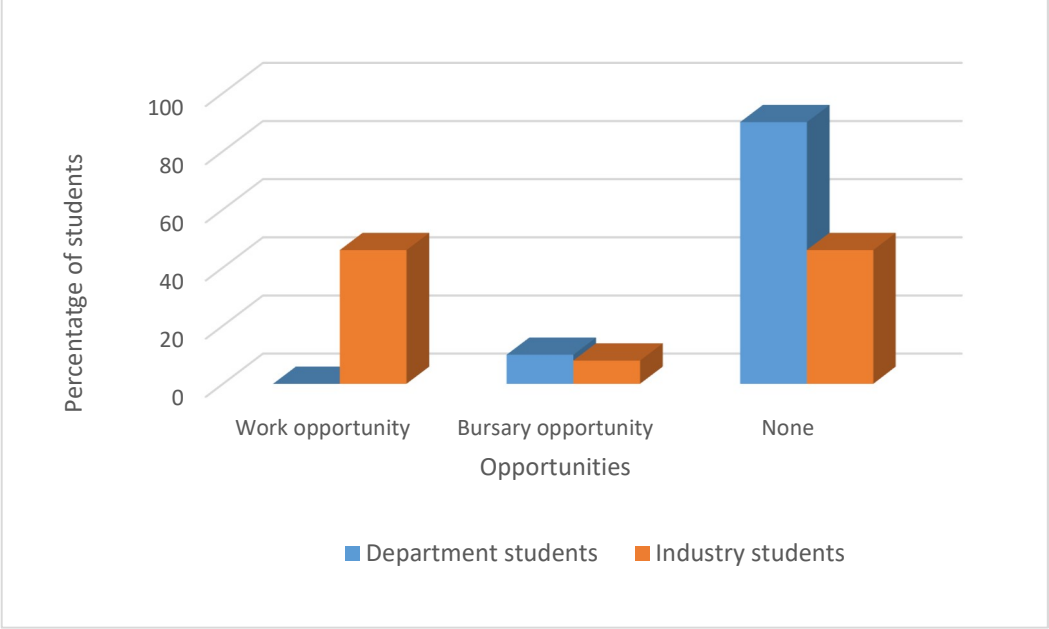

Figure 6. Post WIL opportunities awarded to students

The majority of students from both groups were not given any offers but this number was very high with the department (90%) compared to industry students (46%). A higher number (46%) of industry based students were give job opportunities whilst none of the students based at the department were given a job opportunity. Bursaries were offered to 10% and 8% of the department and industry students, respectively. It is very clear that being placed in the industry will increase employable opportunities.