
Abstract:

The current strength of the National Diploma: Mine Surveying qualification is considered to be the experiential learning component of one year. It has long been considered that this compulsory one year exposure to the working environment enables the newly qualified Mine survey diplomat to be of immediate use within the mining industry with very little site induction required to make the student a fully functional member of a production crew. With the introduction of a new Bachelor degree in Mine Surveying this critical component of the current qualification will no longer form a core component due to a number of legislative and safety concerns. A model that will incorporate most of these requirements is required to replace the current experiential learning model. In order to ensure that all aspects of such a programme is considered a critical review of current experiential learning practices are made. A formal Industry liaison meeting of Mine Surveyors from the main mining companies in South Africa was held to discuss and evaluate the current state of WIL for mine surveyors. Questions were posed to these participants and responses noted using a student response system. An analysis of some of the shortcomings identified is used to provide a basis for the design of a new format of Work Integrated Learning in the form of a second level qualification framework to address the critical stage between graduation and professional registration.
Background to the School of Mines

The Department of Mine Surveying at the University of Johannesburg, South Africa, takes pride in the seamless integration of mine surveying students into the mining industry. The Department is recognized in the mining industry for providing a comprehensive work integrated learning component coupled to teaching modules that maintains close ties to technological advances in the field. This is achieved both by individual research and regular industry visits to remain current. The South African Mining industry traditionally has a conservative approach to education and high expectations of graduates entering industry requiring capable graduates who are well versed in the mining industry’s specific culture.

The course in Mine Surveying has been offered from 1925. In these early days of the Mine surveying course, working men from mines on the Witwatersrand attended a “Sandwich course” that consisted of attending class for two week day afternoons and a Saturday after completing a normal working day. The curriculum included Physical training for 1 hour every morning and four workshops, in Carpentry, Boilermaking, Electrical or Fitting, one of which was to be attended. (Lurie, 2003). The issue of the quality and duration of work experience component was first raised by Munro in 1948, when he commented at the AGM of the Institute that “…the theory of surveying can be learnt, but the art can only be acquired by long and patient experience,. success is usually associated more with training and judgement of the surveyor than theoretical knowledge,…” (Willows-Munro, 1948). By 1967 Lurie appealed to industry to support a full time course which was finally introduced in 1976 when the first full-time diploma course in Mine Surveying was offered. (Lurie, 2003) This course consisted of 18 months of academic work plus 18 months of Work Integrated Learning before graduation.

The evolution of WIL to its current state

In the early years of the mine surveying programme, Munro suggested a model of practical experience that included “…12 months in the sampling department, 6 months learner miner, 6 month in the study (mine planning?) Department followed by work in the survey department…” (Willows-Munro, 1948) in order to ensure that the individual obtained the required experience in order to both be successful in the academic course and in industry. By 1964 Meyer remarked on his concern over the limited knowledge of practical issues of mine surveying students when confronted with problems outside the norm, placing the blame for this state of affairs
squarely on the shoulders on the mentors who “... allow unqualified surveyors to teach new men the routine jobs as quickly as possible and then forget about them, until one makes a mistake of course.” (Meyer, 1964).

Technikon Witwatersrand diploma course model incorporated two years of theory, effectively underpinned by two years of work experience before the student graduated. During the pre-1994 era, it was common to find that all registering mine surveying students would have been placed at a mining company referred to as “Learner Officials”. In this era more than 95% of the students were males with English either as a first or second language and who in most cases would have completed two years of compulsory National Service. That would mean that the student would already have been screened medically and physically and would have reached a certain level of maturity.

The Current WIL model for Mine Surveyors

Changes in the qualification model and curriculum changes post 1994 have reduced the requirements to the current model of 2 semesters of WIL and 6 semesters of academic work for the National Diploma in Mineral Surveying. Before 2012, the high demand for mine surveying students ensured that up to 90% of all students would be bursars by the end of the first year of study and not have a problem in placement for the WIL year. Changes in employment legislation and mining rights application have made the selection of students by mining companies more difficult. Currently mining companies will select candidates for bursaries from specific historically disadvantaged group and specific geographic communities on which the mine is situated.

The activities currently covered in the WIL year (2 semesters) of the Mine survey student aligns the requirements of industry and academia through workplace learning that contains all the components defined by the Council of Higher Education (CHE) as “curricular modalities” for such alignment. These components include Work directed learning, problem based learning and project based learning during the workplace learning phase of the students studies. (Council for Higher Education, 2011 ). Students are required to spend a minimum of one year at the workings of a mine and are expected to provide meaningful work in their time on site. The UJ Work integrated Learning and Service learning policy defines Service Learning as an activity where “…students participate in contextualised, well-structured and organised service activities aimed at addressing identified service needs in a community” (University of Johannesburg Academic Development and
Support, 2014). Unfortunately the most critical component of work integrated learning, namely time to gain the experience has been eroded over the years to accommodate increasing pressures on both academia and industry.

Non-core skills evaluated.

The non-core or soft skill outcomes of WIL are often overlooked. A mine surveyor by definition is expected to perform observations and complicated calculations under extreme environmental and risky conditions. Conditions include hot, wet and cramped conditions and extreme noise levels. Focus on the task of hand must be learned fast in order to perform tasks consistently and accurately. In such an environment, determination, resilience and adaptability combined with the communication skills of a seasoned facilitator are often required...

Aspects such as the operation of moving machinery, working at heights, moving equipment, rock conditions and heat and noise exposure must be receive first priority within MHSA and corporate SOP’s. Students learn to communicate verbally, written and graphically in such a manner as to comply with MHSA requirements.

The new surveyor is exposed to a mining sub-culture culture with its own rich heritage of language, behavior and traditions and belief systems. Students not pre-exposed to this culture may find themselves dealing with unfamiliar cultures in a completely unfamiliar part of the country. The student will be expected to learn the language of the industry including the technical jargon and unique descriptions only found in the industry. Most students come from culturally diverse backgrounds. English could in some cases be third or fourth language for such students and the “mining language” will not conform to anything the student is used to. In order to function effectively and communicate outside the traditional roles and culture from which a student come requires the student to put into practice all the managerial and communication skills exposed to at University. On site the organizational culture will influence every aspect of the student’s life, behavior, dress code, sense of worth, safety protocols and methodologies. During the WIL year the student will have to become fully computer literate, obtain a driving license and improve language proficiency.

Critical Outcomes for the WIL phase.

The following outcomes will have to be met during the WIL year and will contribute to the exit level outcomes required for the qualification. Amongst these outcomes are the following:
1. Solve well-defined to broadly defined problems in Mine Surveying.
2. Analyze and apply theoretical data to solve practical survey problems
3. Communicate professional work to peers and other disciplines selecting appropriate modes of communication
4. Perform effectively as a member of a team

Analysis of the WIL model by Industry representatives

In order to obtain an industry perspective on the current Work Integrated Programme, an Industry liaison meeting the managers of the main mining companies in South Africa were held. Representatives from SASOL, BHP Billiton, Anglo American, Impala Platinum, Lonmin Platinum, Anglo Gold Ashanti, the diamond industry, UNISA and Private practitioners attended the meeting. Although the sample of attendees is small, it is a representative sample of all the industries and companies who provide bursaries to Mine Survey students and have graduate in training programs. In order to stimulate an open conversation the Interwrite\textsuperscript{1} RF Student Response System clickers were used to request anonymous responses on questions posed. A summary of the responses were discussed and recorded as part of the minutes. The purpose of the discussion was to determine the efficiency of the current WIL programme as far as graduate skills is concerned.

Strengths of the current WIL model for Mine Surveyors.

According to the draft guidelines to the UJ Good practice for Work integrated learning “\textit{WIL contributes to national objectives regarding skills development and economic growth by providing graduates with a solid academic underpinning in addition to relevant industry experience.}” (University of Johannesburg, 2011). The main strength of the current WIL model is that it introduces the student to language and culture of the mining industry. This in turn assists the learning process as students can refer to own practical experience in the industry “on-site” when exposed to new theoretical concepts ad terminology. The quality control of the modules provided by the Technical Advisory Committee of the Institute of Mine Surveyors of South Africa ensures that the training remains current and any deviations and shortcomings are identified and corrected immediately. A part of this process is that any shortcomings as a result of poor mentorship is identified and if necessary holding the Mentor responsible for corrective action.

\textsuperscript{1} http://www.einstruction.com/ Copyright 2002 - 2015 Turning Technologies
The industry liaison representatives were asked to respond to the following questions using the Response system.

**Question 1:** “Rate the knowledge performance of recent graduates?” The following responses were recorded:

A. Excellent knowledge of important concepts – 0 Responses
B. Good grasp of important concepts – 3 Responses
C. Moderate grasp of important concepts – 6 Responses
D. Poor grasp of important concepts – 2 Responses
E. Unsatisfactory grasp of important concepts – 1 Response

The response from the group was that it is unrealistic to expect a graduate to be competent in all practical aspects of the profession upon graduation.

**Question 2:** “Do you feel there is any practical value in the current Work Integrated Learning module?” The following responses were recorded:

A. WIL is Most definitely a valuable experience – 5 Responses
B. WIL is a Valuable experience – 5 Responses
C. WIL has some value – 2 Responses
D. WIL has very little value – 0 Responses
E. Undecided – 0 Responses

The group response indicated that WIL addresses the experience and internalization of knowledge that ultimately leads to competence but that it does not need to form part of academic qualification. One of the representatives commented that should there be no WIL during the degree course it will realign industry expectations regarding the work-readiness of graduates to a more realistic expectation that the graduate will require work integrated learning on site.
Question 3: Does the current WIL programme prepare students adequately for the realities of mining?”. The following responses were recorded:

A. Yes, most definitely – 0 Responses  
B. Yes – 4 Responses  
C. Undecided – 5 Responses  
D. No – 1 Responses  
E. No, absolutely not – 0 Responses

Due to the large choice of commodities and types of mining operations that a graduate may eventually end up working in, it was felt that WIL has a greater impact when applied in the correct context with the theoretical foundation.

**Weaknesses of the current WIL model for Mine Surveyors.**

A challenge in the WIL process is the Effective management of WIL students. Mining sites located in geographically remote areas, up to 1 200km from the Johannesburg campus. Travelling to these sites and effective monitoring of students are not possible without intervention from the mines providing the training.

Students must pass a stringent medical examination before being allowed on-site. Students may be declared medically unfit for the occupation they are studying towards and would negate the possibility of the student completing the qualification.

Question 4: Should prospective student undergo an industrial medical as a pre-requisite to entry to the degree? The following responses were recorded:

A. Yes, most definitely – 1 Response  
B. Yes – 4 Responses  
C. Undecided – 2 Responses  
D. No – 4 Responses  
E. No, absolutely not – 0 Responses

The group response was divided almost equally between the “yes” and “no” responses. The discussion identified that is not practicality to require prospective students to undergo an industrial medical assessment. In the case of
bursary students such a medical may be done but it would be difficult to obtain the same compliance from non-bursary students.

The WIL year is often seen by students and training managers alike as an ideal opportunity for students to re-register for outstanding subjects in which the student was not successful. Considering that it takes between 2 – 4 weeks for a student to complete on-site induction and entry and exit medical examinations prior to beginning the WIL and upon completing the WIL year the exposure time is reduced to 11 months, include registration, finding of a suitable WIL provider and if leave of any type (family responsibility or sick leave) is not taken, this number may be reduced to 10 or less months. At the entry stage, provided that a suitable site is found, underlying medical conditions such as hearing, sight, lung disease or any chronic disease may be picked up during the examination phase which may prevent the student from continuing. Pregnancy, will immediately disqualify a student from working on a mine. Physical fitness and heat tolerance has been found in the recent years to exclude more and more students as a result of a more sedentary lifestyle and dietary habits.

The difficult economic times experienced in the mining industry in the past three years is reflected in the drop-off in bursaries provided by mining companies. As a direct result, placement for WIL training has decreased significantly. The current WIL model is sensitive to risk aversion, Health and Safety issues and industrial action such as the Marikana incident (The Mail and Guardian, 2014) . Temporary mine closures due to seismic events and DMR interventions has been found to affect the availability of WIL sites.

**Entry requirements**

In response to the HEQC the new suite of Mine Survey qualifications will no longer include WIL during the academic portion of the qualifications. In contrast experience has been proven that industry experience provides students with a critical understanding of the terminology and spatial understanding of the mining environment. Over the last three years it has been observed that some companies are reverting back to a form of exposure year or cadet program. (Lloyd & Roos, 2015) in order to increase the success rate of first-time students. In order to better understand this apparent contradiction, the industry liaison panel was asked to comment on the suitability of such a program.
Question 5: “In an ideal situation, should a 1 year “apprenticeship” in industry be a pre-requisite to entry to the degree?” The following responses were recorded:

A. Yes, most definitely – 6 Responses
B. Yes – 5 Responses
C. Undecided – 0 Responses
D. No – 1 Response
E. No, absolutely not – 0 Responses

According to the panel, this proposal poses significant practical constraints regarding the selection and placement of students. It was observed that placement of graduates are becoming more difficult and that mining companies would be reluctant to accept the risk of investing money in prospective students that may turn out not be suitable.

The Second level qualification model

In order to register as a Professional Mine Surveyor, the graduate surveyor must complete a prescribed number of years working in industry and write an examination set by the Professional body. The entry requirement for the GCC examinations is a “letter of sobriety” and an ETQA Level 5 Certificate or a Diploma plus at least 3 Years practical experience in mine surveying in the mining industry of which 1 year which must be in the underground workings of a mine. One of the main criticisms of the GCC examination throughput rate is the inadequate preparation of the candidates. Preparation and experience has to be linked. Competency cannot be expected if the candidate has not been exposed or experienced a specific survey problem and have a grasp of how to apply the techniques to different types of problems. Willows-Munro remarked on this in 1948 “…the theory of surveying can be learnt, but the art can only be acquired by long and patient experience, success is usually associated more with training and judgement of the surveyor than theoretical knowledge.” (Willows-Munro, 1948)

Currently a new format of providing a portfolio of evidence related to actual work experience is being investigated. The strategy of this period of post-graduate work integrated learning will be that the candidate will

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2 PLATO
3 A letter written by the mentor stating that the candidate is a person of sober habits and can be trusted to fulfill the responsibilities of a Mine Surveyor
4 Education and Training Quality Assurance body www.fieta.org.za
have gained experience in all aspects of the examination syllabus. The completion of a trial survey which at this stage may be completed after the candidate has successfully completed all examinations will become part of the pre-requisites for candidacy. It is hoped that this exposure will improve the quality of the knowledge candidates through experience. A possible adaptation of the Queensland model which offers a an excellent model of Career Episode Reports5 (CER) (Surveyors Board Queensland, 2014). This model requires a surveyor who wishes to apply for a mining endorsement regulated by the Surveyor’s Act, Section 39 of 2003, to complete an Activity Planning Sheet for each section of mine Surveying applied for, including opencut6, underground coal and underground metalliferous7. (Survey Board Queensland, 2014). The German “Markscheide (Bergbau)” candidates are required to spend up to two years in the relevant government department in order to form an understanding of the workings of the mining regulatory requirements before becoming eligible to write the qualifying examinations. Competence must be the culmination of Qualifications, Skills, Knowledge and Experience (Survey Board Queensland, 2014). It is recommended that the competence aspects of the GCC become a separate aspect incorporated into the second level qualification. The knowledge component of the examination can be better examined and evaluated in the formalized education structures that exist, leaving the DMR to evaluate only the Health and Safety and competency aspect of the certification. The question was posed to the Industry Liaison committee to comment on a proposal that would have candidates complete a portfolio of evidence similar to the Australian and German models before being allowed to write the final GCC examinations.

Question 6: “Do you feel that it will improve the GCC examination pass if candidates were to present the trial survey portfolio before being allowed to write the GCC examinations?” The following responses were recorded:

A. Yes, Most definitely Valuable – 4 Responses

B. Yes, Valuable – 5 Responses

C. Undecided – 1 Response

D. No, it would be of little value – 2 Responses

E. No, most definitely not – 0 Responses

5 The CER must contain evidence that the work has been done: field notes, calculations, plans and reports and written in the first person: “I carried out, calculated, drew the plan, wrote the report etc.”

6 Surface or opencast mining methods

7 Hard rock mining
The value of assimilating theoretical knowledge with the completion of the required portfolio of practical evidence is felt to be a contributing factor to a better throughput rate for the survey examination.

**The way forward.**

New legislation Higher Education Qualification Framework have made WIL more difficult to be offered by Universities because of the requirements around sourcing placement and the overseeing work within industry as a result of amongst others the implications to health and safety issues. In addition, for professional registration no credit is given to the WIL component of the studies. How can the student or graduate be adequately equipped to meet the expectations of employers and the DMR? The primary suggestion is the formalization of the second level qualification. This will provide the method in which a mine surveyor can be introduced to the real life conditions of a mining environment. The sense of responsibility, urgency of execution and focus on the task at hand, respect for superiors and team members alike under physically trying conditions cannot be taught out of a book. The reality of the current South African situation is that in order to achieve transformation in the demographics of the workforce as well as improving access to further learning by previously disadvantaged community members, the possibility of a student being afforded the opportunity of an exposure year before starting their studies is almost non-existent. It is therefore essential that great effort be made to ensure a rigorous WIL component after the student graduates but before legal responsibility is assumed. To address the work-readiness of graduates a formalized 2nd stage qualification is suggested. This model will be designed to include detailed evidence of work completed and may include a compulsory period of work in the offices of the DMR.

Challenges that will prevail in the future include:

1. What components of the current WIL can be incorporated into new degree in the form of vacation- or laboratory work;
2. The specifics of second stage qualifications for graduates before being eligible to register as a professional

The South African Mining Industry demands competent graduates that can be immediately put to work in a production environment with little or no additional training. WIL has been a part of the mining education industry in South Africa as long as the education programme has existed. It is considered an essential part of
introducing and familiarizing a student to the culture, language and corporate ethics that newly graduated person will be exposed to and expected to operate in. In response to stricter MHSA regulations as and corporate regulations, potential employers and WIL providers are more reluctant to accommodate students for WIL opportunities. Experience gained by a student during the WIL component of the education must be experienced in a safe, controlled manner; with reduced risk should things not go according to plan. It is important to expose the student to realistic learning events to make meaning of the theory and lab work that they are exposed to at the university. Experience and competence requires an investment of time and guidance by both student and mentor in order to ensure success. In order to ensure a product of able mine surveyors to the mining industry WIL must remain a very important component of the “rounding off” of a prospective mine surveying student.
Bibliography


