DEVELOPMENT OF SOFT ENGINEERING SKILLS FOR INDUSTRIAL ENGINEERING TECHNOLOGISTS THROUGH EFFECTIVE MENTORING

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Abstract

Engineering deals with solving of society’s problems in a sustainable way and these problems to be solved are defined by the society, which also defines the acceptability of any prescribed solution (Falade, 2006). For engineers to achieve this they have to be equipped with the right technology and skills. Developing hard engineering skills which include computation, analysis and design can be achieved through both tuition and during work integrated learning. However, students require soft skills in addition to hard skills which enable them to effectively communicate and interact easily with others upon entering the real world of work. Work Integrated Learning can contribute towards the imparting of these soft skills. For this to be achieved the student has to be mentored effectively both by the institution and the industrial supervisor assigned to him during Work Integrated Learning. The mentor’s guidance and the working environment assist the student to develop soft skills. This paper discusses different types of soft skills, Work Integrated Learning practice at UNISA’s Department of Mechanical and Industrial Engineering and how the mentors can contribute to imparting of soft skills to students and proposes teaching and mentorship styles required the in various stages of student Work Integrated Learning.

Keywords: soft engineering skills; industrial engineering technologists; effective mentoring
Introduction

During Work Integrated Learning (WIL) the workplace becomes a learning environment whereby work tasks are part of the curriculum, and individual’s performance monitored and assessed (Department of Education RSA, 2007). WIL is widely used in Open Distance Learning and is applied to vocational, technical, continuing and teacher education to impart practical or action knowledge complementing theoretical and propositional knowledge acquired in class in building an individual’s skills and competencies (Mehrotra & Sacheti, 2005). Students are like new employees who need to be mentored. Mentors facilitate learning process (Kaye & Jordan-Evans, 2005). This paper explores soft skills demanded from industrial engineering technologists in the practical engineering work environment. It also discusses current practice in student supervision during Work Integrated Learning at UNISA Industrial and Mechanical Engineering Department and explores ways of improving the imparting of soft skills to the students. The need for soft skills in graduates is identified through a literature review. The role of a mentor in Work Integrated Learning is explained. A discussion follows on how to improve the imparting of soft skills to trainees during Work Integrated Learning.

Background

University of South Africa (UNISA) is an Open Distance Learning university offering National Diploma and Bachelor of Technology degree in Engineering to a wide spectrum of students ranging from school leavers and those already employed inside and outside South Africa. One year of three year National Diploma is spent in industry as Work Integrated Learning. After National Diploma students study one more year and graduate with Bachelor of Technology degree (UNISA, 2010). Upon completion of the degree the student is expected to meet learning outcomes which include being able to solve broadly defined problems using industrial engineering principles and apply management principles (ECSA, 2008). In addition they must achieve a number of critical cross field outcomes which include working collaboratively with others as a member of a team, group, organization, or community
(such as professional or general study area related bodies, institutions, organizations), and communicating effectively using visual, mathematical and/or language skills in the modes of oral and/or written presentation, integration with other business functions and effective communication. These outcomes are achieved through taught courses and Work Integrated Learning. During Work Integrated Learning a student is assigned to a business organization in the manufacturing or engineering sectors which the Mechanical and Industrial Engineering Department sees as appropriate. The university provides student with a log-book for recording daily activities, student guide of the course objective and learning tasks and a mentor’s guide governing the scope of activities undertaken. The learning outcomes for the current Industrial Engineering Work Integrated Learning (UNISA, 2011) are:

- Trainees must be able to determine the most efficient ways of using the factors of production people, machines, materials, information and energy to make or process products.
- Act as bridges between management goals and operational performance.
- Solve organizational, production and related problems most efficiently.
- Develop management control systems to aid financial planning and cost analysis.
- Determine plant location and best combination of raw materials availability, transportation and costs.
- Develop wage and salary administration systems and job management systems.

The mentor is assigned by the business organization to mentor the student. The academic supervisor liaises with the mentor and visits the organization during the training period. The learning outcomes involve a lot of interaction with other people within the organization and thus demand one to use soft skills to be achieved. In this paper will discuss how a mentor can be able to impart soft skills to the student during the Work Integrated Learning period.

**Research Methodology**
A study was carried out on the current students and mentors for National Diploma in Industrial Engineering Work Integrated Learning modules IDP 101E and IDP201E from two years 2009 and 2010 and observation made on the student progress in other taught courses in the Diploma and B Tech Industrial Engineering. Mentors in industry and students were interviewed to get their perspective on Work Integrated Learning and the extent to which soft skills are being imparted during training.

**Literature Review**

In the past engineering education focused on imparting of hard or technical skills, which include technical or administrative procedures related to an organization’s core business like machine operation and safety standards and procedures (Coates, 2006). However, increasing business complexity has shifted focus to coordination and communication; thus employers are putting more weight on soft skills (Firth, 2011). Globalization demands universities to produce engineers who can possess expert knowledge and think in terms of international, technical, social and financial relationships (Hopp, 2000) and equipped with skills to easily cross national and cultural. In this review the author attempts to distinguish between soft and hard skills.

**Introduction to soft skills**

Many authors have written about development of soft skills in engineering tuition (Pulko & Samir, 2003; Falade, 2006). Whitmore & Fry (1974) defined soft skills as important job-related skills that involve little or no interaction with machines and whose application on the job is quite generalized. Soft skills complement hard skills fulfill an important role in shaping an individual’s (Schulz, 2007). Hard and soft skills together constitute professional competence of an individual which allows a goal-oriented and situational accomplishment of working tasks (Kauffeld, Grote, & Frieling, 2003).

**Classification of soft skills**

Soft skills include emotional intelligence, critical thinking, giving feedback and problem solving, report writing and presentation, project and team management (Pulko & Samir, 2003; Coates, 2006).

**Emotional intelligence**
Emotional intelligence involves the accurate appraisal and expression of emotions in oneself and regulation in a way that enhances life by being able to consensually recognize emotional qualities of objects in the environment (Mayer et al., 1990). Poskey (2011) defined it as a set of competencies demonstrating the ability one has to recognize his or her behaviors, moods, and impulses, and to manage them best according to situation. The elements of emotional intelligence include social competencies, social skills, and personal competencies shown below in Table 1.

Table 1: Elements of Emotional Intelligence in the Workplace (Poskey, 2011)

<table>
<thead>
<tr>
<th>Personal competencies</th>
<th>Self awareness, emotional awareness, accurate self-assessment, self-confidence, self regulation &amp; self-control, trustworthiness, conscientiousness, adaptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Competencies</td>
<td>Relationship management, people development, leveraging diversity</td>
</tr>
<tr>
<td>Social skills</td>
<td>Influencing, Communication, Leadership, Change catalyst, Conflict resolution, negotiating, Building bonds, Collaboration and cooperation, Team capabilities</td>
</tr>
</tbody>
</table>

Critical thinking

Critical thinking refers to higher order thinking that questions assumptions (Brookfield, 2000). It is an intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action (Scriven & Paul, 1987). Critical thinking is the mainstay of the most essential workplace skills, and is a strong attribute in people with good analysis and problem-solving skills, ability to learn quickly, creativity and potential for career advancement (Chartrand et al., 2009).

Effective report writing and Presentation skills

Presentation skills are becoming vital in the workplace (Cook, 2011). Soft skills like report writing develop in engineering students through project work (Pulko & Samir, 2003).

Importance of soft skills
Employers and educators have been complaining about a lack in soft skills among graduates from tertiary education institutions (Schulz, 2007). Ford (2007) reports that in the biannual survey of the graduate job market in the UK, published by the Association of Graduate Recruiters (AGR), found that 43% of employers were unable to fill all their graduate vacancies because students had failed to match academic achievement with soft skills. ODEP (2011) observed that new entrants to the job market often lack skills, which include professionalism or work ethic oral and written communication, teamwork and collaboration skills, critical thinking or problem-solving skills.

The lack of soft skills seems to be serious in science and engineering programmes than in humanities since their programmes emphasize soft skills during the course of study (Schwanitz, 1999:482). Vonderheid (2002) observes that engineering students they realize they need soft skills like negotiation and communication when leave academia. He argues often people skills, management skills and personal characteristics overshadow conceptual and process skills as one climbs the corporate ladder and give them adaptability to work in other fields like purchasing which demand soft skills. Soft skills accounts for as much as 70% or individual performance, whereas cognitive ability and technical learning account for 30% (Hommrichhausen, 2002).

More than 40 years ago the German Engineering Association (VDI) recommended that 20% of courses of the engineering curricula should be soft skills (Schulz, 2007). The past 10 years has seen engineering departments on a drive to equip students with basic professional skills and soft skills prior to graduation in order to satisfy needs of employers and professional organizations (Pulko & Samir, 2003).

**Role of mentoring in impacting soft skills**

Soft skills are either imparted through training or experiences and interactions (Baher, 2010). Del Vitto (2008) explains how soft skills can also be trained using an example of cultural diversity in global companies. It can be done through role playing and networking with experienced contemporaries who act as mentors (Baher, 2010). Starcevich (2009) characterizes mentoring as a power free, two-way mutually beneficial learning situation where the mentor provides advice, shares knowledge and
experiences, and teaches using a low pressure, self-discovery approach. However it is important for the mentor to use a coaching approach to impart certain types of soft skills. Coaching is task related and enables learning and development to occur and thus performance to improve (Parsloe, 1999). Starting with sound diagnosis of the capabilities and attitudes, learning and development can occur provided there is specific, factual, and objective feedback (Serrat, 2009). The mentoring and coaching process is shown below on Fig 1.

![Structured Coaching and Mentoring](image)

**Figure 1: Structured Coaching and Mentoring (Serrat, 2009)**

Starcevich (2009) summarized the differences between coaching and mentoring below in Table 2.

**Table 2: Differences between Mentoring and Coaching (Starcevich, 2009)**

<table>
<thead>
<tr>
<th></th>
<th><strong>Mentor</strong></th>
<th><strong>Coach</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus</td>
<td>Individual</td>
<td>Performance</td>
</tr>
<tr>
<td>Role</td>
<td>Facilitator with no agenda</td>
<td>Specific agenda</td>
</tr>
<tr>
<td>Relationship</td>
<td>Self selecting</td>
<td>Comes with the job</td>
</tr>
<tr>
<td>Source of influence</td>
<td>Perceived value</td>
<td>Position</td>
</tr>
<tr>
<td>Personal returns</td>
<td>Affirmation/learning</td>
<td>Teamwork/learning</td>
</tr>
<tr>
<td>Arena</td>
<td>Life</td>
<td>Task related</td>
</tr>
</tbody>
</table>

Landsberg (1996) identifies the skill will matrix illustrated below in Figure 2. It can guide training style adopted by a mentor depending on different circumstances of the trainee. At low skill and low will level directing and supervising is the appropriate way of guiding trainees while at high skill levels engaging and exciting the individual is desirable.

![Skill–Will Matrix](image)

**Figure 2: The Skill–Will Matrix (Landsberg, 1996)**
Results and findings

During the course of tuition of the National Diploma and B Tech in Industrial Engineering by open distance learning in 2009 and 2010 the author made the following observations;

- Open Distance Learning students are not in class except for tutorial classes compared with those in full contact institutions minimizing interaction with fellow student peers during the time they are studying. Although some soft skills are imparted as they engage with the course material a lot depends on their jobs, work environment, managers and colleagues and how they interact.
- There is growing number of new applicants to the National Diploma programme growing at a rate of about 10% per year straight from high school that don’t have jobs but are full time distance learners who have to read materials at home during course of studies.
- The type learning and assessment in the curriculum for distance learning must promote soft skill acquisition by not promoting only the reading of literature but also collection of data form primary sources, communication and analysis.
- Design of curriculum has to take into account the open distance learner’s circumstances, and diverse student profile including diversity in work experience language, age and demographic among others.
- Students do not have enough time to engage with course material and accomplish all learning objectives due to work and family commitments.
- Students find it difficult to do Project Research module at B Tech level particularly formulating problem statement and gathering relevant data and carrying out analysis and evaluation of the projects. A large number find it hard to write up their work.

Challenges to skills transfer during Work Integrated Learning

The following challenges to transfer of soft skills were observed during Work Integrated Learning:

- Lack of suitably qualified and experienced mentors in industries where students are placed. Some supervisors don’t understand the role of industrial engineering technologists and technicians. Many
businesses offering work integrated learning are small to medium scale family enterprises with experienced in what they do but not appropriately qualified.

- Lack of established training and mentorship practice is also a common problem in some companies especially Small to Medium scale Enterprises.
- Students under training end up following work routines on one workstation for a long time and don’t get to rotate and get experience in other sections.
- Supervisors may not have time to adequately supervise trainees work due to high workloads.
- Management style and openness affect participation of trainees in projects, presentations and other functions. Internal conflicts within organizations affect and limit this participation.
- Lack of a proper performance monitoring and measurement system of trainees.

Discussion

Industrial engineering technicians apply engineering theory and principles to problems of manufacturing layout or production, working under the supervision of engineers and technologists. Trainees learn skills through observing other people around them, doing things, adopting what works best for them. In this discussion ways of how to impart soft skills to trainees are looked at in light of the observations and findings. Ways of improving soft skills through mentorship include looking at management style and commitment, appointment of the right mentor, structuring of the training, employing the right training method, and communication.

Selection of appropriate mentor

The mentor for student technologists currently is required to be experienced, hold at least a National Diploma, be a member of the Engineering Council of South Africa as a Professional Technician. This however, is often difficult to enforce due to shortage of places and sometimes the nature of employment to student is in. Many students are finding themselves working for small to medium scale enterprises and organizations which did not traditionally employ engineers like banks and retail chains. As a university we pass on the encouragement for our industry partners to register
potential supervisors with ECSA. However, this requirement is slowly being met by most organizations as they are employing more qualified engineers of technologists.

**Structuring of training programmes**

The structuring of Work Integrated Learning programmes difficult for students who are already in jobs where they hold enormous responsibility making employers reluctant to rotate them to other sections as prescribed a training programme. The organization’s policies on training can overcome these barriers. The mentor must facilitate the learning process either by challenging the student to solve assigned problems using industrial engineering tools taught in various prior course modules rather than do routine work throughout the training period. These assigned problems can be solved in the form of mini-projects with budget and targets. Project work assists students to develop project management and develop team skills. The trainees must then be challenged to produce project reports and present at meetings or other forum during which the audience challenges their ideas and shape their understanding of work.

**Empowering mentors using a top down management approach**

Top management commitment through committing human resources, time and financial resources is essential to training and mentorship. Top managers must acknowledge soft skills contribution to better work environment, better communication, less conflict, and more profitability. Soft skills have become increasingly important attributes required by workers. Empowering managers with mentorship skills and soft skills will enable them to easily impart effective training to others. However, imparting skills is not an easy exercise to old employees but fairly easier to young trainees. An organization can employ executive coaches to ensure change of behavior and frequent feedback, encouragement and reinforcement. Managers who have undergone mentoring programmes are able to assess coaching needs within their departments and coach their supervisors who in turn coach their team members providing effective feedback systems (Coates, 2006). Soft skills can be imparted to trainees if the training provider capable and knowledgeable trainers. Momentum of imparting such
skills requires top management commitment and a structured approach to implementation and reinforcement (Coates, 2006). Reinforcement provides permanent behavioral change.

**Identifying Supervisor’s Coaching and mentoring roles**

The mentor evaluates the student needs considering the matrix in Figure 2, in order to identify the approach to mentoring required. A new trainee may have High Will and Low skill so the mentor must offer guidance and coaching. As the student training progresses there is a need to excite the student with new project challenges. Inappropriate training demoralizes students. The mentor may supervise the student himself or assign the duty of supervising the trainee to another competent section head for certain stages. Table 3 below indicates a proposed matrix of the training approaches that can be used at various stages in the training programme. During induction the student needs initial motivation through a walk through the organization to stimulate their interest by the assigned supervisor so that they get to know each other. The supervisor must sell their credibility to the student and start to establish ground rules and best practices. The student must be familiarized with the plant through coaching where they are coached on processes and procedures applicable the work place. Procedural issues like quality management and control, communication procedures, budgeting and project plan drawing must be done through coaching. The student must be given space to also identify their own projects.

<table>
<thead>
<tr>
<th>Stage in training programme</th>
<th>Training Style</th>
</tr>
</thead>
<tbody>
<tr>
<td>Induction</td>
<td>Mentoring</td>
</tr>
<tr>
<td>Familiarization of the plant/ workplace</td>
<td>Mentoring/ coaching</td>
</tr>
<tr>
<td>Machine operation or other operating procedures</td>
<td>Coaching</td>
</tr>
<tr>
<td>Quality procedures</td>
<td>coaching</td>
</tr>
<tr>
<td>Project management</td>
<td>Mentoring/ coaching</td>
</tr>
<tr>
<td>Drawing project plan</td>
<td>Mentoring/ coaching</td>
</tr>
<tr>
<td>Communication processes, meetings</td>
<td>Mentoring/ coaching</td>
</tr>
</tbody>
</table>

**Modifying teaching approach**

In a face to face tuition university soft skills development can be done by modifying the curriculum to incorporate more of two way communication modes (Pulko & Samir, 2003). However, it is difficult in an Open Distance Learning environment as there is minimal contact with students. The
use video conferences will be explored to ensure students present their project work to lecturers interactively during their study. Students are encouraged to join study groups in their areas with other people studying similar courses even from other universities and colleges.

**Communication**

Although modern technology has led to faster dissemination of information to a lot of people it has complicated the communication process for many. The widespread use of e-mail, the traditional chain of command is often not followed in communication patterns leading to conflicts (Buhler, 2001). The challenge in training is to allow trainees to use modern technologies without losing personal touch and be able to use verbal communication.

**Establishing networking**

Trainees must be given the opportunity to network wherever possible to establish contacts beyond family members, and acquaintances. Networking allows one to share about employment goals and interests building confidence, achieving professional and career development. Most jobs on offer are not advertised by accessed through networks. Ongoing networking within the organization can increase one’s knowledge about their work environment and ability to move up the corporate ladder.

**Teamwork and co-participation**

The trainee must participate in teams during projects and delegation by the mentor ensures active co-participation. Team building depends on the organization’s philosophy and the nature of the work. Interactive nature of teamwork builds communication skills, compromise and conflict resolution.

**Problem Solving and Critical Thinking**

Critical thinking refers to the ability to use knowledge, facts, and data to effectively solve workplace problems. A critical thinker may question why certain steps are taken to complete a task. The ability to develop a well thought out solution within a reasonable time frame.

**Conclusion**

Soft skills are critical in giving confidence, productivity and to unlock future potential in trainees. Training tasks should ensure there is a high level of soft skills imparted to complement hard
skills they gain during Work Integrated Learning. The challenge is the identification of the right mentor for a student and development of mentorship capabilities in organizations where students are placed.

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