# Report on Construction Management and Civil Engineering Education at Universities of Technology

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# REPORT ON CONSTRUCTION MANAGEMENT AND CIVIL ENGINEERING EDUCATION AT UNIVERSITIES OF TECHNOLOGY

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## ABBREVIATIONS

| | |
|---|---|
| AGC | Associated General Contractors of America |
| CIOB | Chartered Institute of Building |
| CM | Construction Management |
| CPD | Continuing Professional Development |
| CTM | Committee for Tutorial Matters |
| ETDP | Education Training and Development Program |
| ESCA | Engineering Council of South Africa |
| ET | Experiential Training |
| HDI | Historically Disadvantaged Institution |
| HEI | Higher Education Institution |
| ICT | Information and Communication Technologies |
| LC | Learning Cycle |
| PAI | Previously Advantaged Institutions |
| NQF | National Qualification Framework |
| SADC | Southern African Development Community |
| SAIB | South African Institute of Building |
| SETA | Sector Education Training Authorities |
| SAQA | South African Quality Assurance |
| TUT | Technikons / Universities of Technology |

## EXECUTIVE SUMMARY

Curriculum change in the main is driven by policy, industry or faculty. In South Africa, several policy initiatives are directed at influencing changes to the curriculum. The White Paper, 1997 stresses the challenge to redress past inequalities and to *transform the higher education system* to serve a new social order, to meet pressing needs, and to respond to new realities and opportunities. Institutions serving the higher education sector have a major role to play in providing the technological and business capability to underpin modern industrial and services development (Frain, 1992). Higher education reaches and trains people to fulfil specialized social functions, enter the learned professions, or pursue vocations in administration, trade, industry, science and technology and the arts (White Paper, 1997).

While maintaining the commitment to high academic standards, Higher Education Institutions also need to be committed to *responding to the needs of industry* both in terms of course content and research. Further, higher education must provide education and training to develop the skills and innovations necessary for national development and successful participation in the global economy.

It is South African government policy that cooperative education should bridge the minds of students at higher education institutions and the industry in which they hope to develop their future careers. To achieve this national objective, institutions of higher education have to pursue strong relationships with, and input from, stakeholders and industry concerning their fields of study. These industry-sensitive programs essentially have to help students in their transition from school to the work place.

Many authors have argued that there should be an appropriate teaching approach that bridges the perceived gap between formal academic instruction and on the job training (Kim, Williams and Dattilo, 2002; Sanyal, 1991; Ellington, Gordon and Fowlie, 1998; Schaafsma, 1996). However, for some time academics and practitioners have recognized the need to balance the relationship between theory as taught in the classroom and practice in the field or industry (Ross and Elechi, 2002). This gap between what is taught in classrooms and what is needed in the workplace is well illustrated in Table 1 adapted from Cook and Cook (1998).

Table 1. Traditional education vs, Workplace

| | **Traditional Education** | **Workplace** |
|---|---|---|
| Requirements | Facts | Problem solving |
| | Individual effort | Team skills |
| | Passing a test | Learning how to learn |
| | Achieving a grade | Continuous improvement |
| | Individual courses | Interdisciplinary knowledge |
| | Receive information | Interact and process information |
| | Teaching separate from learning | Technology |

*(Source: Cook and Cook, 1998)*

It is within this context that several have influenced curriculum design through initiating simulated "world of work" practices and prompted the development of student centred learning approaches (Edward, 2004; Drahun and Lopez Merono, 2004; Jacobs and Miller, 2003). There have also been several recent attempts at re-designing the learning environments (Eason, 2004; DeKereki, Azpiazu and Silva, 2004; Chinyino, 2004).

However, there are few studies, if any, and even less published research that evaluates the relationship between construction theory as taught in the classroom and construction practice in the field from a multi-stakeholder perspective viz. students, academic institutions and employers. This paper reports on the findings of a study conducted to assess student perceptions of the first year and experiential training programmes.

## The Nature of Cooperative Education

Cooperative education is classified as Mode 2 knowledge in that it is characterised by the proliferation of knowledge production in the context of application, which is mostly problem-specific and guided by the requirements of practical relevance such as a specific industrial sector. This particular educational approach provides opportunities for students to have hands-on experience as part of their course of study (Miller, Haupt and Smallwood, 2003). In this way students are prepared for their future careers. They acquire valuable and specialized knowledge and skills by learning from experience and reflecting on that experience while becoming acquainted with the work processes (Hicks, 1996; Rainsbury et al., 1998). Workplace learning therefore provides the underpinning knowledge and attributes of competence needed for the job as a whole such as, for example, aspects of work-place culture, work norms and values (Gillen, 1993). This form of experiential learning may be expressed as the combination of three elements, namely programmed learning in structured settings, questioning learning gained via investigation and research, and own experience (Hicks, 1996).

Apart from co-operative education contributing to more effective learning (Schaafsma, 1996) it also has the potential to be mutually beneficial to both students and employers (Frain, 1992). Employers benefit from having a significant influence on course design and content by ensuring that industry-specific knowledge, awareness and values are integrated into the higher education process. Students benefit from working as they experience firsthand and come to understand the requirements of their chosen career. As they engage in the actual activities in the workplace they gain appreciation for the challenges of their particular job (Ross and Elechi, 2002). They are consequently better able to make informed decisions on their career choices. They also develop enhanced appreciation of concepts learnt in the classroom after applying knowledge in a professional setting (Gordon, Hage and McBride, 2001). This working or in-service period is often the students' first opportunity to apply theoretical, classroom-based knowledge in a practical work situation. They gain a more realistic view of how the world of work operates. Work experience is often a strong determining factor in whether or not students find employment. Co-operative education provides the opportunity for students to enhance their prospects of employment once they graduate (Frain, 1992). They are given the opportunity to demonstrate their abilities to prospective employers. Through this approach, they already have work experience at the moment of academic graduation. Students are introduced to the work ethic, and gain insight into the interpersonal skills needed to survive in the working world (Schaafsma, 1996). They see the opportunities for career development and personal growth that are open to them in their field of study.

In several studies employers noted that more opportunities for work placement during the students' courses would be beneficial and ease their transition into the workplace upon completion of their formal academic programs at HEIs. Spencer (1992) and Blakey (1992) cite the value of work experience for building students, and the CTM Standing Committee: Co-operative Education (2000) maintains that there are advantages of co-operative education for all the role players involved in experiential training. Although literature amplifies the importance of optimum experiential training / co-operative education, students do not gain meaningful practical experience, nor sufficient opportunity to apply their acquired knowledge during their experiential training year in industry while at former technikons (Manthe and Smallwood, 2003). Over the last decade, it seems that ways of learning in higher education have been gradually getting closer to the needs and methods of the real world. However, studies have shown that there still is a mismatch between what employers appear to want and what higher education provides. (Smallwood, 2002; Fester and Haupt, 2003)

## Current University of Technology Instructional Model

In South Africa, University of Technologies (the former technikons) offer construction-related programs on the basis of cooperative education. The four-year Bachelor of Technology program is generally made up of three academic years spent full-time at the institution with the second year spent full-time working in industry. Students complete projects in 2 or 3 subjects during this "experiential year". Students are also required to keep a logbook of all their work activities on a monthly basis. The logbook sets out the required activities that students are expected to experience. In order to return to the institution to complete the remaining two years students have to obtain passing grades in each of these subjects as well as submit a duly completed logbook. Students may also be required to do an oral presentation of work completed during the experiential year.

**Construction Management**

The historical approach to education by institutions previously known as Technikons is practical and outcomes-based, with the intent that their graduates are immediately employable and productive. A key component that ensures this productivity is the inclusion into technikon programmes of periods of experiential learning spent in industry (Haupt 2003). This collaborative approach to education, also known as co-operative education, has 3 stakeholders namely, the academic institution, industry and students. Co-operative education includes periods of academic study alternating with a period of related work experience designed to prepare the student well for the class-to-work transition. For this goal to be reached it is necessary that universities of technology offer relevant training to adequately prepare their graduates for the world of work.

It is believed that the separation between practical and academic work results in a division in the mind of students rather relating the theory to the application that reinforces the basic concepts as taught in the classroom. There are few studies, if any, that evaluate the relationship between construction theory as taught in the classroom and construction practice in the field from students' perspectives. In attempting to respond to the concerns of whether students in the discipline of construction management are adequately prepared for their future careers, this paper reports on the findings of a study that examined the attitudes of students at higher education institutions regarding their experiences of transferring theory to the workplace as well as their views on the course content of their programs.

In the main the findings of the present study echo international experiences relative to Educational Offerings and Experiential Learning with respect to, for example

- The effective use of communication
- Problems and Concerns
- The definition of learning outcomes for experiential learning
- Quality assurance of placement (year out) learning
- The requirements of professional bodies
- Relevance of Construction Management Courses
- Relevancy of Civil Engineering Courses
- Importance of Construction Management Skills
- Importance of Civil Engineering Skills
- Increasing the awareness of rights and responsibilities

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## BACKGROUND

The South African educational landscape has changed to accord with government's commitment to transformation and increased access to higher education by all its citizens. Consequently, institutions previously known as Technikons are being transformed into Universities of Technology, charged with the responsibility of delivering instructional offerings that are both relevant and responsive to the needs and priorities of the national economy. These institutions are expected to offer career-oriented educational programs designed to meet the needs of industry and commerce in a hi-tech global economic environment. Their approach to education is practical and outcomes-based, with the intent that their graduates are immediately employable and productive. A key component that ensures this productivity is the inclusion into Universities of Technology programmes of periods of experiential learning spent in industry (Haupt 2003). This collaborative approach to education, also known as co-operative education, has 3 stakeholders namely, the academic institution, industry and students. Co-operative education includes periods of academic study alternating with a period of related work experience and prepares the student well for the class-to-work transition. For this goal to be reached it is necessary that Universities of Technology offer relevant training to adequately prepare their graduates for the world of work.

At the same time there are growing concerns about the perceived mismatch between industry needs and demand and the graduates produced by Higher Education Institutions (HEIs). Against this background a pilot study was conducted in 2002 to determine the relevance and effectiveness of built environment programs offered by the Universities of Technology sector.

This report presents the findings of a study designed to obtain the perceptions and opinions of the students, industry (employers) and staff in the following related areas:

- Instructional Model Preference
- Experiential Training
- Continuing Professional Development and Professional Registration
- Construction Management Courses at Universities of Technology
- Civil Engineering Courses at Universities of Technology
- Training and Education
- Participation in Construction

## CLARIFICATION AND DEFINITIONS OF TERMS

Neither the SETA nor any other related South African legislation offers any guidance or clarification on the definitions and scope of *experiential learning* and *co-operative education*. Both these terms and concepts are important in the context of delivering on the project brief of the improvement of educational offerings of educational offerings and experiential training in Construction Management and Civil Engineering at Universities of Technology.

### a) Awareness

The knowledge and understanding obtained from formal education and technical reading and exposure to the techniques as they are practised by others. From the engineering point of view, awareness is general familiarity, albeit bounded by the needs of the specific discipline.

### b) Competence

Being in receipt of particular training, fully conversant with systems an issue, practised on a regular basis. Professional competence may further be broadly classified as cognitive or normative (Chan and Cheung, 1996). Accordingly, cognitive competence relates to the possession and application of a body of knowledge that is relevant, acceptable, and exclusive to a social concern.

**c) Construction Manager**

The Construction Manager needs competence in procurement, controlling delivery and commissioning, and awareness of design and briefing skill areas.
"Construction managers plan and coordinate construction projects. They have job titles such as constructor, construction superintendent, general superintendent, project engineer, project manager, general construction manager, or executive construction manager. They many plan and direct a whole project or just part of a project"

From the above sourced definitions, it is clear that there is a common thread of the construction managers to direct and monitor the progress of construction activities, sometimes through construction supervisors or other construction managers. For the purpose of this project, a "construction manager" will be defined as "*the person who possesses the advanced expertise in the theory and practice of management relating to the construction procurement process and construction organisation as a business enterprise and therefore must be able to manage both the business of construction as well as one or more construction projects"*.

**d) Civil Engineer**

"Civil engineers must be able to work in teams, communicate well, work from a system approach, and within the context of ethical, political, international, environment, and economical considerations. Consequently, civil engineers are required to have a broad-based undergraduate education" Chan et al (2002)

**e) Civil Engineering**

"Civil Engineering has been defined as the branch of engineering concerned with designing, building, or repairing of roads, bridges, tunnels, and other public works."

**f) Co-operative Education**

Working together of industry and the education institution, in a process in which academic study is integrated with work experience in order to benefit both the students and industry. This term is used by the TUT sector to describe the integration of productive work into the career-focused curriculum (Council on Higher Education, 2002).

**g) Construction Management**

"The application of advanced expertise in the theory and practice of management relating to the construction procurement process and the construction organization as a business enterprise (cited in Haupt, et al., 2004) and thus the management of the business of construction as well as one or more construction projects".

**h) Engineering**

Engineering is a profession directed towards the skilled application of a distinctive body of knowledge based on mathematics, science and technology, integrated with business and management, which is acquired through education and profession formation in a particular engineering discipline. (Engineering Council, 2001)

**i) Experiential Learning/Internship/Service Learning**

A period of work-based learning undertaken by a student in an employment situation to gain work experience that may be used to link theory and practice and develop transferable skills and enhance the teaching-learning process. This period may be either for academic credit or not. (Greenbank, 2002; Hickox, 2002; Schneider, 1910 in Barbeau, and Stull, 1990).

**j) Understanding**

Understanding is the capacity to use concepts creatively in problem solving in design, in explanations, in diagnosis.

**k) Technikon/University of Technology**

A Higher Education Institution, which concentrates on application of scientific principles to practical problems and to technology, thus preparing learners for the practice, promotion and transfer of technology within a particular vocation or industry (Council on Higher Education, 2002).

**l) Knowledge**

Is information that can be recalled.

**m) Skills**

“The ability to do something well; expertise or dexterity” (Concise English Dictionary, 2002).

“The learned ability to bring about pre-determined results with maximum creativity, often with minimum outlay of time and energy, or both” (KNAPP, 1963)

“The necessary competencies that can be applied in a particular context for a defined purpose” (South African Green Paper on Skills Development Strategy, March)

From the above sourced definitions, it is clear that there is a common thread of the ability to carry out a task. For the purpose of this project, a “skill” will be defined as “*the trained ability to undertake or perform a construction or civil engineering task or activity well”*. The skills are acquired and learned attributes which can applied almost automatically

# 1.0 INTRODUCTION

## 1.1 Terms of Reference

In an attempt to fulfil its mandate, the Education Training and Development Program (ETDP) commissioned a study that would report on the improvement of educational offerings and experiential training in construction management and civil engineering at universities of technology.

The objective of the study was to establish an objective data base which would provide the total extent of relevant information regarding the skills training required as essential for the adequate planning of courses and skills training required by the different disciplines with the ETDP and to formulate models for improved delivery of quality cooperative education that addresses the knowledge and skills shortages. The overall scope of work and framework of study is shown in Figure 1.0.

## 1.2 Motivation for Study

The current system of co-operative education is distinguished to the extent that no overall vision and strategy guides its development priorities. Construction management and civil engineering programs and qualifications are characterised by the following:

- Being poorly articulated;
- Inhibiting student mobility; and
- High levels of inefficiency

Furthermore, these programs are affected by the following with respect to:

- Quality;
- Standards of provision; and
- Outcomes and curriculum

Generally, separate education and training tracks reflect rigid and outmoded distinction between academic education and vocational training. Consequently, technological and vocational education lack parity of esteem with traditional schooling.

Construction management and civil engineering graduates entering the labour market generally suffer from the following:

- A lack of appropriate knowledge and skills;
- Inability to perform adequately in their chosen careers;
- Limited opportunities for employment; and
- Large-scale needs of those without formal jobs, and whose main hopes of making a living lies in the informal sector and in small and medium enterprises.

On the other hand, construction employers (industry) argue that:

- Many programs offered at Universities are irrelevant and outdated;
- Equipment is antiquated; and
- Tuition is of a poor quality

These following observations are made:

- Black Universities of Technology lack meaningful linkages with industry; and
- Are largely disconnected from the local economy; and

These identified and highlighted problems are exacerbated by low enrolments in engineering and technology, fields essential to the achievement of higher levels of technological innovation, and productivity.

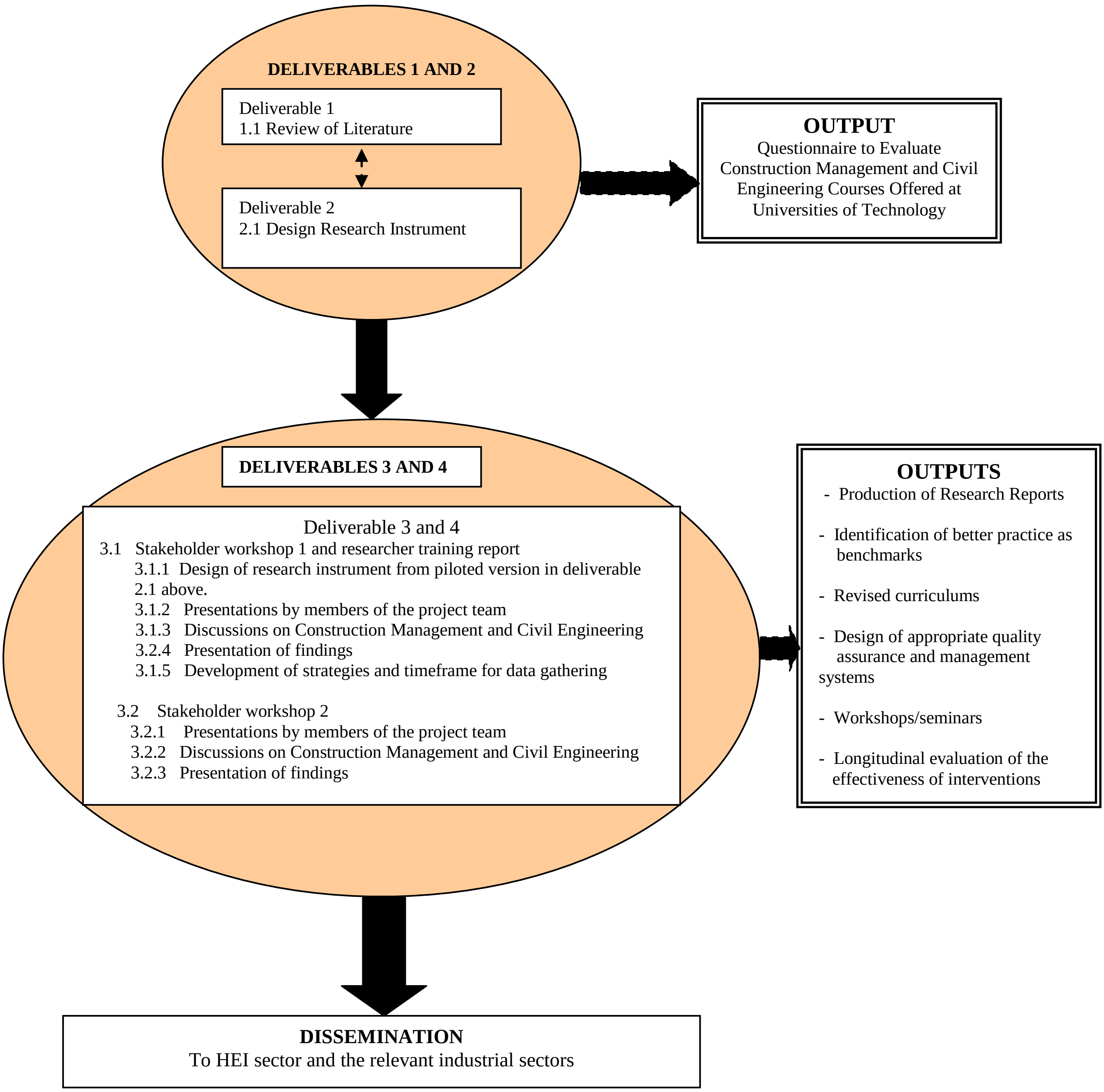


Figure 1. Scope of work and framework of study

## 1.3 Background

The vision of SETA and therefore ETDP is underpinned by the following:

- Development of a sector skills plan within the framework of the national skills development strategy
- Implementation of its sector skills plan by
  - Establishing learnerships;
  - Approving workplace skills plans;
  - Allocating grants in the prescribed manner to employers, education and training providers and workers; and
  - Monitoring education and training in the sector;
- Promotion of learnerships;
- Registration of learnership agreements;

- Application to the South African Qualifications Authority (SAQA) for accreditation as a body contemplated in section 5(1) (a) which relates to overseeing the development of the National Qualification Framework; and sub-section (ii) (bb) of the act which relates to the accreditation of bodies responsible for monitoring and auditing achievements in terms of such standards or qualifications and must, within 18 months from the date of that application, be accredited;
- Collection and disbursement the skills development levies in its sector;
- Liaison with the National Skills Authority on:
  - the national skills development policy;
  - the national skills development strategy; and
  - its sector skills plan;
- Report to the Director – General;
- Liaison with the employment services of the Department and any education body established under any law regulating education in the Republic to improve information
- Appointment of staff necessary for the performance of its functions; and
- Perform any other duties imposed by this Act or consistent with the purposes of this Act.

Against the background of issues identified in the motivational for the study, this research seeks to critically examine and analyze current offerings in the identified fields and professions of construction management and civil engineering at Universities of Technology with a view to formulating models for improved delivery of quality cooperative education that addresses the knowledge and skills shortages.

## 1.4 Overall Scope of Work and Framework of Study

The major activities undertaken and associated steps within each activity and the resultant deliverables achieved in this report are graphically represented in Figure 1.1. Issues associated with the stages (or deliverables) are now discussed as follows:

### 1.4.1 Deliverable 1 - Literature Review

By means of a qualitative approach, the literature was reviewed that dealt with relevant aspects of co-operative education as an instructional approach to built environment education, higher education in South Africa, and the identification of skills necessary in graduates to be meaningfully and gainfully employed in the disciplines of construction management and civil engineering.

### 1.4.2 Deliverable 2 – Design Research Instrument

Aspects identified during the review of literature were discussed and formed the basis of the revisions of the various questionnaires used to evaluate construction management (CM) and civil engineering (CE) courses offered at the former technikons which are now Universities of Technology.

### 1.4.3 Deliverables 3 & 4 - Workshop and Training Report

A series of national workshops were convened that focussed discussions about the disciplines of construction management and civil engineering, and the findings of the study completed earlier as identified in deliverable 2.

### 1.4.4 Dissemination

The printed report provides the primary basis of dissemination of the findings to the co-operative stakeholders. The findings will be presented to a CIOB-Africa sponsored meeting of University Heads of Department offering construction management and civil engineering education programs.

## 1.5 Study Objectives

The primary study objectives were to research and analyse the improvement of educational offerings and experiential training in construction management and civil engineering at University of Technologies. This project sought to address the perceived dissatisfaction with:

1. The quality of graduates emanating from universities of technology in South Africa in the disciplines of construction management and civil engineering; and
2. The experiential learning component of the cooperative education programs designed to produce graduates in the disciplines of construction management and civil engineering.

Further objectives were to assist in the formulation of:

1. An improved model of delivery that addresses these identified areas of dissatisfaction; and
2. Dissemination strategies relative to the findings of the study to the university communities and the relevant industrial sectors.

### 1.6 Expected Outputs

The expected outputs are:

1. To provide information on the status of CM and CE education at UoTs to stakeholders;
2. The identification of the skills and attributes needed by graduates from CM and CE programs at UoTs;
3. Produce a formal report on the findings of the study; and
4. Publication of findings in the form of conference papers and journal articles.

## 2.0 POLICY CONTEXT FOR EDUCATIONAL OFFERINGS

### 2.1 Introduction

The previous section focused on the general introduction, which highlighted the motivation for the study, the terms of reference and project objectives. This section provides a general overview of the educational offerings within Universities of Technology and government policies that inherently affect or contribute to the improvement of educational offerings and experiential training in construction management and civil engineering at these institutions. In particular it addresses the following questions: What role can the institutions play in providing the technological and business capability as required of modern and service development? To what extent can the aspirations outlined in the White Paper (1997) be achieved? How can the perceived mismatch be narrowed down between what employers appear to want and what higher education provides. What is the most suitable instructional model for delivery of construction management and civil ngineering programs at Universities of Technology? The approach adopted is similar to that of the National Advisory Council on Innovation (2003).

### 2.2 Educational Offerings

The SA Construction Industry Status Report of 2004 acknowledges that skills enhancement in the construction industry faces a very particular challenge since the construction sector employs the fourth highest number of persons having no formal education (CIBD, 2004)

With respect to higher education in South Africa, the challenge is to redress past inequalities and to transform the higher education system to serve a new social order, to meet pressing needs, and to respond to new realities and opportunities (White Paper, 1997). Institutions serving this education sector have a major role to play in providing the technological and business capability to underpin modern industrial and services development (Frain, 1992). Higher education reaches and trains people to fulfil specialized social functions, enter the learned professions, or pursue vocations in administration, trade, industry, science and technology and the arts (White Paper, 1997). While maintaining the commitment to high academic standards, HEIs also need to be committed to responding to the needs of industry both in terms of course content and research. Further, higher education must provide education and training to develop the skills and innovations necessary for national development and successful participation in the global economy. It is South African government policy that cooperative education should bridge the minds of students at higher education institutions and the industry in which they hope to develop their future careers. To achieve this national objective, institutions of higher education have to pursue strong relationships with, and input from, stakeholders and industry concerning their fields of study. These industry-sensitive programs must be designed to help students in their transition from school to the work place. Therefore, cooperative education in South Africa must be seen against the backdrop of several initiatives such as the:

- Ongoing review of the curriculum structures of educational offerings at HEIs; and
- National Department of Education recommendations for four-year undergraduate degrees to be introduced in selected HEIs with a view to meeting the demands of the market (Dewar and Shippey, 2002).

The report of the National Department of Education, entitled 'Towards a New Higher Education Landscape: Meeting the Equity, Quality and Social Imperatives of South Africa in the Twenty-First Century' (Republic of South Africa, 2000) emphasizes the need for rationalization of resources and quality assurance. Dewar and Shippey (2002) contend that in it, the task team proposed that provision should be made for the introduction of a four-year first bachelor's degree. The first two years of the degree could provide for the development of required generic and foundation skills and include some broad discipline and multi-discipline-based knowledge. Years three and four of the degree could include a strong emphasis on single discipline and multi-discipline-based specialization, including an introduction to elementary forms of investigation and research methodology. They suggest that, a strong co-operative programme would meet the criteria of, *inter ali*a, overall coherence, well-structured core course requirements, sufficient formative electives to provide variety and depth, flexibility to adapt to new needs and opportunities, recognized exit standards, appropriate external evaluation, and a strong ``taproot'' to postgraduate studies. Other, more generic criteria should include requirements for excellence and equity, provision of transferable and disciplinary skills, and the potential to play an active developmental role in Africa.

Industry employer representatives suggest that education and training offered at higher education institutions such as the former Technikons are inadequate for the needs of their industries (Haupt, 2003). They argue that graduates lack the necessary theoretical skills, training and managerial understanding to ensure immediate meaningful employment creating a mismatch between what employers appear to want and what higher education provides (Graham and McKenzie, 1995). This mismatch contributes to unemployment and the lack of advancement opportunity. The former technikon built environment graduates are ill prepared to contribute to the economic growth of the country, less able to adapt to new skills, and less able to respond to the speed of technological advance (Haupt, 2003). Higher education institutions are therefore faced with both challenges and opportunities to contribute to the realization of national economic priorities through relevant cooperative education programs.

Employers argue that many programs offered at the former technikons, in particular, are irrelevant and outdated. Equipment is antiquated and tuition is poor overall quality. Historically disadvantaged institutions (HDIs) lack meaningful linkages with industry and have largely been disconnected from the local economy. The converse is true of previously advantaged institutions (PAIs) that have optimised their links with industry to secure access of their graduates to the labor market and economy. Institutional redress of the inherited inequalities between HDIs and PAIs as envisaged while not necessarily intensifying has not diminished (Haupt, 2003). Consequently, a distorted labor market is perhaps the most visible legacy of apartheid – a system designed to empower a minority by the exclusion and subsequent marginalization of the majority. These problems are exacerbated by low enrolments in engineering and technology – fields essential to the achievement of higher levels of technological innovation and productivity (White Paper, 1997). Additionally, there is the perception that construction students attending HDIs are less prepared for the world of work than their counterparts at PAIs. This perception affects their access to suitable industry placements (Haupt, 2003).

### 2.3 Current University of Technologies Instructional Model

In South Africa, Universities of Technology offer construction-related programs on the basis of cooperative education. The four-year Bachelor of Technology program is made up of three academic years spent full-time at the institution with the second year spent full-time working in industry. During this "experiential year" students complete projects in 2 or 3 subjects. Students are also required to keep a logbook of all their work activities on a monthly basis. The logbook sets out the required activities that students are expected to experience. In order to return to the institution to complete the remaining two years students have to obtain passing grades in each of these subjects as well as submit a duly completed logbook. Students may also be required to do an oral presentation of work completed during the experiential year.

## 3.0 TYPES OF EXPERIENTIAL TRAINING

### 3.1 Introduction

This section reviews international literature to examine various definitions of and approaches to experiential training relative to construction management and civil engineering.

### 3.2 Types of Experiential Learning

According to literature, much of experiential learning is actually about learning from primary experience, that is learning through sense experiences. Various definitions of 'Experiential Learning' abound in literature. The following sub-section presents examples of them.

Weil and McGills (1986) categorise experiential learning into 'four villages'.

- Village One is concerned particularly with assessing and accrediting learning from life and work experience.
- Village Two focuses on experiential learning as a basis for bringing change in the structures of post-school education
- Village Three emphasises experiential learning as a basis for group conscious raising
- Village Four is concerned about personal growth and self-awareness.

Kolb and Fry (1986) identified four basic learning styles as shown in Table 2 which summarises the learning styles and characteristics.

Table 2. Style and learning characteristics

| Learning Style | Learning Characteristic | Description |
|---|---|---|
| **Converger** | Abstract conceptualization and active experimentation | • Strong in practical application of ideas<br>• Can focus on hypo-deductive reasoning on specific problems<br>• Unemotional<br>• Has a narrow interest. |
| **Diverger** | Concrete experience plus reflective observation | • Strong imaginative ability<br>• Good at generating ideas and seeing things from different perspectives<br>• Interested in people<br>• Broad cultural interests |
| **Assimilator** | Abstract conceptualization plus reflective observation | • Strong ability to create theoretical models<br>• Excels in inductive reasoning concerned with abstract concepts rather than people |
| **Accommodator** | Concrete experience plus active experimentation | • Greatest strength is doing things<br>• More of a risk taker<br>• Performs well when required to react to immediate circumstances<br>• Solves problems intuitively |

Figure 2 highlights the four phases of the learning cycle as suggested by Kolb (1984).

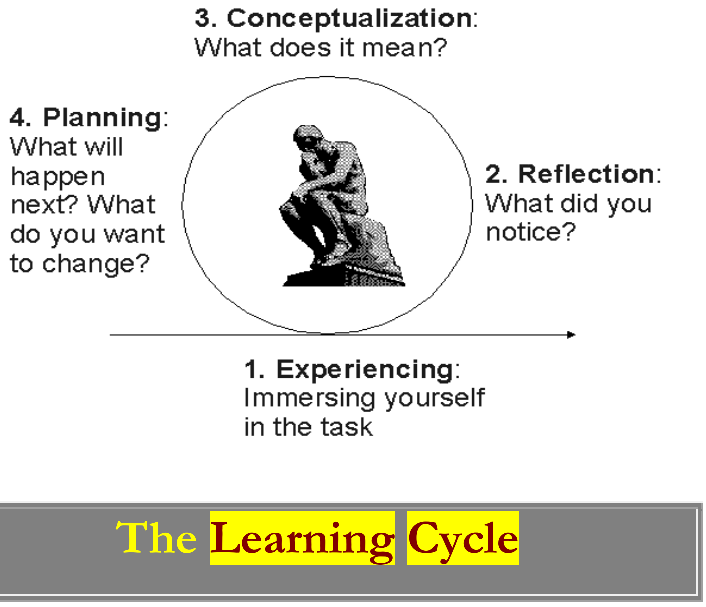


Figure 2. Experiential Learning: Experience as the Source of Learning and Development.
*(Adapted from Kolb, 1984)*

- ***Experiencing***

Experiencing or immersing oneself in the "doing" of a task is the first stage in which the individual, team or organization simply carries out the task assigned. The engaged person is usually not reflecting on the task at this time, but carrying it out with intention

- ***Reflection***

Reflection involves stepping back from task involvement and reviewing what has been done and experienced. The skills of attending, noticing differences, and applying terms helps identify subtle events and communicates them clearly to others. One's paradigm (values, attitudes, values, beliefs) influences whether one can differentiate certain events.

- ***Conceptualization***

According to Kolb (1986), conceptualization involves interpreting the events that have been noticed and understanding the relationships among them

- ***Planning***

Accordingly, planning enables taking the new understanding and translates it into predictions about what is likely to happen next or what actions should be taken to refine the way the task is handled.

The lesson to be drawn from Kolb’s learning cycle is its applicability to the experiential learning component by the three collaborative partners in the co-operative education. The following similarities can be observed in the current co-operative education model in South Africa:

The “Experiencing” stage can be equated to the first or second years of the construction management and civil engineering programs in which students perform normal academic tasks such as completion of assignments and tasks associated with the various subjects in the curriculum. At this time as pointed out by Kolb (1984), students go through the motions of completing the tasks without reflecting on why they are doing them. However, the time spent in industry completing the experiential training component avails them the opportunity to “reflect” where they effectively relate to or experience the similarities between the theoretical aspects as taught in the classroom environment and the applied aspects as demanded by industry.

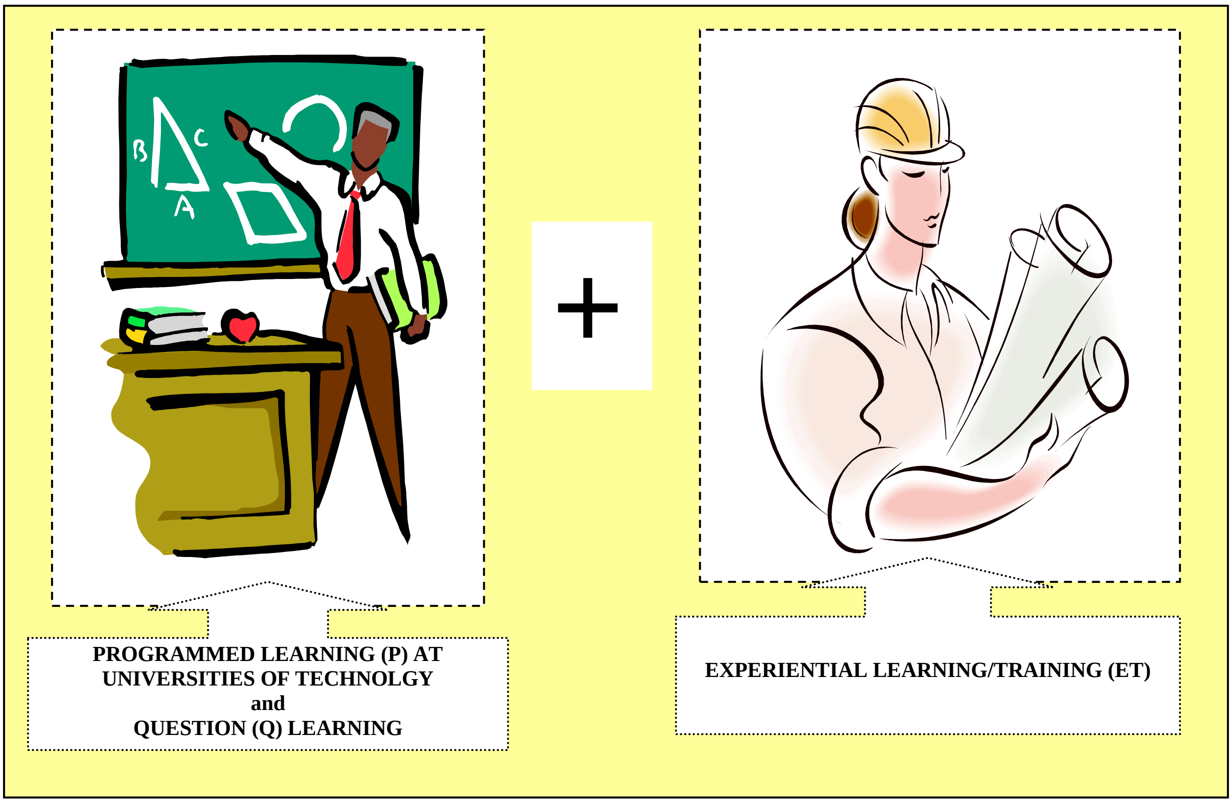


Figure 3. Experiential Learning within Construction Management and Civil Engineering

Figure 3 could be represented by the following formula adapted from Hicks (1996) where the traditional "learning" (L) is composed of two elements namely;

- Programmed Learning (P) or material presented in structured programmes (Civil Engineering or Construction Management)
- Questioned Learning (Q) or knowledge and skills gained via questioning and investigation

Thus P + Q = L (Hicks, 1996)

And the experience gained from the industry would constitute Experiential Learning (ET), therefore

P + Q + ET = L ...................................................................................................Equation 1

According to Davison (1999), the education and training of civil engineers has traditionally involved lectures, tutorials and on-site experience, relying heavily on personal communication between students and teachers. The reference to 'on-site experience' by Davison can be equated to the 'experiential learning or training as inferred in this study.

As observed by Lundall (2003a), the concept of co-operative education can be maintained by combining the principles of the theoretical knowledge with the practice of learning and confirming the basis of such theoretical knowledge through the lessons of application.

The programmed learning at Universities of Technology, therefore, expound on the principles of theoretical knowledge, whereas confirmation of such learning takes place in the experiential training period in industry through application.

However, at Sheffield Hallam University Hill (2001) raised several issues regarding work based learning relative to construction management education. The primary concern was that the topic content and the desired technological knowledge were largely outside the control of the HE institution. Further, there was the lack of control from HEIs over the learning process during the experiential period.

## 4.0 PRELIMINARY LITERATURE REVIEW

This section reviews international literature to examine various definitions of construction management and civil engineering relative to the skills and knowledge areas that need to be addressed. The necessary attributes and skills of Construction Managers and Civil Engineers are specifically reported on. The section is structured as follows:

- The background to the development of construction management in the South African context is presented;
- The necessary construction management skills and knowledge are identified from literature.

Particular attention is also given to the following areas; problems and concerns, relevance of construction courses, quality assurance issue with a summation of the issues raised pertaining to construction management. A similar structure is adopted for presenting the historical development of civil engineering courses within the context of South Africa.

This discussion is followed by an examination of literature pertaining to various concepts such as ‘work placement’, ‘co-operative education’ and the various classifications of learning. The section concludes with the identification of the necessary skills, attributes and qualities of an Engineer.

### 4.1 Introduction

Before attempting to examine any aspects such as the improvement of educational offerings and experiential training in construction management and civil engineering at universities of technology, it is necessary to recognize and identify the various ranges of skills and knowledge required for each discipline (Dorsey, 1991; Young and Duff, 1990, CIOB, 1999).

### 4.2 Construction Management

Construction education at Technikons/Universities of Technology (TUT) in South Africa is based on the cooperative education model. This cooperative education model, pioneered at the University of Cincinnati in 1996 by Professor Herman Schneider (Collins, 1986), embodies the notion that both education and training are equally essential. Education refers to all the ways in which students train and develop to fulfil their potential realized as a result of acquiring skills, attitudes and values which not only reflect the needs of the industry, but also the social, cultural and physical environment in which students live (Guuillaud and Garnier, 2001).

Since the 1980s construction management has emerged as a separate distinct profession with institutions such as the Chartered Institute of Building (CIOB) supporting and recognizing its important role in the construction industry. From that time when construction management was recognized as a professional discipline, undergraduate and postgraduate degree courses have proliferated all over the world. Additionally, the discipline has steadily gained status and recognition in the eyes of industry clients and other built environment professionals (Fryer, 1997). Construction management (CM) has been defined as:

“The application of advanced expertise in the theory and practice of management relating to the construction procurement process and the construction organization as a business enterprise.” (Fryer, 1997)

Within South Africa, in 2002 an interim Executive Committee was formed to consider the merits of creating a Association of Construction Project Managers. The formation of the Association was suggested and supported by the South African Property Owners Association (SAPOA) Building Development Committee. From the onset the founding members were emphatic that the Association should not be an 'old boys club' and should restrict entry to only those who are suitably qualified and practicing in the field of Construction Project Management.

The discipline of construction management is vocational in nature, which results in conflict between vocational and academic objectives, educationalists continually being criticised either overtly or implicitly that the content and approach of undergraduate courses does not meet the needs of practice (McGeorge, 1993). Similarly, civil engineering is a vocational discipline. However, Harriss (1996) maintains that higher educational institutions (HEIs) should be producing graduates who have the initiative, drive and ability to change the industry. Instead "graduates simply blend in and go with the flow". He contends that current undergraduate construction management education has not added value and produced a healthy industry. Furthermore, Smith (2001) reports that graduates from all the disciplines must learn to create employment.

Smallwood (2002) argues that construction management undergraduate programmes need to focus on management, and more specifically the management of resources within defined parameters such as, for example, cost, health and safety, productivity, quality, schedule and the environment. However, to be able to manage resources within defined parameters requires technical expertise relative to the construction process. Studies clearly indicate the need to empower graduates to improve aspects of the construction process such as customer service, health and safety, productivity and quality management. Complementary issues need to be addressed such as: benchmarking, constructability, partnering, procurement systems, re-engineering and value management.

Undergraduate construction management programmes are disassembled into discrete subjects with a single focus. This bears no relation to the way graduates use their knowledge. Harriss (1996) in fact maintains "A graduate does not walk over a freshly stripped suspended slab and think now I'm doing 'Structures 1', only to return to the site office and do some 'Contract Administration 1' or some 'Estimating 2'." A further argument of Harriss (1996) is that undergraduate construction management education should aim to educate a 'general practitioner' in construction who will become a specialist through postgraduate study and working with specialists.

Since students entering HEIs are often ill-prepared for the demands and rigor of higher education academic programs, Steyn (1999) proposes a framework for the design of professional development programmes in institutions to ensure effective learning as a solution to the poor teaching and learning cultures in many South African schools. Such an intervention would additionally foster lifelong learning that is both a governmental objective and a necessity in an industry as dynamic as construction.

### 4.2.1 Construction Management Skills and Knowledge

According to Love, Haynes and Irani (2001), essential personal attributes sought by employers of construction management graduates include intelligence, flexibility, adaptiveness, and the ability to deal with uncertainty and rapid change. They further argue that these graduates need to possess critical skills to enable them to work effectively and efficiently with other participants in the construction process. Construction managers acquire these skills through education and training. The present pedagogic approach of cooperative education followed by Unversity of Technologies embodies the notion that both education and training are equally essential (Haupt, 2003). Construction management graduates need to possess three essential skills, namely practical experience, management tools and techniques, and interpersonal skills (Sears and Clough, 1991). Several skills were identified by Love, Haynes and Irani (2001) which included academic achievement, acceptance of responsibility, adaptability to changing work environments, computer literacy, time management, leadership capability, numeracy, communication, problem solving, environmental awareness, teamwork, and trust and honesty. In their study they found that graduates needed a degree of specialist knowledge, an understanding of information and communication technologies (ICT), ability to communicate, and problem solving skills. Murdoch and Hughes (1996) suggested that construction management practitioners needed to possess a body of knowledge or expertise, hold appropriate professional qualifications, provide a service to the public, and hold mutual recognition of other disciplines.

In the context of growing market demand and attempts by the tertiary education system to meet both the requirements of the market and establish and maintain standards commensurate with responsibility to clients, areas of core competence in the disciplines of construction management and civil engineering need to be identified (Dewar and Shippey, 2002).

Table 3. Ranking of skills for Senior Construction Management

| **Skill** | **Ranking** |
|---|---|
| Numerical | 1 |
| Written communication | 2 |
| Oral communication | 3 |
| Graphic communication | 4 |
| Financial management | 5 |
| Planning and control | 6 |
| Ethical decision making | 7 |
| Leadership | 8 |
| Personnel | 9 |
| Manual | 10 |

*(Source: Dorsey, 1991)*

Research conducted in the United States of America by Dorsey (1991) resulted in the composite summary ranking of skills identified for the positions/functions which require college level certification, senior executive through field engineer (Table 3). Although it may be arguable that the rankings can be adjusted by one notch in either direction, the key point is that the first five skills had strong support among respondents. Smith (2001) concurs that HEIs should develop students` communication skills, analytical abilities and help them become creative with information.

Cecere (1987) conducted research among members of the Associated General Contractors of America (AGC) to determine what was important in two-year college construction curricula. The findings of that study suggest that a strong foundation in communication, mathematics and physics, as well as a basic computer science should be included as part of general educational courses. Emphasis in construction subject areas is important along with basic and applied engineering courses in drafting, surveying and plan reading.

Table 4. Skills and knowledge areas for each levels of construction manager

| **Skill / Knowledge** | **Ranking** | | |
|---|---|---|---|
| | **Junior** | **Middle** | **Senior** |
| Supervision | 1 | 2= | 1= |
| Communication | 2 | 1 | 1= |
| Motivation | 3 | 2= | 1= |
| Leadership | 4 | 2= | 4 |
| Organisation (site) | 5 | 6 | 44 |
| Health and safety law | 6 | 13 | 9 |
| Programming | 7 | 5 | 10 |
| Maintenance | 8 | 7 | 24 |
| Quality assurance | 9 | 8= | - |
| Human resource planning | 10 | 10= | 20 |
| Budgetary control | 13 | 8= | 6= |
| Competitive tendering | 42 | 23 | 5 |
| Costing and estimating | 20 | 18 | 6= |
| Analysis of project risk | 24 | 16 | 8 |

*(Adapted from Young & Duff, 1990)*

Young and Duff (1990) conducted research among three small, six medium and two large United Kingdom building and/or civil engineering contractors to establish an appropriate body of skills and knowledge for three levels of construction management, directors and senior managers. They determined that regional or divisional responsibility constituted level one; middle managers who essentially co-ordinate between head office and site constituted level two; and level three consisted of site personnel. They identified and ranked 56 skills and knowledge dimensions. Table 4 only shows the ranking of some of these.

Supervision, motivation, leadership and communication, namely the interpersonal skills are ranked in the top four positions for all levels of construction management (Table 4). Junior and middle managers reported that skills and knowledge in operational programming, labour forecasting and organisation, and managing of other resources were the next two most frequently required. They also needed to be knowledgeable in the management of quality. Health and safety law was a concern for all levels of management. Senior management placed more emphasis on competitive tendering, budgetary control, costing and estimating, and analysis of project risk. Financial control was also recognised as part of the middle and junior manager duties (Table 4).

Personal organization, communicating, engineering awareness, the ability to deliver on time, communication, and performance monitoring are some of the skills required of graduates. However in tandem with a degree, graduates should be empowered to create employment provided they have the necessary communication skills, analytical abilities and a strong code of ethics (Smith, 2001).

A curriculum pattern outlined by Benning (1990) includes mathematics to stir the thought process for factual reasoning; English, public speaking, social studies and the humanities to reinforce human relationships and communication skills; construction design to enable an understanding of the parameters governing sound construction; business and management to enable an understanding of the economic system and the principles of sound business management, and construction methods and technologies to give the graduate constructor a rudimentary knowledge of the knowledge and skills required at entry level positions . Hannah and Barlow (1995) recommend that a course in value engineering be included in Built Environment tertiary education to provide some of the basic tools of creativity and team building so that a graduate enters the workforce with these skills and a strong desire to use them.

Smith (2003) who contends that although career orientated training equips learners for a specific career the unique nature of the construction process entails the management of complex projects, which requires the co-ordination and co-operation of vendors, suppliers, and subcontractors.

Table 5. CIOB Professional Competencies

| **No** | **Competency** |
|---|---|
| 1. | Decision Making |
| 2. | Communicating |
| 3. | Managing Information |
| 4. | Planning Work |
| 5. | Managing Work Quality |
| 6. | Managing Health and Safety |
| 7. | Managing Resources |
| 8. | Assess Environmental Risk Factors |
| 9. | Managing Costs |
| 10. | Assess Environmental Risk Factors |

*(Source: CIOB 1999)*

According to Benning (1990) the first necessity to achieve cohesion between the BE disciplines will be that constructors relinquish their traditional reliance on designers and develop the capability to co-ordinate the entire construction process from design through to completion. The role of the construction manager should, therefore, include the professional competencies as shown in Table 5. into the learning outcomes which would impact upon the educational curriculum.

The professional competencies shown in Table 5, although drawn from the Chartered Institute of Building (UK), were included in the 37 key skills and attributes investigated in this project. For example the competency relating to 'decision making' is equally matched in Table 18 dealing with the desirable skills and attributes of Construction Management graduates. Similarly, communication is matched by 'written communication skills'

### 4.2.2 Problems and Concerns

In a recent study in the Border/Kei region Manthe and Smallwood (2003b) encountered several problems both systemic and otherwise that directly impacted the academic experiences of first year National Diploma Building students. Since Xhosa speaking students from rural areas predominated in terms of cultural factors, urban multi-cultural areas constituted a challenge to such students. Consequently students had great difficulty in adapting to the new and challenging environment. This finding concurs with that of Phungula (2000) and Myburgh and Grobler (1996) who examined the effect of cultural factors on the academic progress and level of achievement of students.

Manthe and Smallwood (2003b) identified that since employment opportunities in construction were limited in the region, securing employment would be difficult. They also noted that mathematical skills were generally poor with only 5 % of the respondents in their sample having completed mathematics to an acceptable level. This response corroborates the concern regarding the standard of mathematics at schools, raised by, inter alia, Grey's (2000) report that enrolments for the matriculation examinations have declined by 11 percent over a three-year period. Data from the Engineering Council of South Africa (ECSA) indicate that 37% of all engineering disciplines registered with ECSA are in the civil engineering discipline (ECSA, 2003). Further, 2.8% of all registered professional civil engineers are Black. While the intake of candidate engineers appeared to be improving in 2003 (23.8%), the total number of Black engineers-in-training was only 161 persons. Other ECSA statistics show an increase in Black civil engineers from 154 (2%) to 170 (3%) in 2003. The Civil Engineering and Building Contractor (1999) cites the alarming tendency by schools to encourage competent grade 12 students, with potential to become professionals in the science and engineering fields, to change to standard grade mathematics. The situation is exacerbated by varying degrees of financial hardship confirming the need for bursaries and scholarships and part-time employment to alleviate financial pressures of studying at HEIs.

The scarcity of suitable affirmative action candidates for senior management positions in the construction industry is exacerbated because the number of candidates is limited and such candidates are in demand (Tasmer, 1999). Despite affirmative action related legislation, and opportunities available in the construction industry only a small number of graduates are successfully integrated into the construction industry. During their programs of study they do not receive optimum support from the South African construction industry (Manthe and Smallwood, 2003). Insufficient work, lack of knowledge, and the need for their work to be rechecked were cited as the predominating inhibiting reasons with respect to employing students.

### 4.2.3 Relevance of Construction Courses

The creation and establishment of a national qualifications framework (NQF) represents an attempt by the state to impose curriculum changes on tertiary education institutions in the hope of providing more appropriate programs, courses and instructional strategies (van der Vyver, 1999). A reported deficiency in BE programs is a need to become more mature in electronic business methods in order to compete in the global economy (Malherbe, 2002).

There are changes in virtually every aspect of the industry. However, Runeson (1993) notes with concern a survey, which revealed that schools of building are not at the forefront of highlighting and promoting the changes taking place in industrial relations, skills formation, communications and procurement methods.

McGeorge (1993) questions whether vocational courses in the BE have a problem of relevance as graduates are unable to communicate effectively or adapt to challenges. This concern is confirmed by the warning issued to the former Technikons and other institutions in connection with their product (Butt, 1993).

Anecdotal evidence suggests that construction generally lags ten years behind manufacturing. Although the results of a survey conducted by Nkado (2001) to determine required competencies indicated that all the competencies listed were rated at above average in terms of importance, respondents perceived that practitioners only displayed above average competency relative to 39% of these.

Given that talent, skill, qualification and experience improves marketability (Flood, 2002), tertiary institutions should play a role in educating and developing skills and should emphasize the changes taking place in the BE (Architect & Specificator, 2001). However empowerment initiatives are hampered when there is a scarcity of suitable candidates (Pretorious, 1996).

#### 4.2.4 Quality Assurance Issues

Education quality management is proposed by Ngwira and Mwandemela (2001) to assess the quality of teaching and learning which will reassure employers and other stakeholders that the need for high quality, trained and appropriate personnel is being met. Quality management is ensuring that standards are specified and met consistently for a product or service. Quality assessment is the judging of the standards reached by an organization against external criteria.

Kapp (2001) concludes that performance management and performance appraisal are part of the modem corporative, entrepreneurial university. To ensure national and international credibility the SAQA Act prescribes a quality assurance management system that ensures stakeholder involvement, mechanisms for accreditation and the maintenance of quality unit standards.

### 4.3 Views on Training

Training according to the Committee for Tutorial Matters (CTM) Standing Committee: Co-operative Education (2000) refers to experiential and co-operative education and is defined as a method of education, which combines learning in the classroom with learning in the workplace.

Education has been described as all the ways in which people train and develop to fulfil their potential as a result of acquiring skills, attitudes, and values which reflect the social, cultural, and physical environments in which they live (Guillaud and Garnier, 2001). Training, on the other hand, is the systematic development of attitudes, knowledge and skill patterns required by an individual to perform adequately a given task or job. Cooperative education, therefore, aims to prepare people for the world of work within their socio-civic environments. Successful co-operative education programmes are seldom critically examined (Schaafsma, 1996).

Industry placement or “work placement” which is often integral to a co-operative education program is the term used primarily in the United Kingdom to describe a period of time when the student is located in the work-place with the purpose of learning on the job. The placement may be paid or unpaid (Schaafsma, 1996). This particular approach provides opportunities for students to have hands-on experience as part of their course of study. In this way students are prepared for their future careers. They acquire valuable and specialized knowledge and skills by learning from experience and reflecting on that experience while becoming acquainted with the work processes (Hicks, 1996; Rainsbury et al., 1998). This form of experiential learning may be expressed as the combination of three elements, namely programmed learning in structured settings, questioning learning gained via investigation and research, and own experience (Hicks, 1996).

Workplace learning refers to a range of learnings (knowledge, skills and attributes) that are a direct outcome from linking the specific experience in the workplace with the course content provided in a higher education institution (HEI). Workplace learning provides the underpinning knowledge and attributes of competence needed for the job as a whole such as, for example, aspects of work-place culture, work norms and values (Gillen, 1993).

### 4.3.1 Co-operative Education within the Construction Management and Civil Engineering

Cooperative education is classified as Mode 2 knowledge in that it is characterised by the proliferation of knowledge production in the context of application, which is mostly problem-specific and guided by the requirements of practical relevance such as a specific industrial sector. According to Kivinen and Ristelä (2002), knowledge as an abstraction unconnected with action is futile. Therefore, knowledge is first and foremost a matter of doing. More recently, Nowotny, Smith and Gibbons (2001) have introduced the concept of contextual knowledge, the value of which is mainly defined by its social relevance, and hence ultimately on the basis of supply and demand which is determined and driven by industry.

Apart from co-operative education contributing to more effective learning (Schaafsma, 1996) it also has the potential to be mutually beneficial to both students and employers (Frain, 1992). Employers benefit from having a significant influence on course design and content by ensuring that industry-specific knowledge, awareness and values are integrated into the higher education process. Students benefit from working as they experience firsthand and come to understand the requirements of their chosen career. As they engage in the actual activities in the workplace they gain appreciation for the challenges of their particular job (Ross and Elechi, 2002). They are consequently better able to make informed decisions on their career choices. They also develop enhanced appreciation of concepts learnt in the classroom after applying knowledge in a professional setting (Gordon, Hage and McBride, 2001). This working or in-service period is often the students' first opportunity to apply theoretical, classroom-based knowledge in a practical work situation. They gain a more realistic view of how the world of work operates. Work experience is often a strong determining factor in whether or not students find employment. Co-operative education provides the opportunity for students to enhance their prospects of employment once they graduate (Frain, 1992). They are given the opportunity to demonstrate their abilities to prospective employers. Through this approach, they already have work experience at the moment of academic graduation. Students are introduced to the work ethic, and gain insight into the interpersonal skills needed to survive in the working world (Schaafsma, 1996). They see the opportunities for career development and personal growth that are open to them in their field of study.

The academic institution evaluates both components using feedback from students through academic evaluation programs and feedback from employers through records of employment activities. Several authors have argued for a more inclusive and participatory approach to evaluation that includes the academic institution, the employer and the student (Hicks, 1996; Rainsbury et al., 1998). The collaboration between the academic institution and employers emphasizes the connection between academic preparation and job requirements. It is argued that such a co-operative approach offers greater opportunities to blend academic and practical skills. A broad range of activities is required, therefore, to connect academic institutions and the modern work environment. These activities provide program co-ordination and integration of the worlds of school and work.

Several authors have argued that apart from course content relevant to job-related situations, there should be an appropriate teaching approach that bridges the perceived gap between formal academic instruction and on the job training (Kim, Williams and Dattilo, 2002; Sanyal, 1991; Ellington, Gordon and Fowlie, 1998; Schaafsma, 1996). Cooperative education is an educational model designed to achieve the objective of bridging the gap between the classroom and the workplace by incorporating productive work experiences into the curriculum as an integral and regular element of a higher education program.

The separation between practical and academic work creates a division in the mind of students rather than relating the theory to the application that reinforces the basic concepts taught in the classroom. There are few studies, if any, and even less published research that evaluates the relationship between construction theory as taught in the classroom and construction practice in the field.

Manthe and Smallwood (2003a) discuss the classification of learning approaches as either deep or surface learning. A deep approach is typified as an intention to understand and seek meaning, to relate concepts to existing experience, distinguish between new and existing ideas and critically evaluate and determine key themes and concepts. A shallow or superficial approach is typified by an intention to complete the task, memorize information, make no distinction between new ideas and existing knowledge, and to treat the task as externally imposed (Fry, Ketteridge and Marchall, 1999). Experiential learning can be linked to the deep approach and has a holistic nature of combining experience, perception, cognition and behaviour. Moreover, it is about a process of learning where ideas are formed and reformed through experience, a process that permits adaptation (Chell, 2001). A compatible delivery method suitable for the different personalities of learner may be selected from the following: project work; action learning (Mc Gill and Beaty, 1995); simulation (Fry et al., 1999); field trips and work based learning. More recently, 'Webucation' allows for the improvement of skills without having to physically attend a course (Cook, 2001) and the potential of this delivery method is seen by others as limitless (Construction Computing, 2001)

The move from education to work is a time of major change for any person. For new graduates, often with little practical experience of the world of work save possibly a brief industry placement, the transition to full-time employment can be particularly difficult. After perhaps 16 years of formal education, their expectations naturally tend to be high, though their feelings of optimism will be balanced by the natural apprehension associated with such a major change in their life (Graham and Mackenzie, 1995). Considering that the culture in a workplace is vastly different from that on a HEI campus it must be thoroughly understood by new graduates or they will be doomed to fail due to inability to adapt on the one hand and need to translate theoretical academic knowledge into practice on the other.

The four stages that new employees such as construction management and civil engineering graduates experience when they join a new company according to KPMG (1993) are:

*Uninformed optimism.* The new graduate feels positive about the change and themselves. They are happy to have a job and look forward to this new stage of their lives. They may feel apprehensive but generally this is out-balanced by their optimism and confidence that things will be as they have been promised.

*Informed pessimism.* After some time in this new environment their commitment takes a plunge. They might begin to question their ability to cope with such a big change in their lives. They will begin to notice things in the company that seem wrong or stupid to them. The political side of organizations, the paperwork and procedures might be difficult to get to grips with.

*Hopeful realism.* At this stage, they will have gotten over the initial shock, will have found some allies in the organization and will begin to understand how the system works. The work routine will seem more normal.

*Informed optimism.* At this stage they will have seen projects through and will see the way forward to being successful. They will see the opportunities open to a positive, capable and well-motivated person.

Therefore it is necessary to understand how the education system prepares students for the world of work. The basic premise is that the problems of transition will be minimized – and the graduates' performance increased – if their education has prepared them effectively for work. Thus there are two key issues, namely,

1. Appropriateness of ways of working and learning in higher education; and
2. Match of knowledge and skills to employers needs.

Taking the first issue, there are clearly significant differences in ways of working and learning in higher education compared with work. For example:

- At HEIs, students really work for themselves to achieve passing grades, whereas at work they will have to report to a manager or supervisor; and

- At HEIs, there is peer-group security, with other students around while in the workplace there will be many different types of people, of different ages with different levels of education and different backgrounds.

In several studies employers noted that more opportunities for work placement during the students' courses would be beneficial and ease their transition into the workplace upon completion of their formal academic programs at HEIs. Spencer (1992) and Blakey (1992) cite the value of work experience for building students, and the CTM Standing Committee: Co-operative Education (2000) maintains that there are advantages of co-operative education for all the role players involved in experiential training. Although literature amplifies the importance of optimum experiential training / co-operative education, students do not gain meaningful practical experience, nor sufficient opportunity to apply their acquired knowledge during their experiential training year in industry while at the Technikon (Manthe and Smallwood, 2003b). In their study, Manthe and Smallwood (2003b) found that students did not rate their lecturers highly and questioned their subject knowledge. Further their orientation to experiential training often only entailed visits to sites. Students wished to be perceived as part of the work environment during experiential training, and were proactive with respect to endeavours to secure employment. However, less than half of them secured work within three months of initiating such an endeavour. Students were not well paid and primarily assisted with various tasks, as opposed to being responsible for them. Students were given limited opportunity to gain experience or apply acquired knowledge.

Over the last ten years, it seems that ways of learning in higher education are gradually getting closer to the needs and methods of the real world. However, studies (Smallwood, 2002; Fester and Haupt, 2003) have shown that there still is a mismatch between what employers appear to want and what higher education provides.

#### 4.3.2. The Skills, Attributes and Qualities of an Engineer

Engineering is a profession directed at the skilled application of a distinctive body of knowledge and understanding based on mathematics, science and technology, integrated with business and management, which is acquired through education and profession formation in a particular discipline.

The following highlights the general areas that engineering students at honours level need to foster, namely

- Knowledge and understanding
- Intellectual abilities
- Practical skills; and
- General transferable skills

Furthermore, to enable students to become effective engineers, they need to develop certain qualities of mind, through the study of engineering. They need to become

- creative, particularly in the design process;
- analytical, in the formulation and solution of problems;

- innovative, in the solution of engineering problems and transfer of technology;
- self-disciplined and self-motivated, in the pursuit of their studies and professional practice;
- of an enquiring mind, eager for new knowledge and understanding;
- independent of mind, with intellectual integrity, particularly in respect of ethical issues; and
- enthusiastic, in the application of their knowledge and understanding and skills in the pursuit of the practice of engineering and promotion of the engineering disciplines.

Table 6 summarizes the key skills required in Engineering Graduates

Table 6. Key Skills required in Engineering Graduates

| No | Key Skills |
|---|---|
| 1. | Communication |
| 2. | Using Information Technology |
| 3. | Team working |
| 4. | Time management |
| 5. | Appropriate understanding of the legislative and environmental framework in which the engineering process is executed. |

*(Source – Engineering Council, 2000)*

### 4.3.2 Key Abilities of Engineering Subjects

The Engineering Council (UK) identified the following as the key abilities of engineering students:

- Business Management;
- Accounting and Financial Ability;
- Project Management;
- Quality; and
- Marketing.

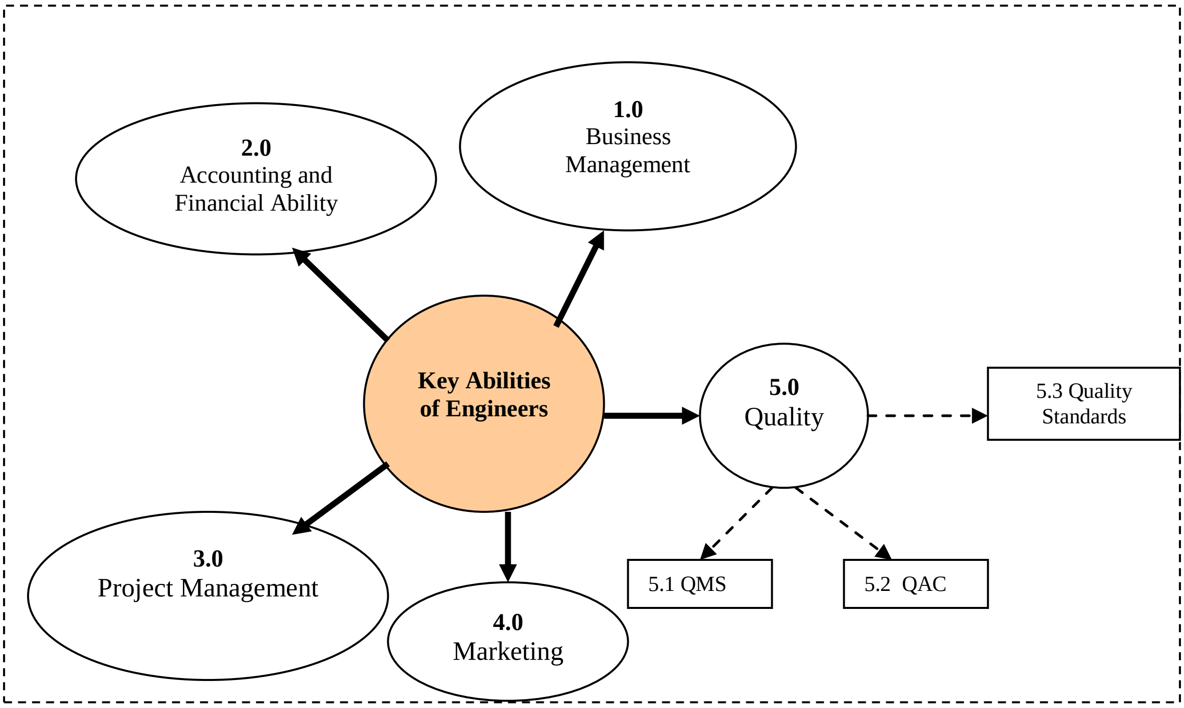


Figure 4. Key abilities of engineers

The six key abilities of engineering as shown in Figure 4 are explained as follows

There is a requirement for Key Skills (often referred to as generic or genral transferable skills) - skills in communication, using information technology, team working, time management, and appropriate understanding of the legislative and environmental framework in which the engineering process is executed. **Business Management** ability includes the use and management of resources, particularly people**;** **Accounting and Financial** ability represents another important aspect of the desirability of a Civil Engineer, whilst successful **Project Management** requires the disciplined organisation of activities and resources. All of the activities in the engineering cycle must be performed with due regard to **Quality -** ranging from Quality Management Systems (QMS) in place, arrangements for Quality Assurance and Control (QAC), to the Quality Standards used in commerce and industry. Finally, **Marketing -** Marketing is about finding out what the customer wants, and then providing it. It is thus inextricably linked to Engineering.

### 4.4 Observations

It is evident that no matter the country or the models used, the experiences of construction management and civil engineering skills are generally similar. The following trends were observed:

- There are different definitions of what constitutes the period the students spend outside the learning environment
- There are three partners to be considered in the co-operative education model, namely students, the academic institutions and the employers (industry)
- Co-operative education, irrespective of the discipline is meant to bridge the gap between the classroom and workplace
- The learning outcomes approach can be utilised to incorporate the roles of construction management and civil engineering into the educational curriculum by including the following:
    - Objectives;
    - Subject knowledge;
    - Discipline; and
    - Competencies.
- There is the need for the provision of a valid methodological approach for higher education institutions to incorporate Construction Management and Civil Engineering.

## 5.0 RESEARCH METHODOLOGY

This report draws on the views and insights of the three partners in the co-operative model, namely the students, academic staff and industry stakeholders. The views were obtained through multiple survey instruments of multiple samples comprising students, industry and academic staff - the partners in the co-operative education approach to construction management and civil engineering. The approach undertaken in the design of the survey instrument and data collection is illustrated in Figure 5 and was composed of three primary steps. Issues associated with the steps are explained as follows:

### 5.1 Determination of the questionnaire format (Step 2)

This step involved the focus and phraseology of the research instrument that was designed to be used to interview stakeholders.

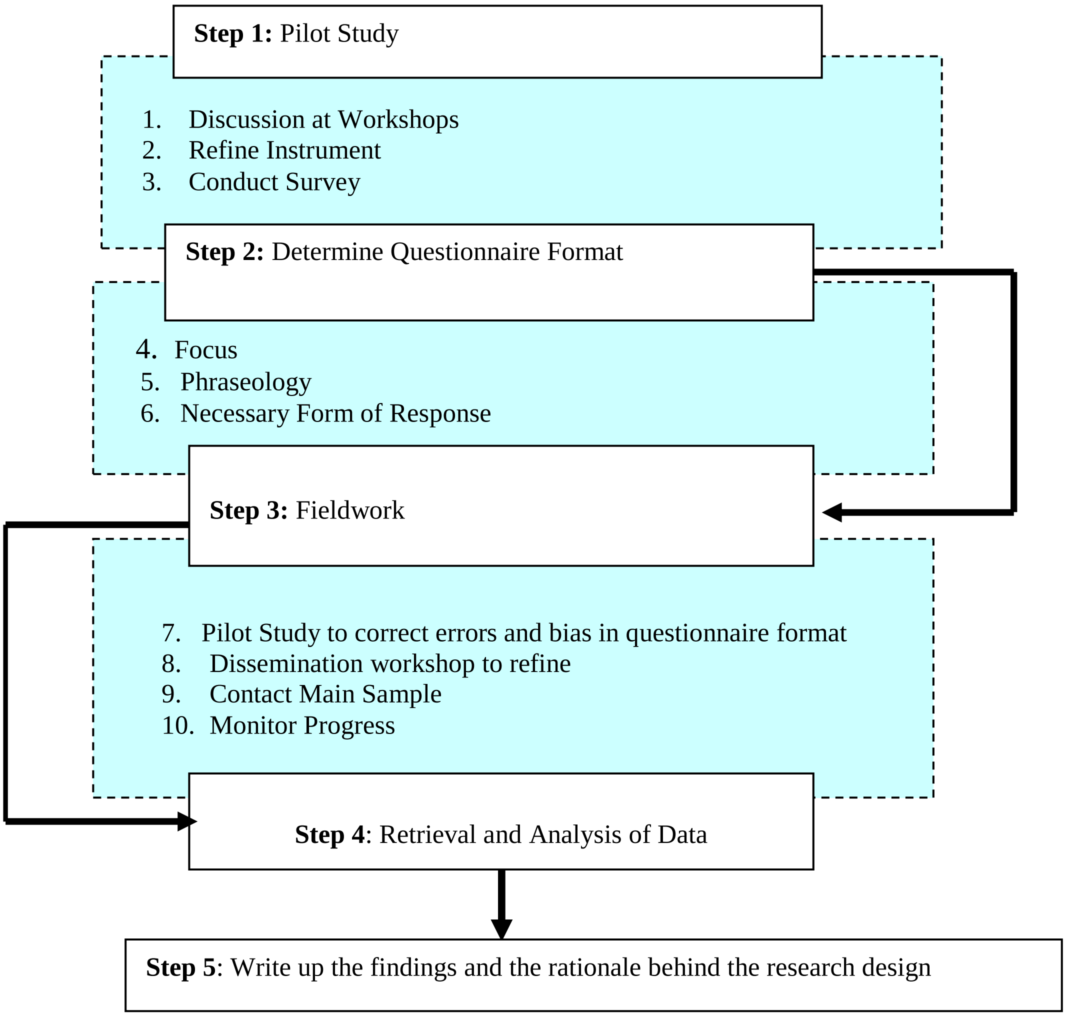


Figure 5. Model for the questionnaire format
*(Source: Adapted from Gill and Johnson, 1991.85)*

## 5.2 Fieldwork (Step 3)

The original plan was to conduct a qualitative approach based on interviews. The original sample data planned is shown in Table 7.

Table 7. Total Sample by Participation

| Partner in the Cooperative Education | Academic Discipline | | Total Responses Received | Percentage of Respondents to Total Sample | |
|---|---|---|---|---|---|
| | Construction Management | Civil Engineering | | Construction Management | Civil Engineering |
| Staff | 30 | NACI | 30 | 8.62% | NACI |
| Total Students | 348 | 123 | 471 | 79.45% | 100% |
| Employers | 60 | NACI | 60 | 11.93% | NACI |
| **Total** | **438** | **123** | **76** | **100.00%** | **100% + NACI** |

As evidenced from Table 7, the majority of the respondents in the research by academic discipline were from Construction Management while the largest group of participants (79.45%) were students. This is not surprising since the research team had more ready access to students than to the other participants in co-operative education. The civil engineering component did not include any detailed survey from the employers and staff as the issues raised in the study had been adequately covered within the National Advisory Council on Innovation (NACI) study of 2003, therefore reference is made to the information and findings as presented in that particular study.

Industry participants were invited to participate in the survey on an “Interview Basis." However, those unable to make time for the interview were called by telephone, faxed the questionnaire and informed that they would be called to do the interview by telephone. Only as a last resort were participants permitted to self-complete the questionnaire. With all the measures undertaken, the desired sample as shown in Table 6 was achieved. These samples were considered representative of the three collaborative partners. The final responses as a percentage of the total by each discipline are also shown for Construction Management and Civil Engineering respectively.

Table 7 shows the frequency of the respondents by participant and discipline as follows: Construction Management: Staff (30), Students (348) and Employers or Industry (60). The responses from the students could further be classified as follows: First year (162) and third and fourth years (186)

From the Civil Engineering perspective, of the 123 students, 69 % were first year whereas the remainder were third year students.

### 5.3 Data Collection

The survey instruments used in this study comprised of various sections and are graphically represented in Figures 6 through 7.

Several questions required 5-point Likert-scaled responses where respondents were asked to rate their levels of agreement or importance relative to various issues being investigated. Qualitative answers were also sought from the respondents in order to qualify their responses and provide deeper and richer meaning..

### 5.4 Data Analysis

The survey instrument used in the Construction Management and Civil Engineering study comprised of 5 sections dealt with the following as illustrated in Figures 6 and 7 respectively. A total of four dimensions of educational offerings and experiential training within South Africa were perceptualised and measured using the 5-point Likert scale. For example in section A that deals with experiential training, respondents were asked to respond to 11 statements relative to what **method** should be used for assessing experiential training where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree.

Scales were Likert type where respondents were asked to rate their levels of agreement or importance. Qualitative answers were also sought from the respondents in order to qualify their responses to previous close ended questions.

The survey instrument which formed part of deliverable no. 2 and used in the evaluation of Construction Management courses offered at the former technikons, now Universities of Technology comprised of 4 sections, namely model preference (7 closed and 4 open questions), opinions on Construction Management courses at TUT (14 closed and 6 open questions), opinions on training and education (3 closed and 2 open questions), and participation in construction (3 closed questions). The survey document is summarised as dealt with in Figure 6.

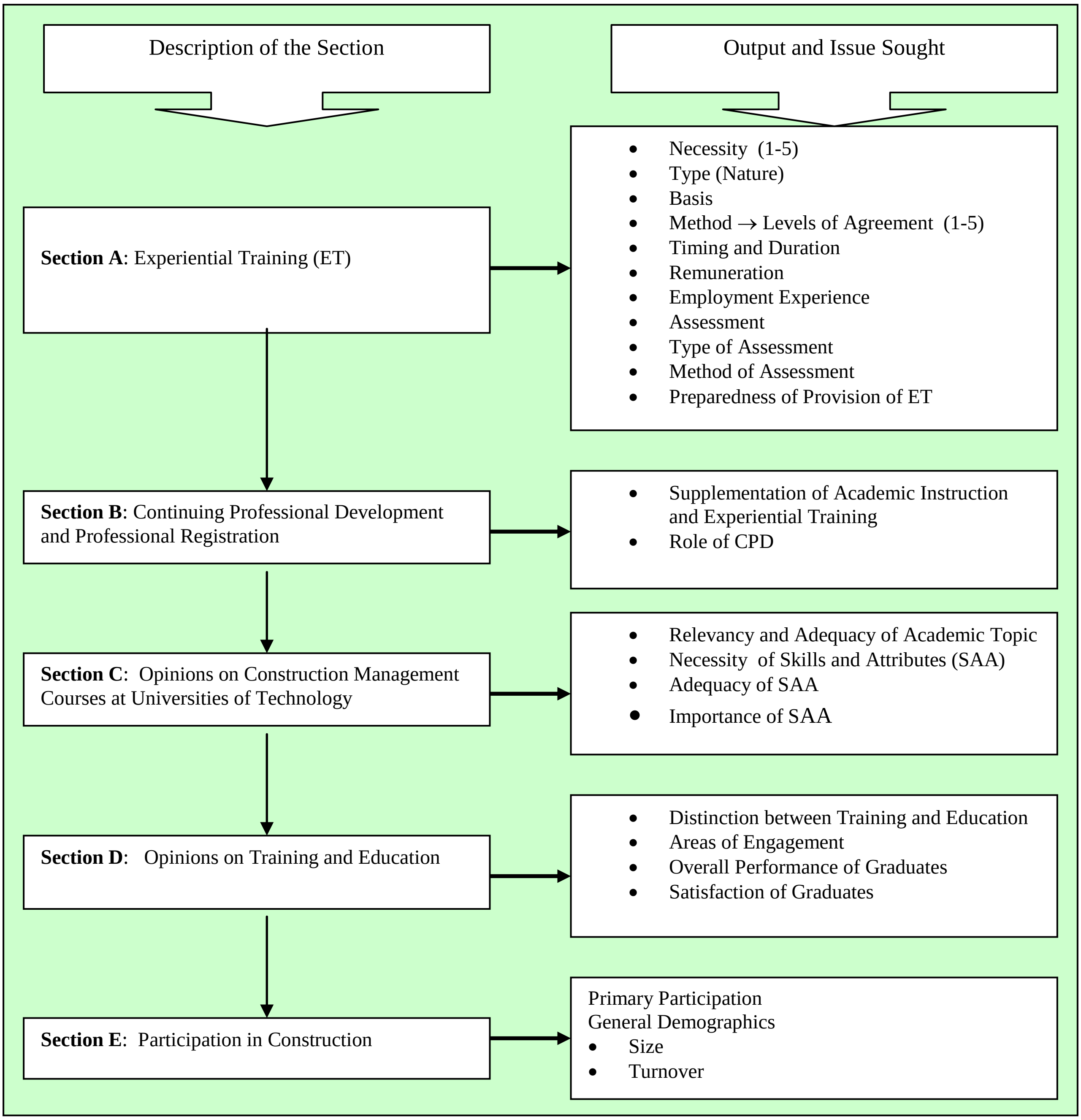


Figure 6. Linkages between Survey Document, Analysis and Output on the Macro Level

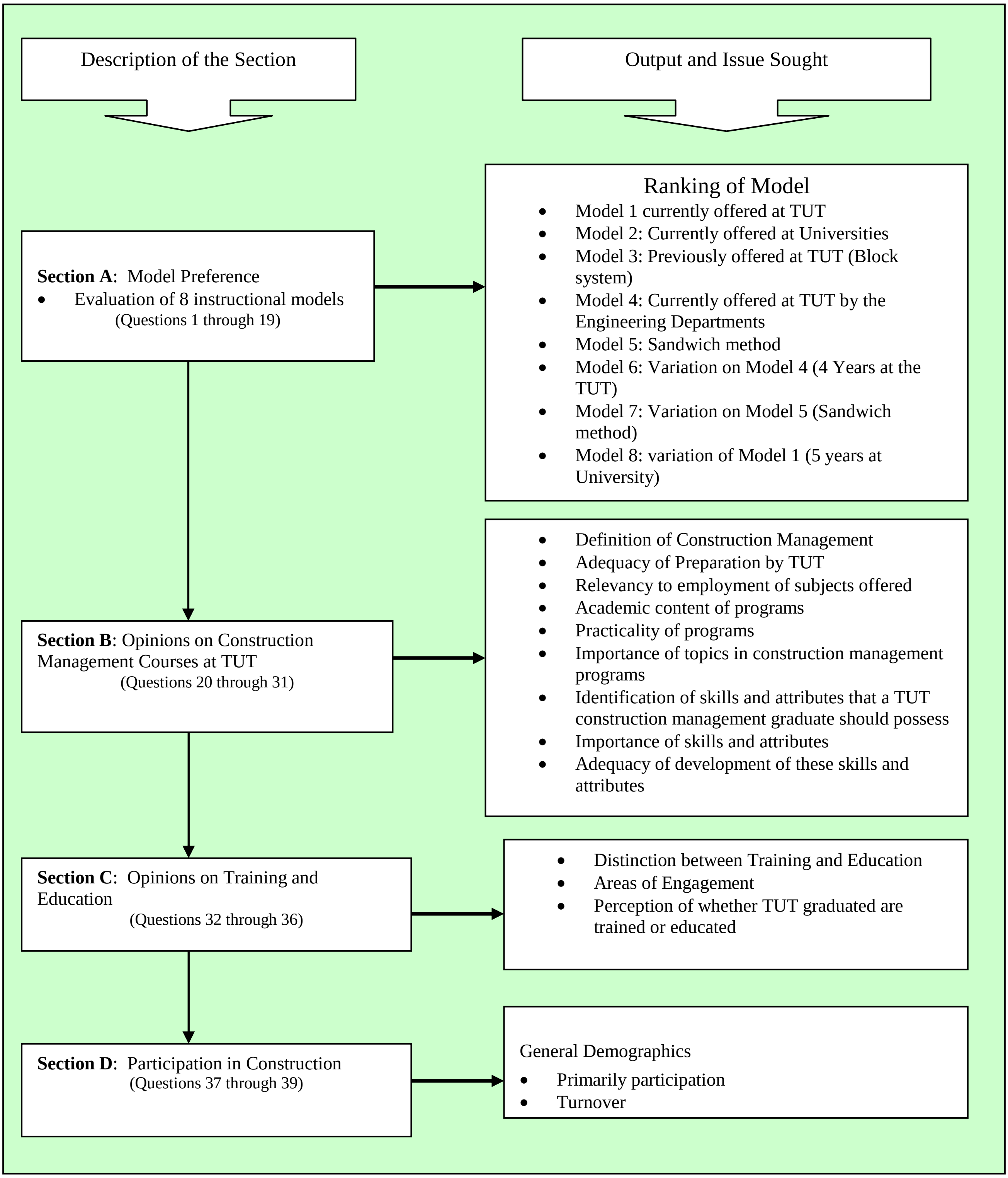


Figure 7. Pilot Survey, Analysis and Output on Macro Level: Construction Management

The Survey instrument used in the Civil Engineering study comprised of 6 sections and dealt with the following as illustrated in Figure 8.

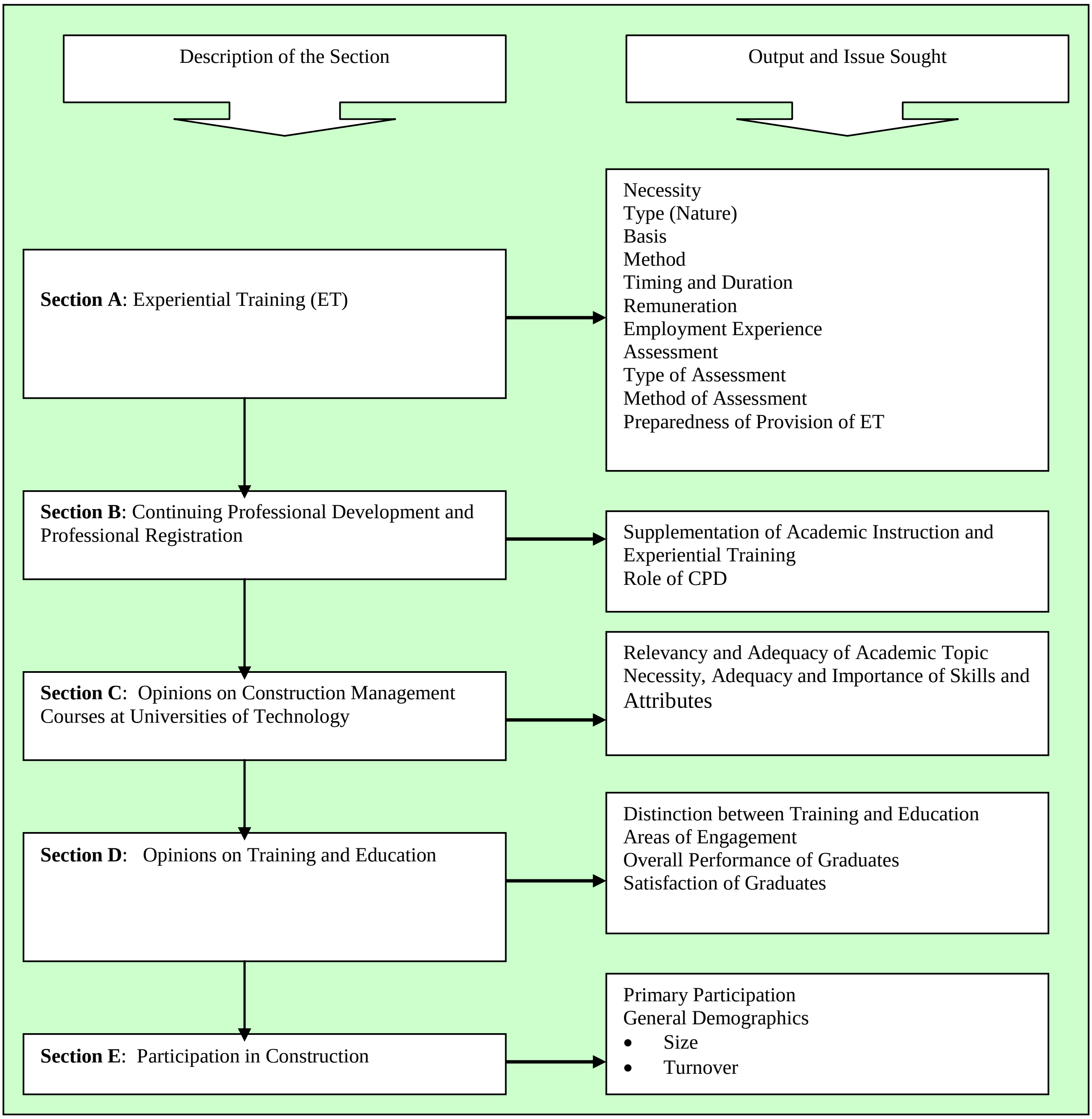


Figure 8. Linkages between Research Instrument on the Macro Level: Civil Engineering

Questions in the survey document outlined in Figures 6 through 8 are Likert type where respondents were asked to rate their levels of agreement or importance. Qualitative answers were also sought from the respondents in order to qualify their responses to close ended questions.

## 6.0 CONSTRUCTION MANAGEMENT: PRELIMINARY FINDINGS OF THE PILOT STUDY

The findings of the preliminary survey are statistically reported descriptively together with measures of central tendency, particularly the means of responses.

### 6.1 Demographics of Respondents

All the industry participants interviewed in the preliminary study were from across the various provinces in South Africa. Figure 9 shows that the majority of companies interviewed employed more than 250 workers.

**Frequency of Respondents by No of Employees**

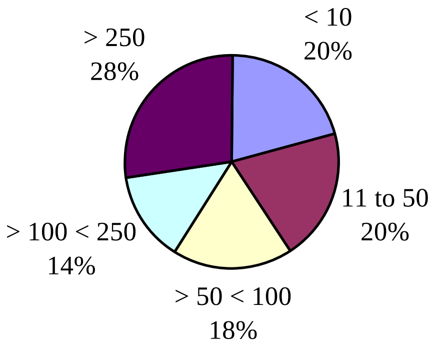


Figure 9. Frequency of Respondents by Number of Employees

The respondents participated primarily in the industry as follows:

- Contractors – 65.1%;
- Subcontractors – 9.3%; and
- Consultants – 25.6%

Figure 11 shows the frequency of respondents by turnover during the past three years. The majority of those interviewed (44%) reported turnovers in excess of R20 million

**Turnover in R millions**

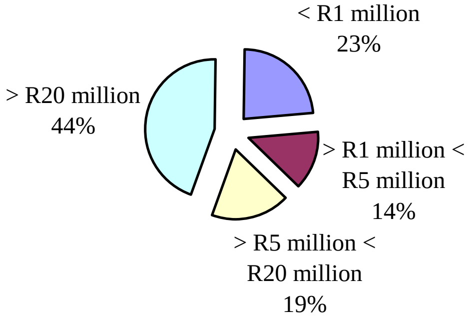


Figure 10. Frequency of respondents by turnover

## 6.2: Model Preference

The responses to how strongly respondents felt about each of the 8 models of instructional delivery were ranked according to their means. These results are shown in Table 8. Evidently, the current university of technology model enjoys the most support followed by the models currently offered by the engineering disciplines at universities of technology and the "UPE" 5-year model. The current university model of instruction without any experiential training period in industry was ranked last.

Table 8. Feelings about models of instruction

| Ranking | Model | Mean | Std. Dev |
|---|---|---|---|
| 1 | Model 1 | 3.93 | 1.27 |
| 2 | Model 4 | 3.80 | 1.02 |
| 3 | Model 8 | 3.49 | 1.14 |
| 4 | Model 3 | 3.37 | 1.36 |
| 5 | Model 6 | 2.96 | 1.32 |
| 6 | Model 5 | 2.87 | 1.31 |
| 7 | Model 7 | 2.85 | 1.25 |
| 8 | Model 2 | 2.58 | 1.22 |

A 5-point Likert preference scale was used where 1 = strongly negative, 2 = negative, 3 = neutral, 4 = positive and 5 = strongly positive.

The models shown in Table 8 are explained as follows with a brief description of each model:

- Model 1: Currently offered at former Technikons.

Year 1: 12 month theory based learning at the former Technikons
Year 2: 12 month mandatory Experiential Training in industry
Year 3: 12 month theory based learning at the former Technikons (graduates with National Diploma)
Year 4: 12 month theory based learning at the former Technikons (graduates with B.Tech degree)

- Model 2: Currently offered at Universities

Years 1-4 theory based learning with no mandatory experiential training requirement (graduates with B.Sc degree or similar)

- Model 3: Previously offered at former Technikons (Block system)

Each academic year is divided into two parts or semesters.
Semester 1: theory based learning at the former Technikons
Semester 2: mandatory experiential training in industry

- Model 4: Currently offered at former technikons by the Engineering Departments

Effectively the same as Model 1 except for semesterization during each year except for year 2 which is spent in industry.

- Model 5: Sandwich method

Each academic year is divided into three parts or semesters.
Semester 1(14-16 weeks): theory based learning at the former Technikons
Semester 2 (10-12 weeks): mandatory experiential training in industry
Semester 3 (14-16 weeks): theory based learning at the former Technikons.
Student graduates with a National Certificate after year 1, National Diploma after year 2, Batchelor's degree after year 3, and a Honors degree after year 4.
Student graduates with a National Diploma after year 3 and a National Higher Diploma after year 4.

- Model 6: Variation on Model 1 (4 years at the former Technikons)

Year 1: 12 month theory based learning at the former Technikons
Year 2: 12 month mandatory Experiential Training at the former Technikons doing simulated projects
Year 3: 12 month theory based learning at the former Technikons (graduates with National Diploma)

Year 4: 12 month theory based learning at the former Technikons (graduates with B.Tech degree)

- Model 7: Variation on Model 5 (Sandwich method)

Each academic year is divided into four parts or semesters.
Semester 1(14-16 weeks): theory based learning at the former Technikons
Semester 2 (10-12 weeks): mandatory experiential training in industry
Semester 3 (14-16 weeks): theory based learning at the former Technikons.
Semester 4 (10-12 weeks): mandatory experiential training in industry at end of years 1, 2 and 3
Student graduates with a National Certificate after year 1, National Diploma after year 2, Batchelor's degree after year 3, and an Honours degree after year 4.

- Model 8: Variation on Model 1 (5 years at university).

Year 1-3: Theory based learning at the university (graduates with B.Sc (Construction Studies) or similar
Year 4: 12 month mandatory Experiential Training in industry
Year 5: 12 month theory based learning at the university (graduates with B.Sc Hons. (Construction Management)

Respondents were asked to rank all the models according to their order of personal preference. These results are shown in Table 9. Considering that the smaller the mean the higher the ranking relative to personal preference, the current university of technology model was preferred by most respondents. As before the next popular models were those currently offered by the engineering disciplines at universities of technology and the former "University of Port Elizabeth" 5-year model.

Table 9. Ranking by personal preference

| Ranking | Model | Mean | Std. Dev |
|---|---|---|---|
| 1 | Model 1 | 3.05 | 2.51 |
| 2 | Model 4 | 3.74 | 2.57 |
| 3 | Model 8 | 4.10 | 2.22 |
| 4 | Model 3 | 4.15 | 2.67 |
| 5 | Model 2 | 4.63 | 2.57 |
| 6 | Model 6 | 4.76 | 2.14 |
| 7 | Model 5 | 5.11 | 2.11 |
| 8 | Model 7 | 5.49 | 2.08 |

From Table 10 it is evident that the current university of technology and engineering models were predicted to enjoy the most support from the industry while the university model without experiential training would have the least support.

Table 10. Ranking by expected industry support

| Ranking | Model | Mean | Std. Dev |
|---|---|---|---|
| 1 | Model 1 | 3.05 | 2.51 |
| 2 | Model 4 | 3.74 | 2.57 |
| 3 | Model 3 | 4.15 | 2.67 |
| 4 | Model 8 | 4.10 | 2.22 |
| 5 | Model 6 | 4.76 | 2.14 |
| 6 | Model 5 | 5.11 | 2.11 |
| 7 | Model 7 | 5.49 | 2.08 |
| 8 | Model 2 | 4.63 | 2.57 |

The distribution of how adequately respondents believed the present models prepared students for immediate employment is shown in Table 11. Evidently 41% reported that preparation was somewhat adequate and 15.4% extremely adequate. The means of responses was 3.51 with standard deviation of 1.05. Items with larger standard deviations indicate a wider dispersion of responses across the corresponding industry respondents. From Table 10, it is evident that there are differences in responses from industry for all the models. The conclusion to be drawn is that there is a huge variation in the perception of the models, despite the high mean values achieved.

Table 11. Adequacy of preparation for employment

| Level of adequacy | Frequency of Respondents |
|---|---|
| Extremely inadequately | 5.1% |
| Somewhat inadequately | 10.3% |
| Neither adequately nor inadequately | 28.2% |
| Somewhat adequately | 41.0% |
| Extremely adequately | 15.4% |

Table 12 indicates the willingness of respondents to use various forums to lobby for the introduction of their preferred model if it were not currently being offered by universities of technology. Of the three forums, influencing bodies such as regional Master Builders Associations (MBAs), Construction Education and Training Authority (CETA) and others were the most preferred while serving on advisory councils or boards of universities of technology departments was the least preferred.

Table 12. Forums of influence

| Forms of Influence | 1 | 2 | 3 | Mean | Std Dev. |
|---|---|---|---|---|---|
| Influence bodies such as regional MBAs, CETAs, and others | 23% | 29% | 48% | 2.26 | 0.82 |
| Lobbying appropriate education authorities | 20% | 43% | 37% | 2.17 | 0.75 |
| Serving on advisory councils or boards of universities of technology departments | 23% | 58% | 19% | 1.97 | 0.66 |

The mean values in Table 12 were obtained using a 3-point Likert scale where 1 = definitely not, 2 = possibly, and 3 = definitely will.

Respondents were asked to indicate their feelings about modularisation, whole qualifications, and the quality of courses offered at universities of technology and universities. The responses are shown in Table 13. The larger the mean the more positive the attitude towards the issues. It is evident that respondents reported more positively about the quality of universities of technology than university programs. Feelings about modularisation of subjects into specialized offerings or unit standards of 14 to 16 weeks were marginally positive while feelings about whole qualifications were more positive.

Table 13. Opinions modularisation, whole qualifications and quality of courses

| Opinions | Strongly negative | Negative | Neutral | Positive | Strongly positive | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|
| Modularization | 8.9% | 22.2% | 31.1% | 22.25% | 15.6% | 3.13 | 1.20 |
| Whole qualifications | 4.4% | 11.1% | 15.6% | 44.4% | 24.4% | 3.73 | 1.10 |
| Quality of universities of technology courses | 2.3% | 6.8% | 18.2% | 50.0% | 22.7% | 3.84 | 0.94 |
| Quality of university courses | - | 6.8% | 34.1% | 43.2% | 15.9% | 3.68 | 0.83 |

### 6.3 Opinions on Construction Management Courses at Universities of Technology

Respondents were asked about they felt about the following definition of construction management (CM):

“The application of advanced expertise in the theory and practice of management relating to the construction procurement process and the construction organization as a business enterprise”

Therefore a Construction Manager is one who applies the advanced expertise in the theory and practice of management.

They were also asked about the adequacy of the preparation of students in construction management in terms of the definition by universities of technology. Their responses are shown in Table 14.

Respondents reported stronger agreement with the definition of construction management than the adequacy of universities of technology preparation of students in the discipline.

Table 14. Opinions on CM definition and adequacy of universities of technology offerings.

| Opinions | Totally disagree | Slightly disagree | Neutral | Slightly agree | Totally agree | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|
| Definition | 4.4% | 8.9% | 22.2% | 28.9% | 15.6% | 3.82 | 1.15 |
| Adequacy | 4.4% | 8.9% | 35.6% | 35.6% | 24.4% | 3.49 | 1.01 |

With respect to the relevance to employment in construction of subjects offered in present Construction Management courses at universities of technology, most respondents reported that the subjects were relevant. However, on the 5-point scale of relevance, the mean was 3.61 between "average" and "relevant". This result is shown in Table 15.

Table 15. Opinion on distinction between education and training

| Very irrelevant | Irrelevant | Average | Relevant | Very relevant | Mean | Std Dev |
|---|---|---|---|---|---|---|
| 2.2% | 2.3% | 36.4% | 50.0% | 9.1% | 3.61 | 0.78 |

Respondents were asked about the importance of nine subject areas in Construction Management programs as well as the adequacy with which universities of technology prepared their students in those areas.

Table 16. Importance of subject areas

| Subject area | Extremely un-important | Slightly un-important | Neutral | Slightly im-portant | Extremely important | Mean | Std Dev |
|---|---|---|---|---|---|---|---|
| Project Management | - | - | 9.1% | 22.7% | 68.2% | 4.59 | 0.66 |
| Construction Technology | - | 2.3% | 4.5% | 29.5% | 63.6% | 4.55 | 0.70 |
| Management Practice | - | - | 11.4% | 43.1% | 45.5% | 4.34 | 0.68 |
| Management Principles and Theories | - | 2.3% | 11.4% | 43.2% | 43.2% | 4.27 | 0.76 |
| Construction Law | - | 4.5% | 13.7% | 40.9% | 40.9% | 4.18 | 0.84 |
| Construction Economics | - | 2.3% | 22.7% | 29.5% | 45.5% | 4.18 | 0.87 |
| Construction Business Environment | - | 2.3% | 27.3% | 40.9% | 29.5% | 3.98 | 0.82 |
| Construction Science | 2.3% | 11.4% | 22.7% | 43.2% | 20.5% | 3.68 | 1.01 |
| Research Methodology | 4.5% | 31.8% | 34.1% | 11.4% | 18.2% | 3.07 | 1.17 |

Their responses ranked by their means are shown in Tables 16 and 17.

Table 17.  Adequacy of topics

| Topic | Extremely un-important | Slightly un-important | Neutr al | Slightly im-portant | Extremely important | Mean | Std Dev |
|---|---|---|---|---|---|---|---|
| Project Management | - | 12.5% | 22.5% | 47.5% | 17.5% | 3.70 | 0.91 |
| Construction Technology | - | 10.0% | 35.0% | 40.0% | 15.0% | 3.60 | 0.87 |
| Management Practice | - | 12.5% | 30.0% | 42.5% | 15.0% | 3.60 | 0.90 |
| Management Principles and Theories | 2.5% | 25.0% | 20.0% | 32.5% | 20.0% | 3.43 | 1.15 |
| Construction Law | - | 20.0% | 25.0% | 50.0% | 5.0% | 3.40 | 0.87 |
| Construction Economics | 2.5% | 12.5% | 42.5% | 35.0% | 7.5% | 3.33 | 0.89 |
| Construction Business Environment | 2.5% | 22.5% | 32.5% | 37.5% | 5.0% | 3.20 | 0.94 |
| Construction Science | 2.5% | 22.5% | 42.5% | 25.0% | 7.5% | 3.13 | 0.94 |
| Research Methodology | - | 27.5% | 42.5% | 22.5% | 7.5% | 3.10 | 0.90 |

Project management, construction technology and management practice, principles and theories ranked as the most important subject areas. Research methodology ranked least with the mean marginally above "neutral". Considering the historically poor research track record of universities of technology this finding is hardly surprising. On the other hand, universities of technology prepared students most adequately in construction technology and construction principles, theories and practice. Project management while being most important to respondents ranked 5th with respect to how adequately universities of technology prepared their students in this area. Importantly the highest mean was only 3.70 (construction technology), which was less than "somewhat adequately", on the 5-point adequacy scale.

Research methodology and construction science while being the least important were also the areas in which students were the least adequately prepared by universities of technology. This finding raises the question about whether this inadequate preparation might result in these areas being regarded as unimportant.

Table 18. Desirable skills and attributes of CM graduates

| Rank | Skills/attribute | Necessary | Not Sure | Not necessary | Mean | Standard Deviation |
|---|---|---|---|---|---|---|
| 1 | Acceptance of responsibility | 100.0% | - | - | 1.00 | 0.00 |
| 1 | Planning, scheduling and controlling construction operations and activities | 100.0% | - | - | 1.00 | 0.00 |
| 3 | Adaptability to changing work environment | 97.8% | 2.2% | - | 1.02 | 0.15 |
| 3 | Time management | 97.8% | 2.2% | - | 1.02 | 0.15 |
| 5 | Worker safety and health awareness | 95.6% | 4.4% | - | 1.04 | 0.21 |
| 6 | Familiarity with construction quality management | 90.9% | 9.1% | - | 1.09 | 0.36 |
| 7 | Trust and honesty | 93.2% | 4.5% | 2.3% | 1.09 | 0.36 |
| 8 | Verbal communication skills | 91.1% | 8.9% | - | 1.09 | 0.36 |
| 9 | Leadership capability | 88.6% | 11.4% | - | 1.11 | 0.32 |
| 10 | Team building capability | 90.9% | 6.8% | 2.3% | 1.11 | 0.39 |
| 11 | Problem solving skills | 93.2% | 2.3% | 4.5% | 1.11 | 0.44 |
| 12 | Interpersonal skills | 84.4% | 15.6% | - | 1.16 | 0.37 |
| 12 | Familiarity with workings and intricacies of industry | 84.4% | 15.6% | - | 1.16 | 0.37 |
| 14 | Ability to exercise professional judgement | 88.9% | 6.7% | 4.4% | 1.16 | 0.47 |
| 15 | Practical building knowledge | 86.4% | 11.4% | 2.3% | 1.16 | 0.47 |
| 16 | Decision making | 88.6% | 6.8% | 4.5% | 1.15 | 0.48 |
| 17 | Managerial knowledge | 84.1% | 13.6% | 2.3% | 1.18 | 0.45 |
| 17 | Active listening skills | 84.1% | 13.6% | 2.3% | 1.18 | 0.45 |
| 17 | Measurement, costing and estimating | 84.1% | 13.6% | 2.3% | 1.18 | 0.45 |
| 20 | Creativity and innovation | 86.4% | 9.1% | 4.5% | 1.18 | 0.50 |
| 21 | Written communication skills | 84.4% | 11.1% | 4.4% | 1.20 | 0.50 |
| 22 | Ability to use surveying and levelling equipment | 84.1% | 11.4% | 4.5% | 1.20 | 0.51 |
| 23 | Up-to-date professional knowledge | 80.0% | 17.8% | 2.2% | 1.22 | 0.47 |
| 24 | Computer literacy | 79.5% | 18.2% | 2.3% | 1.23 | 0.48 |
| 25 | Ability to resolve conflicts and disputes | 84.4% | 6.7% | 8.9% | 1.24 | 0.61 |
| 26 | Numeracy | 73.3% | 26.7% | - | 1.27 | 0.45 |
| 27 | Supervisory skills and ability to train others | 82.2% | 8.9% | 8.9% | 1.27 | 0.62 |
| 28 | Ability to work autonomously | 77.3% | 15.9% | 6.8% | 1.30 | 0.59 |
| 29 | Negotiating skills | 75.0% | 18.2% | 6.8% | 1.32 | 0.60 |
| 30 | Financial management | 72.7% | 20.5% | 6.8% | 1.34 | 0.61 |
| 31 | Academic achievement | 77.3% | 11.4% | 11.4% | 1.34 | 0.68 |
| 32 | Environmental awareness | 59.1% | 36.4 | 4.5% | 1.45 | 0.59 |
| 33 | Work study | 59.1% | 27.3% | 13.6% | 1.55 | 0.73 |
| 34 | Ability to conduct research | 54.5% | 34.1% | 11.4% | 1.57 | 0.70 |
| 35 | Entrepreneurship | 53.3% | 35.6% | 11.1% | 1.58 | 0.69 |
| 36 | Systems development ability | 40.9% | 40.9% | 18.2% | 1.77 | 0.74 |
| 37 | Marketing skills | 38.6% | 43.2% | 18.2% | 1.80 | 0.73 |
| 38 | Ability to conduct statistical analysis | 43.2% | 27.3% | 29.5% | 1.86 | 0.85 |

Respondents were asked to indicate the necessary skills and attributes that universities of technology construction management graduates should possess. The ranking of the means of their responses to 38 skills and attributes is shown in Table 18. The closer the mean is to 1.00 the more necessary the skills and attributes were regarded by respondents.

Acceptance of responsibility; planning, scheduling and controlling construction operations and activities; adaptability to changing work environment; time management; and worker safety and health awareness were the most desirable skills and attributes. Marketing skills and the ability to conduct research were the least desirable skills and attributes.

Table 19. Importance of skills and attributes of CM graduates

| Rank | Skills/attribute | EU | SU | N | SI | EI | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|---|
| 1 | Trust and honesty | - | - | 2.3% | 15.9% | 81.8% | 4.80 | 0.46 |
| 2 | Time management | - | 2.3% | - | 20.5% | 77.3% | 4.73 | 0.59 |
| 3 | Planning, scheduling and controlling construction operations and activities | - | - | 4.5% | 20.5% | 75.0% | 4.70 | 0.55 |
| 4 | Practical building knowledge | - | 2.3% | 2.3% | 22.7% | 72.7% | 4.66 | 0.64 |
| 5 | Acceptance of responsibility | - | 2.3% | 4.5% | 18.2% | 75.0% | 4.66 | 0.68 |
| 6 | Measurement, costing and estimating | - | - | 2.3% | 31.8% | 65.9% | 4.64 | 0.53 |
| 7 | Problem solving skills | - | - | 4.5% | 27.3% | 68.2% | 4.64 | 0.57 |
| 8 | Leadership capability | - | - | 6.8% | 27.3% | 65.9% | 4.59 | 0.62 |
| 9 | Ability to resolve conflicts and disputes | - | 2.3% | 9.1% | 15.9% | 72.7% | 4.59 | 0.76 |
| 10 | Verbal communication skills | - | 4.5% | 4.5% | 18.2% | 72.7% | 4.59 | 0.79 |
| 11 | Decision making | - | 4.5% | 2.3% | 25.0% | 68.2% | 4.57 | 0.76 |
| 12 | Worker safety and health awareness | - | 2.3% | 4.5% | 29.5% | 63.6% | 4.55 | 0.70 |
| 13 | Adaptability to changing work environment | - | 2.3% | 9.1% | 22.7% | 65.9% | 4.52 | 0.76 |
| 14 | Team building capability | - | 4.5% | 4.5% | 25.0% | 66.0% | 4.52 | 0.79 |
| 15 | Written communication skills | - | 2.3% | 6.8% | 31.8% | 59.1% | 4.48 | 0.73 |
| 16 | Ability to use surveying and levelling equipment | - | 2.3% | 6.8% | 31.8% | 59.1% | 4.48 | 0.73 |
| 17 | Creativity and innovation | - | 2.3% | 9.15 | 27.3% | 61.4% | 4.48 | 0.76 |
| 18 | Ability to exercise professional judgement | - | 2.3% | 9.1% | 34.1% | 54.5% | 4.41 | 0.76 |
| 18 | Up-to-date professional knowledge | - | 2.3% | 9.1% | 34.1% | 54.5% | 4.41 | 0.76 |
| 20 | Active listening skills | - | - | 6.8% | 47.7% | 45.5% | 4.39 | 0.62 |
| 21 | Familiarity with construction quality management | - | 4.5% | 6.8% | 36.4% | 52.3% | 4.36 | 0.81 |
| 22 | Financial management | - | 6.8% | 6.8% | 31.8% | 54.5% | 4.34 | 0.89 |
| 23 | Managerial knowledge | - | 2.3% | 13.6% | 34.1% | 50.0% | 4.32 | 0.80 |
| 24 | Interpersonal skills | - | 2.3% | 20.5% | 22.7% | 54.5% | 4.30 | 0.88 |
| 24 | Negotiating skills | - | 6.8% | 6.8% | 36.4% | 50.0% | 4.30 | 0.88 |
| 26 | Supervisory skills and ability to train others | - | 2.3% | 22.7% | 18.2% | 56.8% | 4.30 | 0.90 |
| 27 | Computer literacy | - | 2.3% | 15.9% | 34.1% | 47.7% | 4.27 | 0.82 |
| 28 | Ability to work autonomously | - | 6.8% | 9.1% | 34.1% | 45.5% | 4.23 | 0.83 |
| 29 | Familiarity with workings and intricacies of industry | - | 2.3% | 18.2% | 34.1% | 45.4% | 4.23 | 0.94 |
| 30 | Numeracy | - | 6.8% | 13.6% | 29.5% | 50.0% | 4.23 | 0.94 |
| 31 | Work study | - | 6.8% | 22.7% | 34.1% | 36.4% | 4.00 | 0.94 |
| 32 | Ability to conduct statistical analysis | 2.3% | 6.8% | 22.7% | 31.8% | 36.4% | 3.93 | 1.04 |
| 33 | Environmental awareness | 2.3% | - | 27.3% | 45.5% | 25.5% | 3.91 | 0.86 |
| 34 | Entrepreneurship | - | 15.9% | 18.2% | 34.1% | 31.8% | 3.82 | 1.06 |
| 35 | Systems development ability | 2.3% | 11.4% | 27.3% | 34.1% | 25.0% | 3.68 | 1.05 |
| 36 | Academic achievement | 4.5% | 6.8% | 29.5% | 34.1% | 25.0% | 3.68 | 1.07 |
| 37 | Ability to conduct research | 2.3% | 14.0% | 32.6% | 16.3% | 34.9% | 3.67 | 1.17 |
| 38 | Marketing skills | 2.3% | 18.2% | 25.0% | 34.1% | 20.5% | 3.52 | 1.09 |

The responses of respondents to how important these skills and attributes were in Construction Management graduates and ranking by means of these responses are shown in Table 19. Except for the following items; ability to conduct statistical analysis, entrepreneurship, systems development ability, academic achievement, ability to conduct research and marketing skills, all other items have little or small standard deviations (value less than 1.0) meaning that the respondents were is agreement on most of the stated items. Furthermore all the skills excluding the aforementioned were rated slightly to extremely important by the respondents.

Where EU = Extremely unimportant, SU = Slightly unimportant, N = Neutral, SI = Slightly important and EI = Extremely important.

Trust and honesty; time management; planning, scheduling and controlling construction operations and activities; and practical building knowledge were the most important while systems development ability; academic achievement; ability to conduct research; and marketing skills were the least important.

Table 20. Adequacy of development of Skills and Attributes by universities of technology

| Rank | Skills/attribute | EI | SI | N | SA | EA | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|---|
| 1 | Measurement, costing and estimating | - | 7.7% | 15.4% | 43.6% | 33.3% | 4.03 | 0.90 |
| 2 | Ability to use surveying and levelling equipment | 7.7% | 2.6% | 10.3% | 51.3% | 28.2% | 3.90 | 1.10 |
| 3 | Financial management | - | 10.5% | 26.3% | 31.6% | 31.6% | 3.84 | 1.00 |
| 4 | Planning, scheduling and controlling construction operations and activities | - | 5.1% | 35.9% | 30.8% | 28.2% | 3.80 | 0.91 |
| 5 | Academic achievement | - | 7.7% | 28.2% | 43.6% | 20.5% | 3.77 | 0.87 |
| 6 | Practical building knowledge | - | 15.4% | 28.2% | 43.6% | 20.5% | 3.77 | 0.87 |
| 7 | Work study | 2.6% | 12.8% | 28.2% | 33.3% | 23.1% | 3.62 | 1.07 |
| 8 | Numeracy | - | 10.8% | 35.1% | 37.8% | 16.2% | 3.59 | 0.89 |
| 9 | Ability to conduct research | 5.1% | 10.3% | 30.8% | 30.8% | 23.1% | 3.56 | 1.12 |
| 10 | Worker safety and health awareness | 2.6% | 15.4% | 23.1% | 41.0% | 17.9% | 3.56 | 1.05 |
| 11 | Managerial knowledge | - | 10.3% | 35.9% | 43.6% | 10.3% | 3.54 | 0.82 |
| 12 | Verbal communication skills | 2.6% | 15.4% | 25.6% | 38.5% | 17.9% | 3.54 | 1.05 |
| 13 | Familiarity with intricacies of industry | - | 7.7% | 41.0% | 43.6% | 7.7% | 3.51 | 0.76 |
| 14 | Computer literacy | - | 17.9% | 38.5% | 25.6% | 17.9% | 3.44 | 0.99 |
| 15 | Acceptance of responsibility | 2.6% | 7.7% | 43.6% | 41.0% | 5.1% | 3.38 | 0.81 |
| 16 | Creativity and innovation | - | 25.6% | 30.8% | 23.1% | 20.5% | 3.38 | 1.09 |
| 16 | Decision making | - | 25.6% | 30.8% | 23.1% | 20.5% | 3.38 | 1.09 |
| 18 | Written communication skills | 5.1% | 17.9% | 30.8% | 25.6% | 20.5% | 3.38 | 1.16 |
| 19 | Leadership capability | - | 20.5% | 38.5% | 28.2% | 12.8% | 3.33 | 0.96 |
| 20 | Ability to exercise professional judgement | - | 20.5% | 38.5% | 33.3% | 7.7% | 3.28 | 0.89 |
| 21 | Up-to-date professional knowledge | 5.1% | 10.3% | 51.3% | 17.9% | 15.4% | 3.28 | 1.02 |
| 22 | Active listening skills | - | 23.1% | 35.9% | 33.3% | 7.7% | 3.26 | 0.91 |
| 23 | Time management | - | 17.6% | 53.8% | 12.8% | 15.4% | 3.26 | 0.94 |
| 24 | Familiarity with construction quality management | 5.1% | 15.4% | 38.5% | 30.8% | 10.3% | 3.26 | 1.02 |
| 25 | Ability to conduct statistical analysis | 5.1% | 15.4% | 38.5% | 30.8% | 10.3% | 3.26 | 1.02 |
| 26 | Trust and honesty | 7.7% | 12.8% | 41.0% | 25.6% | 12.8% | 3.23 | 1.09 |
| 27 | Systems development ability | 10.3% | 20.5% | 25.6% | 23.1% | 20.5% | 3.23 | 1.28 |
| 28 | Ability to work autonomously | 5.3% | 15.8% | 42.1% | 26.3% | 10.5% | 3.21 | 1.02 |
| 29 | Entrepreneurship | 10.3% | 17.9% | 28.2% | 28.2% | 15.4% | 3.21 | 1.22 |
| 29 | Supervisory skills and ability to train others | 7.7% | 23.1% | 28.2% | 23.1% | 17.9% | 3.21 | 1.22 |
| 31 | Problem solving skills | - | 27.0% | 35.1% | 29.7% | 8.1% | 3.19 | 0.94 |
| 32 | Interpersonal skills | 7.7% | 20.5% | 25.6% | 38.5% | 7.7% | 3.18 | 1.10 |
| 33 | Ability to resolve conflicts and disputes | 2.6% | 28.2% | 38.5% | 20.5% | 10.3% | 3.08 | 1.01 |
| 34 | Adaptability to changing work environment | 5.1% | 25.6% | 43.6% | 20.5% | 5.1% | 2.95 | 0.94 |
| 35 | Marketing skills | 12.8% | 23.1% | 33.3% | 23.1% | 7.7% | 2.89 | 1.14 |
| 36 | Negotiating skills | 7.7% | 25.6% | 43.6% | 17.9% | 5.1% | 2.87 | 0.89 |
| 37 | Environmental awareness | 12.8% | 17.9% | 43.6% | 20.5% | 5.1% | 2.87 | 1.06 |
| 38 | Team building capability | 10.3% | 28.2% | 28.2% | 30.8% | 2.6% | 2.87 | 1.06 |

Respondents were asked to rate how adequately universities of technology developed these 38 skills and attributes in their students. The results are shown in Table 20 where EI = Extremely inadequately, SI = Slightly inadequately, N = Neutral, SA = Slightly adequately and EA = Extremely adequately.

Table 20 shows that except for the following items; work study, ability to use surveying and levelling equipment, financial management, work study, ability to conduct research, worker safety and health awareness, verbal communication skill, creativity and innovation, decision making, written communication skills, Up-to-date professional knowledge, familiarity with construction quality management, ability to conduct statistical analysis, trust and honesty, systems development ability, ability to work autonomously, supervisory skills and ability to train others, interpersonal skills, ability to resolve conflicts and disputes, marketing skills, environmental awareness, team building capability, and all other items have little or smaller values of standard deviation (sd < 1.0). Furthermore all the skills excluding the aforementioned were rated neutral to slightly adequately by the respondents.

Measurement, costing and estimating; ability to use surveying and levelling equipment; financial management; planning, scheduling and controlling construction operations; and academic achievement were the skills and attributes that universities of technology most adequately developed in their students. On the other hand, negotiation skills; environmental awareness; and team building were the least adequately developed. The differences are important to note between the ranking of those skills and attributes that industry regard as important and those that Universities of technology regard as important apparently focus on with respect to adequate development in their students. The final chapter discusses these in more detail. The findings relative to the employment of graduates of universities of technology graduates are shown in Table 21.

Table 21. Employment of universities of technology trained students

| Employment Opportunities | Yes | No | Not Sure | Mean | Std. Dev |
|---|---|---|---|---|---|
| Previously employed | 84% | 15.6% | - | 1.16 | 0.37 |
| Willingness to employ again | 93.2% | - | 6.8% | 1.07 | 0.25 |

It is evident that 84% of respondents had previously employed a student trained at a University of Technology. Further, 93.2% would be willing to do so again. If presented with a choice 59.1% of respondents would employ a university of technology graduate rather than a graduate from a traditional university. This result is shown in Table 22.

Table 22. Employment Preference

| University of Technology graduate | University Graduate | No Preference |
|---|---|---|
| 59.1% | 9.1% | 31.8% |

### 6.4 Opinions on Education and Training

Respondents were asked about how they felt about the following statement on training and education:

"Training increases skills and competence and teaches employees the "how" of a job whereas education increases their insight and understanding and teaches them "why".

Table 23. Opinion on distinction between education and training

| Totally disagree | Slightly disagree | Neutral | Slightly agree | Totally agree | Mean | Std Dev |
|---|---|---|---|---|---|---|
| 2.3% | 2.3% | 13.6% | 18.2% | 63.6% | 4.39 | 0.97 |

From Table 23 it is evident that 63.6% of respondents totally agreed with the distinction between education and training as suggested in the statement. With respect to what the primary engagement of institutions should be respondents reported as shown in Table 24. Most respondents (68.2%) reported that universities should primarily be involved in education while a similar proportion reported that universities of technology (67.4%) should be primarily involved in training.

Table 24. Primary engagement of institutions

| Institution | Education | Training | Both |
|---|---|---|---|
| University | 68.2% | 15.9% | 15.9% |
| University of Technology | 14.0% | 67.4% | 18.6% |

The findings shown in Table 25 indicate that most respondents regarded universities of technology graduates as being both educated and trained.

Table 25. View of universities of technology graduates

| Trained | Educated | Neither | Both |
|---|---|---|---|
| 22.7% | 13.6% | 4.5% | 59.1% |

### 6.5 Observations

The preliminary findings of this pilot study suggested industry support and preference for the present University of Technology model. There was slight agreement relative to the adequacy with which Universities of Technology prepared their graduates with respect to the stated topics. The relevance of subjects to employment was average. There seems to be an apparent mismatch between skills and attributes that industry regard as important and the adequacy with which they were developed in students by Universities of Technology. There was industry preference for Universities of Technology graduates over traditional university graduates. In the minds of respondents the traditional roles of universities of technology and universities are entrenched.

## 7.0 FINDINGS OF THE ANALYSIS OF THE FINAL SURVEY

### 7.1 Construction Management

In order to achieve the objectives of this study as outlined earlier, each of the stakeholders in the cooperative education model, namely employers, instructors at academic institutions and students, were surveyed nationally. The views were canvassed nationally using self administered structured questionnaires of samples of 60 industry participants, 30 academic staff, 162 first year students, and 186 third and fourth year students. The findings are statistically reported descriptively together with measures of central tendency, particular the means of responses.

### 7.2 Civil Engineering

The findings of the student survey **(n = 123)** are statistically reported descriptively together with measures of central tendency, particular the means of responses where these are informative. The study pertaining to the industry and staff was not undertaken on a full scale, instead observations are drawn from the National Advisory Council on Innovation (NACI) document which covered most of the cardinal issues. These ranged from the University and Universities of Technology graduation trends; demand for engineers and technicians as well as significant structural/strategic issues impacting on the capacity to deliver major capital engineering projects.

#### 7.2.1 Observations from the NACI Report

The NACI (2003) report highlighted some significant structural/strategic issues impacting on the capacity to deliver major capital engineering projects. In particular it identified the following as key challenges pertaining to the strategic issues

- Creating a framework in the national interest
- Industry procurement practices and structure
- Human resources development, skills, capability and performance
- Artisans and skills formation
- Professions and engineering

Against these challenges, the study produced some guiding principles which should be incorporated in any strategy to address current and future skills shortages. A number of them are listed as follows (although the list is not exhaustive)

- Promote an industry with a total construction capability to delivery South Africa's economic and social development foundation into the future – to global standards and in concordance with national transformation objectives.
- Encourage clients to take greater ownership of the challenge
- Maximise the opportunities for skills development utilising recognition of prior learning (RPL) at all possible levels of identified skills shortages
- Recognise that productivity in the construction industry needs improvement in order to increase competitiveness

## 8.0 DETERMINATION OF KNOWLEDGE AND SKILLS NEEDS OF THE INDUSTRY

The information in this section is complied from responses to the two separate instruments namely construction management survey instrument and civil engineering pertaining to students views.

### 8.1 Construction Management

According to a survey conducted by the Construction Management Association of America (CMAA), when asked to rank 120 common project responsibilities according to their importance in a Construction Manager, these responsibilities fell into seven broad areas as follows:

- Project Management Planning;
- Cost Management;
- Time Management;
- Quality Management;
- Contract Administration;
- Safety Management; and
- Construction Management Professional Practice.

The area ranked as the most important was that of Project Management Planning followed by Time Management. A study conducted by Young (1989) demonstrated that there was overall agreement among junior, middle and senior managers as to the requisite skills and knowledge needs of Construction Managers. It identified the following areas of skill and knowledge needs as being the most important:

- Organisation
- Human Relations
- Communication
- Personnel Management
- Operational Planning

### 8.2 Civil Engineering

The subject of engineering should be interpreted with reference to the following specific disciplines within it of:

- Mathematics;
- Science;
- Information Technology;
- Design;
- Business Context; and
- Engineering practice.

Further, it can be summarised under the following themes

- Knowledge and understanding;
- Intellectual abilities;

- Practical skills; and
- General transferable skills.

Generally there is congruence between these skills and those of Construction Management
The criteria for content of engineering programmes are tabulated and summarised in Table 26.

In order to match definitions of engineering in general as tabulated in Table 26, employers were also asked how adequately Universities of Technology prepared students in civil engineering in terms of the definition as provided in the clarification of terms. The findings are reported as part of a broader survey in the following section.

Chan et al (2002) in citing Rosset and Yao (2000) provide the following view of civil engineers

*"Civil engineers must be able to work in teams, communicate well, work from a system approach, and within the context of ethical, political, international, environment, and economical considerations. Consequently, civil engineers are required to have a broad-based undergraduate education"*

Table 26. Criteria for Content of Engineering Programmes

| Discipline | Knowledge and Understanding of | Intellectual Abilities | Practical Skills | General Transferable Skills |
|---|---|---|---|---|
| Mathematics | Appropriate mathematical methods | Ability to select and apply appropriate mathematical methods for modelling and analysing engineering problems | Skill in the use of appropriate mathematical methods for modelling and analysing discipline-specific engineering problems. | Manipulation and sorting of data<br><br>Presentation of data in variety of ways |
| Science | Science appropriate to the specific discipline | Use of scientific principles in the development of engineering solutions to practical problems<br><br>Use of scientific principles in the modelling and analysis of engineering systems, processes and products. | Use of relevant test and measurement equipment.<br><br>Experimental laboratory work | Use of scientific evidence based methods in the solution of problems |
| Information Technology | Principles of IT and Communications (ITC) relevant to the discipline | Use of engineering IT tools (including programming languages where appropriate) | Use of engineering IT tools (including programming languages where appropriate) | Use of general IT tools |
| Design | General principles of design techniques specific to particular products and processes<br><br>Characteristics of engineering materials and components | Analysis of systems, processes and components requiring engineering solutions.<br><br>Creation of new processes or products through synthesis of ideas from a wide range of sources | Design of a system, componet or process practical testing of design ideas in laboratory or through simulation, with technical analysis and critical evaluation of results.<br><br>Research for information to develop ideas further | Use of creativty and innovation in problem solving<br><br>working with limited or contradictory information |
| Business Context | Management and business practices (including finance, law, marketing, personnel and quality)<br><br>Professional an ethical responsibilities including the global and social | Commercial risk evaluation | | effective communication life long learning |
| Engineering Practice | Manufacturing and / or Operational Practice<br><br>Codes of practice and the regulatory framework<br><br>Requirements for safe operation | Ability to produce solutions to problems through the application of engineering.<br><br>Knowledge and understanding ability to undertake technical risk evaluation | Ability to apply engineering techniques taking account of industrial and commercial constraints<br><br>Project management | The engineering solution approach to the solution of problems<br><br>Time and resource management<br><br>Teamwork and leadership |

*Source :* (Quality Assurance Agency for Higher Education, 2000)

## 9.0 The Practice of Experiential Learning

Figure 11 graphically highlights the aspects of experiential learning that are investigated in this study.

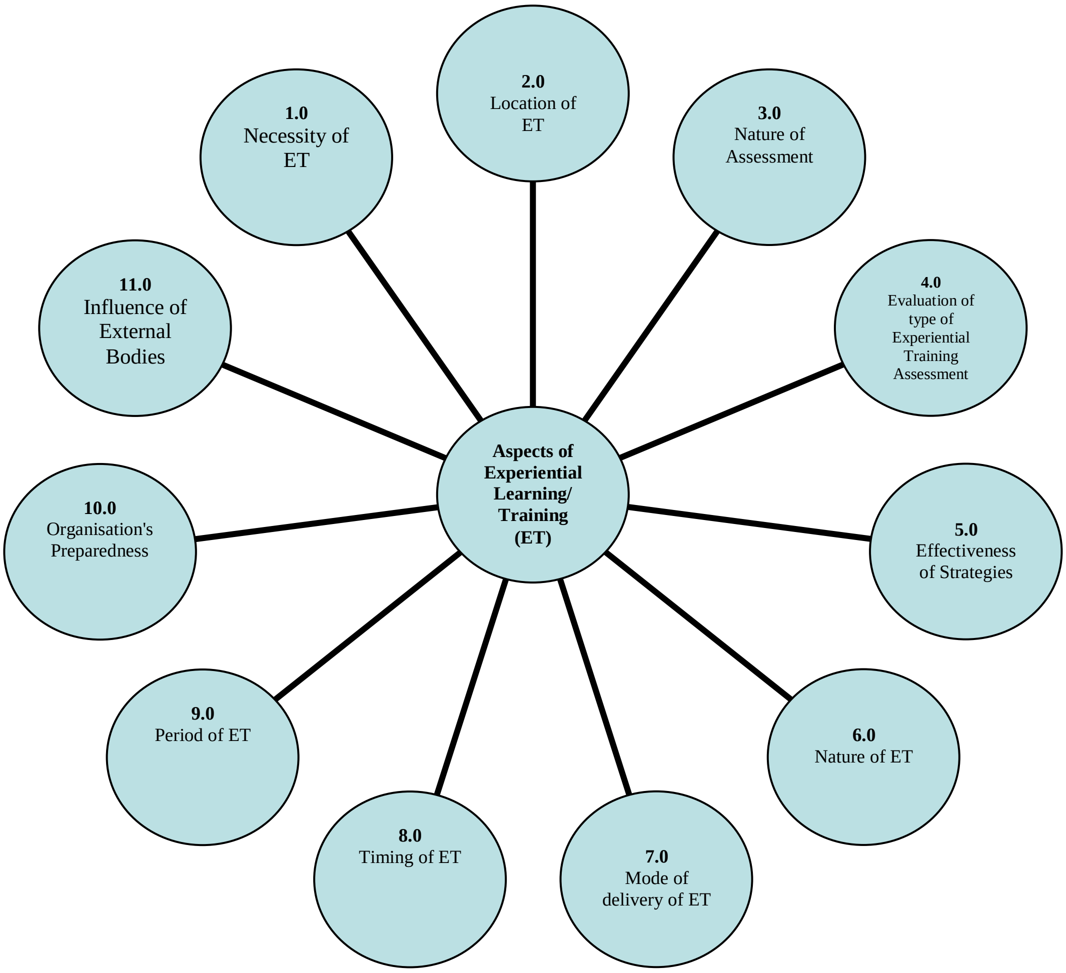


Figure 11. Overview of the Aspects of Experiential Training

The following aspects of Experiential Learning and Training were sought from the three stakeholders namely the students, staff and employers (Industry)

- Necessity;
- Location;
- Nature of Assessment;
- Type of Experiential Training;
- Effectiveness of Strategies;
- Nature;
- Mode of delivery of ET;
- Timing of ET;
- Period of ET;
- Organisation's Preparedness – Remuneration; and
- Influence of External Bodies.

## 9.1 Student Views of Experiential Learning

The information in this section is complied from responses to the two separate instruments namely; construction management and civil engineering student survey instruments pertaining to their views of experiential learning and general opinions of the educational offerings. For each issue 100% is assigned to the total number of responses to the particular question, with non-responses excluded. Although every effort was made to select a cross section of students according to discipline and institution, there is no certainty that the sample finally interviewed is representative of the population as a whole.

### 9.1.1 Construction Management Students

- ***9.1.1.1 Demographics***

The views were canvassed nationally using self administered structured questionnaires of samples of 162 first year students, and 186 third and fourth year students.

- ***9.1.1.2 Experiential Training***

The respondents were predominantly (96.8%) third year National Diploma, Building students registered at the former Cape and Peninsula Technikons (now CPuT) (57.0%), Technikon Witwatersrand (35.5%), and Vaal University of Technology, VUT (7.5%). Most students (89.2%) had any experiential training in Year 2. This period was spent with a range of types of companies, such as contractors (64.6%), professional quantity surveying practices (15.2%), co-contractors (7.3%), property developers (2.4%), and project management firms (1.2%). The mean period of employment was 0.99 years, ranging from 2 months to 5 years.

Most students (76.5%) regarded experiential training either as a necessary (14.4%) or totally necessary (62.1%) component of construction management programs. With respect to the type of experiential training they received, most students (53.3%) reported that a project-based approach was used where they worked on a specific project. Their responses are shown in Table 27.

Table 27. Experiential Training Received: Construction Management Student Views

| Project based | Function/department based | Both | Neither |
|---|---|---|---|
| 53.3% | 7.8% | 35.9% | 3.0% |

The responses to what type of experiential training the students preferred are shown in Table 28. Clearly, students preferred a combination of both types of experiential training in industry. (mean = 4.08/5.00)

Table 28. Experiential Training Preferred: Construction Management Student Views

| Type | Strongly disagree | Disagree | Neutral | Agree | Strongly agree | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|
| Both | 5.8% | 3.3% | 14.2% | 30.0% | 46.7% | 4.08 | 1.13 |
| Project based | 6.3% | 3.6% | 20.5% | 39.3% | 30.4% | 3.84 | 1.10 |
| Function/department based | 4.7% | 10.5% | 24.4% | 41.9% | 18.5% | 3.59 | 1.06 |
| Neither | 77.8% | 4.4% | 2.2% | 6.7% | 8.9% | 1.64 | 1.33 |

Most students preferred that experiential training should be structured (76.1%) and assessed (76.9%). Their responses are shown in Table 29.

Table 29. Nature and assessment of experiential training: Construction Management Student Views

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|
| Structured | 6.6% | 2.6% | 14.6% | 17.2% | 58.9% | 4.19 | 1.19 |
| Assessed | 4.8% | 5.4% | 12.9% | 19.9% | 57.0% | 4.19 | 1.15 |
| Unstructured | 30.2% | 12.8% | 23.3% | 14.0% | 19.8% | 2.80 | 1.50 |

The most preferred agency to assess the experiential component was the employer (mean=3.98) followed by the academic institution (mean=3.95) as evidenced from Table 30.

Table 30. Assessment Agency

| Rank | Agency | Mean | Std. Dev. |
|---|---|---|---|
| 1 | Employer | 3.98 | 1.20 |
| 2 | Academic institution | 3.95 | 1.28 |
| 3 | Independent assessor | 3.20 | 1.72 |

Similarly, most students (55.5%) preferred that experiential learning be undertaken in stages with most also suggesting that the total period of time should be either 12 months (75.6%) or 6 months (40.5%). These responses are shown in Table 31.

Table 31. Period of Experiential Training: Construction Management Student Views

| Period | Rank | Strongly disagree | Disagree | Neutral | Agree | Strongly agree | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|---|
| In stages | | 21.5% | 5.0% | 17.7% | 16.0% | 39.8% | 3.48 | 1.57 |
| 12 months | 1 | 6.3% | 1.6% | 4.7% | 11.8% | 75.6% | 4.49 | 1.09 |
| 6 months | 2 | 21.5% | 5.1% | 13.9% | 19.0% | 40.5% | 3.52 | 1.58 |
| 3 months | 3 | 66.7% | 6.3% | 10.4% | 6.3% | 10.4% | 1.88 | 1.41 |

Table 32 suggests that experiential training should take place after year 1 (mean=3.49) as is presently the case.

Table 32. Location of Experiential Training: Construction Management Students Views

| Rank | Timing | Strongly disagree | Disagree | Neutral | Agree | Strongly agree | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|---|
| 1 | After year 1 | 28.0% | 5.6% | 6.4% | 9.6% | 50.4% | 3.49 | 1.75 |
| 2 | After year 2 | 31.4% | 13.3% | 10.5% | 20.0% | 24.8% | 2.93 | 1.61 |
| 3 | During year 2 | 34.0% | 10.7% | 10.7% | 20.4% | 24.3% | 2.90 | 1.63 |
| 4 | After year 3 | 41.8% | 10.9% | 4.5% | 14.5% | 28.2% | 2.76 | 1.74 |
| 5 | During year 1 | 67.7% | 11.1% | 10.1% | 5.1% | 6.1% | 1.71 | 1.21 |

More students preferred experiential training to take place before the completion of the National Diploma: Building (45.6%) rather than before the completion of the B. Tech. Degree (29.3%).

Relative to how satisfied students were with various aspects of their experiential training experience, they responded as shown in Table 33. Students were more satisfied with the experience that they gained and the supervision of their experiential training, which were aspects that involved employers than they were with placement and monitoring which were aspects that mostly involved the academic institution. This finding replicates the findings of a similar study conducted by Haupt (2003). The response relative to monitoring is cause for concern, as evidenced by the low mean score (ms = 2.95).

Table 33. Satisfaction with Experiential Training: Construction Management Students Views

| | Very dissatisfied | Dissatisfied | Neutral | Satisfied | Very satisfied | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|
| Experience gained | 6.5% | 4.7% | 20.6% | 21.8% | 46.4% | 3.97 | 1.20 |
| Supervision | 13.4% | 7.9% | 21.3% | 25.0% | 32.4% | 3.55 | 1.37 |
| Placement | 24.4% | 11.6% | 25.0% | 16.4% | 22.6% | 3.01 | 1.47 |
| Monitoring | 20.7% | 13.4% | 31.7% | 18.2% | 16.9% | 2.95 | 1.34 |

The responses of students relative to how well the Year 1 academic courses prepared them for their experiential year are shown in Table 34. The mean of 3.49 suggests that they considered the preparation for Year 2 in industry average to well.

Table 34. Academic Preparation for Experiential Training: Construction Management Student Views

| Very poorly | Poorly | Average | Well | Very well | Mean | Std. Dev. |
|---|---|---|---|---|---|---|
| 8.3% | 8.8% | 34.3% | 23.2% | 25.4% | 3.49 | 1.20 |

Their responses with respect to how well their period of experiential training prepared them for Year 3 are shown in Table 35. The mean of 3.79 suggests that they considered their period of experiential training more positively relative to preparation for year 3.

Table 35. Experiential Training as Preparation for Year 3: Construction Management Student Views

| Very poorly | Poorly | Average | Well | Very well | Mean | Std. Dev. |
|---|---|---|---|---|---|---|
| 6.4% | 7.5% | 20.2% | 33.5% | 32.4% | 3.79 | 1.17 |

- ***9.1.1.3 Opinions on Construction Management Courses***

With respect to the relevance of the subjects offered in the present course to the work situation as experienced by students in their period in industry, they responded as shown in Table 36. The mean of 4.10 suggests that present subjects were relevant to the work situation that they had experienced.

Table 36. Relevance of Subjects to Work Situation: Construction Management Student Views

| Very irrelevant | Slightly irrelevant | Average | Slightly relevant | Very relevant | Mean | Std. Dev. |
|---|---|---|---|---|---|---|
| 3.4% | 1.1% | 18.1% | 36.7% | 40.7% | 4.10 | 0.97 |

By comparing the means of their responses, more students regarded the program as being slightly more practical rather than academic in nature as shown in Table 37. This finding is the reverse of what Year 1 students reported.

Table 37. Academic and Practical Nature of Construction Management Program

| Aspect | Not at all | Marginally | Average | Slightly | Very | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|
| Academic | 3.7% | 1.8% | 36.4% | 34.6% | 23.5% | 3.72 | 0.97 |
| Practical | 2.3% | 9.3% | 23.8% | 32.0% | 32.6% | 3.83 | 1.06 |

The respondents were first year National Diploma; Building students registered at the former Cape Technikon (31.5%), former Peninsula Technikon (13.0%), and former Technikon Witwatersrand (55.5%). With respect to how the course content of Year 1 courses compared with what they expected them to be when they decided to register for them, 64.9% reported that the course content compared somewhat favourably with their expectations. The distribution of their responses is shown in Table 38. The mean of the responses suggests that students felt that the course content compared average to well with their expectations.

Table 38. Comparing Course Content with Expectations: Construction Management Student Views

| Very poorly | Poorly | Average | Well | Very well | Mean | Std. Dev. |
|---|---|---|---|---|---|---|
| 6.2% | 4.9% | 24.1% | 41.4% | 23.5% | 3.71 | 1.07 |

Most students reported that the subjects offered in Year 1 were both relevant and responsive to the needs of the construction industry. The distributions of their responses are shown in Tables 39 and 40.

Table 39. Relevance of Subjects to Needs of Industry: Construction Management Student Views

| Very irrelevant | Irrelevant | Neutral | Relevant | Very relevant | Mean | Std. Dev. |
|---|---|---|---|---|---|---|
| 0.6% | 2.5% | 15.5% | 37.9% | 43.5% | 4.21 | 0.84 |

The mean of the responses suggests that students thought that the subjects were relevant to very relevant and also responsive to very responsive to the needs of industry.

Table 40. Subject Responsiveness to Industry Needs: Construction Management Student Views

| Not responsive at all | Slightly responsive | Neutral | Responsive | Very responsive | Mean | Std. Dev. |
|---|---|---|---|---|---|---|
| 0.6% | 3.8% | 16.0% | 41.0% | 38.5% | 4.13 | 0.86 |

The responses to how satisfied students were with the individual subjects offered during Year 1 are shown in Table 41.

Table 41. Satisfaction with subjects offered in Year 1:Construction Management Student Views

| Subject | Very dissatisfied | Dissatisfied | Neutral | Satisfied | Very satisfied | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|
| Construction Management | - | 3.3% | 9.8% | 30.1% | 56.9% | 4.41 | 0.80 |
| Construction Technology | 1.9% | 1.9% | 12.8% | 28.8% | 54.5% | 4.32 | 0.91 |
| Applied Building Science | 4.5% | 7.0% | 14.0% | 25.5% | 49.0% | 4.08 | 1.15 |
| Quantity Surveying | 6.9% | 6.9% | 14.4% | 25.6% | 46.3% | 3.98 | 1.23 |
| Computer skills | 5.2% | 6.5% | 18.2% | 26.6% | 43.5% | 3.97 | 1.16 |
| Site Surveying | 7.7% | 6.4% | 16.7% | 29.5% | 39.7% | 3.87 | 1.23 |
| Communications | 9.6% | 7.6% | 15.3% | 24.8% | 42.7% | 3.83 | 1.31 |

The subjects that students were most satisfied with were Construction Management (4.41), Construction Technology (4.32), and Applied Building Science (4.08). Communications was the subject that students reported being most dissatisfied with.

Most of the students (76.1%) reported favourably relative to how well the course prepared them for their experiential period in industry. The mean (3.94) suggests that the course prepared them average to well for Year 2.

- ***9.1.1.4 Opinions on Education and Training***

Relative to the academic and practical nature of the course students responded as shown in Table 42. By comparing the means of their responses, more students regarded the program as being academic rather than practical in nature.

Table 42. Academic and Practical Nature of Year 1: Construction Management Student Views

| Aspect | Not at all | Hardly | Average | Very | Too much | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|
| Academic | 2.0% | 4.6% | 22.4% | 46.1% | 25.0% | 3.88 | 0.91 |
| Practical | 9.6% | 26.0% | 27.4% | 21.9% | 15.1% | 3.07 | 1.21 |

### 9.1.2 Civil Engineering Students

- ***9.1.2.1 Demographics***

Responses were drawn from 123 civil engineering students on the relevancy of the first year programme. First year students made up 69% of the respondents and 31% were in their third year of study. Second year students currently undertaking experiential learning were not canvassed because of the difficulty of administering their survey instrument in rather remote places of work.

Nearly one sixth of the students who had completed experiential training responded to the questionnaire. Third year students made up 71% of the respondents and 19% of respondents were drawn from fourth year. The rest were students who had completed experiential training but had one or more outstanding subjects to complete from their first year. The majority (88%) of students were employed for between six months and one year with 12% being employed for longer than the compulsory one year period. Students were employed in the sectors shown in Table 43 below:

Table 43. Frequency of respondents: civil engineering student employers for experiential learning

| Sector | % of Respondents | Cumulative |
|---|---|---|
| Construction | 28% | 28% |
| Consulting | 15% | 43% |
| Municipalities (local government) | 22% | 65% |
| Research units | 4% | 69% |
| Suppliers | 4% | 73% |
| Others | 27% | 100% |

- ***9.1.2.2 Experiential Training***

Students were asked to describe the experiential training they received during the second year of the course. A minority (32%) indicated that they had worked in a project-based environment, 12% indicated in a function / department based environment and 48% in both. They were also asked what form experiential learning should take given their experiences. Almost two-thirds (65%) indicated that they thought it should be both project and function based with reasons varying from “it provides insight into what goes on in both environments”, “you get more experience” and there is a need for a “variety of training”.

Students considered experiential training important with more than 60% indicating that it was necessary given that “they learnt a lot during practical training”, “because it exposes you to the working environment” and “helps you to adjust to life in industry”.

There was broad support for experiential training and the current model of students spending a year of the programme in training and undertaking it in stages. However, the timing of the training appeared to be contentious. Most students supported a period after 1st year but before commencement of the final (4th) year of the programme. The big issue was when after the 1st year? Approximately 64% supported going into this training period after completing two years of theory. Only a minority (20%) of the students supported the current model in that it should be completed during the 2nd year of training. This finding is in stark contrast with industry and staff support for students to enter industry after year one due to maturity and acquirement of life skills.

Students were asked to what extent experiential training should be structured (requiring a set of predetermined tasks to be completed or skills to be gained) or unstructured (no such requirement or stipulation). Approximately 70% indicated that it should be structured with the major reasons given “that you get exposed to everything”, “you need skills in any field of work”, and “you need to get involved in industry as much as possible”. In much similar vein, 55% of respondents disagreed that it should be unstructured.

Approximately 67% of students agreed that experiential learning should be assessed and that the assessment should jointly be carried out by the university, the employer and an independent assessor. As with the previous finding, again this is a new slant in that assessment of EL has always only been carried out by the university and employer.

Table 44. Students’ Satisfaction Levels: Civil Engineering Students Views

| Aspects of EL | Frequency of Respondents VDS 1 | DS 2 | N 3 | S 4 | VS 5 | Mean Score | SL | Ranking |
|---|---|---|---|---|---|---|---|---|
| Experience gained | 7 | 2 | 19 | 33 | 39 | 3.95 | 0.790 | 1 |
| Supervision | 12 | 15 | 33 | 26 | 14 | 3.15 | 0.630 | 2 |
| Monitoring | 12 | 15 | 37 | 19 | 17 | 3.14 | 0.628 | 3 |
| Placement | 27 | 14 | 18 | 14 | 27 | 3.00 | 0.600 | 4 |

Students were asked whether they were satisfied with placement and monitoring in industry, the supervision of their work while in industry and experience gained. The results are given in Table 44. Note that the Department of Civil Engineering assisted students in placing them in industry and was responsible for monitoring their progress once placed. It appears that students were not satisfied with placement and monitoring. They appeared on the other hand, to be reasonably satisfied with the employer’s supervision and the experience they gained.

Students were asked how well the academic courses in 1st year prepared them for their experiential year in industry. Reasons were varied as to whether or not they were prepared. Approximately 26% stated that they “had a good background” and “everything they learnt came across during training”.

The opposite is apparent when analyzing the responses to the question of how well the experiential training in 2nd year prepared them for the 3rd year of study. Approximately 55% responded that they were well or very well prepared citing that they “had gained lots during training” and they “knew some things taught in third year”.

Approximately 60% responded that subjects offered in the course were relevant to the work situation. The mean of the responses was 3.81 with a standard deviation of 0.93.

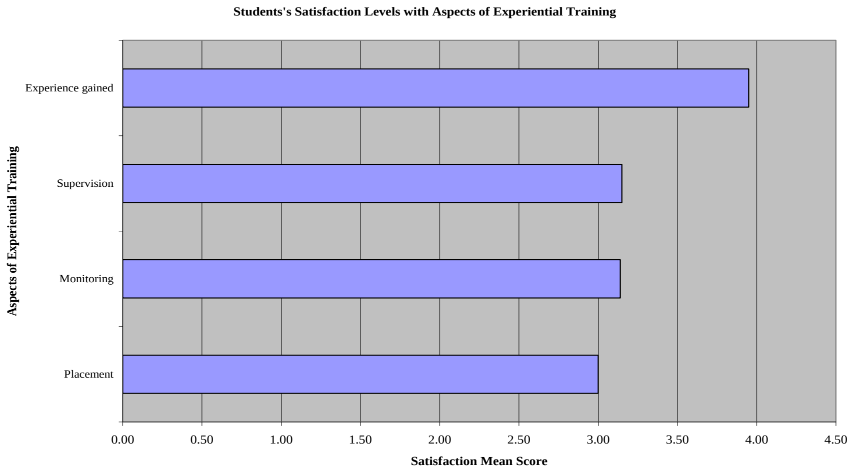


Figure 12. Student's Satisfaction Mean Scores with Aspects of Experiential Training

Students were asked to rate how academic or practical the 1st year was based on their experiences. On the academic side, less than 6% felt that the 1st year was marginally academic or not academic at all with 65% rating it slightly academic to very academic. Most felt the programme to be “loaded with too much work and too little time”. Analysis of the practical side provided similar results. Approximately 12% rated it marginally practical or not practical at all and 53% rated it slightly to very practical. This finding leads to the following question; *does this lead one to believe that the department is on the right track in terms of the mix between academic and practical activities?*

The reasons given appeared somewhat varied with students stating that “doing things practically is the best learning” and that “they get to know the work and therefore experience”.

South Africa is a developing country. The relevance and responsiveness of educational programmes is thus of utmost importance. Students were asked to firstly, rate how relevant and secondly, how responsive the programme is to the economic, social and political needs of the country. More than 60% felt that the programme was both responsive and relevant to the needs of the country. Less than 12% felt it to be slightly or very irrelevant and 7% felt it only to be marginally responsive to the needs of the country.

#### *9.1.1.2 Continuing Professional Development and Professional Registration*

Most respondents (86.7%) reported that they regarded as important the supplementation of academic instruction and experiential training by CPD with 56.7% regarding it as extremely important. Further, 47.9% regarded Universities of Technology graduates as suitable for professional registration in terms of legislation. Most (76.7%) reported that CPD should be a requirement to maintain registration while 90.0%% suggested that Universities of Technology should offer programs that contribute towards CPD and professional registration in terms of legislation.

- #### *9.1.2.3 Opinions on Civil Engineering Courses*

The opinions of students were canvassed on their expectations before they formally registered of the first year of the civil engineering course. Evidently 73% of students reported that their expectations of the first year of the course were more than adequately met. Approximately 3% felt that their expectations were poorly met. These results are shown in Table 45.

Table 45. Comparison of expectations of the civil engineering programmes

| Expectation Levels | Frequency of Respondents | Cumulative |
|---|---|---|
| Very poorly | 2% | 2% |
| Poorly | 1% | 3% |
| Average | 24% | 27% |
| Well | 55% | 82% |
| Very well | 18% | 100% |
| Mean | 3.89 | |
| Standard deviation | 0.77 | |

However, the reasons given for the meeting of expectations were somewhat varied. Approximately 19% stated that the course was what they had expected and 18% stated that expectations were met because of good lectures. The course was found to be interesting and challenging by 15% of respondents and 12% stated that they had learnt the basics in the first year. Only 6% expected the course to be more difficult than they actually experienced.

Students were asked to indicate how relevant they thought the course was to the needs of the construction industry. The responses are shown in Table 46. The majority of students felt that the course was relevant to the needs of industry with 57% responding that subjects taken during the year taught valuable industrial skills. It’s interesting in that the majority of the respondents are first years and that they thought courses to be relevant. One possibility of this finding could be because of the awareness of the needs of the disadvantaged communities that they come from or possibly lack of knowledge or exposure to the industry. It should be noted that third year students would be better equipped to express opinions on the needs of industry given that they had spent a full year in experiential learning before entering the third year of study.

Table 46. Relevancy of the civil engineering course to needs of industry

| Relevancy of Course Needs | Frequency of Respondents | Cumulative |
|---|---|---|
| Very irrelevant | 1% | 1% |
| Irrelevant | 5% | 6% |
| Neutral | 21% | 27% |
| Relevant | 36% | 63% |
| Very relevant | 37% | 100% |
| Mean | 4.02 | |
| Standard deviation | 0.96 | |

Students were asked to indicate how responsive the subjects offered in the first year were to the needs of the construction industry. Their responses are shown in Table 47. Respondents felt that subjects were in the main responsive to the needs of industry with approximately 59% stating that the subjects undertaken during first year “gave them a good idea of what to expect in industry” and “a good picture”. Approximately 13% indicated that “you need to know what you are doing and what to expect”

Students were asked to indicate how satisfied they were with several subjects offered in the first year. The overall impression gained is that students appeared to be largely satisfied with first year civil engineering subjects offered at the university (see Table 48) with the most frequent reasons being that lecturers were “good” and “understandable”. It is recommended that future studies should not include the term whether the lecturer was being “good and understandable”. They appear to be most satisfied with Mathematics and Applied Mechanics and least satisfied with Communication Skills. Further analysis on individual subjects is given below.

Table 47. Responsiveness to construction industry

| Responsiveness | Frequency of Respondents | Cumulative |
|---|---|---|
| Not responsive at all | 2% | 2% |
| Slightly responsive | 6% | 8% |
| Neutral | 22% | 30% |
| Responsive | 39% | 69% |
| Very responsive | 31% | 100% |
| Mean | 3.91 | |
| Standard deviation | 0.98 | |

- ***9.1.2.5 Opinions on Education and Training***

Table 48. Satisfaction levels with 1st Year subjects (%): civil engineering student views

| Subjects | Frequency of Respondents | | | | |
|---|---|---|---|---|---|
| | VD | DS | N | S | VS |
| | 1 | 2 | 3 | 4 | 5 |
| 1. Communication Skills | 4 | 11 | 39 | 26 | 20 |
| 2. Site Surveying | 5 | 4 | 18 | 30 | 43 |
| 3. Computer Skills | 5 | 4 | 21 | 28 | 42 |
| 4. Construction Materials | 1 | 8 | 25 | 24 | 42 |
| 5. Construction Methods | 0 | 2 | 25 | 35 | 38 |
| 6. Management | 2 | 7 | 25 | 33 | 33 |
| 7. Applied Mechanics | 3 | 5 | 11 | 26 | 55 |
| 8. Mathematics | 1 | 4 | 13 | 27 | 55 |

As mentioned earlier, students were least satisfied with the subject Communication Skills. Only 15% of those surveyed specifically indicated that their language skills had improved significantly in the first year because of the subject Communication Skills. In addition, 30% indicated that they were satisfied with the subject because the lecturer was "good" and "understandable". South Africa is a multilingual society where eleven official languages enjoy equal status under the national constitution and that most students entering the civil engineering programme at the university speak English as a second or third language. Furthermore, English has recently become the language of communication in the civil engineering industry.

Table 49. Dissatisfaction levels with 1st Year subjects (%): civil engineering student views

| Subject | Mean | STD | CV | SLI | Rank |
|---|---|---|---|---|---|
| COS = Communication Skills | 3.44 | 1.08 | 31.40 | 0.688 | 1 |
| MGT = Management | 3.88 | 1.02 | 26.29 | 0.776 | 2 |
| CTS = Computer skills | 3.97 | 1.13 | 28.46 | 0.794 | 3 |
| CMA = Construction Materials | 3.99 | 1.03 | 25.81 | 0.798 | 4 |
| SS = Site Surveying | 4.04 | 1.08 | 26.73 | 0.808 | 5 |
| CME = Construction Methods | 4.08 | 0.84 | 20.59 | 0.816 | 6 |
| AME = Applied Mechanics | 4.25 | 1.02 | 24.00 | 0.850 | 7 |
| MAT = Mathematics | 4.33 | 0.92 | 21.25 | 0.866 | 8 |
| | 31.98 | | | | |

Students expressed satisfaction with the subject Site Surveying largely because the lecturer was "good" and "understandable". More than one quarter (27%) stated that they were satisfied because their computer skills had improved during the year. This can be attributed to the lack of access to computer facilities at historically disadvantaged schools. Less than half (44%) indicated that they were satisfied with the subject because the Computer Skills lecturer was "good" and "understandable".

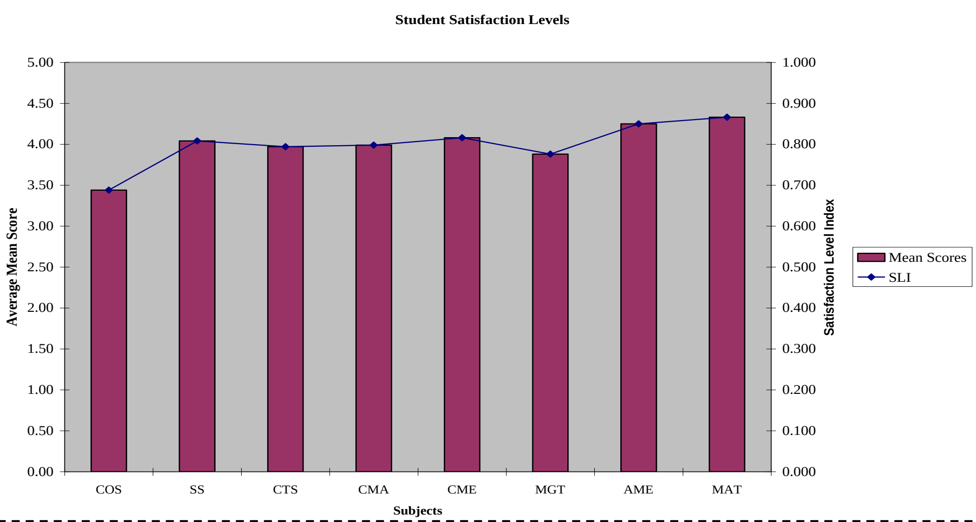


Figure 13. Civil engineering student satisfaction levels - mean scores indices

Somewhat different responses were given for the related subjects Construction Materials and Construction Methods with 30% and 42% of students indicating that they were satisfied with the subject because the lecturer was “good” and “understandable”. Approximately 20% stressed the importance of “knowing your construction materials” and 25% the importance of knowing “methods of construction”. Approximately 42% indicated satisfaction with the Management subject because the lecturer was “good” and “understandable”. However, very few students appeared to know the importance of the subject. This is evident from the wide range of responses with only 14% indicating it was important to “know how to deal with people on site” and a meagre 5% stressing the importance of “knowing contracts and legal matters relating to tenders”. This finding compliments the earlier study by Miller and Haupt (2003) within the Construction Management discipline in which the findings indicated that Management still ranked as the most important. Conclusions to be drawn from this observation are that there is a clear need to re-focus the way Management subjects are taught and not necessarily the Project Management Body of Knowledge (PMBOK).

The last two subjects surveyed were Applied Mechanics and Mathematics. These were two historically difficult and “at risk” subjects in the civil engineering curriculum. Most students registering for the programme had studied at previously disadvantaged high schools where teachers lacked the necessary skills to firstly prepare students adequately in Mathematics and Science and secondly, to prepare students for tertiary education. Schools also had a significant lack of laboratory resources. This led to students having “gaps” in their learning.

A majority (70%) of the respondents indicated satisfaction with Applied Mechanics because the lecturer was “good” and “understandable”. However, only 9% indicated the importance of “knowing about forces on structures” and 7% indicated that it gave “the basics on how to do calculations”. The same trend was apparent in Mathematics with 64% indicating satisfaction because of having a good lecturer and only 13% relating satisfaction to “being able to solve problems”. A small number (4%) indicated it enabled them to think better.

Students were asked to indicate how well the course was preparing them for the 2$^{nd}$ year of study. They spend the experiential learning year at a civil engineering company applying what they had learnt in the first year and also being prepared for the 3$^{rd}$ year of study. Most students indicated that they were well prepared for industry with varying reasons given as shown in Table 50. More than one third (35%) indicated that “preparation is good”. Around 27% indicated that “you actually learn the work you do on site”. This lends weight to the argument that one learnt when one engaged with the world of work. A further 9% indicated that they found the work to be “very relevant to first year but, more intense". It should be noted that 31% of respondents had completed their experiential training and could thus comment on the adequacy or otherwise of their experiences.

Table 50. Course Preparation for 2nd Year: Civil Engineering Student Views

| | Frequency of Respondents | Cumulative |
|---|---|---|
| Very poorly | 3% | 3% |
| Poorly | 6% | 9% |
| Average | 22% | 31% |
| Well | 36% | 67% |
| Very well | 33% | 100% |
| Mean / Standard Deviation | 3.90 / 1.02 | |

Students were asked to indicated how academic or practical the 1st year of the course is (Refer Tables 51 and 52). Most students felt that the course was very academic. However, a closer look at reasons given reveal students may not have understood the question with 22% feeling that "lots of work is done in class", 62% commenting on an acceptable workload and a mere 13% commenting on the theoretical component of the 1st year programme.

Table 51. Academic nature of the civil engineering course

| | Frequency of Respondents | Cumulative |
|---|---|---|
| Not at all | 1% | 1% |
| Hardly | 3% | 4% |
| Average | 30% | 34% |
| Very much | 47% | 81% |
| Too much | 19% | 100% |
| Mean | 3.78 | |
| Standard deviation | 0.82 | |

Students think that the course is a very practical one with 69% indicating that they are "exposed to lots of practicals". Only 8% indicated that they did not have enough time for practicals and 5% stated that they did not have enough equipment for practicals.

Table 52. Practical nature of the civil engineering course

| | Frequency of Respondents | Cumulative |
|---|---|---|
| Not at all | 1% | 1% |
| Hardly | 7% | 8% |
| Average | 32% | 40% |
| Very much | 33% | 73% |
| Too much | 27% | 100% |
| Mean | 3.77 | |
| Standard deviation | 0.97 | |

## 9.2 Staff Views of Experiential Learning

The information in this section is complied from responses to the two separate instruments namely; construction management survey instrument and civil engineering pertaining to staff views of experiential learning and general opinions of the educational offerings. For each issue 100% is assigned to the total number of responses to the particular question, with non-responses excluded. Although every effort was made to select a cross section of staff according to discipline and institution, there is no certainty that the sample finally interviewed is the representative of the population as a whole.

### 9.2.1 Construction Management

- ***9.2.1.1 Profile of Respondents***

Most academic staff (53.6%) surveyed were not professionally registered while 57.1% were involved with some aspect of construction industry related research.

- ***9.2.1.2 Experiential Training***

Most respondents (96.7%) regarded experiential training either as a necessary (30.0%) or totally necessary (66.7%) component of construction management programs. With respect to whether this experiential training should be project based or function/department based where students worked in the various departments of the employing organization, most respondents (53.3%) preferred a combination of both. Most respondents (86.7%) preferred experiential learning to be structured and that it should be assessed (93.3%). Their responses relative to the method of assessment are shown in Table 53.

Table 53. Assessment Methods: Staff Views

| Rank | Method | Mean | Std. Dev. | CV |
|---|---|---|---|---|
| 1 | Term report method | 4.48 | 0.80 | 17.86 |
| 2 | Rating sheet | 4.33 | 1.00 | 23.09 |
| 3 | Competency based assessment | 4.07 | 0.83 | 20.39 |
| 4 | Continuous assessment | 4.04 | 0.88 | 21.78 |
| 5 | Project based assessment | 3.96 | 0.94 | 23.73 |
| 6 | Job sponsor assessment | 3.81 | 1.10 | 28.87 |
| 7 | Portfolio assessment | 3.76 | 0.93 | 24.73 |
| 8 | Observation method | 3.52 | 1.16 | 32.95 |
| 9 | Panel assessment | 3.31 | 1.23 | 37.16 |
| 10 | Self-assessment method | 3.00 | 1.44 | 48.00 |
| 11 | Peer assessment | 2.70 | 1.44 | 53.33 |

The most preferred assessment methods were term reporting, rating sheet and competency based assessments. The most preferred agency to assess the experiential component was the employer followed by the academic institution as evidenced from Table 54.

Table 54. Assessment Agency: Staff Views

| Rank | Agency | Mean | Std. Dev. |
|---|---|---|---|
| 1 | Employer | 4.16 | 1.11 |
| 2 | Academic institution | 4.15 | 1.17 |
| 3 | Academic institution, employer and student together | 4.12 | 1.03 |
| 4 | Independent assessor | 2.96 | 1.37 |
| 5 | Student | 1.83 | 0.89 |

Similarly, most respondents (80.0%) preferred experiential learning to be undertaken in stages with most suggesting that the total period of time should be either 12 months (77.8%) or 6 months (70.0%). Table 55 suggests that experiential training should take place 1 year later than at present, namely after year 2.

Table 55. Location of Experiential Training within Academic Program-Staff Views

| Rank | Timing of experiential learning | Mean | Std. Dev. | CV |
|---|---|---|---|---|
| 1 | After year 1 | 4.09 | 1.24 | 30.32 |
| 2 | During year 2 | 3.45 | 1.53 | 44.37 |
| 3 | During year 3 | 3.00 | 1.73 | 57.67 |
| 4 | During year 1 | 2.80 | 1.54 | 55.00 |
| 5 | After year 2 | 2.80 | 1.40 | 50.00 |
| 6 | After year 3 | 2.41 | 1.42 | 58.92 |

Relative to how adequately employers were equipped to mentor students during their experiential period in industry the mean response of academics was 3.17 (out of maximum of 5). They reported a mean response of 3.43 relative to how adequately the experiential learning experience of students satisfied their requirements.

- ***9.2.1.3 Forums of influence***

Table 56 provides an indication of the effectiveness of various forums to influence construction management programs at universities of technology. Of the three forums, influencing bodies such as regional Master Builders Associations (MBAs), Construction Education and Training Authority (CETA) and others were the most preferred while lobbying education authorities was the least preferred.

Table 56. Forums of Influence: Staff Views

| | Ineffective | Neutral | Effective | Mean | Std. Dev. |
|---|---|---|---|---|---|
| Influencing bodies such as regional MBAs, CETAs, and others | 17.4% | 47.8% | 34.8% | 2.36 | 0.64 |
| Serving on advisory councils or boards of universities of technology departments | 16.0% | 40.0% | 44.0% | 2.28 | 0.74 |
| Lobbying appropriate education authorities | 17.4% | 47.8% | 34.8% | 2.17 | 0.72 |

- ***9.2.1.4 Continuous Professional Development (CPD)***

Most respondents (86.7%) reported that they regarded as important the supplementation of academic instruction and experiential training by CPD with 56.7% regarding it as extremely important. Further, 47.9% regarded Universities of Technology graduates as suitable for professional registration in terms of legislation. Most (76.7%) reported that CPD should be a requirement to maintain registration while 90.0%% suggested that Universities of Technology should offer programs that contribute towards CPD and professional registration in terms of legislation.

- ***9.2.1.5 Relevance and adequacy of instructional offerings***

The findings in Table 57 suggest that according to academic staff, former technikon graduates are more suited to managing a specific project than the business of construction and a number of projects. They are in agreement relative to this aspect with their industry counterparts.

Table 57. Adequacy of Management Ability

| Rank | Scope of management | Mean | Std. Dev. |
|---|---|---|---|
| 1 | A specific project | 3.72 | 0.84 |
| 2 | The business of construction | 3.71 | 0.81 |
| 3 | A number of projects | 3.52 | 0.77 |

Respondents were asked about the relevance of eight topics in CM programs as well as the adequacy with which Universities of Technology prepared their students in those topics. Their responses ranked by their means are shown in Tables 58 and 59.

Table 58. Relevance of Topics: Staff Views

| Rank | Topic | Mean | Max Possible Score | Std. Dev. | CWF |
|---|---|---|---|---|---|
| 1 | Construction technology | 4.67 | 5.00 | 0.73 | 0.136231 |
| 2 | Management principles, theories and practice | 4.50 | 5.00 | 0.84 | 0.131272 |
| 3 | Project management | 4.48 | 5.00 | 0.94 | 0.130688 |
| 4 | Construction economics | 4.37 | 5.00 | 0.93 | 0.127480 |
| 5 | Construction business environment | 4.26 | 5.00 | 0.76 | 0.124271 |
| 6 | Construction law | 4.19 | 5.00 | 1.14 | 0.122229 |
| 7 | Construction science | 4.00 | 5.00 | 0.83 | 0.116686 |
| 8 | Research methodology | 3.81 | 5.00 | 1.08 | 0.111144 |
| | Total | 34.28 | 40.00 | | 1.000 |

Construction technology, management principles, theories and practice and project management ranked as the most relevant topics. Research methodology ranked last. On the other hand, Universities of Technology prepared students most adequately in construction technology, management principles, theories and practice, and construction science. The adequacy ratings were generally higher than those given by industry participants. Research methodology and project management were also the areas in which students were the least adequately prepared by Universities of Technology. This finding raises the question about whether this inadequate preparation might result in these areas being regarded as unimportant. These results are shown in Table 59.

Table 59. Adequacy of preparation by Universities of Technology in topics

| Rank | Topic | Mean | Max Possible Score | Std. Dev. | CWF |
|---|---|---|---|---|---|
| 1 | Construction technology | 4.29 | 5.00 | 0.76 | 0.14627 |
| 2 | Management principles, theories and practice | 4.00 | 5.00 | 0.72 | 0.13638 |
| 3 | Construction science | 3.68 | 5.00 | 0.77 | 0.12547 |
| 4 | Construction economics | 3.57 | 5.00 | 0.92 | 0.12172 |
| 5 | Construction business environment | 3.57 | 5.00 | 0.88 | 0.12172 |
| 5 | Construction law | 3.57 | 5.00 | 0.88 | 0.12172 |
| 7 | Project management | 3.54 | 5.00 | 1.04 | 0.12070 |
| 8 | Research methodology | 3.11 | 5.00 | 1.07 | 0.10603 |
| | | 29.33 | 40.00 | | 1.000 |

Respondents were asked to indicate the necessary skills and attributes that Universities of Technology construction management graduates should possess. The ranking of the means of their responses to 38 skills and attributes is shown in Table 60.

Table 60. Desirable skills and Attributes of CM Graduates

| Rank | Skills/attribute | Mean | Standard Deviation. |
|---|---|---|---|
| 1 | Computer literacy | 2.97 | 0.19 |
| 1 | Worker safety and health awareness | 2.97 | 0.19 |
| 1 | Acceptance of responsibility | 2.97 | 0.19 |
| 1 | Problem solving skills | 2.97 | 0.19 |
| 5 | Verbal communication skills | 2.93 | 0.26 |
| 5 | Planning, scheduling and controlling construction operations and activities | 2.93 | 0.26 |
| 7 | Practical building knowledge | 2.93 | 0.37 |
| 8 | Time management | 2.90 | 0.31 |
| 8 | Academic achievement | 2.90 | 0.31 |
| 8 | Numeracy | 2.90 | 0.31 |
| 8 | Active listening skills | 2.90 | 0.31 |
| 8 | Measurement, costing and estimating | 2.90 | 0.31 |
| 13 | Decision making | 2.90 | 0.41 |
| 14 | Ability to exercise professional judgement | 2.86 | 0.35 |
| 14 | Familiarity with construction quality management | 2.86 | 0.35 |
| 14 | Ability to use surveying and levelling equipment | 2.86 | 0.35 |
| 14 | Trust and honesty | 2.86 | 0.35 |
| 18 | Up-to-date professional knowledge | 2.83 | 0.38 |
| 19 | Ability to resolve conflicts and disputes | 2.83 | 0.60 |
| 20 | Interpersonal skills | 2.82 | 0.38 |
| 21 | Managerial knowledge | 2.82 | 0.48 |
| 22 | Leadership capability | 2.79 | 0.41 |
| 22 | Financial management | 2.79 | 0.41 |
| 24 | Familiarity with workings and intricacies of industry | 2.76 | 0.44 |
| 25 | Supervisory skills and ability to train others | 2.76 | 0.51 |
| 26 | Adaptability to changing work environment | 2.75 | 0.44 |
| 27 | Team building capability | 2.72 | 0.45 |
| 28 | Ability to work autonomously | 2.72 | 0.53 |
| 29 | Creativity and innovation | 2.66 | 0.55 |
| 30 | Entrepreneurship | 2.62 | 0.62 |
| 31 | Negotiating skills | 2.59 | 0.57 |
| 32 | Environmental awareness | 2.55 | 0.69 |
| 33 | Work study | 2.48 | 0.69 |
| 34 | Ability to conduct research | 2.38 | 0.78 |
| 35 | Systems development ability | 2.28 | 0.75 |
| 36 | Marketing skills | 2.21 | 0.82 |
| 37 | Ability to conduct statistical analysis | 2.21 | 0.77 |

Irrespective of their professional background, respondents (staff) were asked to rank the desirability of 37 skills and attributes in Construction Management graduates. Each skill was rated on a five-point scale. The means and standard deviation for the 37 items appear in Table 60. Items with larger standard deviations indicate a wider dispersion of responses across the corresponding construction management staff. There are no differences in responses from staff for these items.

Computer literacy, worker safety and health awareness, acceptance of responsibility and problem solving skills were reported as the most desirable skills and attributes that CM graduates needed to have.  Systems development ability, marketing skills and ability to conduct statistical analysis were the least desirable skills and attributes.

Table 61. Importance of Skills and Attributes of CM Graduates

| Rank | Skills/attribute | Mean | Std. Dev. |
|---|---|---|---|
| 1 | Trust and honesty | 4.63 | 0.63 |
| 2 | Planning, scheduling and controlling construction operations and activities | 4.59 | 0.57 |
| 3 | Numeracy | 4.59 | 0.69 |
| 3 | Time management | 4.59 | 0.69 |
| 5 | Measurement, costing and estimating | 4.56 | 0.58 |
| 5 | Acceptance of responsibility | 4.56 | 0.58 |
| 7 | Practical building knowledge | 4.56 | 0.64 |
| 8 | Active listening skills | 4.52 | 0.58 |
| 9 | Verbal communication skills | 4.51 | 0.64 |
| 10 | Decision making | 4.48 | 0.64 |
| 11 | Problem solving skills | 4.44 | 0.75 |
| 11 | Worker safety and health awareness | 4.44 | 0.75 |
| 13 | Up-to-date professional knowledge | 4.41 | 0.69 |
| 13 | Interpersonal skills | 4.41 | 0.69 |
| 15 | Familiarity with construction quality management | 4.41 | 0.75 |
| 16 | Ability to use surveying and levelling equipment | 4.41 | 0.80 |
| 17 | Financial management | 4.37 | 0.69 |
| 18 | Ability to resolve conflicts and disputes | 4.37 | 0.84 |
| 19 | Creativity and innovation | 4.33 | 0.68 |
| 20 | Ability to work autonomously | 4.33 | 0.83 |
| 21 | Computer literacy | 4.30 | 0.67 |
| 22 | Ability to exercise professional judgement | 4.30 | 0.72 |
| 23 | Supervisory skills and ability to train others | 4.30 | 0.78 |
| 23 | Negotiating skills | 4.30 | 0.78 |
| 23 | Team building capability | 4.30 | 0.78 |
| 26 | Managerial knowledge | 4.29 | 0.72 |
| 27 | Familiarity with workings and intricacies of industry | 4.26 | 0.76 |
| 27 | Leadership capability | 4.26 | 0.76 |
| 29 | Adaptability to changing work environment | 4.22 | 0.70 |
| 30 | Academic achievement | 4.15 | 0.66 |
| 31 | Entrepreneurship | 4.15 | 0.91 |
| 32 | Environmental awareness | 4.11 | 0.85 |
| 33 | Work study | 3.96 | 1.01 |
| 34 | Ability to conduct statistical analysis | 3.85 | 1.06 |
| 35 | Ability to conduct research | 3.85 | 1.13 |
| 36 | Systems development ability | 3.78 | 1.09 |
| 37 | Marketing skills | 3.67 | 1.04 |

The responses of academics to how important these skills and attributes were in CM graduates and ranking by the means of these responses are shown in Table 61. Trust and honesty; planning, scheduling and controlling construction operations; numeracy and time management were the most important while ability to conduct research; systems development ability; and marketing skills were the least important.

Irrespective of their professional background, respondents (staff) were asked to rate how adequately Universities of Technology developed these 37 skills and attributes in their students. Each skill was rated on an five-point scale. The means and standard deviation for the 37 items appear in Table 62. Items with larger standard deviations indicate a wider dispersion of responses across the corresponding construction management staff. There are differences in responses from staff for these items.

Table 62. Adequacy of development of skills and attributes by technikons

| Rank | Skills/attribute | Mean | Std. Dev. |
|---|---|---|---|
| 1 | Ability to use surveying and levelling equipment | 4.07 | 0.87 |
| 1 | Measurement, costing and estimating | 4.07 | 0.87 |
| 2 | Academic achievement | 4.00 | 0.83 |
| 4 | Planning, scheduling and controlling construction operations and activities | 3.89 | 0.85 |
| 5 | Numeracy | 3.81 | 0.92 |
| 6 | Practical building knowledge | 3.81 | 1.08 |
| 7 | Familiarity with construction quality management | 3.67 | 0.92 |
| 8 | Managerial knowledge | 3.63 | 0.97 |
| 9 | Financial management | 3.59 | 0.84 |
| 10 | Up-to-date professional knowledge | 3.59 | 0.93 |
| 11 | Time management | 3.56 | 0.89 |
| 12 | Computer literacy | 3.56 | 0.93 |
| 13 | Worker safety and health awareness | 3.56 | 1.01 |
| 14 | Leadership capability | 3.54 | 0.90 |
| 15 | Ability to exercise professional judgement | 3.52 | 0.85 |
| 15 | Active listening skills | 3.52 | 0.85 |
| 17 | Acceptance of responsibility | 3.52 | 0.94 |
| 18 | Ability to work autonomously | 3.50 | 0.99 |
| 19 | Familiarity with workings and intricacies of industry | 3.48 | 0.85 |
| 20 | Verbal communication skills | 3.44 | 0.85 |
| 21 | Adaptability to changing work environment | 3.41 | 0.80 |
| 22 | Problem solving skills | 3.41 | 1.12 |
| 23 | Trust and honesty | 3.40 | 1.15 |
| 24 | Interpersonal skills | 3.33 | 0.96 |
| 25 | Team building capability | 3.27 | 1.15 |
| 26 | Creativity and innovation | 3.26 | 1.10 |
| 27 | Decision making | 3.22 | 0.93 |
| 28 | Ability to resolve conflicts and disputes | 3.15 | 1.20 |
| 29 | Supervisory skills and ability to train others | 3.11 | 1.01 |
| 30 | Work study | 3.11 | 1.05 |
| 31 | Entrepreneurship | 3.11 | 1.09 |
| 32 | Ability to conduct research | 3.11 | 1.12 |
| 33 | Environmental awareness | 3.07 | 0.87 |
| 34 | Negotiating skills | 3.00 | 0.96 |
| 35 | Ability to conduct statistical analysis | 3.00 | 1.11 |
| 36 | Marketing skills | 2.85 | 1.06 |
| 37 | Systems development ability | 2.85 | 1.19 |

Ability to use surveying and levelling equipment; measurement, costing and estimating; academic achievement; and planning, scheduling and controlling construction operations and activities were the skills and attributes that Universities of Technology most adequately developed in their students. On the other hand, ability to conduct statistical analysis; marketing skills; and systems development ability were those least adequately developed. The differences are important to note between the ranking of those skills and attributes that industry regard as important and those that Universities of Technology apparently focus on with respect to adequate development in their students. These differences might suggest that a mismatch exists.

### 9.2.2 Civil Engineering

This component of the study was not undertaken however the following observations from the National Advisory Council on Innovation (NACI, 2003) are drawn pertaining to the University and Universities of Technology graduation trends; demand for engineers and technicians

- ***9.2.2.1 University and Universities of Technology graduation trends***

The study conducted by NACI (2003) found that overall, the graduation trends at South African universities and universities of technology had recorded a decline in the number of engineering graduates over the past ten years. However this study did not report on the data for technicians and technologists which did not enable any comparisons to be made with university graduates. However the following observations are drawn from the NACI report

- From 1991 to 2001, with exception of 2000, there was an increase in the total number of universities of technology graduates from the National Diploma programmes.
- The decrease in 2000 of graduates could be attributed to the phasing out of the National Diploma in favour of the B Tech degree programmes.

On the other hand, traditional Universities were equally stable with regards to the graduation trends and the following observations are drawn:

- The period between 1991 and 1995 saw a slight increase in the number of graduates followed by a slight decrease in 1999.
- The number of graduating students stabilised in 2000
- There has been an increase in the number of post graduate engineering students

The following conclusions were drawn from the report:

- The labour market required a higher order of skills
- Tertiary institutions had responded well to the challenges identified above
- Lack of reliable figures on the migration of engineers was of major concern and complicated the process of planning.

## 9.3 Employer Views of Experiential Training: Construction Management

The information in this section is complied from responses to the construction management survey instrument pertaining to employers (industry) views of experiential learning and general opinions of the educational offerings. For each issue 100% is assigned to the total number of responses to the particular question, with non-responses excluded. Although every effort was made to select a cross section of employers according to size and turnover, there is no certainty that the sample finally interviewed is the representative of the population as a whole.

### 9.3.1 Demographics of Industry

All the industry participants interviewed were from across the provinces in South Africa. Figure 15 shows that the majority of companies interviewed employed more than 250 workers.

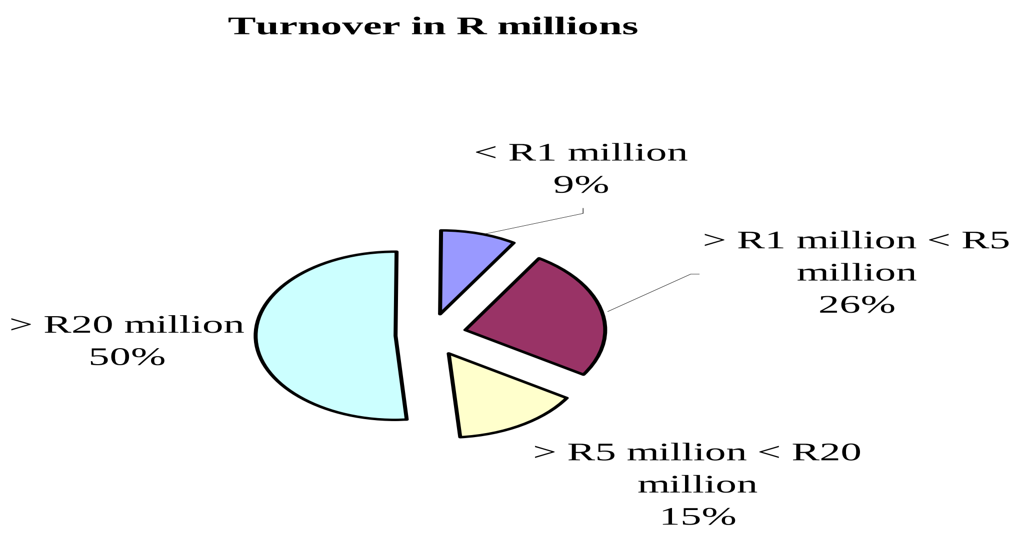


Figure 14. Industry – frequency of respondents by size of employment

However the average size of labour force employed by industry (employers) respondents was evenly distributed across all categories.

The respondents participated primarily in the industry as follows:

- Contractors – 48.9%;
- Subcontractors – 2.2%; and
- Consultants – 48.9%

With the breakdown of consultants as follows:

- Engineers – 4.4%;
- Project Managers – 17.8%;
- Quantity Surveyors – 15.6%;
- Other 11.1%.

The geographical location of the industry representative sample were as follows

- Eastern Cape – 10.0%
- Free State – 2.0%
- Guateng – 30.0%
- Kwazulu-Natal – 16.0%
- Northern Cape – 4.0%
- North West - 2.0%
- Western Cape – 24.0%
- Multiple Provinces – 12.0%

Figure 15 shows the frequency of respondents by turnover during the past three years. The majority of those interviewed (51%) reported turnovers in excess of R20 million

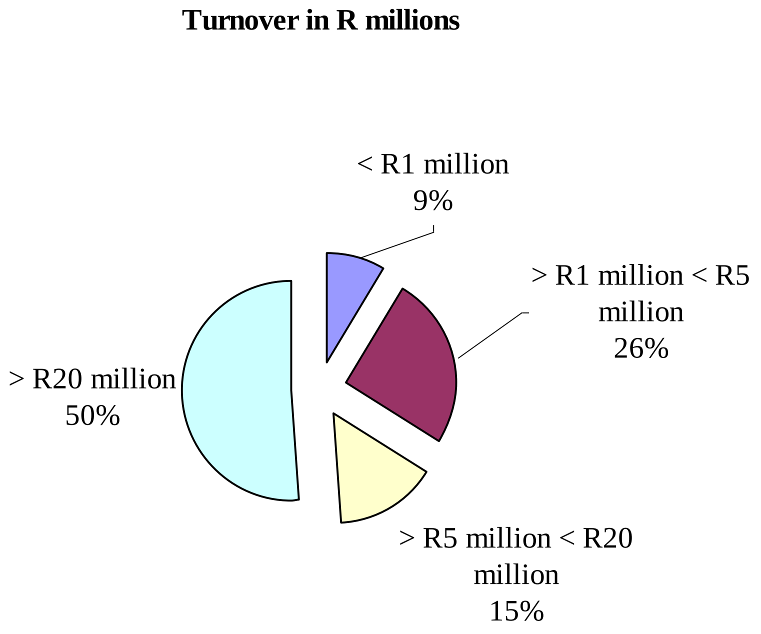


Figure 15. Industry – Frequency of Respondents by Turnover

Notably, more work opportunities were available in the Gauteng province of South Africa than in most other provinces.

- ***9.3.2.1 Experiential Training***

Most employers considered experiential training to be either necessary (24.1%) or totally necessary (72.4%), confirming the findings of previous studies conducted by Haupt, Smallwood and Miller (2004); Fester and Haupt (2003). These findings are shown in Table 63.

Table 63. Necessity of Experiential Training

| Totally Unnecessary | Unnecessary | Neutral | Necessary | Totally Necessary | Mean | Std. Dev. |
|---|---|---|---|---|---|---|
| 1.7% | - | 1.7% | 24.1% | 72.4% | | |

Most industry participants (74.5%) preferred that they should be responsible for the assessment of the experiential training component of construction management programs as evidenced from Table 64.

Table 64. Assessment Agency

| Rank | Agency | Yes | No | Mean | Std. Dev. |
|---|---|---|---|---|---|
| 1 | Employer | 74.5% | 25.5% | 1.25 | 0.44 |
| 2 | Academic institution | 69.6% | 30.4% | 1.30 | 0.46 |
| 3 | Independent assessor | 21.4% | 78.6% | 1.79 | 0.41 |

Similarly, most respondents (78.9%) preferred that experiential learning be undertaken in stages with most suggesting that the total period of time should be either 12 months (63.6%) or 6 months (34.1%). Table 65 suggests that experiential training should take place 1 year later than at present, namely after year 2. The smaller the mean value the more positive the feeling about the location of the experiential training period within the academic program.

 

Table 65. Location of Experiential Training within Academic Program

| Rank | Timing of experiential learning | Yes | No | Mean | Std. Dev. |
|---|---|---|---|---|---|
| 1 | After year 2 | 80.0% | 20.0% | 1.20 | 0.41 |
| 2 | After year 1 | 71.4% | 28.6% | 1.29 | 0.46 |
| 3 | After year 3 | 66.7% | 33.3% | 1.33 | 0.48 |
| 4 | During year 2 | 60.9% | 39.1% | 1.39 | 0.50 |
| 5 | During year 1 | 47.4% | 52.6% | 1.52 | 0.51 |
| 6 | During year 3 | 47.1% | 52.9% | 1.53 | 0.51 |

- ***9.3.2.2 Organisation's Preparedness for Provision of Experiential Training***

In terms of the industry's preparedness for the provision of Experiential Training to Construction Management students, an overwhelming 67.2% were prepared to do that with remuneration, whereas 15.5% were not and the minority (10.3%) didn't know whether they would or not. However when the respondents were asked whether they would wish to offer experiential training to Construction Management students without remuneration, the majority (46.6%) stated that they would not do that whereas only a minority (19.0%) was prepared to offer Experiential training without any form of remuneration. The summary of the Industry responses is shown in Figure 16.

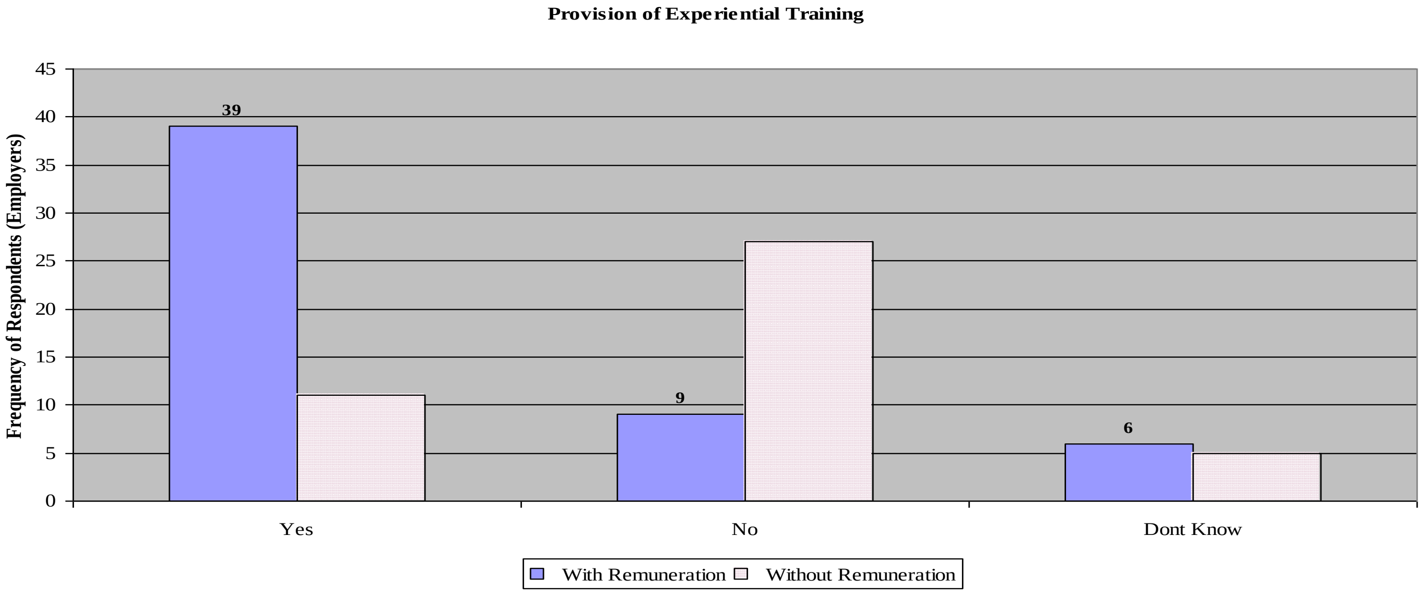


Figure 16. Preparedness of Respondents to provide Experiential Training

- ***9.3.2.4 Location (Basis) of Experiential Training***

With respect to whether this experiential training should be project based or function/department based where students work in the various departments of the employing organization, most respondents (70.7%) preferred a combination of both. Figure 17 shows the frequency of distribution of respondents according to the location of Experiential Training.

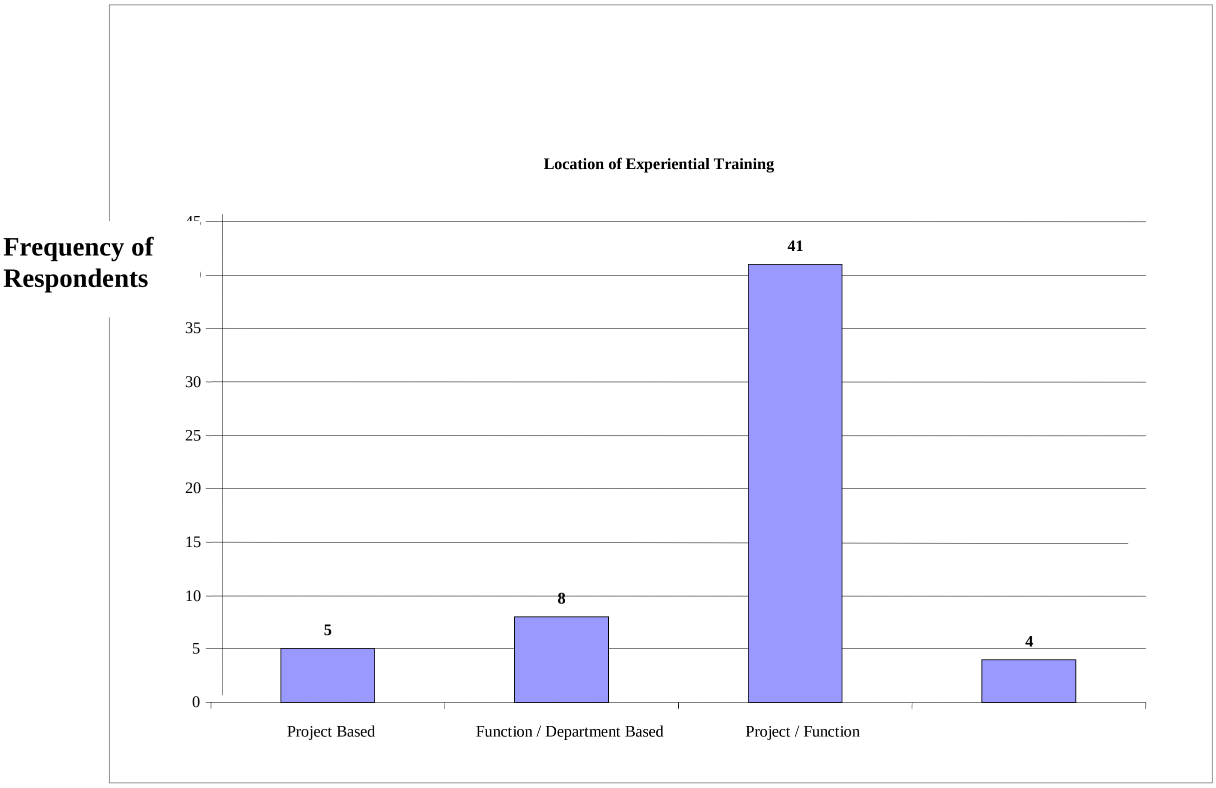


Figure 17. Location of Experiential Training

- ***9.3.2.5 Structure and Assessment of Experiential Training***

Most respondents (82.5%) preferred experiential learning to be structured and that it should be assessed (89.7%). Their responses relative to the method of assessment are shown in Table 66. The most preferred assessment methods were continuous, project and competency based assessments.

Table 66. Method of Assessment

| Rank | Method | Yes | No | Mean | Std. Dev. |
|---|---|---|---|---|---|
| 1 | Continuous assessment | 56.6% | 43.3% | 1.43 | 0.50 |
| 2 | Project based assessment | 53.7% | 46.3% | 1.46 | 0.50 |
| 3 | Competency based assessment | 51.9% | 48.1% | 1.48 | 0.50 |
| 4 | Rating sheet | 48.1% | 51.9% | 1.52 | 0.50 |
| 4 | Term report method | 48.1% | 51.9% | 1.52 | 0.50 |
| 6 | Observation method | 44.4% | 55.6% | 1.56 | 0.50 |
| 7 | Self-assessment method | 35.2% | 64.8% | 1.65 | 0.48 |
| 8 | Portfolio assessment | 33.3% | 66.7% | 1.67 | 0.48 |
| 8 | Job sponsor assessment | 33.3% | 66.7% | 1.67 | 0.48 |
| 10 | Peer assessment | 24.1% | 75.9% | 1.76 | 0.43 |
| 11 | Panel assessment | 16.7% | 83.3% | 1.83 | 0.38 |

By ranking the means of the responses the most preferred method of assessment was continuous assessment (56.6%) followed by competency assessment (53.7%). The least preferred method of assessment was panel assessment (16.7%). The smaller the mean the more positive the feeling about the assessment method

- ***9.3.2.6 Timing and Duration of Experiential Training***

Most employers (77.6%) preferred experiential training to take place in stages. These employers mostly (48.3%) preferred the length of the experiential training to be one year in duration. On the other hand, 25.9% preferred the period to be six months long while the remaining 1.7% preferred a 3-month long period in industry.

- ***9.3.2.7 Forums of influence***

Table 67 provides an indication of the effectiveness of various forums to influence construction management programs at the former technikons. Of the three forums, influencing bodies such as regional Master Builders Associations (MBAs), Construction Education and Training Authority (CETA) and others were the most preferred while lobbying education authorities was the least preferred.

Table 67. Forums of Influence

| Strategy | Ineffective | Neutral | Effective | Mean | Std. Dev. |
|---|---|---|---|---|---|
| Influencing bodies such as regional MBAs, CETAs, and others | 11.8% | 43.1% | 45.1% | 2.33 | 0.68 |
| Serving on advisory councils or boards of universities of technology departments | 18.8% | 43.8% | 37.5% | 2.19 | 0.73 |
| Lobbying appropriate education authorities | 24.5% | 63.3% | 12.2% | 1.88 | 0.60 |

Based on the Computation of the Effectiveness Index and Ranking of Strategies, the following strategies were ranked in ascending order as:

- Influencing bodies such as regional MBAs, CETAs, and others
- Serving on advisory councils or boards of universities of technology departments
- Lobbying appropriate education authorities

- ***9.3.2.7 Continuous Professional Development (CPD)***

Most respondents (84.5%) reported that they regarded as important the supplementation of academic instruction and experiential training by CPD with 44.8% regarding it as extremely important. Further, most (63.2%) reported that CPD should be a requirement to maintain registration while 83.9% suggested that Universities of Technology should offer programs that contribute towards CPD and professional registration in terms of legislation. There was mixed responses relative to whether universities of technology graduates were suitable for professional registration.

- ***9.3.2.8 Relevance and adequacy of instructional offerings***

The findings in Table 68 suggest that according to industry respondents universities of technology graduates are more suited to managing a specific project than the business of construction and a number of projects. Respondents were asked about the relevance of eight topics in CM programs as well as the adequacy with which universities of technology prepared their students in those topics. Their responses ranked by their means are shown in Tables 69 and 70.

Table 68. Adequacy of Management Ability

| Rank | Scope of management | Mean | Std. Dev. |
|---|---|---|---|
| 1 | A specific project | 3.56 | 0.88 |
| 2 | The business of construction | 2.96 | 0.98 |
| 3 | A number of projects | 2.91 | 0.96 |

The larger the mean in Table 68, the stronger the level of agreement with the statement.

Table 69. Relevance of Topics

| Rank | Topic | Mean | Max Possible Score | Std. Dev. | CWF |
|---|---|---|---|---|---|
| 1 | Project management | 4.35 | 5.00 | 0.87 | 0.1384 |
| 2 | Construction technology | 4.25 | 5.00 | 0.97 | 0.1352 |
| 3 | Management principles, theories and practice | 4.05 | 5.00 | 0.83 | 0.1288 |
| 4 | Construction law | 3.96 | 5.00 | 0.96 | 0.1260 |
| 5 | Construction business environment | 3.91 | 5.00 | 0.84 | 0.1244 |
| 6 | Construction economics | 3.89 | 5.00 | 0.96 | 0.1237 |
| 7 | Construction science | 3.85 | 5.00 | 0.92 | 0.1225 |
| 8 | Research methodology | 3.17 | 5.00 | 1.12 | 0.1009 |
| | **Total** | **31.43** | **40.00** | | **1.000** |

Project management, construction technology and management principles, theories and practice ranked as the most relevant topics. Research methodology ranked last with a mean marginally above "neutral." Considering the historically poor research track record of universities of technology this finding is not surprising.

Table 70. Adequacy of preparation by former technikons in topics

| Rank | Topic | Mean | Max Possible Score | Std. Dev. | CWF |
|---|---|---|---|---|---|
| 1 | Construction technology | 3.57 | 5.00 | 1.08 | 0.13699 |
| 2 | Management principles, theories and practice | 3.44 | 5.00 | 0.99 | 0.13200 |
| 3 | Project management | 3.37 | 5.00 | 0.99 | 0.12932 |
| 4 | Construction business environment | 3.25 | 5.00 | 0.96 | 0.12471 |
| 5 | Construction law | 3.22 | 5.00 | 0.98 | 0.12356 |
| 6 | Construction economics | 3.20 | 5.00 | 0.97 | 0..12279 |
| 7 | Construction science | 3.16 | 5.00 | 0.94 | 0.12126 |
| 8 | Research methodology | 2.85 | 5.00 | 0.95 | 0.10939 |
| | **Total** | **26.06** | **40.00** | | **1.0000** |

On the other hand, former technikons prepared students most adequately in construction technology, construction principles, theories and practice, and project management. Importantly the highest mean was only 3.57 (construction technology), which was less than "somewhat adequately" on the 5-point adequacy scale.

- ***Opinions on Construction Management Courses***

Research methodology and construction science were also the areas in which students were the least adequately prepared by the former technikons.

Table 71. Computing the Industry Relevancy-Adequacy Gap

| Subject | Relevancy-Adequacy Gap: Relevancy Mean Score RMS[1] | Adequacy Mean Score AMS[2] | Absolute Difference R-A (+/-) | Actual % Gap | Max Relevancy Adequacy % Gap | Ranking |
|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| Project Management | 4.3519 | 3.367 | 0.9849 | 22.63 | 32.66 | 1 |
| Construction Technology | 4.2593 | 3.571 | 0.6883 | 16.16 | 14.82 | 2 |
| Management Principles, Theories and Practice | 4.0526 | 3.440 | 0.6126 | 15.11 | 31.20 | 3 |
| Construction Law | 3.9636 | 3.225 | 0.7386 | 18.63 | 20.73 | 4 |
| Business Environment | 3.9091 | 3.250 | 0.6591 | 16.86 | 35.00 | 5 |
| Construction Economics | 3.8889 | 3.208 | 0.6809 | 17.51 | 22.22 | 6 |
| Construction Science | 3.8519 | 3.163 | 0.6889 | 17.88 | 22.96 | 7 |
| Research Methodology | 3.1668 | 2.854 | 0.3128 | 9.88 | 36.67 | 8 |

*Note: 1. The Relevance Mean Score (RMS) is obtained form Table 6 as scored by Industry*
*Note 2. The Adequacy Mean Score (AMS) is obtained form Table 7 as scored by Industry*

Where 1 as the most subject lacking adequacy and 8 as the least important subject
Where the Relevancy-Adequacy Gap is computed as follows: (RMS-AMS)/RMS

This finding raises the question about whether this inadequate preparation might result in these areas being regarded as unimportant. The Industry Relevancy-Adequacy Gap (see Table 71) was computed from a combination of Tables 69 and 70.

**The Relevancy-Adequacy Gap**

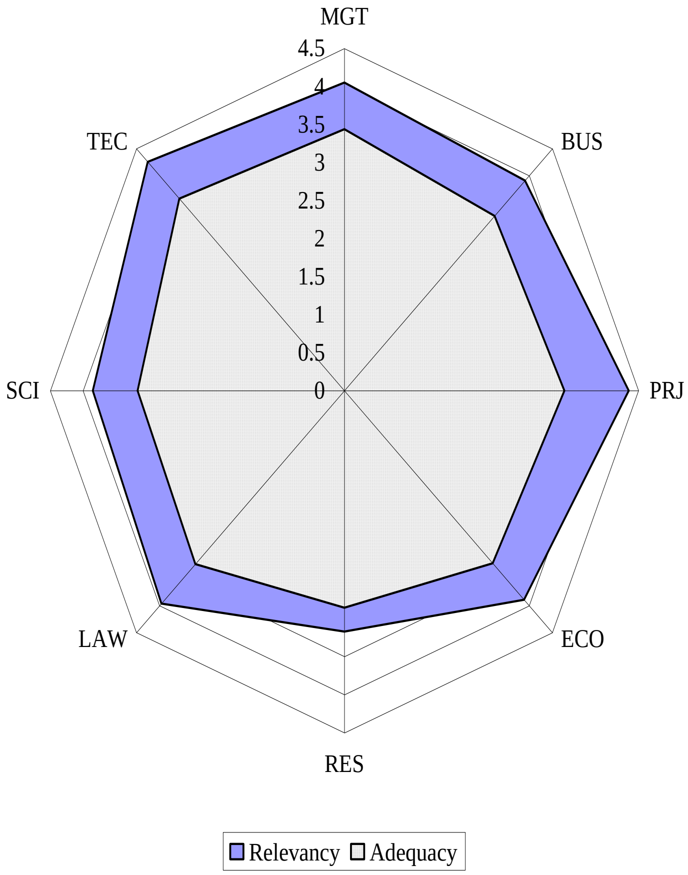


Figure 18. Communicating the Relevancy-Adequacy Octagonal Profile Radar Chart for Industry

- ***9.3.2.9 Opinions on Construction Management Graduates***

Respondents were asked to indicate the necessary skills and attributes that former technikons construction management graduates should possess. The ranking of the means of their responses to 37 skills and attributes is shown in Table 72. Time management, computer literacy, worker safety and health awareness, and planning, scheduling and controlling construction operations and activities were reported as the most desirable skills and attributes that CM graduates needed to have.

The ability to conduct research, systems development ability and ability to conduct statistical analysis were the least desirable skills and attributes.

Table 72. Desirable skills and attributes of Construction Management graduates

| Rank | Skills/attribute | Mean | Std. Dev. |
|---|---|---|---|
| 1 | Time management | 2.95 | 0.30 |
| 2 | Computer literacy | 2.93 | 0.32 |
| 3 | Worker safety and health awareness | 2.91 | 0.34 |
| 4 | Planning, scheduling and controlling construction operations and activities | 2.89 | 0.37 |
| 5 | Acceptance of responsibility | 2.86 | 0.48 |
| 6 | Practical building knowledge | 2.86 | 0.44 |
| 7 | Problem solving skills | 2.86 | 0.40 |
| 8 | Adaptability to changing work environment | 2.86 | 0.35 |
| 9 | Ability to exercise professional judgement | 2.82 | 0.43 |
| 10 | Trust and honesty | 2.81 | 0.55 |
| 11 | Verbal communication skills | 2.81 | 0.55 |
| 12 | Decision making | 2.81 | 0.52 |
| 13 | Managerial knowledge | 2.77 | 0.60 |
| 14 | Active listening skills | 2.77 | 0.50 |
| 15 | Measurement, costing and estimating | 2.75 | 0.61 |
| 16 | Interpersonal skills | 2.75 | 0.51 |
| 17 | Supervisory skills and ability to train others | 2.73 | 0.56 |
| 18 | Familiarity with construction quality management | 2.72 | 0.56 |
| 19 | Numeracy | 2.71 | 0.59 |
| 20 | Leadership capability | 2.71 | 0.56 |
| 21 | Ability to resolve conflicts and disputes | 2.70 | 0.53 |
| 22 | Team building capability | 2.68 | 0.57 |
| 23 | Creativity and innovation | 2.68 | 0.57 |
| 24 | Ability to work autonomously | 2.65 | 0.61 |
| 25 | Up-to-date professional knowledge | 2.61 | 0.62 |
| 26 | Financial management | 2.60 | 0.70 |
| 27 | Ability to use surveying and levelling equipment | 2.60 | 0.65 |
| 28 | Familiarity with workings and intricacies of industry | 2.60 | 0.60 |
| 29 | Academic achievement | 2.59 | 0.68 |
| 30 | Environmental awareness | 2.52 | 0.66 |
| 31 | Negotiating skills | 2.50 | 0.71 |
| 32 | Work study | 2.29 | 0.73 |
| 33 | Entrepreneurship | 2.28 | 0.77 |
| 34 | Marketing skills | 2.15 | 0.80 |
| 35 | Ability to conduct research | 2.09 | 0.81 |
| 36 | Systems development ability | 2.07 | 0.78 |
| 37 | Ability to conduct statistical analysis | 2.05 | 0.77 |

The responses of respondents to how important these skills and attributes were in CM graduates and ranking by the means of these responses are shown in Table 73. Trust and honesty; acceptance of responsibility; problem solving skills; and worker safety and health awareness were the most important while ability to conduct research; systems development ability; and ability to conduct statistical analysis were the least important.

Respondents were asked to rate how adequately universities of technology developed these 37 skills and attributes in their students. The results are shown in Table 74. Academic achievement, planning, scheduling and controlling construction operations and activities, and numeracy were the skills and attributes that universities of technology most adequately developed in their students. On the other hand, creativity and innovation, ability to conduct statistical analysis, and marketing were those least adequately developed. The differences are important to note between the rankings of those skills and attributes that industry regard as important and those that universities of technology apparently focus on with respect to adequate development in their students.

Table 73. Importance of skills and attributes of Construction Management Graduates

| Rank | Skills/attribute | Mean | Std. Dev. |
|---|---|---|---|
| 1 | Trust and honesty | 4.56 | 0.60 |
| 2 | Acceptance of responsibility | 4.48 | 0.54 |
| 3 | Problem solving skills | 4.42 | 0.65 |
| 4 | Worker safety and health awareness | 4.39 | 0.67 |
| 5 | Time management | 4.39 | 0.67 |
| 6 | Decision making | 4.39 | 0.56 |
| 7 | Verbal communication skills | 4.33 | 0.63 |
| 8 | Planning, scheduling and controlling construction operations and activities | 4.32 | 0.71 |
| 9 | Practical building knowledge | 4.30 | 0.71 |
| 10 | Interpersonal skills | 4.30 | 0.65 |
| 11 | Measurement, costing and estimating | 4.29 | 0.71 |
| 12 | Familiarity with construction quality management | 4.18 | 0.63 |
| 13 | Ability to work autonomously | 4.16 | 0.75 |
| 14 | Team building capability | 4.16 | 0.73 |
| 15 | Adaptability to changing work environment | 4.12 | 0.78 |
| 16 | Leadership capability | 4.10 | 0.77 |
| 17 | Active listening skills | 4.09 | 0.85 |
| 18 | Ability to resolve conflicts and disputes | 4.09 | 0.74 |
| 19 | Ability to exercise professional judgement | 4.07 | 0.82 |
| 20 | Creativity and innovation | 4.07 | 0.78 |
| 21 | Supervisory skills and ability to train others | 4.07 | 0.76 |
| 22 | Numeracy | 4.07 | 0.73 |
| 23 | Computer literacy | 4.04 | 0.65 |
| 24 | Ability to use surveying and levelling equipment | 4.02 | 0.90 |
| 25 | Up-to-date professional knowledge | 4.00 | 0.87 |
| 26 | Managerial knowledge | 3.96 | 0.82 |
| 27 | Financial management | 3.95 | 0.86 |
| 28 | Familiarity with workings and intricacies of industry | 3.84 | 0.82 |
| 29 | Negotiating skills | 3.84 | 0.77 |
| 30 | Environmental awareness | 3.79 | 0.82 |
| 31 | Academic achievement | 3.75 | 0.71 |
| 32 | Entrepreneurship | 3.53 | 0.95 |
| 33 | Marketing skills | 3.35 | 0.95 |
| 34 | Work study | 3.31 | 0.90 |
| 35 | Systems development ability | 3.23 | 1.00 |
| 36 | Ability to conduct statistical analysis | 3.23 | 0.97 |
| 37 | Ability to conduct research | 3.14 | 0.95 |

Table 74. Adequacy of development of skills and attributes

| Rank | Skills/attribute | Mean | Std. Dev. | Coefficient of Variation (CV) | Relative Attribute and Skills Index |
|---|---|---|---|---|---|
| 1 | Academic achievement | 3.64 | 0.74 | 20.32 | 0.728 |
| 2 | Planning, scheduling and controlling construction operations and activities | 3.52 | 0.95 | 26.99 | 0.704 |
| 3 | Numeracy | 3.52 | 0.77 | 21.88 | 0.704 |
| 4 | Computer literacy | 3.50 | 0.74 | 21.14 | 0.700 |
| 5 | Ability to use surveying and levelling equipment | 3.49 | 0.88 | 25.21 | 0.698 |
| 6 | Measurement, costing and estimating | 3.46 | 1.00 | 28.90 | 0.692 |
| 7 | Practical building knowledge | 3.46 | 0.94 | 27.17 | 0.692 |
| 8 | Active listening skills | 3.42 | 0.87 | 25.44 | 0.684 |
| 9 | Trust and honesty | 3.38 | 0.84 | 24.85 | 0.767 |
| 10 | Up-to-date professional knowledge | 3.35 | 0.91 | 27.16 | 0.670 |
| 11 | Time management | 3.35 | 0.81 | 24.18 | 0.670 |
| 12 | Ability to work autonomously | 3.31 | 0.93 | 28.09 | 0.662 |

 

Table 74. Cont'd

| Rank | Skills/attribute | Mean | Std. Dev. | Coefficient of Variation (CV) | Relative Attribute and Skills Index |
|---|---|---|---|---|---|
| 13 | Acceptance of responsibility | 3.31 | 0.75 | 22.66 | 0.662 |
| 14 | Familiarity with construction quality management | 3.30 | 0.83 | 25.16 | 0.658 |
| 15 | Verbal communication skills | 3.29 | 0.82 | 24.92 | 0.658 |
| 16 | Managerial knowledge | 3.27 | 0.94 | 28.75 | 0.654 |
| 17 | Familiarity with workings and intricacies of industry | 3.21 | 0.90 | 28.04 | 0.642 |
| 18 | Interpersonal skills | 3.20 | 0.87 | 27.19 | 0.640 |
| 19 | Financial management | 3.19 | 0.89 | 27.90 | 0.638 |
| 20 | Problem solving skills | 3.19 | 0.87 | 27.27 | 0.638 |
| 21 | Ability to exercise professional judgement | 3.19 | 0.77 | 24.14 | 0.638 |
| 22 | Adaptability to changing work environment | 3.19 | 0.70 | 21.94 | 0.638 |
| 23 | Decision making | 3.17 | 0.95 | 29.97 | 0.634 |
| 24 | Worker safety and health awareness | 3.17 | 0.91 | 28.71 | 0.634 |
| 25 | Team building capability | 3.13 | 0.76 | 24.28 | 0.626 |
| 26 | Leadership capability | 3.12 | 0.94 | 30.13 | 0.624 |
| 27 | Work study | 3.04 | 0.87 | 28.34 | 0.608 |
| 28 | Ability to resolve conflicts and disputes | 3.02 | 0.81 | 26.82 | 0.604 |
| 29 | Ability to conduct research | 3.00 | 0.97 | 32.33 | 0.600 |
| 30 | Environmental awareness | 3.00 | 0.95 | 31.67 | 0.600 |
| 31 | Supervisory skills and ability to train others | 2.98 | 0.91 | 30.54 | 0.596 |
| 32 | Negotiating skills | 2.92 | 0.79 | 27.05 | 0.584 |
| 33 | Entrepreneurship | 2.91 | 0.86 | 29.55 | 0.582 |
| 34 | Systems development ability | 2.87 | 0.92 | 32.06 | 0.574 |
| 35 | Ability to conduct statistical analysis | 2.85 | 1.01 | 35.44 | 0.570 |
| 36 | Creativity and innovation | 2.83 | 0.91 | 32.16 | 0.566 |
| 37 | Marketing skills | 2.83 | 0.72 | 25.44 | 0.566 |

- ***9.3.2.10 Industry Opinions on Education and Training***

Respondents were asked to about how they felt about the following statement on training and education:

"Training increases skills and competence and teaches employees the "how" of a job whereas education increases their insight and understanding and teaches them "why."

Table 75. Opinion on distinction between education and training

| Totally disagree | Slightly disagree | Neutral | Slightly agree | Totally agree | Mean | Std. Dev. |
|---|---|---|---|---|---|---|
| - | 3.6% | 8.9% | 44.6% | 42.9% | 4.27 | 0.77 |

From Table 75 it is evident that 42.9% of respondents totally agreed with the distinction between education and training as suggested in the statement. With respect to what the primary engagement of institutions should be respondents reported as shown in Table 76. Most respondents (71.7%) reported that universities should primarily be involved in education.

Table 76. Primary Engagement of Institutions

| Institution | Education | Training | Both |
|---|---|---|---|
| University | 71.7% | 1.9% | 26.4% |
| Universities of Technology | 22.8% | 38.6% | 38.6% |

The findings shown in Table 77 indicate that most respondents regarded former technikons graduates as being both educated and trained.

Table 77. View of former technikons graduates

| Trained | Educated | Neither | Both |
|---|---|---|---|
| 14.3% | 26.8% | 7.1% | 51.8% |

### 9.3.3 Civil Engineering: Employers Views

- ***9.3.3.1 Research***

A pilot study was conducted to determine the relevance and effectiveness of civil engineering programs offered by the former technikons sector. In particular, the study sought to determine the knowledge and skills needs of industry with a view to the formulation and design of an improved model of instructional delivery, and the dissemination of the findings to stakeholders. In order to achieve these objectives the views of a random sample of industry participants in the Western Cape were canvassed using a self-administered structured questionnaire. The authors accept the limitation common to most surveys of the self-declarations of the respondents with respect to knowledge, attitudes, beliefs and behaviours.

- ***9.3.3.2 Demographics of Industry***

Evidently 83% of respondents had previously employed a student trained at a former technikon, with that same percentage willing to do so again. If presented with a choice 66.67% of respondents would employ a former technikon graduate over a university graduate. All of the respondents (100%) reported that universities should primarily be involved in education. Half of the respondents reported that former technikons (50%) should be primarily involved in training while the other (50%) reported that former technikons should primarily be involved with both education and training.

- ***9.3.3.3 Opinions on Civil Engineering Courses***

The responses to how strongly respondents felt about each of the eight most common models of civil engineering instructional delivery at HEIs in South Africa were ranked according to their means. Evidently, the current University of Technology model enjoyed the most support followed by models that incorporated a period of experiential training in industry. The sandwich method of instruction where the academic year is divided into trimesters, with experiential training in the middle, was ranked last. Respondents were asked how adequately the present cooperative education model prepared students for immediate employment. Evidently 17% of the respondents reported that preparation was neither adequate nor inadequate and 83% somewhat adequate. The mean of responses was 3.83 with standard deviation of 0.41.

Respondents were asked to indicate their feelings about the quality of courses offered at University of Technology and Universities. 67% of respondents felt positive about the quality of course offered at Universities of Technology and only 50% felt positive about the quality of course offered at Universities.

They were also asked how adequately Universities of Technology prepared students in civil engineering in terms of the definition “Civil Engineering has been defined as *the branch of engineering concerned with designing, building, or repairing of roads, bridges, tunnels, and other public works*.”

Respondents reported stronger agreement with the definition of civil engineering than the adequacy of University of Technology preparation of students in the discipline.

With respect to the relevance to employment in civil engineering subjects offered in present CE courses at Universities of Technology, most respondents reported that the subjects were relevant. However, on the 5-point scale of relevance, the mean of 3.2 was between “average” and “relevant.”

- ***9.3.3.4 Experiential Training***

Respondents were asked about the importance of sixteen topics in CE programs as well as the adequacy with which Universities of Technology prepared their students in those topics. The results of these responses are given in Table 78. Communication Skills, surveying, construction technology and project management ranked as the most important topics. Research methodology ranked last with a "slightly unimportant to neutral" mean. Considering the historically poor research track record of Universities of Technology this finding is not surprising. On the other hand, Universities of Technology prepared students most adequately in construction technology and structural analysis and design, surveying, transportation engineering and water engineering. Project management while being one of the most important to respondents ranked low with respect to how adequately Universities of Technology prepared their students in this area. Importantly the highest mean was for construction technology, which was rated "somewhat adequately" on the 5-point adequacy scale.

Table 78. Importance of Topics: Civil Engineering Employers Views

| Rank | Topic | Mean | Max Possible Score | Std. Dev. |
|---|---|---|---|---|
| 1 | Communication Skills | 4.80 | 5.00 | 0.45 |
| 2 | Surveying | 4.33 | 5.00 | 0.82 |
| 3 | Construction Technology | 4.33 | 5.00 | 0.82 |
| 4 | Project Management | 4.33 | 5.00 | 1.21 |
| 5 | Computer Skills | 4.20 | 5.00 | 1.10 |
| 6 | Management Principles and Theories | 4.17 | 5.00 | 1.17 |
| 7 | Mathematics | 4.00 | 5.00 | 0.89 |
| 8 | Geotechnical Engineering | 4.00 | 5.00 | 0.63 |
| 9 | Civil Engineering Documentation | 4.00 | 5.00 | 1.22 |
| 10 | Structural Analysis and Design | 3.83 | 5.00 | 0.75 |
| 11 | Entrepreneurship | 3.83 | 5.00 | 1.33 |
| 12 | Transportation | 3.67 | 5.00 | 0.82 |
| 13 | Water Engineering | 3.67 | 5.00 | 0.82 |
| 14 | Environmental Awareness | 3.60 | 5.00 | 1.14 |
| 15 | Legal Aspects in Civil Engineering | 3.50 | 5.00 | 1.38 |
| 16 | Research (Including Research Methodology) | 2.83 | 5.00 | 0.98 |

The findings in Table 78 are consistent with literature. For example 'Communication Skills' was highly rated by the employers (mean score = 4.80). Bonk, Imhoff and Cheng (2002) argue that Communications skills, both written and oral, remain key to professional success within the engineering profession.

Respondents were asked to comment on the adequacy of the three-year (National Diploma) and the four-year (Bachelor of Technology Degree) qualifications. These are summarised in Tables 79 and 80.

Although entrepreneurship was rated as being slightly important, Universities of Technology inadequately prepared students. Respondents felt that in addition to entrepreneurship, students were also inadequately prepared in environmental awareness as well as research. This finding raises the question about whether this inadequate preparation might result in these areas being regarded as unimportant. Interesting to note is the importance of water engineering and transportation engineering being rated as "neutral to somewhat important" and students', yet in terms of adequacy had means of 3.40 and 3.60 respectively.

Respondents were asked to indicate the necessary skills and attribute that Universities of Technology civil engineering diplomates and graduates should possess. Computer literacy, Adaptability to changing work environment, Active listening skills and time management were some of the most desirable skills and attributes. Ability to conduct research and both the National Diploma and Bachelor Degree levels was the least desirable skill.

Table 79. Adequacy of Preparation for National Diploma

| Rank | Topic | Frequency of Respondents (%) | | | | | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|---|
| | | EI | SI | N | SA | EA | | |
| 1 | Construction Technology | | | | 100 | | 4.00 | 1.10 |
| 2 | Structural Analysis and Design | | | | 40 | 60 | 3.60 | 0.55 |
| 3 | Surveying | | 20 | 20 | 40 | 20 | 3.60 | 1.14 |
| 4 | Transportation Engineering | | | 40 | 60 | | 3.60 | 0.55 |
| 5 | Water Engineering | | | 60 | 40 | | 3.40 | 0.55 |
| 6 | Geo-technical Engineering | | 20 | 20 | 60 | | 3.40 | 0.89 |
| 7 | Computer Skills | | 25 | 25 | 50 | | 3.25 | 0.96 |
| 8 | Mathematics | 20 | | 60 | 20 | | 2.80 | 1.10 |
| 9 | Management Principles and Theories | | 60 | | 40 | | 2.80 | 1.10 |
| 10 | Legal Aspects in Civil Engineering | | 20 | 80 | | | 2.80 | 0.45 |
| 11 | Communication Skills | | 75 | | | 25 | 2.75 | 1.50 |
| 12 | Civil Engineering Documentation | | 25 | 75 | | | 2.75 | 0.50 |
| 13 | Project Management | | 40 | 60 | | | 2.44 | 0.55 |
| 14 | Entrepreneurship | 20 | 60 | 20 | | | 2.00 | 0.71 |
| 15 | Research (Including Research Methodology) | 40 | 20 | 40 | | | 2.00 | 1.00 |
| 16 | Environmental Awareness | 75 | 25 | | | | 1.25 | 0.50 |

Where EI = Extremely Inadequate, SI = Somewhat Inadequate, N = Neither Adequate or Inadequate, SA = Somewhat Adequate, and EA = Extremely Adequate

Respondents were asked to rate how adequately Universities of Technology developed 38 skills and attributes in their students. Written communication, ability to use survey and levelling equipment and numeracy were the skills and attributes that Universities of Technology most adequately developed in their students. On the other hand, negotiating skills; entrepreneurship; and supervisory skills and ability to train others and conflict resolution were those least adequately developed. The differences are important to note between the rankings of those skills and attributes that industry regard as important and those that Universities of Technology apparently focus on with respect to adequate development in their students.

Table 80. Adequacy of Preparation of Bachelor Degree

| Rank | Topic | Frequency of Respondents (%) | | | | | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|---|
| | | EI | SI | N | S A | EA | | |
| 1 | Construction Technology | | | | 80.0% | 20.0% | 4.20 | 0.45 |
| 2 | Structural Analysis and Design | | | 20.0% | 80.0% | | 3.80 | 0.45 |
| 3 | Transportation Engineering | | | 40.0% | 60.0% | | 3.60 | 0.55 |
| 4 | Water Engineering | | | 40.0% | 60.0% | | 3.60 | 0.55 |
| 5 | Mathematics | | 20.0% | 40.0% | 20.0% | 20.0% | 3.40 | 1.14 |
| 6 | Surveying | | 20.0% | 40.0% | 20.0% | 20.0% | 3.40 | 1.14 |
| 7 | Geotechnical Engineering | | 40.0% | | 60.0% | | 3.20 | 1.10 |
| 8 | Computer Skills | | 50.0% | | 50.0% | | 3.00 | 1.15 |
| 9 | Legal Aspects in Civil Engineering | | 40.0% | 20.0% | 40.0% | | 3.00 | 1.00 |
| 10 | Management Principles and Theories | 20.0% | 20.0% | 20.0% | 40.0% | | 2.80 | 1.30 |
| 11 | Project Management | 20.0% | 20.0% | 40.0% | | 20.0% | 2.80 | 1.48 |
| 12 | Communication Skills | | 75.0% | | | 25.0% | 2.75 | 1.50 |
| 13 | Civil Engineering Documentation | | 25.0% | 75.0% | | | 2.75 | 0.50 |
| 14 | Research (including research methodology) | 20.0% | 20.0% | 40.0% | 20.0% | | 2.60 | 1.14 |
| 15 | Entrepreneurship | 60.0% | | 20.0% | 20.0% | | 2.00 | 1.41 |
| 16 | Environmental Awareness | 50.0% | 25.0% | 25.0% | | | 1.75 | 0.96 |

Where EI = Extremely inadequately, SI = Somewhat inadequately, N = Neither adequately nor inadequately, SA = Somewhat adequately and EA = Extremely adequately.

- ***9.3.3.5 Observations of Civil Engineering Industry***

The preliminary findings of the study indicated industry support and preference for the present Universities of Technology model that incorporated in the curriculum a period of experiential training spent in industry. There was least support for the sandwich (trimester) model of instruction, which makes provision for practical periods in the second trimester of every academic year. Universities of Technology prepared their graduates somewhat adequately for employment. Universities of Technology also adequately prepared their students in the areas of construction technology, mathematics, structural analysis and design, communication skills, transportation engineering, water engineering and geotechnical engineering. The most desirable skills and attributes of CE diplomats and graduates differed somewhat from the adequacy with which Universities of Technology developed them in their students. This finding suggests a possible mismatch which needs further unpacking in a more comprehensive study.

## 10.0 CONCLUSIONS AND RECOMMENDATIONS

This section has not been written in a logical manner. Students views precede industry views and then reappear again. We need to conclude the study better than is the case here Can you reorganize so that it flows better?.

This research project has presented an overview of the educational offerings and experiential training in construction management and civil engineering at Universities of Technologies. In order to achieve a global perspective of the current position relative to educational offerings and experiential training, model preference, continuing professional development and professional registration, construction management courses at universities of technology, civil engineering courses at universities of technology and participation in construction, the study was contextualised against international experiences as extracted from a review of international literature and study visits. This chapter summarizes the key findings and the various issues associated with educational offerings and experiential training at Universities of Technology. It draws conclusions from the research discussed in various sections of this report and gives recommendations on how to address the identified challenges. The section reports on each of the three partners in co-operative education, namely students, employers (industry) and staff (academic) with special reference to the construction management and civil engineering disciplines.

### 10.1 Construction Management

#### 10.1.1. First Year Student Views of Experiential Training

Most students reported that the first year course content compared favourably with what they expected. They found the subjects to be relevant and responsive to the needs of industry. Students were in the main satisfied with the subjects that were offered with Communications being the one they were least satisfied with. The survey found that the first year program adequately prepared students for their period of experiential training in industry. They found the first year program more academic than practical.

The survey of senior students found that almost all of them had spent some time working in industry for a wide range of companies. In most cases this period was a year. They regarded experiential training as necessary. While most students had worked on a particular project, they preferred that they should work on both a project as well as be exposed to the operation of their employer by working in the various departments of the organization. This period should be structured and assessed in a manner that allowed for employer involvement. They preferred their experiential training to take place in stages for a total duration of 12 months, preferably after completion of year 1 as is presently the case. Students were more satisfied with the aspects of their experiential training that involved their employers than those that involved their instructors. They agreed with their first year counterparts that the first year program prepared them adequately for year 2, which is their experiential year. They also viewed their experiential training as positive preparation for the academic year 3. Subjects in the present course were relevant to the work situation that they had experienced during their time in industry. In contrast to their first year counterparts, the senior students regarded the course as more practical than academic.

In order to produce a revised construction management curriculum that will be accredited, satisfy the demands of industry, develop in graduates those desirable construction management skills and attributes that will enable them to transfer theory taught in classrooms to the work place. The challenge is for a meeting of the minds of students, industry and academic institutions.

#### 10.1.2. Senior (Third and Fourth Year) Students

Most senior students regarded experiential training as necessary to totally necessary. They found the Year 1 program as 'average' to 'well' preparation for experiential period in industry in year 2. It is likely that the socio-economic background resulted in a more realistic view or perspective of experiential training. Where students battled to find industry placements they reported more negatively about their experiences.
These students regarded the program as more practical than academic. It is noteworthy that these senior students had spent periods in industry and thus could reflect on their firsthand experiences.

- Relevancy of Academic Subjects in Universities of Technology

Most first year students entering the Universities of Technology construction management programs, do so without experience of the industry itself. Therefore, the perceived relevance of the course content to the CI, according to them is exactly that, a perception. The third year students on the other hand had completed a period of experiential learning in the CI of at least six months. They are better able to speak with some authority about the relevance of the course content to the industry.

- Adequacy of Preparation of Academic Subjects in Universities of Technologies

Generally, Year 1 students at the Universities of Technology found the Construction Management program to be both relevant and responsive to the needs of industry. However, considering that most of these students had not been previously exposed to the industry itself during this year, this finding needs to be treated with caution. Further, the study suggests that as the level of satisfaction with course content increased the degree of relevance and responsiveness to industry needs also increased.

- Satisfaction of Academic Subjects in Universities of Technologies

Relative to levels of satisfaction, students at CPUT reported least satisfaction with Computer Skills and Communication, which are both communication subjects. It is likely that not requiring adequate language proficiency by CPUT as an admission requirement might be contributory to this finding. At former technikons, Quantity Surveying was the subject students were least satisfied with. In this case the institution had experienced problems with the responsible lecturer. It is likely that there is a relationship between student subject satisfaction and lecturer satisfaction. Both institutions were dissatisfied with the subject, Surveying, probably because of the curriculation of the subject and its perceived irrelevance to the industry.

#### 10.1.3 Opinions on Education and Training

Students generally felt that the programs offered as being slightly more practical rather than academic in nature.

#### 10.1.4 Employers (Industry)

#### 10.1.5 Staff Views

- Industry's (Employers) Preparedness for Provision of Experiential Training

In terms of effectiveness of strategies in construction management programs, regional bodies such Master Builders Association and CETA's were considered more influence by staff than other forums of influence such as serving on advisory councils or boards of formers technikons. The least ranked forum of influence was lobbying education authorities. Staff was of the view that experiential training should take place after year 1. The next sub section discusses the importance of supplementing academic instruction and experiential training

#### 10.1.5.1 Continuing Professional Development and Professional Registration

CPD was regarded as important for assessing the suitability of graduates for professional registration. Furthermore staff were of the view that it had an impact on registration in terms of legislation and that the Universities of Technology should design programs geared towards the contribution to CPD and Registration

#### 10.1.5.2 Opinions on Construction Management Courses

Construction technology was considered more relevant, followed by management principles, theories and practice. In terms of ranking, research methodology was least considered to be relevant.

## 10.2 Civil Engineering

### 10.2.1 Experiential Training

From the review of relevant literature it is evident that several aspects of cooperative education have been researched. Many of the findings of these studies have relevance for the development of a more effective and relevant built environment education instructional program. Several key skills and competencies were identified. Further the findings of the literature informed the development and refinement of an appropriate research instrument to gather data to be used in the possible re-curriculation of construction management and civil engineering offerings at Universities of Technology. Some of the problems surrounding current programs have been noted and incorporated.

#### 10.2.1.1 Student Views

It is rather surprising that student expectations were largely met on the course. Most students entering the programme have little or no experience of formal career counselling before entering tertiary studies. This could be as a result of students in the main feeling that lecturers and lectures were "good and understandable" during the year.

The first year of the Civil Engineering programme appears, from a student perspective, to be relevant and responsive to the needs of the country. This is evident from both first year surveys undertaken for this study and should probably be seen in the context of the demographics of students registering for the programme. Most come from previously disadvantaged backgrounds and communities that lack basic infrastructure and services.

Preliminary findings also indicate that the department needs to significantly improve delivery in the subject Communication Skills given its importance in the transfer of knowledge and the language of communication in industry. It's also evident that the content driven subjects Construction Materials, Construction Methods and Management needs attention. There may therefore be opportunities for extending the integrated teaching approach to these subjects so that students improve their communication skills in the context of the discipline. The department currently uses an integrated teaching approach in the subjects Communication Skills and Construction Methods. The importance of this is further illustrated in an industry survey conducted by Haupt and Miller (2004) who found that companies rated communication and project management skills to be of the most important in the civil engineering industry. Industry also stated that students are not adequately prepared in project management.

However, analysis of the experiential training survey reveals that students are divided on the following aspects:

- When that training should take place.
- How it should be conducted

Therefore it would therefore be useful for the department to unpack the timing, structure and assessment of experiential training in a more comprehensive study with industry partners to optimise the time that students spend in industry. Industry expressed similar sentiments.

#### 10.2.1.2 Employers (Industry)

The preliminary findings of the study indicated industry support and preference for the present Universities of Technology model that incorporated in the curriculum a period of experiential training spent in industry. There was least support for the sandwich (trimester) model of instruction, which makes provision for practical periods in the second trimester of every academic year. Universities of Technology prepared their graduates somewhat adequately for employment. Universities of Technology also adequately prepared their students in the areas of construction technology, mathematics, structural analysis and design, communication skills, transportation engineering, water engineering and geo-technical engineering.

#### 10.2.1.3 Staff

The views of civil engineering staff were reported in the NACI document and are not addressed in this section.

Preliminary findings also indicate that the department needs to significantly improve delivery in the subject Communication Skills given its importance in the transfer of knowledge and the language of communication in industry. It's also evident that the content driven subjects Construction Materials, Construction Methods and Management needs attention. There may therefore be opportunities for extending the integrated teaching approach to these subjects so that students improve their communication skills in the context of the discipline. The department currently uses an integrated teaching approach in the subjects Communication Skills and Construction Methods. The importance of this is further illustrated in an industry survey conducted by Haupt and Miller (2004) who found that companies rated communication and project management skills to be of the most important in the civil engineering industry. Industry also stated that students are not adequately prepared in project management. The course appears, from a student's perspective, to have a good balance between the academic and practical components and therefore equally essential.

The findings indicate that the satisfaction level index (SLI) methodology adopted and derived to summarize the satisfaction of each subject by the students is reliable, valid and un-dimensional.

### 10.2.4 Opinions on Education and Training

The course appears, from a student's perspective, to have a good balance between the academic and practical components and therefore equally essential. Most students feel they are adequately prepared for the experiential training part of the course to be undertaken in the second year and they consider experiential training to be an important part of their overall training. The industry study mentioned earlier also highlighted industry support for the current co-operative education model.

Table 81. Maximum absolute difference and percentage agreement between Industry and Staff

| Skills/attribute | Rank | | Absolute Difference | Rank Agreement Factor | Percentage Dis-agreement | Percentage Agreement % |
|---|---|---|---|---|---|---|
| | Industry $R_{i1}$ | Staff $R_{i2}$ | $D_i$ | RA | PD | PA |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Trust and honesty | 1 | 1 | 0 | 0 | 0.00 | 100.00 |
| Acceptance of responsibility | 2 | 6 | 4 | 0.1081 | 11.76 | 88.24 |
| Problem solving skills | 3 | 11 | 8 | 0.2162 | 25.00 | 75.00 |
| Worker safety and health awareness | 4 | 12 | 8 | 0.2162 | 26.67 | 73.33 |
| Time management | 5 | 4 | 1 | 0.02702 | 3.58 | 96.42 |
| Decision making | 6 | 10 | 4 | 0.1081 | 15.38 | 84.62 |
| Verbal communication skills | 7 | 9 | 2 | 0.0541 | 8.33 | 91.67 |
| Planning, scheduling and controlling construction operations and activities | 8 | 2 | 6 | 0.1622 | 20.00 | 80.00 |
| Practical building knowledge | 9 | 7 | 2 | 0.0541 | 10.00 | 90.00 |
| Interpersonal skills | 10 | 14 | 4 | 0.1081 | 22.22 | 77.78 |
| Measurement, costing and estimating | 11 | 5 | 4 | 0.1081 | 25.00 | 75.00 |
| Familiarity with construction quality management | 12 | 15 | 3 | 0.0811 | 21.42 | 78.58 |
| Ability to work autonomously | 13 | 20 | 7 | 0.1892 | 58.33 | 41.67 |
| Team building capability | 14 | 25 | 11 | 0.2973 | 110.00 | -10.00 |
| Adaptability to changing work environment | 15 | 29 | 14 | 0.3783 | 175.00 | -75.00 |
| Leadership capability | 16 | 28 | 12 | 0.3243 | 200.00 | -100.00 |
| Active listening skills | 17 | 8 | 9 | 0.2432 | 225 | -125.00 |
| Ability to resolve conflicts and disputes | 18 | 18 | 0 | 0 | 0 | 0 |
| Ability to exercise professional judgement | 19 | 22 | 3 | 0.0811 | 0.000 | 0 |
| Creativity and innovation | 20 | 19 | 1 | 0.02702 | 50.0 | 50.00 |
| Supervisory skills and ability to train others | 21 | 23 | 2 | 0.05410 | 50.0 | 50.00 |
| Numeracy | 22 | 3 | 19 | 0.02702 | 316.67 | -216.67 |
| Computer literacy | 23 | 21 | 2 | 0.0541 | 25.00 | 75.00 |
| Ability to use surveying and levelling equipment | 24 | 16 | 8 | 0.2162 | 80.00 | 20.00 |
| Up-to-date professional knowledge | 25 | 13 | 12 | 0.3243 | 100.00 | 0.000 |
| Managerial knowledge | 26 | 26 | 0 | 0000 | 0.00 | 100.00 |
| Financial management | 27 | 17 | 10 | 0.02702 | 62.50 | 32.50 |
| Familiarity with workings and intricacies of industry | 28 | 27 | 1 | 0.02702 | 5.56 | 94.44 |
| Negotiating skills | 29 | 24 | 5 | 0.13510 | 25.00 | 75.00 |
| Environmental awareness | 30 | 32 | 2 | 0.05410 | 9.09 | 90.91 |
| Academic achievement | 31 | 30 | 1 | 0.02702 | 4.17 | 95.83 |
| Entrepreneurship | 32 | 31 | 1 | 0.02702 | 3.58 | 96.42 |
| Marketing skills | 33 | 37 | 4 | 0.10810 | 14.28 | 85.75 |
| Work study | 34 | 33 | 1 | 0.02702 | 3.33 | 96.67 |
| Systems development ability | 35 | 36 | 1 | 0.02702 | 3.125 | 96.875 |
| Ability to conduct statistical analysis | 36 | 34 | 2 | 0.05410 | 5.88 | 94.12 |
| Ability to conduct research | 37 | 35 | 2 | 0.05410 | 5.56 | 94.44 |

## 10.3 Comparison of findings between Industry and Staff

The findings in Table 81 suggest that apart from the trust and honesty (rank = 1), ability to resolve conflicts and disputes (rank = 18) and managerial knowledge (rank = 26) as an important skills or attributes desirable of Construction Management graduates, there was complete disagreement in the ranking of the skills and attributes. Both Industry and Staff

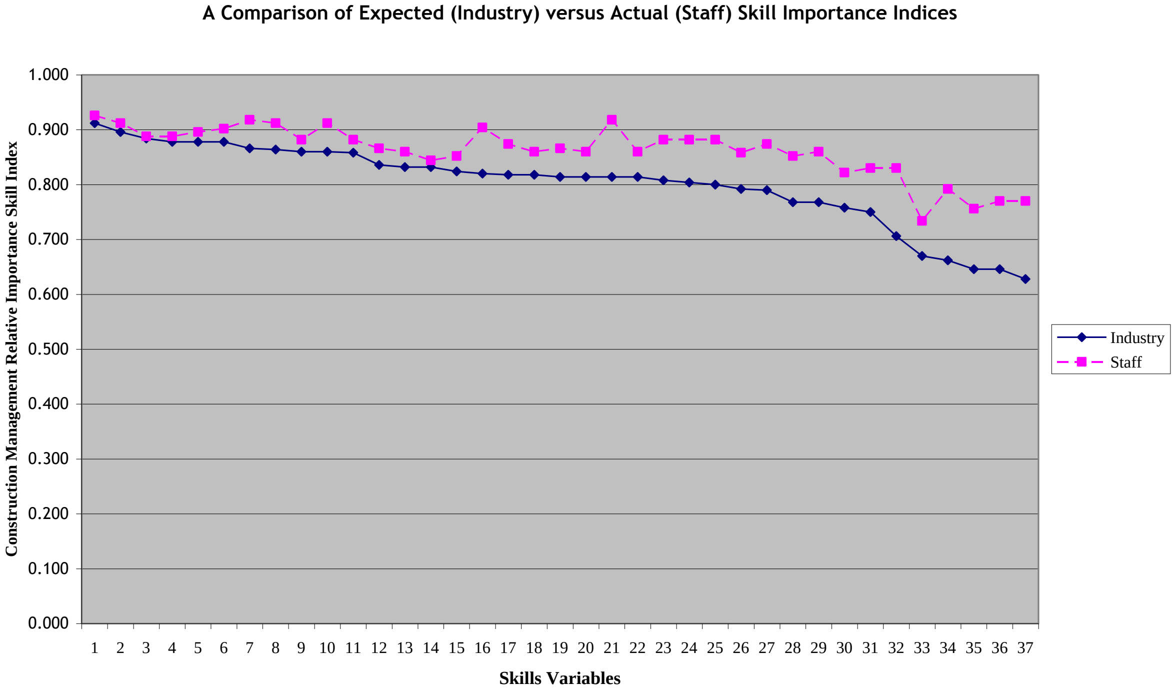


Figure 19: A Comparison of expected (Industry) versus actual (Staff) skill importance indices

### 10.3.1 Construction Management

Examination of Figure 19 reveals that there is complete disagreement over the 37 skills between Industry and academia (staff), however the construction management relative importance indices throughout the skills are above the medium levels (>0.6) with almost 75 % of the indices in the high range (> 0.8). The conclusion to be drawn is that whereas staff might attach high (great) importance to the necessary skills and attributes necessary of Construction Management Graduates, Industry's perception though less, is still on the positive side. Therefore despite the mismatch between Industry and Staff, both scored high levels (mean score > 4.0) in seventy-five percent of the necessary skills and attributes.

### 10.3.2 Civil Engineering

The most desirable skills and attributes of Civil Engineering diplomats and graduates differed somewhat from the adequacy with which Universities of Technology developed them in their students. This finding suggests a possible mismatch which needs further unpacking in a more comprehensive study.

## 10.4 Lessons Learnt: Agreements and Disagreements

The lessons learnt from the study may be summarised as follows:

- **Background of Students**

Backgrounds of students and their prior exposure to the construction industry mirror their expectations, with students from more privileged backgrounds having higher expectations of the programme and consequently the industry, and students from less privileged backgrounds having more realistic expectations from the programme and industry.

- **Student's Positive Attitude**

The experiential training experience brings the programme into perspective for students who feel more positively towards the subsequent years than before doing experiential training.

### 10.5 Recommendations

In the main the findings of this study confirm those of the pilot industry survey conducted a year ago. Both industry stakeholder and academic staff respondents regarded experiential training as a necessary component of construction management programs. There was agreement on the following issues pertaining to conduct, period and location of experiential training:

- Experiential training to be conducted in stages with a total duration of 12 months with some support for a shorter period of 6 months.
- This assessed experiential training period should be structured
- Experiential training should include both project based and function/department based elements.

There were differences in opinion about which assessment methods should be used. However, there was congruence about employers being involved in the assessment of experiential training. There were also differences in opinion about when experiential training should take place. Both samples agreed that bodies such as regional MBAs, CETA, and others were the preferred forums of influence with educational authorities being the least preferred. CPD was regarded as important to supplement both academic instruction and experiential training, and that it should be a requirement to maintain professional registration. Universities of Technology (Universities of Technology) should offer programs that contribute to CPD. There was disagreement about whether universities of Technology graduates were suitable for immediate professional registration. There was agreement that Universities of Technology graduates were best suited to managing a specific project. The findings suggest that there are differences between what the construction industry and academic staff at Universities of Technology perceive as relevant and important both with respect to subject areas or topics and skills and desirable attributes. There are also differences about the adequacy of the development by Universities of Technology of skills and attributes necessary to practice construction management. In order to curriculate an effective construction management program requires a meeting of the minds relative to the relevance and importance of necessary skills and attributes. The traditional roles of Universities of Technology are still entrenched in the minds of industry respondents.

This report has highlighted issues in the various sections of the report that indicate several areas for further research and development. Against this background a number of recommendations are listed (the list is not exhaustive):

- The effective use of communication
- Problems and Concerns
- The definition of learning outcomes for experiential learning
- Quality assurance of placement (year out) learning
- The requirements of professional bodies
- Relevance of Construction Management Courses
- Relevancy of Civil Engineering Courses
- Importance of Construction Management Skills
- Importance of Civil Engineering Skills
- Increasing the awareness of rights and responsibilities

Many students enter the UT and CU construction management programs specifically because of the experiential learning component and the opportunity to work in the industry before completion of the academic program (Fester and Haupt, 2003; Haupt, 2003; Schaafsma, 1996). The perception is real to these students (Kramer, 2004; Barclay, 1996) that the experience gained during the experiential learning period will give them an added advantage when they return to the industry on completion of their academic program. In this way a core need of the South African economy for a technologically skilled workforce (White Paper 1997) is satisfied.

### 10.6 Model to Address the Revised Curriculum

Its recommended that the revised curriculum adopt the following two models namely; Learning Outcomes Approach (LOA); and the Structure of the Observed Learning Outcomes (SOLO).

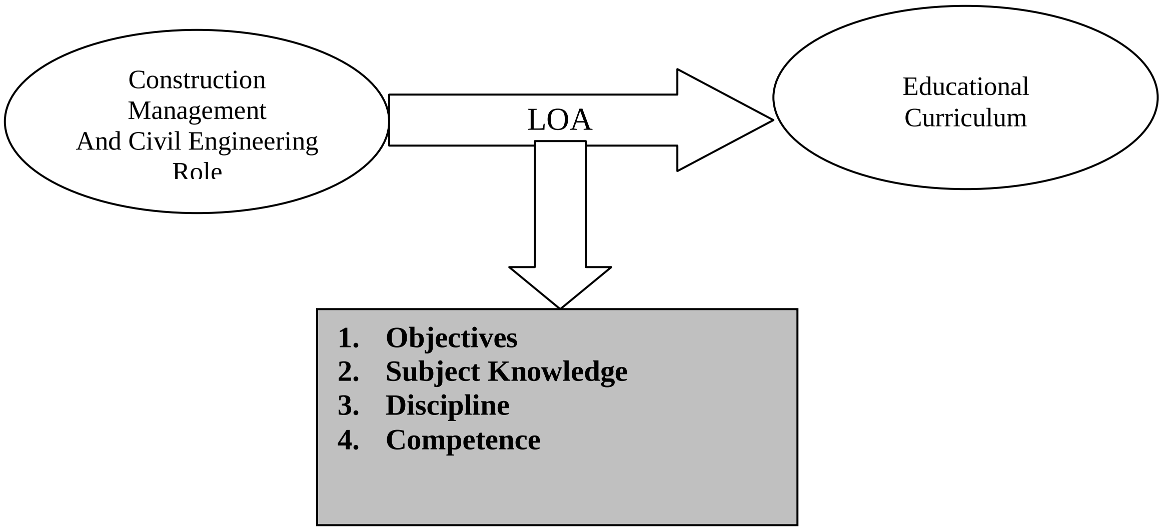


Figure 20: Learning Outcomes Approach (LOA) - Model 1

Figure 20 suggests that in developing the revised curriculum, the learning outcomes of each subject offered with the Civil Engineering and Construction Management can be written with the inclusion of the four areas identified namely; objectives, subject knowledge, discipline (specific) and competencies which where addressed in Chapter Two. For example, the issue of competencies can be addressed as follows:

Watson, Howarth and Gibson (2005) demonstrate how modules or subjects can be designed around 'competences'. One recommendation for the former technikons would be the introduction of a module or subject called 'Reflection on Experiential Training'. Thus the language of competences would have similarities to the language of academic learning outcomes. As part of the assessment process, students would be expected to provide a 'Portfolio of Evidence' covering the required learning outcomes/ competences. In the case of Construction Management students, this would include the 37 skills and attributes identified in this study. Similarly, the Civil Engineering students would focus on the importance of topics as identified by the employer's views (Table 9.52)

The Relationship Between Approaches and Outcomes

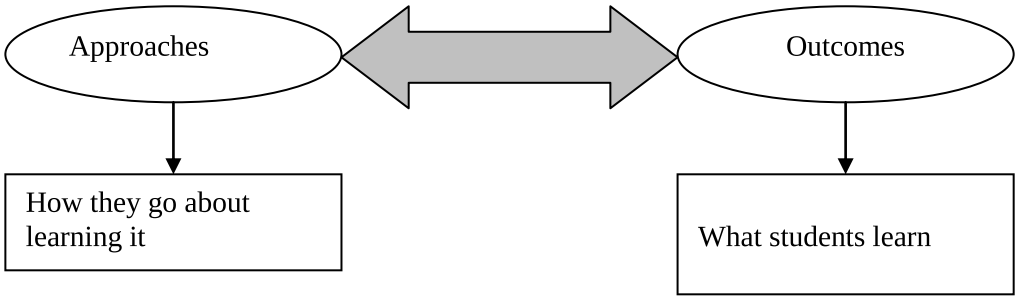


Figure 22: Structure of the Observed Learning Outcomes (SOLO) – Model 2
(Source: Watson and Chileshe, 2004)

### 10.6.1 Areas Requiring Improvement

As articulated by Bonk, Imhoff and Cheng (2002), educational institutions must strive to improve their curricula to keep in step with demands of the engineering profession. One area or skill identified that requires improvement for both Construction Management and Civil Engineering students is writing. Formers technikons must pool their efforts between the Departments of Civil Engineering / Construction Management and the technical writing aspects with the English department to integrate writing skills more fully into both the construction management and civil engineering curricula.

### 10.6.2 How to Address the Improvement Issues

As suggested by Bonk, Imhoff and Cheng (2002), the starting point should be the first-year classes in both Civil Engineering and Construction Management classes. The following approach is suggested:

Familiarize new students with both the civil engineering and construction management profession by introducing courses which can be weaved into their syllabus the elements of audience, genre, and design, as well as collaborative team approaches. As identified earlier, some of the formers technikons still conducted their classes in Afrikaners, while this is commendable, the requirements of the industry is that English should be preferred mode of communication.

Its is proposed that the traditional assignments currently offered at formers technikons can be complimented by student presentation, mock peer reviews, and simulated professional conferences. Bonk, Imhoff and Cheng (2002) in citing Nirmalakhadan and White (2000) state that, in the case of Civil Engineering, other courses, even those laboratory-tested, also provide opportunities for intergrating writing through reports judged on not just technical content, but also grammar, argumentation, and graphics.

The following issues must be addressed in both Civil Engineering and Construction Management in order to ensure that the integration is successful; *content* and *assessment*. Accordingly the issue of content refers to particular writing components incorporated into these courses, whereas the issue of assessment should involve industry participation.

Other observations from literature as to what should be looked at in order to improve the model of delivery are as follows:

- Preparation for Multidisciplinary Practice
- Strengthening Specialist Skills
- Promoting Integrative Professionals with International Competitiveness.
- Designing University Curricula in Collaboration

The last point relates to the academic institution, industry engagement. According to Chan et al (2002), this can take shape in the following formats;

- Industry/academic collaboration;
- Student industrial placement; and
- Student mentoring scheme with senior professionals from industry

Although it can be argued that most of the highlighted issues do take place, a model which takes into account the equal contribution (33.3%) of the three partners namely; students, staff, and industry is the way forward. However, a careful investigation is required as to what extent the industry should take owner of what is taught, even though the equality in collaborative terms is being advocated for.

In summation, as asserted by Chan et al (2002), if formers technikons are to offer a full contribution to profession education, they should take a more proactive role in offering a multidisciplinary, continuous professional education that should not be based or limited to the standard curricula, hence the need for revision.

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