Integrating the Development of Employability Skills into a Civil Engineering Core Subject through a Problem-Based Learning Approach*

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Institutions of higher learning are expected to design their programmes to meet the needs of industry to ensure that students acquire the skills, both technical and non-technical, that will be used in future employment. Thus academic institutions have to develop teaching strategies to meet these demands. This paper presents a strategy in teaching, utilising the problem-based learning approach, which allows for the development of non-technical skills in a civil engineering core subject. The teaching strategy is based on the assumption that, by using the active knowledge base in a particular subject with specific application strategies, both technical and non-technical applicable skills can be developed in an integrated manner. An example is provided to illustrate the teaching strategy, and student perceptions of the strategy are also presented.

INTRODUCTION

LEARNING ENVIRONMENTS continue to be studied and different teaching strategies tried in order to understand their impact on the students' acquisition of knowledge and to respond effectively to the demands being made by industry, which include the possession of both technical and non-technical skills. In recent years, there has been a movement towards using the problem-based learning (PBL) approach as a teaching strategy [1].

According to Thomas *et al.* [2], PBL is concerned with integrating new knowledge and skills with knowledge already possessed by the learner. This development of new knowledge and skills is achieved through the stimulus of a real problem.

From the above definition of PBL and on the basis of educational theory, which tells us that connections/linkages are more likely to be made when the elements to be linked are experienced together [3], and that students learn through active engagement rather than passivity, it was felt that the PBL approach would be the best strategy to achieve the goal of integrating the development of non-technical skills into the curriculum.

The skills intended to be developed are categorised by competency areas, namely, communication, presentation, planning, identifying and solving problems, social development and working effectively with others, and collecting, analysing, organising and critically evaluating information, all of which relate to the generic critical outcomes determined by the South African Qualifications Authority (SAQA) [4].

THE APPROACH

The problem-based learning approach is being implemented in a civil engineering core subject at Port Elizabeth Technikon, within the context of a three-stage instructional method as outlined by Mgangira [5]. It is a structured interactive process and has its basis in the classical learning process of orientation, practice and feedback [6].

A 'task brief' is usually given to the students in week 7, of a 13 study-week semester. At this stage, the students' technical knowledge is at the point where they have at least developed the confidence arising from understanding the principles of soil testing. The task brief has two main sections: an introduction section, in which the objectives of the task are outlined and a list of the skills intended to be developed is given; and a problem description section, in which the boundary conditions of the task are given. The submission date is also given with the brief.

The meeting

The students are asked to discuss the task brief in their groups in preparation for a meeting with the lecturer. They are asked to make an 'appointment' for the meeting in order to get a feel for the environment in which they will be working. There is flexibility in scheduling the meeting. This is to

allow the students to make their own decision as to when they deem it fit to schedule the meeting, thus developing self-management and planning skills.

At the end of the meeting, feedback is given to the students on their level of preparedness for the meeting and their general participation during the discussions. It is during these meetings with the groups that the lecturer is able to assess whether the group is working as a team or not. Through the meeting, it is also possible to determine the extent to which the group members understand the task ahead of them and how each member has interpreted the task. Where it is obvious that the members do not all understand the task in the same way, the lecturer points out to them the importance of ensuring that all members understand exactly what is to be done. This is seen as a way to encourage the students to arrive at a solution in the form of joint action. The following is an example of the task brief.

The task

Each group was given the reference code for their soil sample and the conditions for preparing the material for making the soil–cement bricks/blocks. The production of the soil-cement bricks/blocks closely followed what one would expect on a community-based project, regarding the method of measuring the materials, water requirement and method of mixing. Hand mixing was used. The production of the bricks/blocks was done using the hand-held compactor typically used by the communities.

The boundary conditions of the task, which were given to the students during the meeting, included the soil–cement proportions and the number of taps required to compact the mixture once placed in the compactor. Each group had a different type of soil, but, in some cases, different groups had the same type of soil sample and the same mixing proportions, but were required to use a different number of taps for compaction. In this way, the influence of soil consistency and compactive effort on the strength of the final product, as discussed in the lecture on the theory of compaction, were illustrated.

The project was planned in such away that it allowed for a form of partnership to develop between the different groups in the classroom. Data, for example, needed to be collected from other groups and analysed in order to complete the whole project. The desire to enhance teamwork, interpersonal relationships, as well as skills in data collection and analysis, was the motivation behind this approach. Contributions to group activity, fulfilling responsibilities within the group, constituted the teamwork. Group 'managers' were requested to ensure that each member was given a specific task in the group.

Presentation

In writing the report, each group member was required to write a section of the report. The document files were then merged together into one document to produce a single group report. This approach offers the opportunity for the development of report writing by the individual members in the group, thus developing their communication skills. An oral presentation was scheduled after the submission of the written report.

While the overall report presentations were very good, of concern was the fact that most of the reports did not display critical data analysis skills. Considering that the students are only in their second year of study, it is probably expecting too much of them to have acquired such skills to the required level. However, feedback was obtained by analysing the data they collected from other groups.

STUDENT PERCEPTION

It was deemed necessary to ascertain the students' perceptions of this teaching strategy and determine the extent to which the students felt that they acquired the intended skills. A questionnaire was used to capture this data. The questionnaire had three parts and used a combination of open and closed questions in addition to listing. For the purpose of this article, only section C of the questionnaire will be considered. This section of the questionnaire had open questions and a listing of the skills intended to be developed. The students were asked to select the skills they felt they had acquired from the given list. Listing the skills is seen as a means of increasing self-awareness among the students with respect to the skills that are required to be developed. While the intended skills, in general terms, relate to the SAQA generic critical outcomes, they have also been determined as the cluster skills required by employers in a study by De Lange [7]. In the first semester of the 2001 academic year, 26 out of 37 students registered for Geotechnical Engineering II returned the questionnaire, and, in the second semester, 33 out of 38 registered students returned the questionnaire. The results of the open question section of the questionnaire are used to modify the overall teaching strategy.

Table 1 shows the responses of the two groups that attended the course in the 2001 academic year. In this article, information management, as listed in Table 1, includes data collection and analysis, and information sourcing from the library and websites.

The number in brackets in the frequency percentage column is the ranking according to the students' perceptions regarding the acquisition of that skill in a particular semester group. While the two groups ranked the skills differently, the results show that the teaching strategy has provided the majority of the students with the opportunity to develop skills in communication, teamwork and problem-solving. Student perceptions indicate that

Table 1. Student response on the acquired skills

Intended skills	Semester I/2001		Semester II/2001	
	Frequency	Frequency %	Frequency	Frequency %
Communication	25	96 (1)	28	85 (2)
Problem-solving	23	88 (3)	30	91 (1)
Information management	20	77 (4)	17	52 (5)
Group effectiveness and teamwork	24	92 (2)	25	76 (3)
Organisational effectiveness and leadership	19	73 (5)	19	58 (4)
Facilitation	14	54 (6)	16	48 (6)

over 75 % in both groups felt that the project helped them acquire these skills. Of note is how facilitation is the lowest in ranking for both groups, indicating that an average of 51 % felt that they acquired this skill.

A closer look at the responses shows that some of the students in the same group did not feel that they acquired a particular skill, while the rest of the group members indicated that they did. Since the questionnaire was evaluated by the Bureau for Educational Support at the Port Elizabeth Technikon and the content of the questionnaire and specific items on it were first discussed with the students in the previous academic year, it seems most likely that this outcome was due to their individual perception and not to a problem in the interpretation of the listed skills.

In the open question section, positive comments were given by the students about the teaching strategy, such as 'I was really encouraged to have such a project handed to us as it developed confidence in me' or 'the project is OK because it gives students other skills and does not focus on the technical side only and it is practical'. On the other hand, concern was expressed by some students that the time allocation was inadequate for a project of this kind and that it was difficult at the beginning to understand what was expected of them, as it was the first time they had done something like this.

CONCLUSIONS

This article has illustrated one of the advantages of using the problem-based learning approach. Students are able to link theory to practical application in a local context. At the same time, they are able to exercise several skills, such as problem-solving, communication, information management, group effectiveness and interpersonal skills.

On the basis of the student evaluation and comments made in the open question section of the evaluation questionnaire, it is very clear that the problem-based learning approach increased the relevance of the course to the students. While the process of curriculum transformation is still continuing, it is felt that, by closely observing the learning process, it is possible to develop a conceptual framework through which the development of technical and non-technical employability skills can be integrated into the curriculum through the problem-based learning approach.

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