

# A DIAGNOSTIC STUDY ON THE TEACHING AND LEARNING STYLES IN ENGINEERING EDUCATION

M. Alseddiqi, R. Mishra

University of Huddersfield, Queensgate, Huddersfield HD1 3DH, UK

## ABSTRACT

*This paper presents the results from a study undertaken to analyse the teaching and learning effectiveness in engineering education courses, specifically for Technical and Vocational Education (TVE) system in Bahrain. Teaching and learning diagnostic assessment tools were developed for both TVE teachers in electrical and electronic engineering and a pilot group of TVE students. The purpose was to examine the existing approaches of teaching and learning practised in TVE educational environments. The analysis indicated that TVE teachers applied limited methods of teaching and learning. However, the TVE students had widely varying learning preferences, as they are more motivated by the experiential learning approach used by the teachers.*

**Keywords** Teaching and Learning, Experiential Learning, Engineering Education, Teaching and Learning

## 1 INTRODUCTION

The TVE system incorporates different engineering specialisations such as electronic and telecommunication engineering, building services, mechanical engineering, and computer technology. It is a two-tier system of education (TVE Directorate in Bahrain, 2004) which includes school-based learning (SBL) and work-based learning (WBL).

SBL comprises specialised technical modules (for industry-specific skills) and supportive modules (for generic employability skills) (TVE Directorate in Bahrain, 2006). WBL includes students' involvement in real work environment. The SBL and WBL are both intended to equip the graduates with skills in the cognitive, affective and psychomotor learning domains required for their successful future careers.

It has been observed that there is a lack of empirical investigation into the TVE system in the context of ensuring that the learning outcome's contents, teaching and learning processes and assessment methods are effectively linked together. The TVE partners indicated that there are issues such as traditional teaching and learning processes, limited access to information technology, lack in curriculum review and development process, limited abilities to link between theoretical contents and practical tasks, and lack in linking the curriculum content with assessment approach.

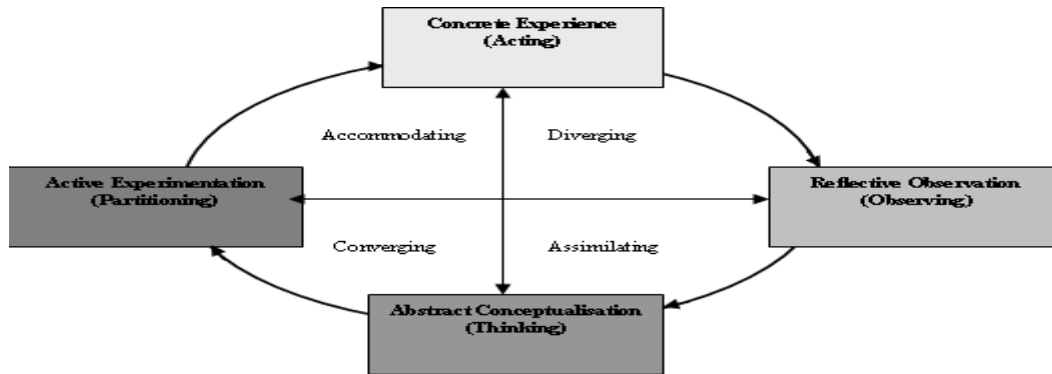
This paper investigates the issues surrounding the teaching and learning methodologies being used in TVE system in Bahrain and proposes recommendations to improve its effectiveness.

## 2 THE TEACHING AND LEARNING STYLES IN TVE SYSTEMS

The teaching and learning styles available in literature can be used to benchmark the existing teaching practices. A UNESCO report (2005) defined the teaching and learning as the method of delivering knowledge and skills to students using various techniques of learning including lectures, individual learning, group project, on-line learning, etc.

Kolb (1984) formulated an experiential learning theory from the empirical work of Dewey, Lewin and Piaget. The theory combined Dewey's philosophical expediency, Lewin's social psychology and Piaget's cognitive model. It explains the exchange of knowledge between the students and the teachers in a structured manner. Baker et al. (2002) confirmed that the students' experiential learning uses conversation as a mode to transform knowledge into experiences. The experiential learning theory includes pedagogic activities that incorporate both the academic and the practical activities.

Figure 1 illustrates that the functioning of the model is based on the idea that the students' learning preferences can be represented in two dimensions: dimension one represents the transformation from (concrete experience) to (abstract conceptualisation) along vertical axis as the approach to acquire knowledge; and dimension two represents the transformation from (reflective observation) to (active experimentation) along horizontal axis as the process of acquire knowledge.



**Figure 1- The Experiential Learning Model and Learning Styles Cycle (Kolb, 1984)**

Figure 1 also clearly shows that the students with a preferred converging learning style (thinking and partitioning) helps them to understand the theoretical information through active experimentation thereby allowing them to develop finer details of the theoretical concepts. In accommodating learning style, the students may gain new knowledge by working in groups, solving problems relying on others' information, and learning from other peoples' technical work. After that, the students prefer to watch and gather information rather than practical applications in diverging learning style. The divergers add different experiences to the learning processes from the concentrate experience and process those experiences through reflective observation. During the learning processes, divergers perform better in reviewing existing circumstances, listen openly to others' opinions, generate new ideas, conduct brainstorming sessions, and gather information. After the students gathered the information, they focus on analysing the information in the assimilating learning style. Furthermore, the assimilators are theorist students who have a preference for approaching knowledge acquisition through abstract conceptualisation and complete things through reflective observation. Assimilators prefer the theoretical learning approach as they are best at reading, thinking, analysing situations, and putting information into a logical sequence. The conclusion is that the student should have a balance of learning styles for effective learning output (McCarthy, 2010).

Various publications have demonstrated that the teaching and learning processes for TVE are still traditional and no significant amendments have been implemented over recent decades. Hillier (2009) showed that the TVE system in Australia contained a traditional approach to teaching and learning where teachers delivered the curriculum content in theoretical sessions. These were followed by practical tasks demonstrated to students in the workshop and/or laboratory. After that, students were asked to perform the theoretical and practical tasks using different learning methods, in order to demonstrate their understanding of the curriculum concepts.

A recent study in TVE system in Bahrain emphasised the existing problems in TVE teaching and learning processes (UNESCO Report, 2005). The results stated that the existing teaching and learning strategy is not suitable for modern industrial requirements. The affective domain skills, which are so important in industrial setup, have not found to be integrated with teaching and learning processes. The study recommended the need for embedding affective domain skills in both curriculum development and teaching and learning processes.

Although, there were some changes have been considered in the teaching and learning processes in engineering education courses, there are still outstanding difficulties in matching between teaching and learning styles preferred by both TVE teachers and TVE students.

The next section presents the teaching and learning diagnostic assessment tools that have been used to identify the learning styles that TVE teachers prefer for delivering the learning activities as well as the learning styles preferred by TVE students.

### **3 THE TEACHING AND LEARNING DIAGNOSTIC ASSESSMENT TOOLS**

There are two teaching and learning diagnostic assessment tools namely; the teachers' diagnostic assessment tool and the students' diagnostic assessment tool. Both tools contain different learning activities which have been formulated on the four learning styles of Kolb's model.

The teachers' diagnostic assessment tool has been developed to assess the preferred teaching styles employed by teachers during the knowledge transfer process. This assessment tool consists of 20 typical learning activities. The tool has been distributed to 20 TVE teachers from electrical and electronic engineering specialisation. The purpose was to collect information on the teaching styles used in engineering education courses.

Each learning activity of the teachers' diagnostic assessment has four possible modes of delivery. The teachers were asked to rank the preferred modes of delivery for each learning activity using the scale as shown below:

- 4 The most-used approach to teaching and learning
- 3 Good approach to teaching and learning
- 2 An adequate approach to teaching and learning
- 1 The least-used approach to teaching and learning

The emphasis of this tool is to critically analyse the existing teaching and learning mechanisms practised by the TVE teachers during the delivery of engineering education courses.

The student's diagnostic assessment tool incorporates 24 typical learning activities. The tool indicated the preferred learning styles by the students.

The tool has been distributed to a pilot group of 30 students in the field of electrical and electronic engineering. Each learning activity has four possible learning styles. The students were asked to rank the styles according to their preferred way of learning:

- 4 The most-preferred approach to learning
- 3 Good approach to learning
- 2 An adequate approach to learning
- 1 The least-used approach to learning

It was obvious that both diagnostic assessment tools (teacher and student) were designed in such a manner that it would interest the respondents to rank the teaching and learning activities according to their preferred styles of learning. The assessment tools have been reviewed and validated by experts from TVE.

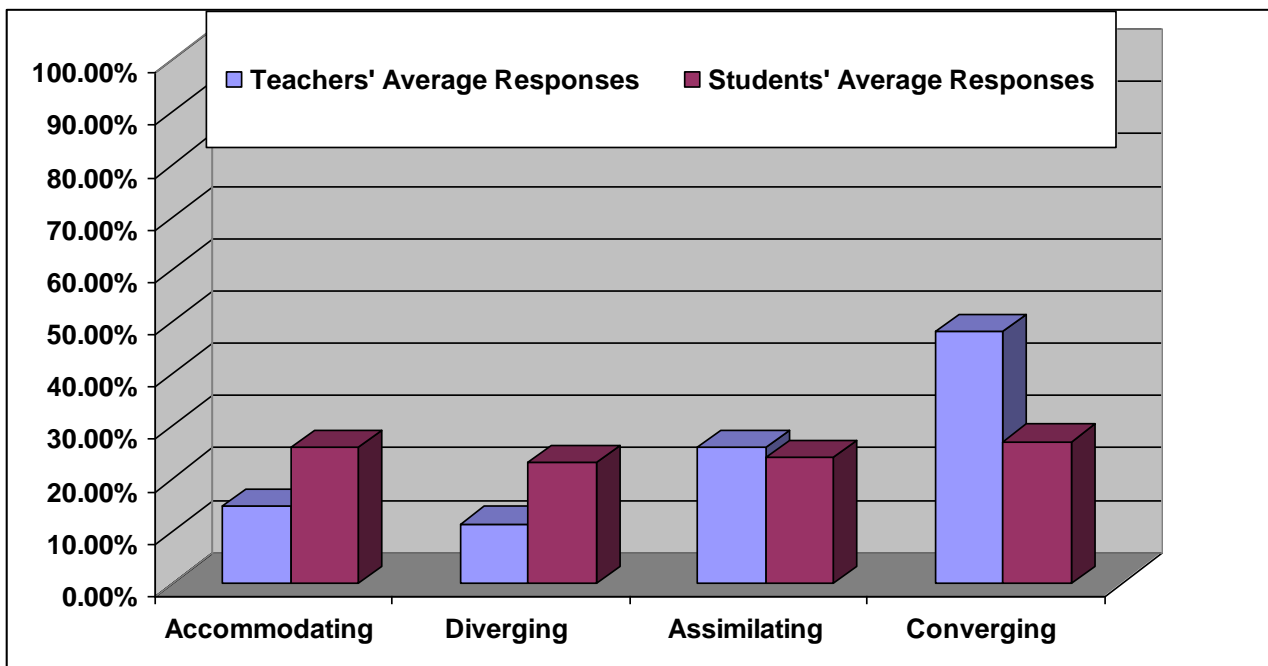
### **4 RESULTS AND DISCUSSION**

This section of the paper presents the results from the teachers' diagnostic assessment tool and the students' diagnostic assessment tool. Then, both results have been compared and final conclusion has been produced.

Figure 2 compares between the average results from both, the teachers' and the students' responses to the identified learning activities. The x-axis represents the learning styles of Kolb's model: accommodating, diverging, assimilating, and converging. The y-axis represents the respondents' average percentage to the teaching and learning styles to the identified learning activities in both tools.

Looking at the average teachers' responses, it can be seen that 48% of the respondents indicated that the converging learning style is the most-used approach to teaching and learning during the delivery of engineering education courses. The respondents clarified that they mainly used the converging learning styles because the existing learning activities of TVE curriculum have been designed mainly to improve students' thinking skills and psychomotor skills so that the students should be able to understand and apply different tasks in practice.

26% of the respondents used the assimilating learning style, in the delivery of the learning activities. The average results indicated that the respondents have used abstract conceptualisation as an approach to knowledge transfer, and reflective observation as a process of transferring the knowledge during the theoretical sessions in SBL. The respondents also approved of giving the students the opportunity to read, think, analyse situations and put information in a logical sequence during the process of teaching and learning.



**Figure 2 – The Average Responses to the Learning Styles**

In contrast, only 15% of the respondents delivered the learning activities using the accommodating learning style and 11% of the respondents delivered the learning activities using the diverging learning style.

With respect to the average responses from the teachers, they justified the nature of the existing learning materials; the content and time allowed for each module forced them to be limited in their ways for delivering the learning activities. In total, figure 2 shows that:

- Converging was the most-used approach to teaching and learning
- Assimilating was a good approach to teaching and learning
- accommodating was an adequate approach to teaching and learning
- Diverging was the least-used approach to teaching and learning

From the students' responses it can be seen that almost an equivalent percentage has been given for each learning style as shown below:

- 27% of the respondents preferred the converging style,
- 26% of the respondents preferred the accommodating learning style,
- 24% of the respondents preferred the assimilating learning styles, and
- 23% of the respondents preferred the diverging learning style.

The above findings showed that the TVE students had widely varying learning preferences. The TVE students preferred learning styles are not always compatible with the delivery styles of the TVE teachers. It is therefore imperative to modify the teaching and learning process to incorporate different learning styles in the delivery mechanism.

To satisfy the needs of the students and assist the teachers in the delivery of the learning activities, it is suggested that an effective guideline for teaching and learning styles should be developed for typical engineering education courses. The guideline will ensure that the learning methods through observing, thinking, partitioning and acting modes are delivered effectively. In addition, the guideline should address all the preferred learning styles by students. So, a stable approach for teaching and learning styles should be provided to overcome students' difficulties in learning and enable them to perform well during the delivery of engineering education courses. Furthermore, the TVE teachers should be trained to use the developed guideline for delivering the engineering education courses effectively and improve their ability to link between theoretical and practical learning activities.

## 5 CONCLUSION

This paper has specified that the TVE system needs an effective teaching and learning processes for the delivery of engineering education courses. The results from the teaching and learning diagnostic assessment tools showed that the TVE teachers preferred learning styles for delivering of the learning activities were different than the learning styles preferred by TVE students.

In order to satisfy the needs of TVE students and assist TVE teachers in the delivery of the learning activities, a guideline should be proposed to accommodate all the preferred learning styles Kolb's model. The guideline should improve the effectiveness of teaching and learning approach for engineering education courses. The guideline will contribute to the improvement of the educational effectiveness in TVE system in Bahrain.

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