Design and Development of an On-Line Work-Based Learning (WBL) Module to Enhance the Technical and Vocational Education (TVE) System in Bahrain

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Abstract

This paper outlines the results from a research study conducted by the authors to identify the existing employability skills gap between TVE system in Bahrain and industrial requirements. Based on the study results, an on-line WBL module has been developed and will be introduced in SBL, delivered with innovative technology. The module aims to improve teaching and learning strategies, develop TVE students' competencies, and meet the industrial requirements. The module has been designed to have elements from the day-to-day working environment of an industrial setup as well as various elements from the interface of industry and society. The on-line WBL module is expected to make a major contribution to the improvement of TVE in Bahrain because it will challenge all students and teachers to recognise, make informed responses, and work comfortably with the diverse requirements that they encounter in the WBL environment.

1. Introduction

Various socio-economic indicators have resulted in the increased pressure on the TVE sector, and modern industrial requirements have changed it from supply driven to demand driven. A strength and weakness analysis of the existing provisions indicated that the TVE is facing a number of operational challenges linked to the delivery of appropriate courses and training sessions used to allow the development of proper skills required by modern industry. An employability skills model has been proposed, to structure the contents of school-based learning (SBL) and work-based learning (WBL) and close/minimise the identified skills gap (Mishra et al, 2009). This paper focuses on the process of designing and developing a pedagogic framework for the learning materials of an on-line WBL module. The module will enhance the teaching and learning provisions in the TVE system and contribute to the improvement of the educational policy in Bahrain.

2. Background

2.1 The research project

There is a lack of empirical investigation into the TVE system in Bahrain in the context of meeting the requirements of the labour market (the industrial companies that TVE serves in Bahrain). The limitations of the current technology in TVE, the industrial socio-economic and technological challenges, and the up-to-date employability skills required by industries call on the need for more experimental research to investigate and analyse the effectiveness of enhancing new technology in the teaching and learning processes in the TVE system.

An improved model has been developed which shows the required employability skills that need to be integrated through teaching and learning processes in SBL and WBL. This model has been used as the basis for restructuring the content of the WBL module to meet the visible needs of TVE and the labour market. An attempt has been made to address as many of the invisible needs as possible through the developed curriculum content. The TVE students will study the restructured WBL module before undertaking work placement in industry. The authors aim to develop

a generic employability skills model applicable to a diverse range of TVE systems around the world. However, the data in the present study was limited and the model is currently specific to the pilot study for TVE in Bahrain (Mishra et al, 2009).

The rationale behind using technology in pedagogical practices was that it could be a feasible solution to meet the needs of industry as well as improve general education outcomes. Development of an effective virtual learning environment system (e-learning package) will contribute to closing/minimising the identified employability skills gap.

A series of training workshops have been scheduled during the research project. The general aim is to design and create the physical learning materials of the WBL module, followed by action on converting those materials to e-learning contents. These workshops give participants (TVE teachers, TVE specialists, and participants from industry) an opportunity to develop the teaching and learning materials based on industrial requirements from employability skills, apply models of learning into teaching and learning processes, and identify a learning model which combined learning environments during the module's implementation. Participants also learned about Bloom's taxonomy of learning theory, which considers the learning levels in cognitive, affective and psychomotor dimensions (Bloom, 1956). Then, participants have applied the pedagogical concepts of those taxonomies in structuring the learning activities of the physical learning materials.

2.2 The Educational Context in the TVE System

The main objective of the TVE system in Bahrain is to equip TVE graduates with the skills, knowledge and work ethics required for various industries such as the petroleum industry, electronic and telecommunication engineering, building services, mechanical engineering and computer technology. This is achieved through a two-tier system of education (TVE Directorate in Bahrain, 2006) 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). The WBL is intended to equip the graduates with skills in the cognitive, affective and psychomotor learning domains required for their successful future careers.

In the mid-1980s, the concept of information technology has been introduced in the secondary schools in Bahrain. The Ministry of Education (MoE) has provided computer laboratories in general education schools as well as in TVE schools. More recently, learning resource centres have been initiated in various schools, with personal computers linked to the World Wide Web (MoE, 2009).

Recently, the MoE has employed information and communication technology (ICT) in teaching and learning processes. As more technological laboratories, equipment, and software have been introduced and integrated within the curriculum, the objectives are to provide students with knowledge, values, attitudes, and skills including ICT. The aim is to convert the Bahraini society and economy to a technological society and knowledge-based economy.

3. The Model of Development

3.1 The model of the development process

Figure 1 represents the model of development that has been initiated for facilitating the WBL module. The stakeholders' requirements have been used as an input to the model. These stakeholders participated in the training workshops. They were selected from TVE experts including teachers and specialists, industrial supervisors, IT support specialists, and a pilot group of TVE students (electrical and electronic engineering students). They worked as independent groups and in collaboration with each other within a structured process. This structure is based on the 'industrialised model of development' as each group's experts played their part in the design and development process (Bradley and Oliver, 2003) of the WBL module.

The management and progress-monitoring group consisted of the researcher (the first author), the Chief of TVE Centre of Excellence (CoE) in Bahrain, a CoE specialist, and a TVE specialist. This group was responsible for managing and monitoring the overall progress of the other groups, namely: institutional management group, learning materials development group, prototype design and management group, expert review and evaluation group, and

industrial companies' pilot group. The management and progress monitoring group was also responsible for proposing the research work plan and approving the scheduled work plan.

The industrial companies group represented industries served by TVE and other industries that are not served directly. These companies are expected to receive the pilot group of TVE students in the WBL programme after the implementation of the on-line WBL module in SBL. The companies' involvement was crucial in identifying the employability skills requirements and the personnel from the company worked in parallel with the groups on course development including module's descriptions, module's objectives, and learning activities. The institutional management group has compiled information on stakeholders' needs and carried out a feasibility study of required resources, and user requirements (including students and teachers). This group started working before the start of course material development phase.

The learning materials development group contained experts from TVE (teachers and specialists) who designed the overall pedagogic framework of the WBL module as well as produced the physical learning materials.

The prototype design and development group has worked on the technical development and converted the module's contents to the format of e-learning contents. This group usually receives the final technical approval from the management and progress monitoring group in order to develop the e-learning prototype. The prototype development has been based on a user-centred design strategy (Hussein, 2005) comprising; user analysis, knowledge/information analysis and communication (Tomei, 2008), structure and representation, and interface and navigation design (Vavoula and Sharples, 2002). This group has started working from the basis of user requirements (students and teachers). Then the prototype has been sketched, with e-learning resources content, and e-learning layout design.

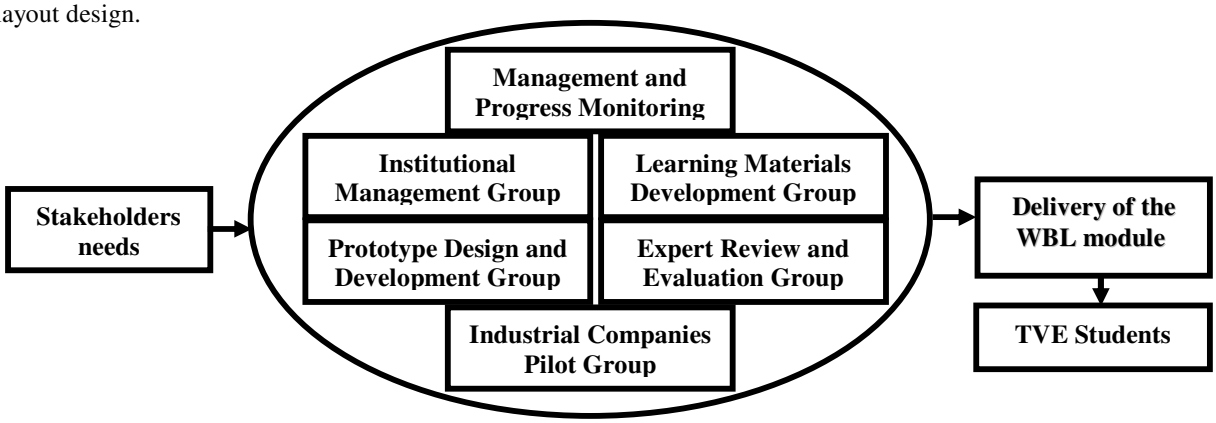

Figure 1 – The Development Model Process

The expert review and evaluation group conducted the expert evaluation to measure the effectiveness of the proposed e-learning package. The group also has assessed the technical aspects of the package. Moreover, the group has set recommendations to both the learning materials development group and prototype design and development group for quality improvements. Therefore, both groups ensured the quality of the physical learning materials and the completed e-learning package. The final approval has been given by the management and progress monitoring group.
The output of the model has been the e-learning package of the WBL module. The module will be implemented to a pilot group of electrical and electronic engineering students in TVE institutions in Bahrain.

3.2 The Learning Materials Development Process

After identifying the needs of the stakeholders, strengths, weaknesses, opportunities, and threats (SWOT) analysis technique has been used by the management and progress monitoring group to identify the requirements of the proposed WBL module. Figure 2 explains the four steps of SWOT analysis. The purpose was to analyse, plan, apply, and take decisions for the process for setting up the overall structure of the WBL module.

The next stage of the development process was the module description. The participants of the workshop were taught how to do this. The description has specified seven different aspects including: the learning outcomes, objectives (knowledge, skills, and affective objectives), range of content coverage (theoretical and practical contents), teaching and learning methods, activities (knowledge and understanding, abilities and capabilities, and real-work activities), and assessment strategies (summative and formative). After completion of the module's description exercise by the workshop participants, the work has been evaluated by the management and progress monitoring group to measure its effectiveness and benchmark it to the learning materials standards. Feedback has been given to participants both by e-mail and during the next training workshop.

Strengths – The required employability skills by TVE system and Bahrain industrial companies were available from the developed employability skills model. The model's skills components were considered in designing and developing the contents of the WBL module.	**Opportunities –** The existing TVE development project (TVE, 2008) planned to develop learning materials for TVE practical modules which would give an opportunity to share ideas and experiences with TVE specialists. Also, the first author experience as being the project advisor for almost three years would help.
Weaknesses – Forces from other people who were against the change and new technology (introducing new module with technology).	**Threats –** New timetable plan was required in order to include the WBL module within the timetable of semester 1 prior to the WBL programme. Also, approval by the TVE Directorate to include the module needed time from.

Figure 2 – SWOT analysis

3.3 Materials for work-based learning (WBL)

The learning materials of the WBL module has been developed to impart practical skills, knowledge and attributes related to TVE requirements as well as industrial needs. The module has been scheduled in the first semester timetable and delivered to TVE students during the SBL before they go to the WBL programme. The module contained systematic and well-connected learning activities that provided various learning opportunities for TVE students using problem-based learning (PBL) method. Indeed, the WBL module was developed to include various scenarios that underlined the variety of learning outcomes introduced for TVE students: work-related knowledge, work and life literacy and understanding, and the technical skills as the basis for enhancing their performance during WBL programmes. Also, the module addressed the lower and higher learning levels of the three taxonomies of Bloom. The learning activities were developed with respect to the skills, attitudes, and knowledge required by the industry (Alseddiqi at el, 2009).

The learning materials development group worked in parallel with the industrial companies' pilot group in the process of developing the learning materials. They worked together to link the module's contents (theoretical and practical) to industrial, economic, and social needs. They also considered the collaborative learning approach (Chin and Carroll, 2000) in designing the learning activities, as students could learn from each other and share learning experiences. The groups underlined that the benefits of collaborative learning theory focused on the process, the social aspects, and the emotional aspects of collaborative learning. Therefore, working collaboratively should improve students' communication skills, problem solving, team work, thinking skills, and cultural awareness during their on-line and classroom discussions and workshops activities during SBL. In addition, the groups recommended that the module's contents should be upgraded frequently because the industrial needs are changing dramatically and rapidly at local, national and international level.

4. The Pedagogical Framework

After structuring the module and highlighting the importance of designing learning activities related to WBL, the training workshop introduced a pedagogical framework for aligning the module's learning outcomes, learning and teaching activities, and the assessment strategies with the requirements. As Biggs (1999) described, the 'pedagogical design' ensures that the learning outcome's contents, learning activities, teaching and learning processes, assessment methods, and learning environments are effectively linked together. Figure 3 shows how to link the module's learning activities with teaching and learning methods as well as the assessment strategy. The learning outcomes (planned activities including academic knowledge and social skills) should be tailored to students' interaction with the learning environment (including physical and virtual learning environments). JISC (2004) underlined that the learning activities should be designed to meet internal and external objectives. For example, in the WBL module, the learning activities were designed to achieve educational goals (TVE goals) and labour market expectations (industrial companies' requirements).

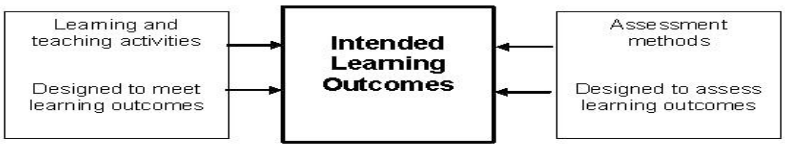

Figure 3 - Aligning learning outcomes, learning and teaching activities, and assessment. (Biggs, 1999)

In the WBL module, the aim is to design and develop on-line work-based learning activities to enhance TVE students' experience. The module also ensures that TVE students receive necessary training during SBL in the employability skills required by industry, before they join WBL programmes.

From the identified requirements from the workshops (Abdulrasool and Alseddiqi, 2010) and industrial needs (Alseddiqi, et al, 2009; Mishra, et al, 2009) the WBL module was developed to include six case studies as shown below. The duration of the module was planned to be 18 weeks.

Case study 1 - General background to an industry
This case study covers the important information that a student is supposed to possess when he/she is placed on the WBL programme in an industry or company, including the required employability skills components and occupational health and safety procedures that need to be followed in the industry.

Case study 2 – Technical competency 1: Designing and assembling a battery charger for car battery
This case study involves activities in collecting information about battery specifications from customers, choosing appropriate components, building the circuit, and testing the fabricated circuit with the battery. The circuit consists of a full wave rectifier using semi-conductor diodes and a central tapped step-down transformer for transforming the domestic 240 V to 12 V AC and rectifying it to 12 V DC.

Case study 3 - Technical competency 2: Developing a car parking counter circuit using digital logic gates
This contains a number of tasks for step-by-step development of a digital counter circuit from the basic fundamental blocks of logic gates. The case study is a binary digital counter counting the number of cars entering a car parking lot, with the help of suitable sensors or switches. The number of cars parked in the parking area is indicated by seven segment displays which are interfaced to the counters through suitable decoders.

Case study 4 - Technical competency 3: Constructing a direct on line (DOL) starter for a 3-phase induction motor
This case study involves building a DOL starting circuit using contactors, push buttons, and overload relays to start and run a 3-phase induction motor. The case study also engages troubleshooting techniques adopting the problem-based learning methodology to identify the various faults that occur and their causes in a DOL starter.

Case study 5 - Technical competency 4: Constructing and maintaining fluorescent light fittings

This case study is to utilise a problem-based learning approach to study the working of a fluorescent lamp and diagnose the various faults that can occur in a fluorescent lamp fitting.

Case study 6: Work Environment competency

This case study covers the important competencies that the student is supposed to demonstrate during the WBL programme in an industry or a company. The outcomes of this case study include skills, competencies and attributes that are mostly required in the industrial environment.

Those topics have been selected as learning case studies after reviewing the SBL occupational standards and SBL curriculum in electrical and electronic engineering by experts from the TVE system. Also, the tasks were related to activities that students would engage in and work on during the WBL programme. Moreover, the tasks included learning activities that are specifically related to employability skills components displayed in the developed employability skills model (Mishra et. al, 2009). For example, case study 1 included pictures and short videos from the pilot group of industries/companies that included various applications as well as employability skills such as communication skills, problem solving, team working, etc.

The WBL module was developed to achieve different objectives including knowledge and understanding objectives, affective objectives, and abilities and skills objectives.

Knowledge and understanding objectives: The module included various activities to develop students' levels of knowledge and understanding by:

- Encouraging students in more critical thought provoking learning activities.
- Integrating independent learning activities as students become independent learners, problem solvers, and decision makers.

Affective objectives: The module contained learning activities that are related to organising and acting on information given during the learning outcomes:

- Organising, comparing different values as well as solving conflicts.
- Adopting behaviour and performing willingness to change.
- Building the concept of transferable skills, learning individually and in teams.
- Building the concept of establishing relationships, building work ethics and honesty, and relating personal interests.

Abilities and skills objectives: The module included learning activities that require high quality demonstration, constructing and designing novel work:

- Measuring the students' performance in doing the activities from given instructions and/or memorised information.
- Providing learning through different activities which integrate academic and occupational skills learned in SBL (classroom and workshop activities) with skills required by the industry in WBL programmes.
- Combining learning tasks to meet novel requirements and define new strategies for work on learning activities.
- Evaluating students in activities which require high quality performance with no guidance

In order to meet the aims and objectives of the above learning module, figure 4 represents the three models which have been considered to build the pedagogical context of the WBL module:

- Model 1 - Bloom's taxonomy of learning model (to develop the theoretical content of the learning materials).
- Model 2 - Blended learning (for a mixture of different learning environments to implement the theoretical and practical activities of the WBL module).
- Model 3 - Experiential learning model (to develop the teaching and learning styles as methods of delivery).

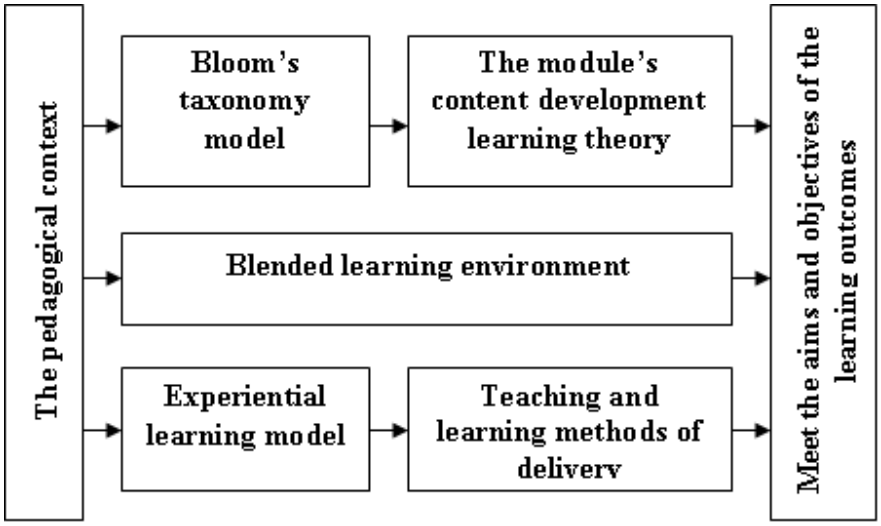

Figure 4 – The pedagogical models used in the development process of the WBL module

The first model has been an effective framework used as a tool to critically develop the learning materials of the WBL module. The revised framework contained three dimensions of learning, namely: cognitive, affective and psychomotor dimensions (Anderson and Krathwohl, 2001). Also, the framework provides the opportunities to apply the above mentioned objectives in various learning activities. Dalton (2003) added that the learning activities should include different types such as informational documents, on-line activities, collaborative activities, demonstrations, and discussions in terms to support different levels of complexity of the learning objectives.

The existing learning outcomes of electrical and electronic engineering courses in TVE in Bahrain were critically analysed using the framework of Bloom's taxonomy (Abdulrasool and AlSeddiqi, 2010). The purpose of this exercise was to know exactly what learning levels of the three taxonomies have been covered in the outcomes of the learning activities offered. The results of the analysis show that the outcomes have been designed to focus on lower learning levels rather than the higher learning levels of Bloom's taxonomy during theoretical and practical sessions in SBL.

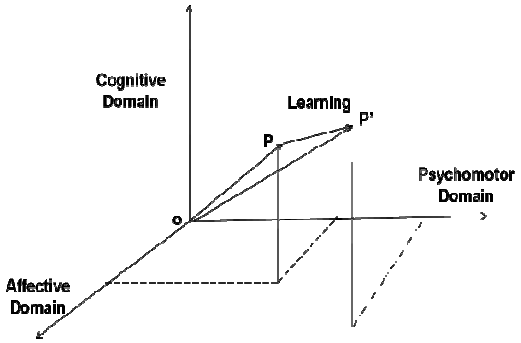

Figure 5 – Bloom's Levels of Learning (Kumar, 2006)

From the evidence obtained during the training workshop (Abdulrasool and AlSeddiqi, 2010), it has been noticed that participants have had substantial shift in their thought about how to improve the teaching and learning processes in TVE system. They were aware on how to consider Bloom's three taxonomies as well as their levels of learning in developing curriculum contents. Figure 5 shows the mechanism of integrating higher levels of learning activities into developing the learning materials, activities and assessment strategies. The results should bring improvements to the learning process in order to meet the industrial requirements identified in previous studies and workshops.

A mixture of learning environments resources have used in the implementation stage of the WBL module (e-learning package). The e-learning package contains six different learning case studies to be delivered over 18

teaching and learning weeks. The course material corresponding to each outcome is to be delivered in 24 lessons divided into 8 lessons for on-line interaction, 8 lessons for practical implementation, and 8 lessons for formative and summative assessments. The e-learning package simulates real-world applications by using diagrams, hyperlinked text, video, pictures, interactive examples, modelling, virtual reality simulations and animations, etc. The practical sessions are conducted using problem-based learning (PBL) activities on various projects related to the employability skills required by industry.

The delivery model is based on experiential learning model from Kolb's learning cycle (Kolb, 1984). The Experiential learning theory converts knowledge to experience through fours phases namely: diverger, assimilator, converger, and accommodator.

During the workshop (Abdulrasool and AlSeddiqi, 2010), teaching and learning assessment tools were distributed to participants after they had completed a number of activities involving various teaching and learning methods. The purpose was to examine the teaching and learning approaches practised in the TVE educational environment. The results confirmed that TVE students were heterogeneous groups of students and require the experiential learning approach. The experiential learning model allowed students to make their own learning choices and relate what they were learning to the real-world environment.

Based on the three models, the WBL module included activities and case studies that were related to learning materials as well as real-life examples that were implemented in a blended learning environment and delivered using effective teaching and learning methods. The students' learning level was automatically assessed by multiple choice questions enabling quick feedback. Also, summative activities were included during the practical lessons to ensure that various processes of learning could be integrated.

5. The Technological Context

For appropriate delivery of the on-line WBL module (e-learning package) to the pilot group of TVE students, the institutional management and the prototype design and development groups worked in parallel to develop a complete multimedia laboratory. This laboratory is equipped with the following: furniture, desk-top computers, active board, overhead projector (OHP), Internet connection, local area network (LAN), e-learning software, and learning management system (LMS). It is located in the Centre of Excellence for TVE at Sh. Khalifa Institute of Technology.

In the technological development process of the e-learning system, the prototype design and development group provided technical support and considered the following aspects: prototype development; knowledge/information analysis and communication; structure; representation; interface and navigation design.

Prototype Development – The prototype has been developed on the basis of stakeholders' requirements. The group started working after analysing the user requirements, e-learning resources contents, and e-learning layout design.

Knowledge/Information Analysis and Communication – At this stage, the technical and social perspectives of all users should be included (Tomei, 2008). The group ensured that the prototype design had communication patterns for sophisticated technical support and created open communication channels. Social networking between students and teachers was considered as a critical issue in application and interpretation of the learning activities delivered through the e-learning package.

Structure and Representation – The multimedia laboratory included LAN and LMS with web portals as components to manage, monitor and maintain electronic data and communication in the prototype. The prototype design and development group designed a layout for activities, and assessments within the e-learning package. Toolbook (SumTotal, 2010) was used as an instrument to convert the learning materials and assessments into e-learning contents. Toolbook provided extra functionality such as buttons, icons, live hyperlinks, and audio and video clips that might be added to provide a better representation of the prototype as well as meet user satisfaction. The e-learning content could then be shared in the learning environment (multimedia laboratory) using LAN, which can be integrated in LMS.

Interface and Navigation Design – After converting the learning materials and assessments to e-learning contents, the prototype interface and navigation design were critically checked against some of the usability issues such as system effectiveness and flexibility in Internet browsing, moving from one activity to another in the e-learning package.

These requirements provide the technical support for the learning materials which incorporate multimedia elements. For example, some learning activities include videos of real-life examples that convert the learning materials into reality, as well as enhancing the learning experience of students.

With respect to users' (teachers and students) interaction with the on-line module, the module provided 'on-line socialisation' activities which focused on developing a supportive learning environment for the students to collaborate on-line (Salmon, 2000). The module will give students an opportunity to exchange information by interacting with learning materials and having on-line discussions. Using the on-line technology will encourage knowledge by sharing ideas, and challenging each other by posing problems.

The expert review and evaluation group has assessed the usability of the prototype design through four main elements: learning ability, attitude, flexibility and effectiveness (Hussein, 2005):

I. Learning ability – Users (students and teachers) should learn how to use the e-learning package. As scheduled in the implementation plan, an induction and orientation programme is expected to be delivered to all users. The orientation includes introduction to the WBL module, the aim and objectives of the module, the module's learning outcomes, teaching and learning methods, and assessment strategies. In addition, the orientation gives in-depth details on participating in group discussion activities.
II. Attitude – Students and teachers should enjoy using the e-learning package and find it friendly. The series of training workshop has encouraged the participants to enjoy using and interacting with the new technological module within the TVE system.
III. Flexibility – The e-learning package should be flexible so that teachers can adapt the learning resources to meet the abilities of different students. ToolBook has the features for modifying, deleting, and adding contents to the e-learning package.
IV. Effectiveness – The designed e-learning package should meet the learning objectives and the purpose of the design. The quality of the effectiveness of the on-line WBL module has been continually maintained.

6. Conclusion

The analysis of the existing TVE system found that there were a number of challenges that TVE is facing in order to cope with modern industrial needs. An improved employability skills model was proposed, to be primarily applicable to meet the needs of the TVE system and the industrial requirements in Bahrain. This paper mainly concentrated on describing development of the pedagogical framework and creation of learning materials for an on-line learning module. The purpose of this module was to address the TVE's needs and industrial requirements using e-learning technology through an innovative teaching and learning approach. A model for designing and developing the on-line WBL module was structured on the basis of the 'industrialised model of development'. The model's input was from stakeholders who participated in the training workshops. They were selected from TVE experts including teachers and specialists, industrial supervisors, IT support specialists, and a pilot group of electrical and electronic engineering TVE students. A number of groups have been formed, each with its own occupation. They worked as dependent groups and in collaboration within a structured developmental process for analysing, planning, creating and evaluating the learning materials in two phases: physical and on-line learning materials. The pilot version of the e-learning package has been evaluated by teachers (expert evaluation). The prototype has been modified and improved according to the experts' comments. The pilot implementation is expected in the academic year 2010-2011 on the selected group of electrical and electronic engineering from TVE institutes. The effectiveness of the e-learning package is then evaluated by the users (teachers and students) after the implementation of the pilot.

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