DISTANCE LEARNING OF ENGINEERING BASED SUBJECTS: A CASE STUDY

Felicia L.C. Ong (author and presenter)
University of Bradford, United Kingdom

Ray E. Sheriff (author)
University of Bradford, United Kingdom

Summary

With the advancement of technology, significant changes have been introduced into the learning and teaching environment. The importance of enhancing the interest of learners is an on-going challenge for educators of all levels. In this respect, teaching and learning practices are adapting to students' exposure to technological and social trends. In this presentation, a case study of using technology to enhance the learners' environment for engineering-based subjects in higher education is presented. The approach consists of delivering interactive materials through a Virtual Learning Environment and integrating web application technologies to enhance the learners' experience. Due to the vast subject areas in engineering and the variety of content of each subject, a general methodology is first identified and adopted. This consists of stages that show the progress from initial development to deployment of the materials, followed by evaluation of the module and further improvements carried out on the module based on qualitative evaluation. The evaluation process consists of the application of electronic surveys for feedback on the distance learning module. In addition, monitoring of the students' usage of the materials is also carried out. The presentation concludes with the presentation of the initial results from a current e-learning module.

1 Introduction

The convenience of the Internet has made it an essential tool in how we go about handling the daily aspects of our lives. This has brought about the demand for more innovative, creative and useful applications that can improve and support the digital generation. It is widely recognised that educators can exploit these innovative tools to aid in bridging the learning and teaching environment for learners, especially for those located off-campus, at remote sites. Using technologies in a learning and teaching environment is widely described as e-learning or as technology enhanced learning (TEL). In this paper, the approach of incorporating technologies in enhancing and delivering engineering-based subjects for distance learners will be presented.

The methodology applied to the development of e-learning materials, which is a gradual and, often, time-consuming process, is described in Section 2. A sample of the materials developed and delivered is showcased in Section 3, before drawing conclusions in Section 4.

2 Adopted Approach

2.1 Overview

From the outset of putting in place a programme of development and deployment, it was deemed necessary to have a procedure in place to cultivate an e-learning culture among staff within the University of Bradford's School of Engineering, Design and Technology (EDT). Therefore, the approach that was to be implemented needed to be easily comprehensible, as well as functional. Based on these requirements, the Plan-Do-Check-Act (PDCA) cycle was deemed to be a suitable approach to be employed. The PDCA cycle was developed by Shewhart [1] and made popular by Deming [2] when it was introduced as a quality management tool in Japan after the Second World War. Figure 1 shows the PDCA cycle, also commonly known as the Deming cycle or Shewhart cycle, which is widely used as a management tool within corporate environments. For example, Toyota is using the PDCA cycle as a fundamental problem solving framework [3]. The PDCA cycle is incorporated in the ISO 9001:2008 standard and is stated as an established, logical method that can be used to improve a process [4].

Figure 1: Plan-Do-Check-Act (PDCA) Cycle

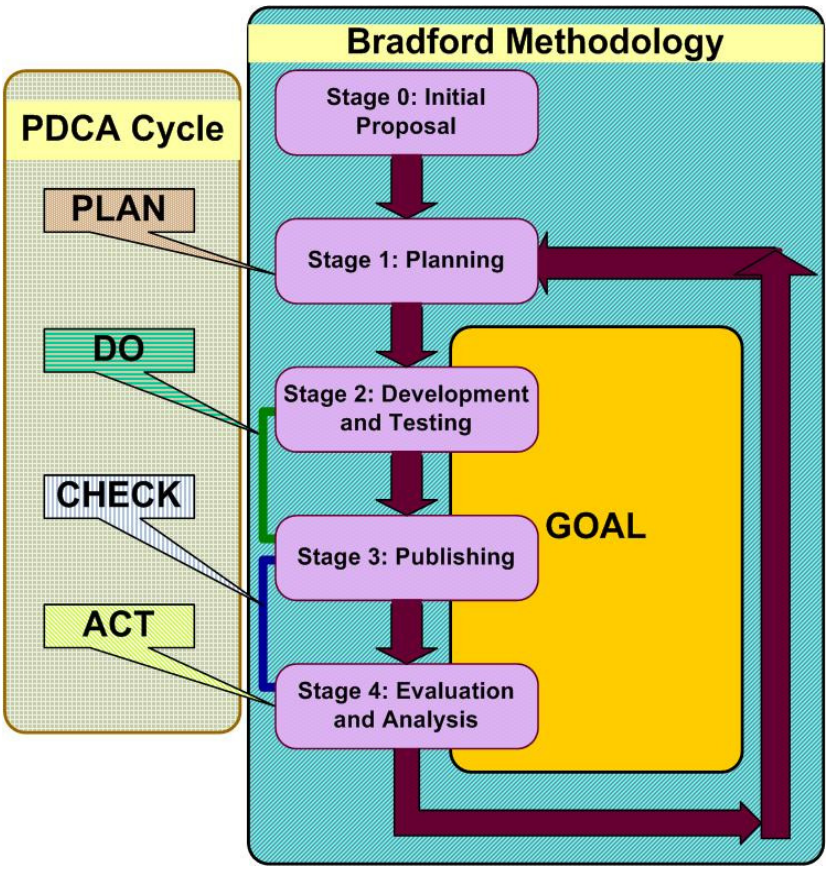

Figure 2: Bradford Methodology

Due to the nature of the *modus operandi* within the School, the approach was altered and adapted for the e-learning development. The modified approach, known as the Bradford Methodology, which was maintained to be broadly similar to the PDCA cycle, is shown in Figure 2. It can be seen that the Bradford methodology consists of five main stages, which will be further elaborated in Section 2.2.

2.2 Bradford Methodology

In the following, Module Coordinator refers to the lecturer with overall responsibility for the delivery and assessment of a module. A module is a collection of material that together forms a programme of learning on a given subject. Each module has specific aims, learning, teaching and assessment strategies, and learning outcomes, and comprises 100 study hours. The Distance Learning Development Officer is responsible for transforming standard modules into formats suitable for off-campus delivery.

The Bradford Methodology comprises five stages, as follows:

- **Stage 0: Initial Proposal**

  In the Initial Proposal stage (Stage 0), an outline discussion is arranged by the Distance Learning Development Officer with the respective Module Coordinator responsible for the module to be developed into distance learning format. A module comprises 100 hours of learning material and includes lecture material, tutorials and, possibly, laboratory experiments.

- **Stage 1: Planning**

  An initial meeting is organised between the Distance Learning Development Officer and the responsible Module Coordinator to discuss how the module will be developed into distance learning format. Critical events are highlighted, existing and required resources are identified and an implementation schedule is agreed.

- **Stage 2: Development and Testing**

  The core development of the distance learning module and materials will be performed. It can be seen that another PDCA cycle is employed within this stage, with goals of completing the respective e-learning materials and publishing the materials, such as through the University's virtual learning environment (VLE), which In University of Bradford's case, is Blackboard.

  Plan

  The approach for this stage is based on that agreed at Stage 1, with the Module Coordinator categorising the materials into sections.

  Do

  This requires applying TEL tools to the module, for example, the creation of interactive tutorials. The module materials are developed and tested in the previously identified sections.

  Check

  The developed materials for the respective sections are then presented to the Module Coordinator for analysis and feedback. The Module Coordinator then identifies any improvements required, or approves the materials by indicating that they are ready for publishing.

  Act

  For the "ACT" cycle, improvements identified are studied and implemented. If the materials are approved for publishing by the Module Coordinator then they are prepared for delivery under Stage 3. If the Module Coordinator identifies improvements before publishing, then the cycle is reverted back to the "Plan" phase in Stage 2, where remedial action is performed.

- **Stage 3: Publishing**

  When the materials are ready to be published and made available to students, they are released in the agreed delivery format, such as through the University's VLE.

- **Stage 4: Evaluation and Analysis**

  In this stage, evaluation will take place. A questionnaire for feedback is provided at the end of the module delivery to encourage students to reflect on their experience and voice their opinion. The Module Coordinator then takes into consideration the comments and feedback. The lessons learnt are then used to further identify improvements required and shared with other Module Coordinators, as a form of establishing best practice. The improvements identified will then progress back to Stage 1.

3 Outcomes

3.1 Overview

In this section, examples from developed modules are presented. This also includes a summary of students' feedback from the evaluation survey activity described in Stage 4 of Section 2.2.

3.2 Examples of Developed Modules

3.2.1 Lecture Delivery

The lecture materials are delivered in audio and/or visually recorded formats, such as via interactive lecture materials, video podcast (Vodcast) or PowerPoint slides with audio podcast. An example of each of these employed techniques is shown in Figures 3, 4 and 5, respectively.

For the example of interactive lecture materials, as shown in Figure 3, the lecturer records the audio of the lecture and syncs the material to the lecture material. The lecture material, which also has quizzes integrated into the learning material to highlight the important concepts for the lecture, are finally published and uploaded as SCORM content onto the VLE. The playback of the lecture material is delivered through the VLE's SCORM player, which is quite similar to a video recording except the delivery only consists of the lecturer's audio recording and the lecture slides.

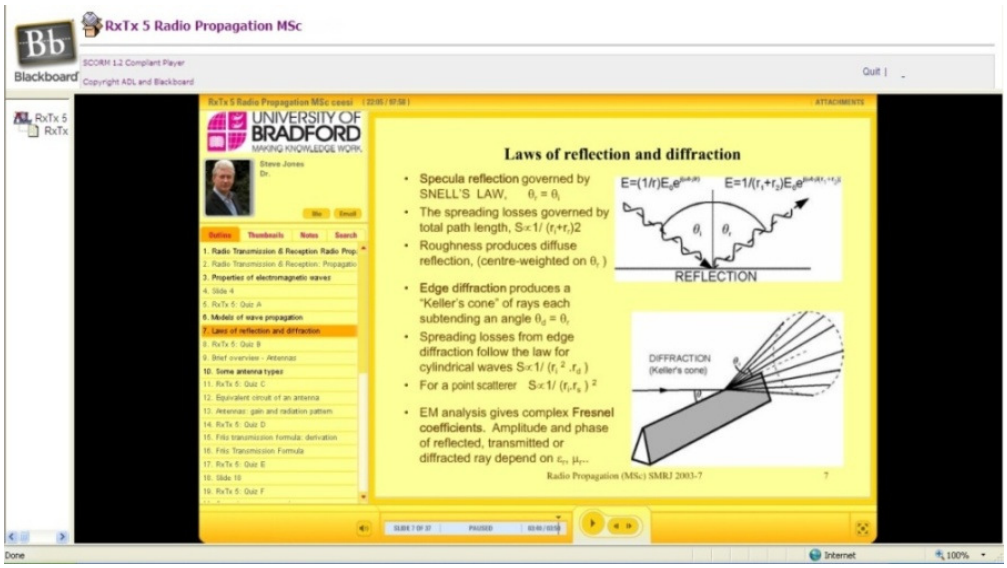

Figure 3: Interactive Lecture Material

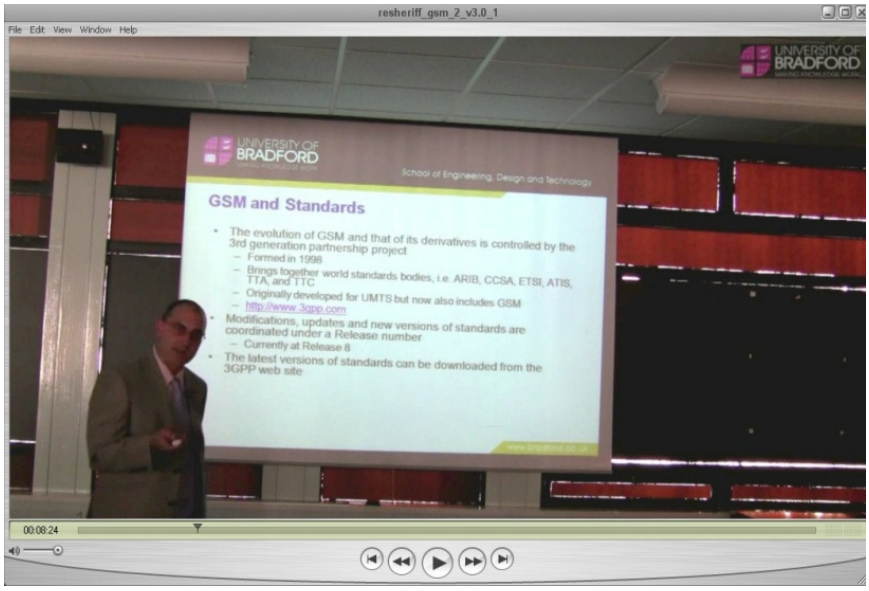

Figure 4: Video Podcast

With the popularity of portable media devices, such as IPod, iTouch and MP3 players, the use of vodcast and podcast have been introduced in some modules. An example of a vodcast is shown in Figure 4, whereby a lecture has been recorded and delivered in a format that can be uploaded onto the VLE. Students then can select to play the vodcast on-demand or download it. The downloaded vodcast can then be stored in their portable devices and played at a convenient time, for example, while travelling.

An example of an audio podcast is shown in Figure 5, whereby the subject lecturer has recorded the audio of the lecture delivered on campus. Similar to the vodcast, the audio file is stored on the VLE and students can play back the audio on-demand through the VLE or download and store it on their mobile device for playing back at a later time. The visual aids, i.e. the lecture slides, are also available on the VLE so that students could refer to these while listening to the audio podcast.

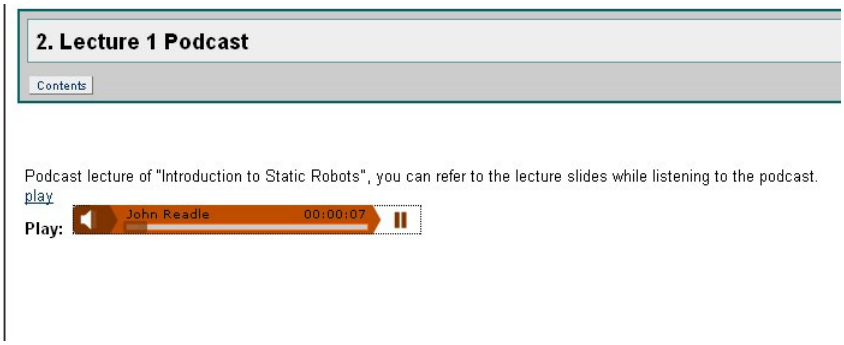

Figure 5: Audio Podcast

3.2.2 Tutorial Delivery

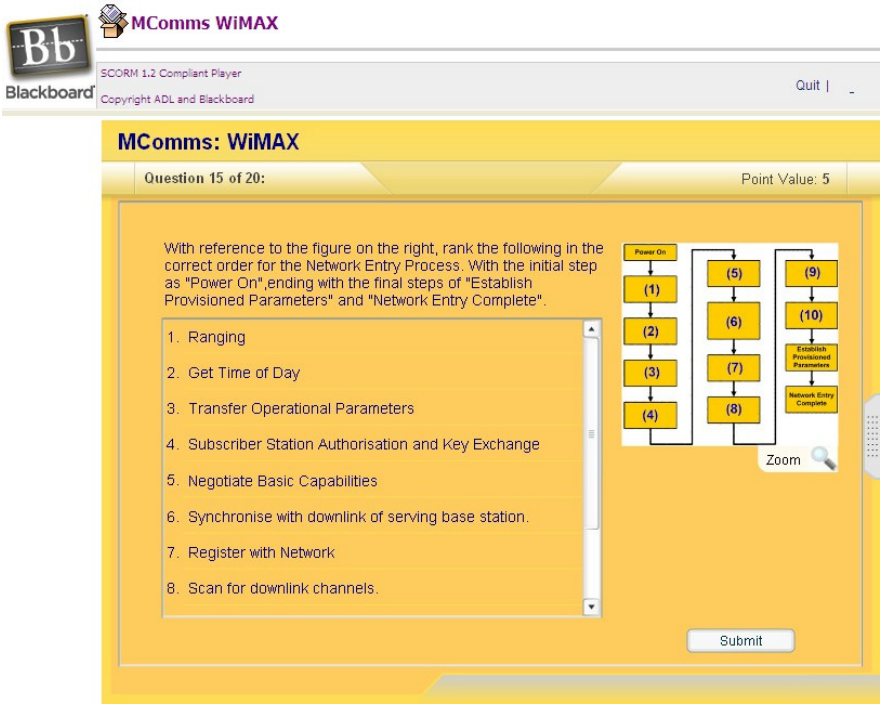

Figure 6: MCQ-based Tutorials

Tutorials are delivered mostly based on two formats: Multiple Choice Questions (MCQs) and long-questions.

The MCQ-based approach, as shown in Figure 6, aims to provide immediate feedback to students concerning their answers to tutorial questions. The model answer for a particular tutorial is provided to students once they have completed and submitted their responses. A

student's grades and answers of their latest attempt are stored in the VLE's gradebook, whereby the lecturer can review the student's progress.

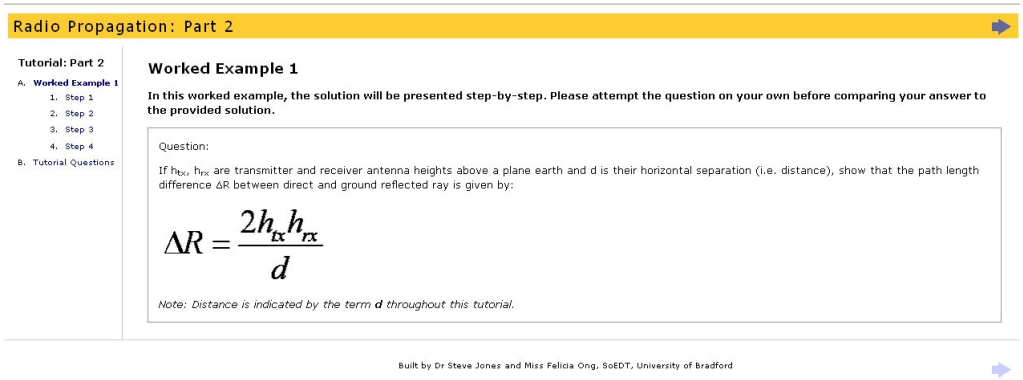

Figure 7: Long-Question based Tutorial (Question)

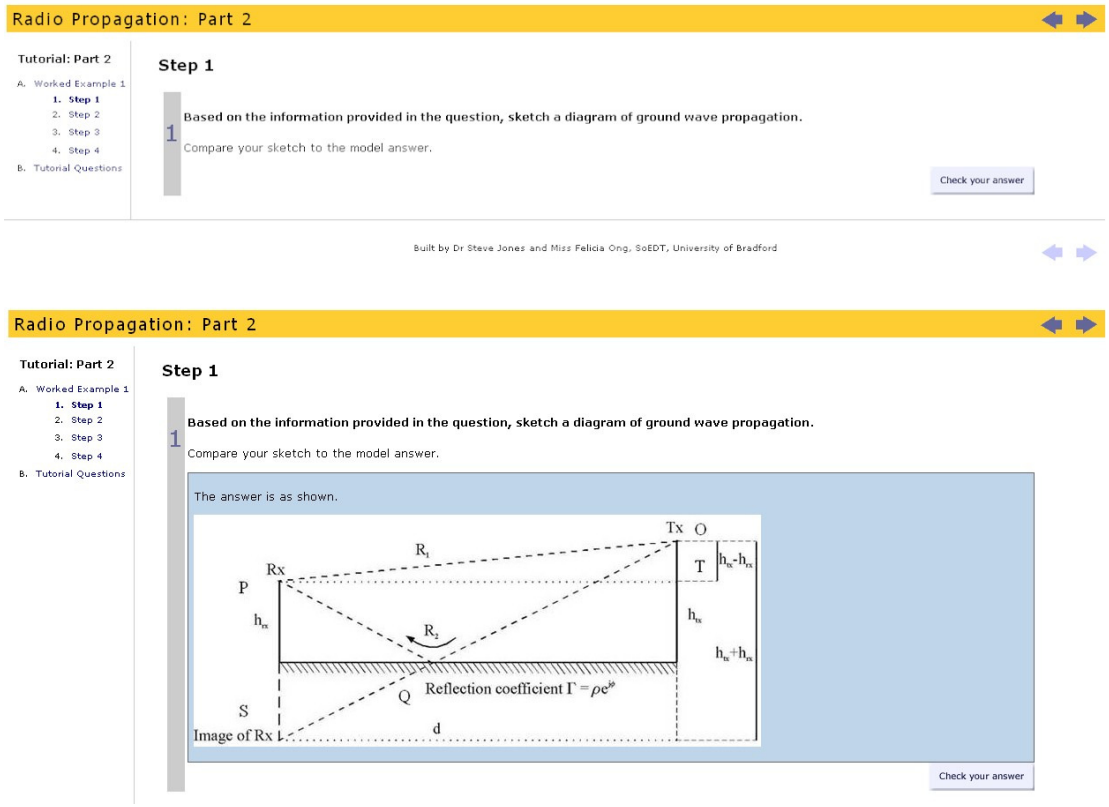

Figure 8: Long-Question based Tutorial (Answer)

The other format is a long-questioned-based tutorial, whereby students can compare their solution with the model answer. For this tutorial, some lecturers use the approach of guiding the student gradually through the solution, as shown in Figures 7 and 8, by adopting a step-by-step question and answer, instead of providing the complete model solution to the question all at once.

3.3 Evaluation Survey

The students' feedback of the TEL materials is obtained through a non-compulsory on-line survey. Also, course statistics of the materials are recorded by the VLE and are available to be reviewed by the subject lecturers. It was noted that students were not keen on voluntarily filling in the feedback survey. Those students that did provide feedback were positive with regards to the TEL materials, with feedback such as "finding the TEL materials useful" and "fun and easy to grasp". Moreover, based on the survey, most students required about an

hour or more to complete the technology-enhanced tutorials, although clearly this depends on the structure and content of the tutorial. An example of the survey is shown in Figure 9.

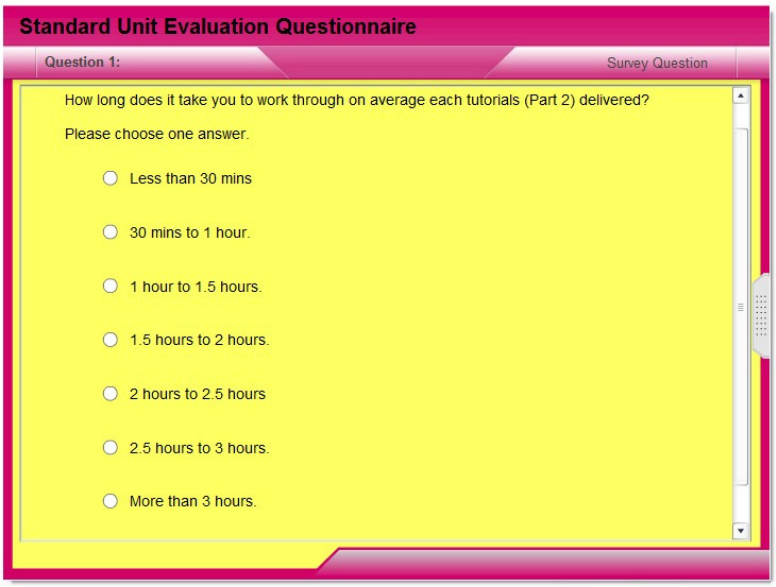

Figure 9: Evaluation Survey Example

4 Conclusion

In this paper, the PDCA cycle was used as a basis for the Bradford methodology, which was adopted as the approach for developing e-learning modules. Samples of the materials developed have been described and showcased. In the case study, it was observed that students find the learning aids useful, beneficial and were open to using technologies in their studies. However, there is room for improvement and it can be seen that for future work there are opportunities to expand the approach by integrating other technologies to enhance the students' learning. For example, the adoption of m-learning together with e-learning and adopting the trend of open shared access learning could further aid in enhancing the student's learning experience.

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