AN EVALUATION OF ELECTRONIC PRODUCT DESIGN EDUCATION USING HYPERMEDIA-RESOURCED LEARNING ENVIRONMENTS

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ABSTRACT

The work outlined here provides a comprehensive report and formative observations of the development and implementation of hypermedia resources for learning and teaching used in conjunction with a managed learning environment (MLE). These resources are used to enhance teaching and learning of an electronics module in product design at final year undergraduate level in Loughborough University. This research has taken place over a two year period when such resources were developed and implemented. Such hypermedia-based learning resources were developed by the author and include text, graphical, video and sound based media.

The managed learning environment referred to in this paper as 'Learn' is a university wide file-server system which is used to facilitate distance learning as well as provide support to many aspects of teaching, learning and assessment at Loughborough University. The work reported here focusses on the use of the MLE in support of face to face learning as this module is not undertaken on a distance learning basis. The author has uploaded all relevant teaching and learning resources onto the MLE for accessibility by the students on this module. Moreover, internet-based learning resources and assessments, in the form of pre-written computer programs and circuit building projects, were developed by the author, to enable the students to gauge their knowledge and understanding at staged points through the tutorial and laboratory sessions within the module.

In addition, this paper presents through case study, the way in which this module is delivered and received, illustrating how such resources are used by both teacher and learner. As such this proves as , an exemplar for effective deployment of such supportive technologies and resources in learning, teaching and assessment of a product design and technology module at undergraduate level.

Keywords: Hypermedia-based learning resources, electronic product design

INTRODUCTION

The aim of the work reported here is to provide an evaluation of the observed outcomes of the development and implementation of a managed learning environment (MLE). It was used in conjunction with hypermedia-based learning resources for the delivery of a microcontroller interfacing module in the final year of an undergraduate industrial design and technology course. The objective is to find out how this can be used to enhance the learning and teaching experience of the students. This was conducted through discussions with students, feedback through assessment, and course evaluation. Such outcomes enabled the module development team to expand the scope of the module content to encompass more advanced applications of microcontroller interfacing and control. The MLE was developed to supplement and enhance the existing learning and teaching experience and not merely replace lectures, tutorials and laboratories. Students could elect not to use the managed learning environment

and still participate in learning, as paper-based handouts and resources were also given to the students.

1. Managed Learning and Web-based Instruction

Managed learning environments implemented using hypermedia and instructional-based systems have been developed and used extensively in support of modules and courses in higher education [1]. Web-based instruction (WBI) is broadly defined as: "...a hypermedia-based instructional program which utilises the attributes and resources of the world-wide-web to create a meaningful learning environment where learning is fostered and supported.". A more acute definition of web-based instruction is: "...the application of a repertoire of cognitively oriented instructional strategies within a constructivist and collaborative learning environment, utilising the attributes and resources of the world wide web" [2].

Web-based instruction, also referred to as web-based training, is defined [3] as: "Individualised instruction delivered over public or private computer networks and displayed by a Web browser. Web-based training is not downloaded computer-based training, but rather on-demand training stored in a server and accessed across a network. Web-based training can be updated very rapidly, and access to training can be controlled by the training provider. Consequently, in design education, there has been significant development of instructional based teaching and learning technologies for the delivery of distance learning courses specifically in computer-aided design and manufacturing [4]. The managed learning resources as described and implemented in this work have been designed in accordance with effective teaching and learning practice [5]. Furthermore, much of the development and testing of such resources have been aligned with current research aimed at the evaluation of learning technologies for the support of distance learning. Furthermore, it is predicted that: the potential benefit from formulating evaluation methodologies for the Web (for instructional materials) depends on whether the Web will become a permanent medium or a passing fad? In fact, the "Web will likely to become a most popular medium soon for the delivery of distance education type materials." [6]. Such literature supports the assertion that web-based instruction is a growing trend. In addition, it indicates that a critical factor to the success of web-based instruction is the incorporation of usability design into the development process. The design issues gleaned from related literature include: transfer of existing course material, as is, to WBI, without considering using the medium's capabilities such as graphics or communications, like listservers. Ignoring the forms and styles required by the medium, such as using the structure of a traditional lecture course, as the structure for a WBI course and use of existing course material, while ignoring features without restructuring existing material to fit the features, can affect student learning. Moreover, research into evaluation of such implementations has focussed on the development of methodologies for evaluation rather than the processes and techniques for the evaluation of such learning technologies from a user perspective. The Managed Learning Environment utilises hypermedia-based instructional resources along with self-assessment tutorials. It was designed initially to facilitate blended learning and it supports face-to-face teaching and provide learning resources that were accessible without the time tabled teaching sessions.

2. Learning Resources Used In This Study

The learning resources used in this work comprised tutor-generated resources, student generated resources and a strategy for assessment. The tutor-generated resources consisted of lecture notes with corresponding slideshows,

supplementary notes, simulations, video-based media, links to relevant websites and scanned versions of articles (with copyright permission). Such student-generated resources comprised: electronic schematic designs, assembly code programs, analysis of circuit function and detailed explanation of microcontroller program execution.

There were two groups of students in this study named cohort 03 and cohort 04. Cohort 03 undertook this module in 2003 and cohort 04 did so in 2004. Both groups experienced the learning and teaching resources and assessments through the use of the managed learning environment, with the exception that the tutor initially gave cohort 3 tasks to write the microcontroller programs from printed handouts. This proved to be unproductive and inefficient as the students in the main, had no prior experience of computer programming. The tutor therefore issued prewritten programs along with circuit construction exercises 'reverse engineering' of existing programs in order to overcome this hindrance to learning. Therefore cohort 04 did not have this experience of attempting to write such programs from printed handout.

2.1 The Managed Learning Environment (MLE) learn@lboro

The MLE is a virtual space where learning, assessment and interaction can take place in a structured and managed way fully integrated into and linking university wide information systems. It provides student-level information comprising university-wide information on university procedures and regulations and support services. More importantly the MLE provides links to modules, tutors, lecture materials and course related news alerts. Course and module information is provided through portal news and bulletins. Each module has its own dedicated website which is structured such that staff can: provide news; create, upload & link to teaching materials; host on-line discussions; set and receive assignments; upload reading lists; obtain class lists and organise as well as set online group work. The MLE provides a mechanism toward joined up systems or systems integration by creating links *"seamlessly"* to other systems such as web servers (departmental and central), 'Learn' and the university library resources system.

2.2 The Hypermedia-Based Tutorials & Self Assessment Laboratories

The hypermedia-based tutorials accessible from the MLE provide a valuable learning resource in as much as they clearly provide instruction to the student in the use of the PIC programming environment MPLab® IDE. The class learning time was divided between a lecture and laboratory upon the use of the tutorials in the design of microcontroller programs and subsequent circuit interfacing exercises. The students were given lectures on the architecture of the microcontroller device. They were taught programming techniques and formal methods for representation of such code.These hypermedia-based tutorials enabled students to draw upon the theoretical foundations in microcontroller interfacing and logic representation that the students follow, and refer to the tutorial instructions whilst using the package.Figure 1 illustrates a screen shot of the index to managed learning resources on microcontroller interfacing. As can be seen from Figure 1, the resources are shown in terms of lecture notes, lecture slideshows, laboratories, tutorials and downloadable learning resources. The students are also provided with paper-based lecture notes and MPLab® IDE tutorials for this module. The laboratories and downloadable resources are solely accessible from the MLE. The emphasis here is to enable the use of the MLE as much as possible in the delivery of this module. The self-assessment laboratories, developed by the author, provided the students with the ability of performing a series

of staged checks within the teaching and learning of microcontroller interfacing. This enabled the students to assess themselves the theoretical background of the subject. These self-assessment tutorials were essentially a series of self-assessment tutorials and circuit construction exercises that were accessible from the MLE. From week seven onwards, the students were grouped into pairs and worked on a design project which required designing and making a small two wheeled buggy to follow a black line on a white background. This required designing electronic interfacing for light detection inputs and motor control and speed outputs from the microcontroller. The design project emphasised the approach of learning technology through designing, which is an vital aspect of this work.

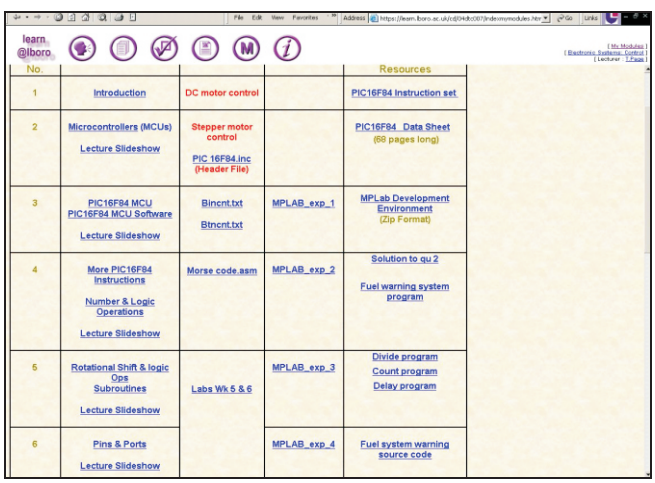

Figure 1:Sample Screen shot from Managed Learning Environment

Through repeated circuit construction exercises with prewritten PIC programs, of which there are approximately thirty, the students readily learn the semantics of programming at assembly (low) level. It is therefore asserted by the author, that by learning programming at assembly language level, the student can extrapolate such skills more easily at higher-level, such as in using other languages for example C or C++. In essence, it is learning by doing tasks and undertaking such tasks repetitively [7].

3. Discussion Of Observations

Through observation and module evaluation, it was found that these resources enabled students to work at their own pace through such tutorials without the fear that they may be falling behind the scheduled milestones and learning outcomes each week within the module. This provided for differences in learning rates and styles among the group of students. The design project played a significant role in putting into practice what had been learned in the laboratories using the circuit construction exercises. This approach enables the students to manage their learning in an organised and structured manner, the hypermedia-based approach tends to appeal the students, as they have become quite accustomed with using the internet as a research and learning resource.

The managed learning environment contains all the lecture slides and notes for the students to relate the theoretical foundations of microcontroller interfacing with the pragmatic emphasis of digital and analogue circuit design and construction. It was also found that students tended to explore the subject further than was done before the implementation of this approach to teaching and learning. There have been advantages in utilising these approaches to the delivery of this module.

Evaluation of this module was undertaken by administering a questionnaire to both year groups. This questionnaire sought to elicit learners' views and responses with regard to a number of issues relating to the use of the 'Learn' server, the approach to teaching and learning on this module and the quality as well as the quantity of work required in the module. The questionnaire provided a five-point Likert scale of responses ranging from 'strongly agree' to 'strongly disagree' statements. Tables 1 and 2 show the responses to these questions. The following questions were answered by students at the end of the module:

1 Do you believe that the quantity of work was within your capabilities?

2 Do you believe that the quality of work was within your capabilities?

3 Were the learning resources appropriate in fulfilling your approach of learning on this module?

4 Was the approach of 'reverse engineering' of existing programs found to be a more productive way of learning programming than inputting instructions by typing?

5 Did the delivery of this module encourage independent learning (albeit much of the assessment was done in groups of two)?.

6 Were the laboratories are within (or properly stretched) your capabilities?

Question Numbers

Cohort 03	1	2	3	4	5	6
Strongly Agree	-	-	2	5	-	-
Agree	4	8	5	3	8	7
Neutral	3	3	3	3	3	4
Disagree	4	-	1	-	-	-
Strongly Disagree	-	-	-	-	-	-

Table 1: Questionnaire responses (cohort 03 n=11)

Question Numbers

Cohort 04	1	2	3	4	5	6
Strongly Agree	1	2	2	2	2	3
Agree	11	12	4	7	11	11
Neutral	-	-	8	3	1	-
Disagree	2	-	-	2	-	-
Strongly Disagree	-	-	-	-	-	-

Table 2: Questionnaire responses (cohort 04 n=14)

As can be seen by comparing responses in Tables 1 and 2, it is evident that for questions 1, 2, 5 and 6, there is a notable shift in responses towards 'agree' and 'strongly agree'. Nevertheless, for question 1, two respondent's in cohort 04 disagreed that the quantity of work was within their capability. Similarly, two respondents from cohort 04 disagreed with the statement that 'reverse engineering' of existing programs proved to be more productive than inputting programs by typing.

The reason for this is that in cohort 3, the students were initially directed to learn programming by typing instructions into the text editor which proved to be very time consuming, prone to errors and non-productive. The method of 'reverse engineering' was deployed to overcome such drawbacks and as such, cohort 04 learned programming using reverse engineering without inputting instructions in the editor. It is of interest to note that for question 3, eight respondents in cohort 04 provided a neutral response. Possibly for this question they could neither agree nor disagree with their responses.

The self-assessment problems enabled students to find their own level of skill and efficiency in undertaking the learning tasks. Nevertheless, there were some problems encountered in issuing assignment-based problems too early during the module. For example, many students attempted the assignment before completing the electronics laboratories and circuit construction exercises.

Conclusion

This case study provided an insight into the observed outcomes of using a managed learning environment in tandem with using hypermedia-based learning resources for the delivery of a microcontroller interfacing material in a final year module of an Industrial Design and Technology undergraduate degree course. A series of assessment tutorials, accessible from the managed learning environment, provided the students with self-assessment of the theoretical and practical foundations of computer and microcontroller device interfacing. The observations were made with respect to how things were done before and comparing this to what is being done now. Through discussions with students, feedback through assessment, and course evaluation, such comparative observations led the course development to expand the scope of this module in order to provide for focus in more varied aspects of interfacing i.e. through visual display and interaction devices such as keypads and other human interfaces.

It has been found, since its introduction, the MLE has been greatly appreciated and widely used by students in general. It almost seems that when given a task their first point of reference is the internet and by utilising the MLE in the teaching of this module it has become proven and useful tool for the teacher and student alike.

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