Supporting Distance and Flexible Education
Challenges in the Design and Development of Online Learning Resources

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Abstract: In This Study, the Challenges in the Design, Development and Implementation of Online Learning Resources to Support a First Year Distance/Flexible Education Students for Their Final Assessment in an a Computer Aided Engineering Design (CAD) Class Have Been Considered. since a Majority of the Flexible/Distance Learning Students Are Active Workers (Mature Students Involved in Different Industrial Sectors) They Want to Gain the Appropriate Skills and Practical Knowledge They Need for Their Careers. It Is Quite Evident That the Provided Resources Should Meet Student Expectations and Improve Their Academic, Transferable and Employability Skills. in This Regard, the Learning Resources Should Be Developed Considering the Actual Challenges in Delivering a Good Engineering Education, Unit Specification and Students Difficulties (Identified through the Received Feedback) in following and Fully Understanding Some of the Guided Reading. Questions regarding the Level at Which the Mathematical Theory Should Be Taught in the Class, as Well as the Amount of Engineering Knowledge the Students Should Gain, Should Be Considered. the Use of CAD Simulation Software - Very Effective in Delivering Technical Subjects and Self-Directed Learning - Should Be Considered for Improving Student's Computer Knowledge and Abilities They Should Develop along the Learning Process. the Study Illustrates the Challenges in the Design and Development of Engineering Learning Resources - Complex Engineering Problems Which Would Traditionally Involve a Classical Form of Instruction - Generated as Electronic Documents outside the Traditional Learning Environment. the Study Presents Learning Strategies and Shows That Computer Simulations and Visualization Represents Powerful Tools in Self-Directed Learning. to Validate the Findings, an Evaluation Procedure Was Considered.

1 INTRODUCTION

The actual advance of learning environments, due to the technology integration into classroom and advance into teaching methods enhance student learning and equip them with the essential skills needed in the actual society. As mentioned in Guzdial and Soloway, 2002, regarding the advance in teaching methods and IT technology, integrating students in an advanced technological environment while providing the necessary abilities and skills makes them more adaptable and successful professionals. Specific IT technology - hardware and software based - have been developed in this regard for the improvement of the mentioned cognitive skills (Hassan, 2000; Tan and Thoen, 2000). As stated in Sankar *et al*. 2008, Raju and Sankar, 1999, and Mbarika *et al*., (2001), instructional materials such as audio and video are considered to be valuable tools in dealing with complex engineering problems.

Learning integration with hypertext (Spiro and Jehng, 1990) have been considered very prolific in in problem-solving skills, while the development of multimedia studies provide distance and flexible education students with "anchors" which support active learning (Bransford et al., 1990). In as study performed by Oliver and Omari, 1999, about the delivery of online 'teaching', it was considered that this environment better supported active learning activities when comparing with the classical printed materials.

As mentioned in Goodhew, 2012, teaching engineering in Distance and Flexible Education add new challenges to the tutors. As summarised in Goodhew, 2012, technology sustained learning, team working, and quantitative treatment of the topics represents essential key factor in delivering

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‘good engineering teaching’, that is, the use of engineering simulations software boost engineering teaching (Ibrahim, 2011). Moreover, well designed engineering materials (Raju and Sankar, 1999; Kulik et al., 1984) supports students learning while providing good opportunities to review the teaching material and assess student’s competence and knowledge. In addition, it provides an insight into tutor expectations and allows students to prepare for their assessments/examinations (Snooks, 2004). It was also shown that their use represents a key element in delivering ‘good teaching’ due to the improved student’s performance (Sankar and Clayton, 2010; Snooks, 2004).

Located in the South of UK, Bournemouth University (BU) recruits students worldwide which increase the need for the use of the e-learning environments. One of the last approaches in the School of Design, Engineering and Computing regards the development and delivery of a flexible learning Engineering Education programme. This flexible delivery approach actively pursued by the Faculty of Design and Technology, shows Bournemouth University dedication to increase focus on diversity, to actively consider the role of distance and flexible learning (Crede and Borrego, 2012; Madden et al., 2013; Porter et al., 2014). As mentioned in Weller, 2002, providing support (developing effective learning environments) to the flexible and distance education students is essential for their success. As part of the Engineering Education programme, a Computer Aid Design module is delivered to a cohort of approximately 20-30 students which are active industry workers and want to maximize the course related knowledge and to obtain skills that are most practical and useful to what they are doing on a daily basis.

To answer the student’s needs and to facilitate an effective flexible learning environment, new learning resources have been designed, developed and implemented as online materials for the Computer Aid engineering Design (CAD) module. The developed learning resources (containing computer simulations and analysis) which responds student’s difficulties in following and fully understanding some of the guided reading while preparing for their examinations (Macdonald et al., 2002), represents a key strategy of enhancing student’s creative thinking and learning (Sankar et al., 2008). Due to the importance of the new created resources in supporting students learning different strategies have been considered and used in their design. Questions regarding the amount of mathematical and engineering knowledge the students should gain as well as the effectiveness of computer programming have been considered. To validate the findings and obtain a comprehensive picture of the learning resources efficiency and effectiveness, an evaluation procedure has been considered.

2 THE DESIGN AND DEVELOPMENT PROCESS OF LEARNING RESOURCES

The content of the learning resources should be designed following the unit specification and its educational objectives (UKPSF policy – “Design and plan learning activities and/or programmes of study”[UKPSF]). The resources should consider the actual challenges in delivering a good engineering education (Feisal and Rosa, 2005) and provide a good understanding (critical reading, thinking and evaluation) of the design limitations as well as the knowledge level/threshold the students should gain. The resources should consider the analysis and interpretation of engineering data and results, while reflecting at the mathematical theory behind. Moreover, the analysis should be performed using a user friendly CAD system which would allow improvement of their computer knowledge.

Due to the agenda of flexible/distance education students - usually mature students actively involved to different industrial sectors – which want to gain skills and knowledge that is most practical for their careers (motivation to learn), it is evident that the learning resources should be designed to meet their expectations through developing theirs academic, transferable and employability skills. The learning resources content should relate to real-world problems by identifying, analysing and discussing criteria for solving non-conformal engineering problems in unstructured situations, therefore motivating student’s active learning. As mentioned by P.K. Raju, a Thomas Walter Professor at Auburn University, “Some students learn textually, that is, they literally have to have the words in front of them to understand engineering concepts. Others are very visual in their approach to learning, and have to have some degree of visual simulation in order to understand the material.” [ISSUU Fall Magazine] . An extended analysis of different learning styles (visual, sensitive, intuitive, verbal, active, reflective, sequential, global) and design of learning activities is highlighted in Ferrer and Kirschning, 2014.

The effectiveness of the learning resources highlighted by the use of analytical and computer programming (Kattan, 2008; Hahn, 2009) and visual techniques (Kurowski, 2014; Huei-Huang Lee, 2014) includes (UKPSF policy – "Develop effective learning environments and approaches to student support and guidance"[UKPSF]):

i) analytical example(s) which explain and relates analytical engineering to the mathematical theory behind (identify criteria to solve problems)

ii) computational resources used as a pattern in solving similar problems (analyse alternatives – unstructured situations) and to enhance students interests

iii) Solidworks/Autodesk Inventor tutorial(s) as a visual formative resource (motivate students) to enhance understanding, and improve students skills and knowledge.

3 STRATEGIES USED IN THE DESIGN OF THE LEARNING RESOURCES

Due to the importance of the learning materials/resources in: (i) supporting students learning performance/satisfaction, (ii) providing an insight into tutor/students expectations, (iii) providing helpful materials for the students to prepare for their assessments/examinations, and (iv) providing opportunities to review the teaching material, the next principles/strategies (Sankar and Clayton, 2010; Sankar, Varma and Raju, 2008) have been considered for their development in a *Student – Tutor* relation:

A: STUDENT - *Dissemination and Use*

A1. *Critical Reading* – Clear tutor expectation regarding the careful reading of the technical resources in order to analyse, reflect and discuss finding with tutor and colleagues (students should be directed to discuss the findings using the myBU forum provided by Bournemouth University)

A2. *Self-directed Learning* - Provide opportunities for different students to modify and adapt the provided learning resources and to share the obtained results with the tutor and colleagues (using the provided myBU forum)

A3. *Self-evaluation and Feedback* – The students should be encouraged to use the BU forum to communicate with each other and with the tutor. In addition, students could be asked to record their progress - reading and evaluation - on the self-directed learning.

A4: *Individual and Team Works* - Encourage the students to work both individual and in teams (to enables students brainstorming and teamwork strategies) based on their interaction through myBU forum, etc. Tutor guiding should be used to help group interaction.

All the mentioned resources dissemination and use (A1 to A4) include the use of the myBU forum which should "provide a sense of community with constructive feedback", that is, an important aspect in increasing students satisfaction (Boling *et al*., 2012).

B: TUTOR - *Design, Development and Implementation*

B1. *Partnership* – Due to the educational importance of the learning resources, it is quite essential for the Design, Engineering and Computing faculty members to get involved in this development (development of learning materials). Moreover, it may be beneficial to develop resources in partnership with professional from industry.

B2. *Quality* – Enhance the quality of the provided resources by reviewing them with professional from industry, testing them (if possible) in an engineering environment, and eventually publishing them in engineering education journals and/or conferences.

B3. *Competency* – Great competency of the learning resources can be achieved by sharing with industry professionals/students before using them in flexible or distance learning (feedback expected).

B4. *Organisation/Storage* – Organize and store the learning resources in such why (electronic repository) so it can be easily retrieve by students/tutors based on different/combined search criteria such as index, topic, discipline, field of application, etc.

4 EVALUATION OF THE LEARNING RESOURCES

In order to obtain a good idea about the effectiveness of the developed learning resources as well as the effort put by the students in the learning processes (Spiro and Nix, 1990; Sankar and Clayton, 2010; Sankar et al., 2008), two evaluation forms have been developed/considered (UKPSF policy – "Assess and give feedback to learners"[UKPSF]). The first evaluation form is using the descriptors, (i) the clarity of the developed case studies, (ii) the study relevance, (iii) the amount of time spent (individually or group working), and (iv) instructionally helpfulness. The clarity, relevance, helpfulness and time descriptors are considered on a 4-point scale, from unclear to clear, irrelevant to relevant, not helpful to helpful and short period to long period of time respectively, as below (Table 1).

Table 1: A 4-point continuum scale form for evaluation of student learning.

	1	2	3	4
Clarity of the developed resources	← Unclear		Clear →	
Relevance of the developed resources	← Irrelevant		Relevant →	
Amount of time spent on the developed case studies	← Short		Long →	
Instruction helpfulness of the developed case studies	← Not helpful		Helpful →	

The second evaluation form shown in Table 2 present questions such as “I developed my CAD skills” or I’m confident to use stress and strain analysis to design engineering systems” on a 4-point Likert scale[LITEE]. The scale has a rating from 1 to 4 which represents answers starting from not favourable or “Strongly Disagree” response, to answers representing the very favourable of “Strongly Agree” response.

Table 2: A 4-point Likert scale form for evaluation of student learning.

	← Disagree		Agree →	
	1	2	3	4
I improved my capacity to appraise stress and strain				
I developed my CAD skills				
I’m confident to use stress and strain				
I understand meshing process				

In addition, the students may be asked to answer some questions (Sankar and Clayton, 2010; Sankar et al., 2008) regarding learning resources strengths and weaknesses, and to suggest other specific descriptors/constructors, which will make data analysis manageable and meaningful (UKPSF policy – “Develop approaches to student support and guidance”[UKPSF]). Finally, a statistical evaluation should be performed on the student’s feedback, to obtain o clear perspective of how the learning resources affected students learning, and to convey new possible developments which will further assist the new generations of flexible/distance education students.

5 TUTOR AND TECHNOLOGY ROLE IN THE DEVELOPMENT OF LEARNING RESOURCES

It is easy to see how the teacher’s role, in the development process of the learning resources, becomes that of a facilitator[ISSUU Fall Magazine] directing students through the developed materials: the clearer the provided resources (tutorials, media, case studies, etc.) are to the students the better the chances are that the student’s expectations will be met (learning and examinations). Moreover, the use of computer programming in the development of the learning resources should enhances students learning experience (Gibbons and Fairweather, 1998).

Computer programming (Ibrahim, 2011; Tiernan, 2010) plays an important role in engineering education by developing student’s skills while stimulating “their interest and enthusiasm”, that is, a key factors for a good education. Running and understanding the provided programs/resources and eventually using them as patterns in solving similar problem represent another guarantee that different learning styles are addressed.

Especially in engineering education, computer simulation has been shown to be very effective in delivering technical subjects and to respond to the student’s needs (due to a series of technical characteristics such as visualization and simulation tools). As mentioned in Bradley *et al*., 2007, and Mbarika *et al*., 2001, an excellent pedagogical method for the delivery of engineering concepts in the field of ITC and engineering is given through the use of instructional materials which involve simulations, materials which provide a valuable interactive experience for students (Sankar and Clayton, 2010). It is to be mentioned that all the consideration above are in direct agreement with the UKPSF policy regarding the “use and value of appropriate learning technologies”[UKPSF] while “engaging” and “incorporating the research, scholarship and the evaluation of professional practices”[UKPSF] in the teaching disciplines.

6 CONCLUSIONS

The challenges in the design and development of online learning resources for answering student’s needs and for facilitating an effective distance learning environment have been considered in this study. The created learning resources (computer simulations, analytical and numerical solutions, tutorials, etc.) - which present themes related to engineering - respond student's difficulties in following and fully understanding some of the guided reading.

Due to the importance of the learning resources in delivering and supporting students learning, different strategies have been considered for their design. Questions regarding the amount of mathematical and engineering knowledge the students should gain, the effectiveness of computer programming resources, and improvement of their transferable skills (such as critical reading, thinking and evaluation) and abilities they should develop, have been considered.

It was concluded that the use of learning resources containing simulations and visualization, as well as multimedia materials, can be successful applied outside the traditional learning environment. Considering student's feedback, an evaluation procedure has been presented for a clear view of the efficiency/effectiveness of the generated resources.

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