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Online Resource Platform for Mathematics Education

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Introduction

The aim of this project was to develop and explore the use of a Shareable Content Object Reference Model (SCORM) integrating a web-based platform for the study of mathematics as part of an active learning environment. The platform was designed to provide active support to engineering students especially those in their first year of study. Early use of the platform can identify possible areas of weakness and provide the self-learning environment required for students to become more proficient in areas where they are lacking key skills or are finding concepts difficult to understand.

The platform consists of a set of tests and applications for the study of engineering mathematics. The tests can adapt and change depending on the answers provided by the student, including video feedback for incorrect answers before the student progresses to the next question. Based on the idea that teaching a concept is the best way to learn that concept, the students become actively involved in the platform as they create the videos that provide feedback to the other users of the platform. This active learning, constructivist approach provides an environment of achievement and ownership that allows students of all levels to enjoy the learning experience.

"*Tell me and I forget, teach me and I may remember, involve me and I learn*"
Benjamin Franklin

Rationale for Project

European Context:

- European Higher Education Area (EHEA)[1]: Encourages the development of new competencies and skills through active learning methodologies.
- Bologna Process (1999): Fosters student-centred learning, innovative teaching methods and supportive learning environment.

Irish Context:

- National Strategy for Higher Education to 2030 (DES 2011)
  - Emphasises the need for teachers in higher education to… '*stimulate active, not passive learning*'
  - It points to the need to… '*create a process of active learning by posing problems, challenging student answers, and encouraging students to apply the information and concepts*'

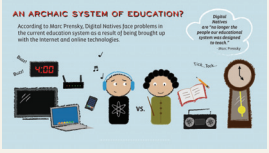
DIT Context:

- College of Engineering and Built Environment (DIT 2011)
  - Response to DIT Strategy on Student Engagement.
    - Use modern technology to support student learning.
    - Increase diversity of learning experience.

[1] European Higher Education Authority: http://www.ehea.info/

Background

- Traditional hierarchical approach to learning is no longer suitable to meet the changing needs and expectations of the student.
- Communication methods are influenced by advances in technology.
  - Students: Have different learning and communication styles.
  - Lecturer: Must communicate with a similar set of tools.



Source: http://www.educatorstechnology.com/2014/05/mobile-learning-explained-visually.html

- A deeper learning experience is stimulated through a pedagogical shift…

passive learning ⇨ ***active*** learning

Source: http://www.educatorstechnology.com/2014/05/awesome-new-flipped-learning-graphic.html

- Role of active learning:
  - Shifts the focus from content delivery by the lecturer to active engagement of the material by the student.
  - A principle aim of active learning is to… '*Maintain and encourage students; motivation to learn, to inspire confidence and make them ambitious during their studies*' [McCabe and O'Connor 2014]
  - Key elements of the active learning approach:
    - Active responsibility for learning on the students' part,
    - Proactive management of the learning experience,
    - Independent knowledge construction, and
    - Lecturers as facilitators.

[Anderson et al. 2005]

Methodology

The approach taken for this project follows the design-based approach described by Reeves (Reeves et al. 2004) and is illustrated in Figure 1.

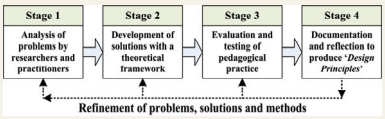


Figure 1: Design based research stages

- **Stage 1:** Core mathematical concepts which are proving difficult to understand are initially identified using either a standard Math's Diagnostic Test (MDT) or through a student survey.
- **Stage 2:** A set of online resources consisting of quizzes created by the lecturer and feedback videos created by the student are developed. The feedback videos allow students to synthesise and disseminate knowledge from various sources.
- **Stage 3:** Evaluation of students performance is carried out using the online quizzes. Students are encouraged to give feedback and demonstrate active performance.
- **Stage 4:** Outputs in the form of knowledge (i.e. student learning) and products (i.e. quizzes and videos). Feedback is obtained from students through surveys and focus groups.

Implementation

Phase 1: Student as co-creators

- Solutions to mathematical problems are recorded as videos.
- Consequently students determine their own learning by exploring rather than receiving knowledge.

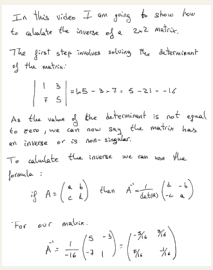


Figure 2: Extract from typical student-created script.

Figure 3: A Wacom graphics tablet[2].

Figure 4: Students use graphics tablets to write the solution which is captured as video.

Phase 2: Creating the online resource platform

- Online resources (i.e. quizzes) are created with student content (i.e. feedback videos).

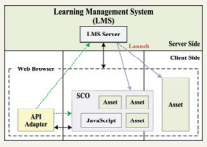


Figure 5: The SCORM run time environment[3].

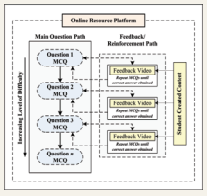


Figure 6: Main question and feedback/reinforcement paths.

Overview of how the platform works (Figures 5 & 6):

- A SCORM is a collection of technical standards for e-learning software products. It defines how the online learning content and Learning Management System (LMS) communicate with each other and is illustrated in Figure 5.
- The quizzes were created using Wondershare QuizCreator[4] which allows for the customised instant feedback created by their peers.
- The SCORM objects (SCOs) are made up of quiz questions and feedback videos which are assembled into packages.
- The LMS loads the SCOs and delivers them according to the instructions which detail the order and number of questions to be answered. This can be tailored to manage the different paths that can be taken depending on the answers provided by the student.
- Multiple choice style quiz questions (see Figure 7) are accessed in ascending order of difficulty. An incorrect answer will cause the student to be directed from the main question path (MQP) to the feedback/reinforcement path (FRP) where they may view videos created by their peers to help reinforce the concept being examined by the question.

Figure 7: A typical quiz question in webcourses

- On successful completion of a question the student is directed back to the MQP where they can proceed to the next question.

[2] Wacom Graphics Tablets: http://www.wacom.com/en/gb/
[3] Adapted from 'ADL SCORM Run-Time Environment - Overview': http://www.cen-ltso.net/main.aspx?put=242
[4] Wondershare QuizCreator: http://www.wondershare.com/pro/quizcreator.html

Selected Results

The initial mathematical capabilities of students from a level 7 common engineering programme (DT097) were measured using a standard MDT. The results (Figure 8) show a greater proportion of grades in the lower half of the range suggesting a poor grasp of key mathematical concepts.

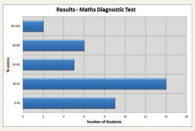
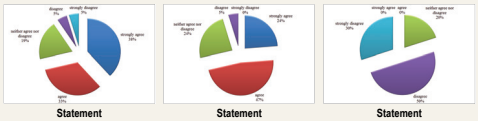


Figure 8: MDT score results



Statement *'Creating the videos was a very useful tool for learning'*

Statement *'The tutorial sessions where we create the videos were more enjoyable than the normal tutorials'*

Statement *'If you could rewrite the math's module, you would remove the video component'*

Figure 9: Selected responses to survey questions.

A sample of student responses from a survey (n = 21) are illustrated above (Figure 9). Responses are based on a 5-point Likert scale.
Additional responses (Figure 10) show a general preference for a mix of traditional and video tutorial session.

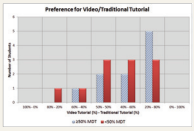


Figure 10: Tutorial type preferences.

Benefits of Intervention

Benefits of Intervention (Phase 1):

- The students' core competencies improve i.e.
  - By discussing solutions with their peers they are encouraged to think more deeply about the problem.
  - They're better equipped to succeed in their studies as a result of developing a more robust set of core mathematical skills.
- Creating the videos is typically an iterative process which serves to reinforce knowledge of the material with each iteration.
- Students are more empowered by their participation:
  - Self-determined and learner-centred learning
  - Collective and individual responsibility
  - Greater confidence and increased motivation

Benefits of Intervention (Phase 2):

- Web-based platform available to DIT students across multiple programmes and stages:
  - Encourages self-learning
  - Completed at students own pace
  - Available 24/7 from any web-enabled device

Summary & Future Work

- The platform can be prolonged over time:
  - Self-improving
  - Self-regenerating
  - Shared across programmes and stages
- Multidisciplinary opportunities to extend the project into other technical based modules.
- Expertise gained to be used to create interventions and support in areas where a lecturer may identify specific issues.

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Dissemination Outputs

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