Curriculum Design Pattern

Global Learning by Design

Name of Pattern

A game-based learning tool for structural analysis course

Date

December 2014

Abstract

This project attempted to develop a game-based teaching tool to address the issues of teaching complex concepts in structural/ civil engineering, scaffolding engineering knowledge and providing valuable feedback to large cohorts of students. A key difference in this gaming application is the embedment of a “concept inventory” approach (Venkatesan et al. 2007; Molyneaux, 2008) while retaining the popular `fun’ and `pleasure’ aspects of gaming. Instant feedback and leaderboards were provided to students. This game-based learning tool drew a higher level of engagement and encouraged autonomous learning amongst students. RMIT students were involved in the development of the game.

Learning Context

This game-based learning tool was designed to address the learning needs of first year civil engineering students. The class size is approximately 200 to 300, content predominantly delivered in face-to-face teaching mode. Students from the City Campus, Melbourne, were provided access and engaged in playing the game as part of their learning in Semester 2, 2015. This tool can also be used by TAFE students and other first year engineering programs such as Mechanical engineering and Aerospace engineering students.

Rationale/Aim

Albion and McKeown (2010) state that lecture-based teaching is largely unpopular with students leading to reduced attendance and engagement. This disinterest is even more prominent in some civil engineering courses that are ridden with complex concepts. Therefore, The aim of this pattern is to develop concepts into game-based learning tools and test their effectiveness as an alternative and engaging pedagogy to the face-to-face teaching of complex concepts in structural and civil engineering.

Learning Design

Process of activities:

Step 1

Identify a learning outcome from a course outline that is suitable for game based learning.

Step 2

Identify the concept or concepts that relate to the chosen learning outcome based on the teaching material.

Step 3

Choose a game metaphor that can simulate the learning of the concepts you have identified. A good way to check the validity is to verify whether the sub-concepts can be adopted as different levels of the game.

Step 4

Develop the theoretical problem and simulate the problem using the game metaphor.

Step 5

Using a concept inventory approach choose possible incorrect answers and integrate that for each game level.

Step 6

Develop a scoring scheme based on reliable parameters (eg. how quickly a student solves the game problem and the number of incorrect attempts).

Step 7

Develop “hints” for incorrect answers as feedback. Lecture materials can be provided for feedback.

What are the learning outcomes?

- The student gains a comprehensive, theory-based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline.
- Application of established engineering methods to complex engineering problem solving.

What are the challenges that could impact on this pattern? How will you overcome them?

- The challenges lie in the ideas of linking instructive learning and game-based learning. This challenge can be overcome by focussing on key concepts or formulae that are covered through normal teaching.

Conditions

Critical success indicators/factors that influence use/implementation of the solution (eg. needed roles, types of resources), resources needed to solve the problem.

- An understanding of game-based learning techniques, eg. the paradigm to be used.
- Programming expertise or support may be required for developing apps.
- An understanding of the concepts that can be developed as a gaming framework. Literature review of concept inventories in specific fields is desirable.
- Students may need access to smartphones. Access to Blackboard Learn is necessary.

Resources/Technology

Education resources:

- Google Doc: Step-by-step instructions on how to create a prototype
- PowerPoint: A game-based approach to teaching structural analysis
- A browser-based version of the game
- Google Doc: Instructions for students

Technology resources

- Unity 3D
- YouTube
- RMITPlay app (Android)

Staff resources

- Specific programming expertise may be required or access to expertise.

Other resources

- Game Based Learning: Resource Roundup http://www.edutopia.org/game-based-learning-resources
- RMITPlay YouTube video https://www.youtube.com/watch?v=b2JFOFKmEOA
- Albion, P., & McKeown, L. (2010). "The seamless integration of web 3D technologies with university curricula to engage the changing student cohort", Report CG7-488, Australian Learning and Teaching Council, Australia.
- Molyneaux, T. (2008). "The use of concept inventory to provide individual automated feedback from online tests", 19th AaeE conference, publication accessible at https://researchbank.rmit.edu.au/view/rmit:13563
- Venkatesan, S., Molyneaux, T., and Setunge, S. (2007). "An evaluation of Problem Based Learning (PBL) in Civil Engineering", Proceedings of the International conference on Engineering Education and Research, ICEER-07, December – 2007, Melbourne, Australia.

Case Studies

For users of the pattern to add comments, make suggestions and present case studies to support it.

- Case study application tested with CIVE 1188 Structural Analysis cohort in Semester 2, 2015. New developers can try one single course/unit of study.
- Comments can be emailed to Srikanth.venkatesan@rmit.edu.au

Summary of the pattern developed: The pattern demonstrates that concepts covered through an instructive mode of teaching can be developed into a game tool using concept inventory approach.

Case study example presented in the pattern: The above pattern has been applied to a civil engineering course CIVE 1188 Structural Analysis.

Implementation procedure: Developers can use most of the screens and the general layout but may need modifications based on the `concept' that needs to be emphasised (since concepts may vary depending on the teaching material).

Outcomes

Game-based learning has generated a significant degree of engagement. During the demonstration of the game tool (prior to release) 90% of the students (out of a sample of 60) noted that the game-based tool would engage them in active learning. After the game release, similar numbers have confirmed they enjoyed the game-based learning. The game tool being fun and interactive helped student engagement based on the feedback received via emails.

Keywords

Game-based learning, statistics, structural analysis, civil engineering, engineering, game data analytics, mechanics of solids.