WISEngineering: Massive Online Science and Engineering Education by Embracing Social Media

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Abstract

This tutorial presents WISEngineering, a web-based massive online education system that embraces social media for engaging youth in an informal learning setting. The system provides a mobile tablet based solution for fostering youth learning and encouraging learners to develop knowledge in a social media environment. The system employs and adapts the Edx EASE automated grading engine and allows automated assessment of learning outcomes. This tutorial presents features of the WISEngineering system and discusses the impacts of social media on massive online learning.

Keywords: Social Media; Massive Online Education; Learning Outcome Analysis; Automated Grading; Mobile Application; Web Application; Automated Report Generation

1. Introduction

WISEngineering (http://wgg3.hofstra.edu) is a comprehensive web-based engineering design environment, enriched with social media features. It is designed to address several challenges in informal education. For example, the system can help learners to effectively document hands-on engineering experiments for future reflection. It also promotes a group environment for youth to reflect and refine engineering designs. Leveraging the state of the art automated grading and machine learning techniques, WISEngineering provides large scale learning outcome analysis and can perform comparative study of outcomes of an engineering curriculum across regions and years.

Built upon the open source Web Based Inquiry Science Environment (WISE) [1], WISEngineering answers the challenges of massive online informal learning by embracing emerging technologies. It supports learners to define problems, including specifications and constraints, develop knowledge, ideate, test, evaluate, and refine their solutions. This tutorial introduces the full system feature to audience interested in the application of social media in education.

2. Idea Exchange using Social Media

With a special chrome web application designed for a 7 inch Android tablet device, WISEngineering allows youth to view all the related engineering lab curriculum materials while working on a hands-on experiment. Learners no longer have to walk between their desktop computers and the work-bench that they use to assemble their projects.

The tablet version of WISEngineering supports all the powerful tools already included in the WISE system for supporting scientific calculation and analysis. Figure 1 shows an example of the data weighing and plotting tool available in the system.

Figure 1. Mobile Data Diagram Plotting Tool

In particular, WISEngineering provides several tools to support engineering design, e.g., a design wall and a design journal. The design wall is similar to social networking websites or blogs (see Figure 2) and it enables collaboration by learners to comment an engineering design. They can submit images as well as video clips in the design or testing phase. The design journal is a private scratch book that keeps track of the entire engineering process. From the design journal, learners can select to publish their “private” entries to the public design wall for sharing. Both the design journal and design wall facilitate authentic engineering practices as well as reflection. The system employs a distributed cluster at the server end to ensure the performance of video processing.

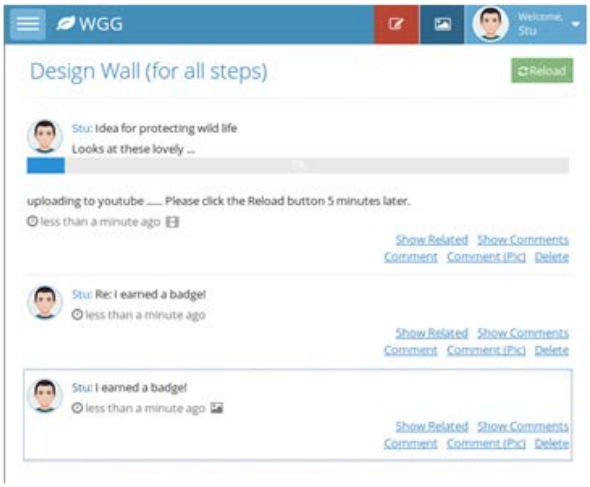

Figure 2. WISEngineering Mobile Design Wall

2. Automated Grading and Outcome Assessment

WISEngineering has a powerful data collection and analysis toolset, which leverages the EdX EASE automated grading engine [2]. Built upon this engine, WISEngineering provides a complete learning outcome analysis system.

As shown in Figure 3, the WISEngineering Data Analysis Engine extracts and parses the structure of each project (as shown in the tree view on the left), and automatically tags each reflection question with automated grading criteria (the summary information is shown on the right side, e.g., it shows the number of criteria defined, trained and calibrated for a project).

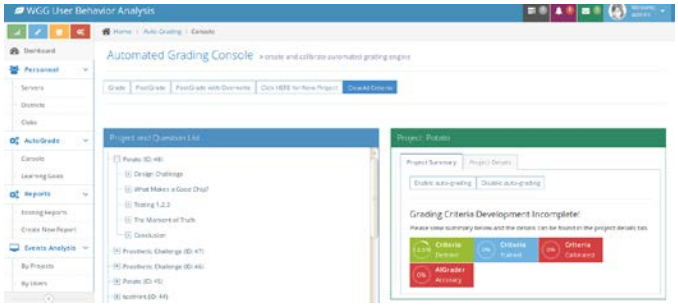

Figure 3. Data Analysis Portal

To automatically grade each project, a curriculum designer has to first design grading criteria, and associate them with a set of pre-defined learning outcomes. As shown in Figure 4, to define grading criteria for a short answer question (e.g., “understanding the design trade off”) involves 6 steps. In the last step, a curriculum designer can choose to associate the grading criteria with a predefined outcome (e.g., engineering design or reading skills). A question can have multiple grading criteria defined, and a weighted sum formula could be defined to calculate the weighted grades. Comments can be automatically generated based on learner response/score, and they can be automatically pushed to the grade book overnight so that learners can see feedback in the system.

Figure 4. Grading Criteria

Figure 5 shows the training facilities provided to curriculum designers. The toolset allows a learning facilitator to provide training samples, generate a grading model, calibrate the grading model and view statistics (e.g., grading quality of the model). As shown on the left side of Figure 5, the system allows a designer to choose between providing a manual sample or retrieving an existing answer from the system and assigning a grade. The data are then processed by a machine learning based grading module. A designer can view the quality of the model (as shown in the right bottom of Figure 5) at any time, and can decide to release/use the model in the system.

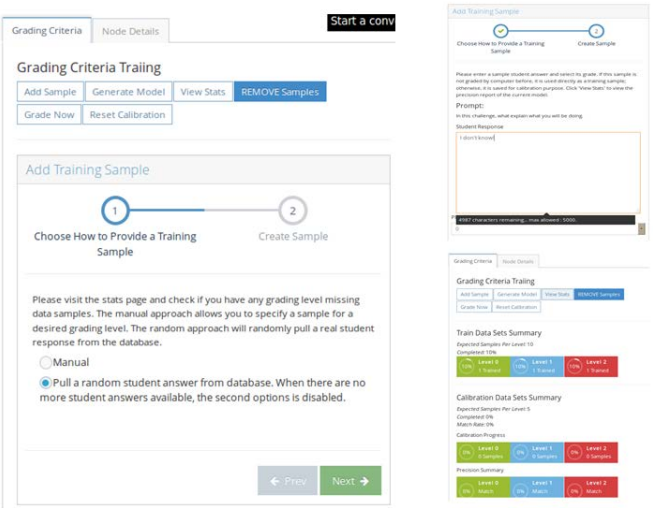

Figure 5. Training of Automated Grading System

3. Data Collection and Report Generation

WISEngineering supports a distributed and scalable structure that supports aggregation of reports from all satellite servers. The main server communicates with each satellite server using a public key encryption communication protocol.

The organizational structure can be defined and revised at any time by the project PI. Then using this organizational structure, the main reporting server sends request to related satellite servers for learning data and aggregates them. Figure 6 shows an example of a weekly report.

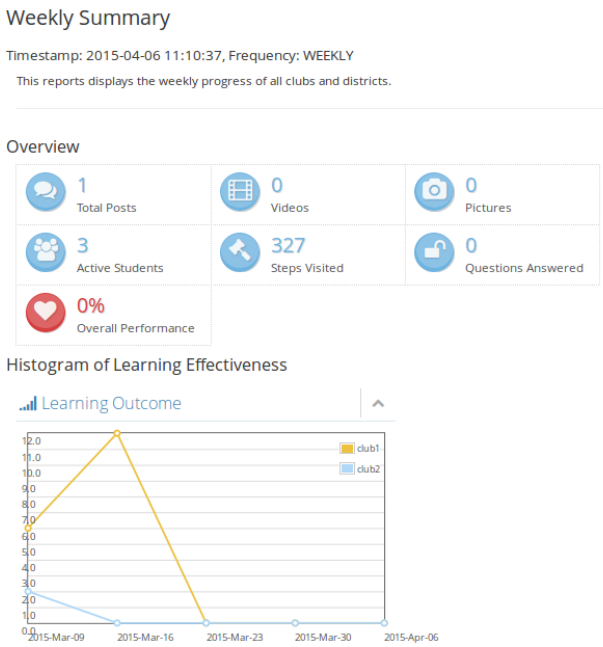

Figure 6. Sample Weekly Report

As shown in Figure 6, the first part of the weekly report displays the summary data (e.g., the number of design wall and design journal posts, the number of pictures/video clips submitted, and the number of steps visited and questions answered). Then the report follows with a histogram that displays the general/weighted learning outcome effectives (converted to 100 point scale) for all clubs. The report presents the itemized analysis for each individual learning goal and for each club. The learning outcome scores are consistent because they are calculated using the same weighted sum, extracted from all the questions in the entire system which are tagged with the specific learning outcome under study. The histogram allows educators to quickly evaluate the teaching effectiveness of a learning club.

4. Structure of Tutorial

The proposed tutorial consists of three components: (1) a brief introduction of the WISEngineering system, (2) hands-on tutorial and experiments with the system, and (3) a discussion of the social media impacts on online education. Tablets will be provided to audience for experimenting with the system.

Acknowledgement

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5. References

[1] The Web Based Inquiry Science Environment (WISE), available at https://wise.berkeley.edu/, retrieved 05/07/2015.

[2] EDX EASE Automated Grading Engine, availabel at https://github.com/edx/ease, retrieved 05/07/2015

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