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Proceedings of the International Conference on Computing in Civil and Building Engineering
W Tizani (Editor)

A web-based academic records tracking system for outcome-based education

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Abstract

Recently, a lot of attention is paid to evaluate the outcomes of education, i.e. whether the students learn what is expected of the programme and subject and be evaluated against measurable metrics. The Accreditation Board for Engineering and Technology (ABET) has been continuing to strengthen the outcome-based accreditation process and many institutes have begun to adopt Outcome-based Education (OBE), a method of curriculum design and teaching that focuses on what students can actually do after they are taught. The desired outcomes are confirmed first and then the curriculum and instructional materials; and assessments are created to support the intended outcomes. While we see OBE could shed light on improving education quality, some teachers may find that this approach adds layers of complexity to their duties. This paper proposes a web-based academic records tracking system for OBE, which aims to relief teachers' burdens and provides immediate and detailed feedback to students and reflection to teachers. As well as the conventional e-Learning functionalities, the system provides criteria-referenced assessment (CRA) tools that assist teachers to assess the performance of students according to pre-defined criteria, weighting and rubrics. As it is a web-based system, criteria and rubrics could be shared and customized among teachers. Moreover, since it organizes material systemically, teachers could keep track of students' continuous progress easily. With a few steps, academic reports that include graded and descriptive results, statistical charts and other business intelligence reports could be generated to both students and teachers on the fly. The ultimate goal is quality teaching and learning.

Keywords: teaching quality, outcome-based education, criteria-referenced assessment, web-based

1 Introduction

Outcome-based education (OBE) is a philosophy of education that contrasts with the traditional education, which mainly focuses on the resources provided to students. Instead, OBE is more student-oriented in such a way that a student's performances of various criteria are continuously measured empirically. As Spady, a pioneer of OBE, suggested over a decade ago, OBE means clearly focusing and organizing everything in an education system around what is essential for all students to be able to do successfully at the end of their learning experiences (Spady, 1994). This implies that OBE starts with a clear picture of what is necessary for students to be able to do before organizing the required materials such as curriculum and assessments. Harden (2007) further explained that OBE plays an important role in monitoring students' progress through the different phases of the curriculum and the planning for a more seamless continuum between undergraduate education, postgraduate education,

and specialist training. Therefore, it is not difficult to understand why professional organizations such as The Accreditation Board for Engineering and Technology (ABET) has been continuing to strengthen the outcome-based accreditation process, and many institutes have begun to adopt OBE.

Although OBE offers a bright vision for education, it is not a panacea and problems may arise if an outcome-based approach is improperly implemented. One critical problem is that some teachers may find that the implementation of OBE adds layers of complexity to their duties, especially for the teachers who have been brought up with a traditional paradigm that is based on lectures (Hashim, 2009). This paper proposes a web-based academic records tracking system for OBE, which aims to relief teachers' burdens and provide immediate and detailed feedback to students and reflection to teachers. As well as the conventional e-Learning functionalities, the system provides criteria-referenced assessment (CRA) tools that assist teachers to assess the performance of students according to pre-defined criteria, weighting and rubrics. As it is a web-based system, criteria and rubrics could be shared and customized among teachers. Moreover, since it organizes material systemically, teachers could keep track of students' continuous progress easily. With a few steps, academic reports that include graded and descriptive results, statistical charts and other business intelligence reports could be generated to both students and teachers on the fly.

2 Designing a system for OBE

There has been limited study of information and communication technologies (ICT) for supporting OBE. Although there were frameworks introduced to help us to understand the wide variety of educational technology applications (Huang, 2001), little or no actual OBE application was developed. The major objective of the proposed academic records tracking system (ARTS) is to assist institutes to implement OBE curriculums through ICT, so that the major users of it (both teachers and students) enjoy the fruitfulness of OBE with minimum input efforts. First of all, the system has to match with the requirements of OBE (Harden, 2002):

1. Development of clearly defined and published learning outcomes that must be achieved before further progression;
2. Designing a curriculum to ensure the achievement of the learning outcomes;
3. Designing an assessment process that matches the learning outcomes for individual students to ensure that they achieve the outcomes;
4. Provision of remediation and enrichment for students as appropriate.

Requirement [1] is based on the contributions of curriculum designers and educators, where the learning outcomes have to be defined and developed by relying on the contributors' knowledge and experience. As this part is related to pedagogical design, there is not much room to use ICT to help the contributors to "generate" their desired outcome. For requirement [2], an OBE criterion and its achievements are commonly evaluated by using rubrics. Rubrics can be designed to formulate standards for levels of accomplishment and used to guide and improve performance, and it can be used to make these standards clear and explicit to students (Allen and Tanner, 2006). In simple term, a set of rubric provides scaled levels of achievement for a criterion. For instance, for the criterion "critical reflection", certain rubrics (scaled levels of achievement) are designed for it, such as "Gave a discussion of learning experience, but the account was generally descriptive without critical or alternative comments (C)", "Discussed own learning experience with evidence of a critical approach (B)", "Analysed and critically reflected upon own learning experience, and found new paths for further development (A)", and so on. If a student "discussed own learning experience with evidence of a critical approach", then his/her teacher gives him/her a grade B. Moreover, instead of representing rubrics as grades, some designers or teachers prefer using numerical scales. For example,

75 - 85 marks, instead of grade B. Therefore the first task that ARTS has to accomplish is to provide assistance in managing both graded and numerical scale rubrics, so that users of the system can add and remove rubrics to a criterion easily. More importantly, rubrics have to be reusable for many criteria in order to reduce the user effort for criteria creation.

With the understanding of the concepts behind rubrics, requirement [3] is rather straightforward. It means that a teacher assesses a student's learning outcome according to the pre-defined criteria and their rubrics. For simplicity, we call this kind of assessment as a Criteria-Referenced Assessment (CRA). For example, a teacher is to create an assessment to evaluate students' critical reflection and independent learning skills. In order to access a student's performance, the teacher has to refer to the rubrics of critical reflection and independent learning respectively, and mark the student's assignment. The teacher then gives one grade or marks for each criteria. In this example, since there are two grades or marks for the assignment, the teacher may want to apply weighting on them, such as 60% for critical reflection and 40% for independent learning. Therefore, the second task of ARTS is to provide a user-friendly interface for the teachers to include criteria to an assignment, input grades or marks by referring to the rubrics quickly, and apply weightings if necessary. As many institutes have already been using e-learning systems to handle assignment/assessment submissions, ARTS has to be bridged with the e-learning systems so that an assignment can be imported to ARTS for CRA, and the consolidated results in ARTS can be exported to the e-learning system or other administrative system for further processing (e.g., generating transcripts).

Requirement [4] takes place after assessments such that remediation and enrichment are made for an individual student according to his or her learning outcome. We believe this requirement has to be fulfilled through mutual understanding. That is, on one hand, the teacher should understand why an individual student cannot achieve an expected level, and what can be done for further improve that student's performance; On the other hand, the student should understand his or her strengths and weaknesses in different criteria and the expectation of the teacher. Therefore, ARTS has to keep track of the history of an individual student, and provide statistical analysis of learning performance in both individual student and whole class basis. As a result, the teacher can decide "what have to do next" by referring the reports generated by ARTS and give comments for students. Also, the students know their performance on each criterion, and the improvement can be done as suggested by the teacher. This is the third task that ARTS has to accomplish.

In a nutshell, ARTS has to provide three key features, namely, rubrics management, assessment, and reporting. It consists of interfaces for importing rubrics in various formats (e.g., MS Excel, plaintext file, etc.), importing assessments / assignments from e-learning systems, and exporting the consolidated academic results to administrative system. The conceptual diagram is depicted in Figure 1.

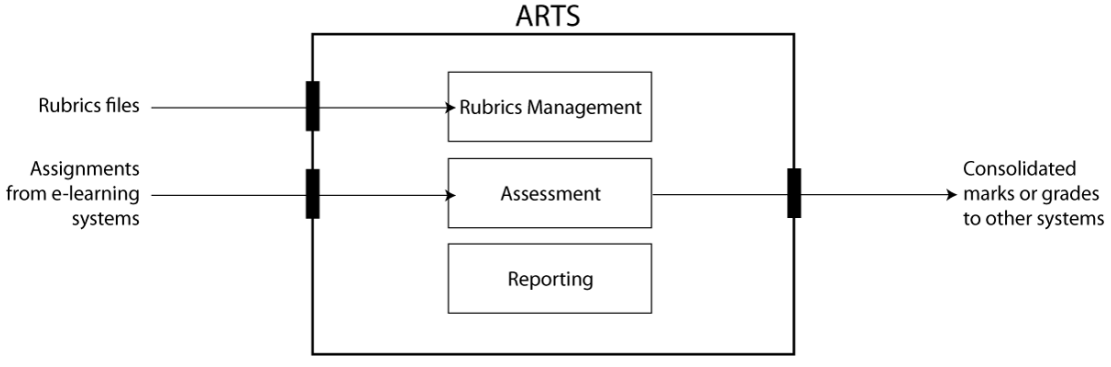

Figure 1. Conceptual diagram of ARTS

3 Development and Implementation

Even a system is useful and user friendly, if it is costly, difficult to install or maintain, people's intention of adoption would be not very high. Since ARTS is a web-based system, users of it are not required to install any additional software other than a web browser. ARTS is also cost-effective because both the development tools and operating environment are freeware. The sever side of ARTS is developed in Java programming language, where its binary code could on be executed on any Java Virtual Machine (JVM) regardless of computer architecture. That means the server side of ARTS could run on various common operating systems with JVM, including Linux, Mac OSX, Unix, and Windows. For the database management system (DBMS) of ARTS, MySQL is used and connected with the Java binaries via Java Database Connectivity (JDBC). Since ARTS is a web-based system, the front end it naturally contains HTML codes and JavaScripts. In order to enhance user experience, asynchronous JavaScript and XML (AJAX) technology is used so that the system retrieves data from the server asynchronously in the background without interfering with the display and behavior of the existing page. ARTS is fully compatible with the common browsers nowadays such as Internet Explorer, Firefox, Safari, and Chrome. Based on the above-mentioned technologies, ARTS was developed and the three key features were implemented.

3.1 Rubrics Management

In order to relief the workloads of users who manage the rubrics and reduce data redundancy, all rubrics are kept in a centralized location, which is called "rubrics pool". Teachers can pick any criteria and the related rubrics from the pool and map them with their assessments directly, without spending time creating rubrics of their own. For the users who have rubrics management privilege like curriculum designers, they can create rubrics for different criteria in ARTS' environment or import rubrics from other file formats such MS Excel. As shown in Figure 2, they can also edit, delete, and change the grade/marks property of the criteria.

TITLE	DESCRIPTION	MARKED BY MARKS	EDIT	DELETE
Critical reflection	(ability to evaluate own process of learning to make improvements)	☐	✎	☒
Experiments	(learning by doing)	☐	✎	☒
Generic Grade	in Grade	☐	✎	☒
Generic Mark	mark range	☑	✎	☒
Generic Rubrics	grade description	☐	✎	☒
Independent learning	(Self-motivation in furthering knowledge, skills and interests)	☐	✎	☒
Presentation - Ideas and Concepts	Ideas and Concepts (Clearly developed)	☐	✎	☒
Presentation - Organization	Organization (Work is easy to understand)	☐	✎	☒

Figure 2. Rubrics pool

By clicking “edit” button of a criterion, its related rubrics are shown as the screenshot in Figure 3. Designers can add / remove rubrics for the criterion and change their grades / marks scale. In this example, the criterion is “critical reflection” and the scales of the rubrics are represented by grades.

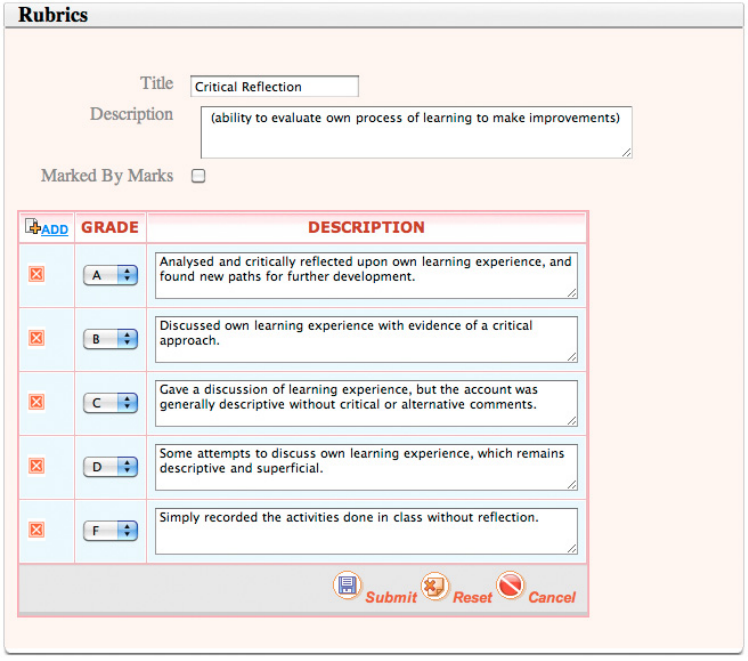

Figure 3. Edit the rubrics of a criterion (grades scale).

3.2 Assessment

After a student has submitted an assignment or has finished a task, the teacher can perform CRA through the assessment function. As shown in Figure 4, one criterion of an assignment is to evaluate “versatility of thinking” that consists of five rubrics. For this criterion, as the curriculum designer has decided to use marks as the rubric scale, the teacher only needs to enter marks according to the achievement of the student. For instance, if the student shows “a high level of flexibility to generate diverse ideas by thinking analytically and laterally” in this assignment, then the teacher should give a mark within 90 to 100. We can see one advantage of using rubrics here: even the marking is done by another teacher, the variation of the result should be very low.

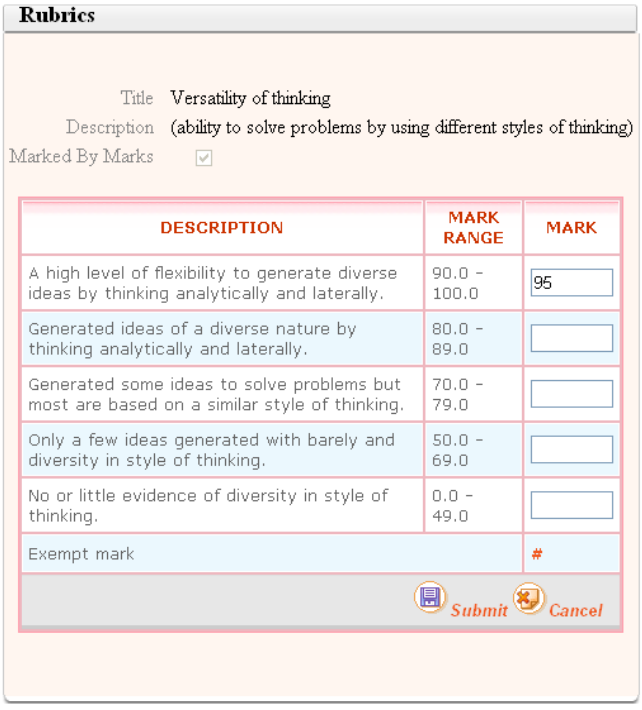

Figure 4. Assessment of a criterion with rubrics in marks scale.

3.3 Reporting

ARTS provides rich representation format for teachers to analyse the performance of students individually and in whole-class basis. It can generate tables, bar charts, spider chart, etc. so that teachers could compare an individual student's performance in various criteria with that of the whole class and decide appropriate remediation and enrichment. From the view of the students, they obtain the comments by the teachers, where the comments address their strength and weakness in different criteria. Figure 5 shows the spider chart and bar chart generated by the system.

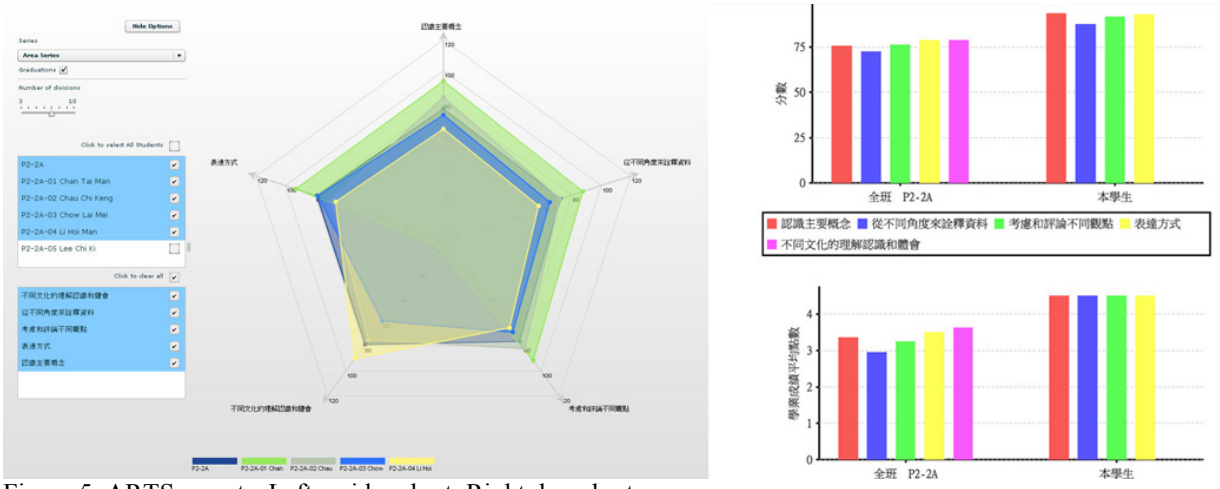

Figure 5. ARTS reports. Left: spider chart; Right: bar chart.

4 Actual Use

ARTS has been evaluated by several educators and positive comments were received. In fact, a department of our University has been using a well-developed e-learning system that runs on Windows Server with Microsoft SQL Server as the DBMS for years and they wanted to adopt ARTS and integrate with their e-learning system. As mentioned previously, ARTS provides interfaces to communicate with other existing systems already and therefore the integration process should not be complex. However, for better data control and because the IT team was not very familiar with MySQL, they want to store the data of ARTS in their MS SQL Server. As a consequence, we decided to implement the original MySQL database schema on their MS SQL server. Fortunately, except MySQL, JDBC could be used to connect with various types of DBMS, with just minor modifications of the Java codes. Finally only few man-days were used for the entire integration. ARTS has been running in their server for over a semester period and there was no technical issue reported.

5 Conclusions

This paper introduces ARTS, a web-based academic system for outcome-based education. The key features of ARTS include rubrics management, assessment, and reporting, which are helpful to curriculum designers, teachers and students. The system provides interfaces for integrating with other existing platforms such as e-learning and administrative systems. It has been used by an academic department seamlessly for over a semester period and its reliability is satisfactory. Nevertheless, although we are proud of the technical success of ARTS, it does not mean ARTS solves all problems come with OBE implementation. As Spady (1994) suggested, OBE is not a computer program, a technique, a quick-fix, a panacea, or a miracle. OBE is a transformational way of doing business in education and ARTS is just a useful tool to assist the educators to perform the transformation. The most critical factor affecting the successfulness of OBE implementation is obviously the quality of the stakeholders. Therefore it is hoped that the educators, on one hand, to make better use of ICT applications like ARTS to assist teaching and relief their workloads; and on the other hand, to have an adequate preparation for the challenges of the transformation.

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