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Incorporating Digital Badges and Ontology into Project-based Learning

Jian Liao, Simon Hooper
Learning, Design, and Technology
College of Education, Penn State University
State College, Pennsylvania, USA
{jxl1089, sxh12}@psu.edu

Minhong Wang
Faculty of Education
The University of Hong Kong
Hong Kong, China
magwang@hku.hk

Abstract—The rapid development of technology makes learning goals much more complex, diverse, and keeping changing. In reality, each product of design must be ‘ultimately particular’, which complicates the holistic learning objectives of a technology training class in the school setting, and, in turn, runs the risk of becoming disconnected in the minds of learners and teachers. In order to address this issue, a solution named DBOPBL (Digital Badges, Ontology & Project Based Learning) is put forward in this paper.

Keywords—digital badges; ontology; web2.0; project-based learning

I. INTRODUCTION

The project approach to learning is a method of teaching in which an in-depth study of a particular topic is conducted [1][2]. It integrates knowing and doing. Students apply what they know to solve authentic problems and produce results that matter. These cannot be taught in a textbook, but must be activated through experience” [3].

However, the rapid development of technology makes the learning goals much more complex, diverse, and continuing updated. Plus, the complicated real situation needs each product of design to be ‘ultimately particular’ [4], which complicate the holistic learning objectives of a class in school setting to greater extent and “run the risk of becoming disconnected in the minds of learners and teachers” [5]. In order to address this issue, a solution named DBOPBL that combines digital badges, ontology and project-based learning cycle is put forward in this paper.

II. RELATED WORK

A. Digital Badges

Like physical badges, digital badges are emblems to give members to display the accomplishment of various achievements. In learning environments, digital badges could be used to encourage alternative, peer-based assessment [6], and function as transformative assessment that shape existing learning or allow new ones to be created [7] [8].

B. Ontology

“An ontology defines the basic terms and relations comprising the vocabulary of a topic area, as well as the rules for combining terms and relations to define extensions to the vocabulary” [9]. The four related features: conceptualization, explicit, formal and share [10]. Some famous ontology systems or tools include WordNet [11], Protege [12] and Hownet [13].

C. Project-based Learning Cycle

Schwartz and his colleagues designed a project-based learning model called Star.legacy to organize the students’ learning, in which students will obtain each learning objective progressively by experiencing a learning cycle including Generate Ideas, Multiple Perspectives, Research & Revise, Test Your Mettle and Go public [14] [15].

III. DIGITAL BADGES INFRASTRUCTURE BASED ON ONTOLOGY

From the definition of digital badges and ontology, some common points between them can be found:

- Both them have a directed graphic infrastructure, which includes nodes and relationships between nodes.
- For both them, the nodes in the graph could represent the concepts in the knowledge structure.
- For both them, the relationships between nodes could include “is part of”, “is kind of” and “is prerequisite of”, see table 1.

TABLE I. BASIC RELATIONSHIPS BETWEEN NODES

<table>
<thead>
<tr>
<th>Name</th>
<th>Present</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PartOf</td>
<td>PO(A,B)</td>
<td>Node A is a part of Node B</td>
</tr>
<tr>
<td>KindOf</td>
<td>KO(A,B)</td>
<td>Node A is a Kind of Node B</td>
</tr>
<tr>
<td>PrerequisiteOf</td>
<td>PRO(A,B)</td>
<td>Node A is prerequisite of Node B</td>
</tr>
</tbody>
</table>

Figure 1. The directed graph containing both badges and ontology

These features in common provide a possibility to combine the infrastructure of digital badges and ontologies
into the same directed graph, see figure 1, in which yellow nodes represent both badges and knowledge units, while blue nodes represent just knowledge units. Moreover, the regular line means ‘PartOf’, the arrowed line means ‘KindOf’ and the dotted arrowed line present ‘PrerequisiteOf’.

IV. INCORPORATING DIGITAL Badge AND Ontology INTO PBL CYCLE

As mentioned above, in DBOPBL, students are encouraged to continuingly improve their projects based on other’s comments and change of situation. Thus, the whole project-based learning process can be broken down to many phases. In each phase, students need to experience a learning cycle to obtain a deeper understanding on a technological module.

- Attraction
  The first step in each cycle is attracting students to explore what the technology on a badge can do. This step can be conducted by providing demonstrative products or projects on each badge.

- Selection
  This step students need to make choices to choose corresponding badges to complete their tasks in this cycle. This can be conducted by recording the students’ selection online.

- Scaffolding
  In this step, the teacher and the learning system will facilitate the students’ learning. Due to the diversity of learning objective, it is more important to provide them some project starter and relevant learning resources, such as video tutorial, some free technology-learning websites, and communities.

- Badge Claim
  After students complete the corresponding tasks, they can claim the badge by providing instructor with the corresponding evidences, such as the source code, screenshot, and web address.

- Evaluation
  In this step, a teacher needs to make a judgment if the student is eligible to earn the badge by checking their validity and legality of the evidences.

- Badge Grant
  Once a student has passed the evaluation, s/he can get the badge. The student can show the new badge to others and earn the corresponding credits on the badge. If the student fails to earn it, s/he needs to back to the step of scaffolding to redesign the project feature or even get back to the ‘attracting’ to reselect another badge s/he want to earn.

V. THE SYSTEM FRAMEWORK OF DBOPBL

Figure 2. The System Framework of DBOPBL

Figure 2 shows the system framework and data flow of a DBOPBL system. In this framework, student can browse the project demonstration, register new feature of project, set the relationship between feature and ontology, and claim badges, while a teacher can evaluate students’ evidence, grant badges and manage the badge ontology. Here is also
an automatic reasoning process after the teacher has decided
to grant a badge to a student, the system will replace the
current badges automatically according to the badge rule
base.

VI. A CASE STUDY IN TECHNOLOGY EDUCATION IN
HIGHER EDUCATION

A. Context Overview

Design studio is a course opening for graduates of
Learning, Design and Technology in Penn State University.
It provides learners with the training of many different
cutting-edge technologies. Besides, since there are many
different technologies it allows learners to take this course
more than once in up to four semesters. All current 16
students are adult learners. Yet some of them just graduated
as bachelors or masters while others had worked for many
years. The technical backgrounds of them are quite different.
Some of them might have little technique skills, but others
have more advanced skills. Furthermore, the learning
requirements of them are various. Some of them would like
to use graphic design and video editing techniques to design
learning materials, while others prefer to learn coding to
develop learning systems.

B. System Prototype

![Figure 3. The prototype of DBOPBL](image)

Figure 3 shows the prototype of a website that we have
developed by using Drupal, Commons distribution and
badge module of Drupal to support DBOPBL. It includes the
functions of browsing and importing badge on ontology,
along with the functions to support six steps in the learning
cycle in DBOPBL.

C. Discussion

By using DBOPBL, the learning objectives could be
more flexible and adaptive, which is more similar to the
‘authentic’ situation to use certain technology to meet the
demands of real world. Student would be able to decide their
learning content and path according to their intrinsic interests
and the ‘ultimately particular’ demands of their projects.
From the standpoint of the instructor, the procedures of
learning are fixed and easy to monitor and control, and more
importantly, the design of instruction is theory grounded to
improve students’ understanding and improve their ability to
learn how to learn.

VII. CONCLUSION

This paper provides a model named as DBOPBL, which
incorporates digital badges, ontology and project-based
learning cycle to support technology training in current
diverse and continually updating technology environment.
By using DBOPBL, the learning process would make a
balance between the diversity of learning goals and the
degree of understanding of students on technology modules.
The next research about DBOPBL would be exploring
how to use Web 2.0 mechanism to support students to create
new badges and learning contents to relieve the workload of
teachers and improve students’ knowledge construction.

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