Projedemy — An Online Project-Based Learning Tool for Tertiary Education

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ABSTRACT

Project based learning (PBL) is a method of learning in which learners obtain knowledge and skills by working on a real-world project for an extended period of time. PBL has been found to be an effective and enjoyable approach, its overall adoption rate in higher or tertiary education, however, is relatively low. Rooted from three major challenges in proliferating PBL to higher education, this project proposed, designed and created a prototype, *Projedemy*, to provide an integrated solution and to facilitate the adoption of PBL among a broader audience. This project is conducted via a development track and the final deliverable is a web application for students, teachers and other associated parties.

Author Keywords

Educational technology; web applications; project-based learning; tertiary education.

ACM Classification Keywords

H.4.m. Information Systems Applications: Miscellaneous;

D.2.8. Software Engineering;

H.5.2. User Interfaces.

INTRODUCTION

Project based learning (PBL) is a method of learning in which learners obtain knowledge and skills by working on a project for an extended period of time. Because of the authentic, engaging and meaningful nature of the project, learning sciences researchers have found it an effective and enjoyable way to learn and develop deeper learning competencies [1]. Higher or tertiary education has lagged behind K-12 education in adopting PBL because of difficulties from both teacher and student sides [2]. *Projedemy* aims to provide a solution to the three major challenges below in implementing PBL in undergraduate

and graduate school settings.

- It is often challenging to recruit a community partner (client-based project) to stay connected with the project over an extended period of time, often over multiple semesters. Thomas's study [3] suggests difficulties persist in aligning learning goals of the course with the needs of community partners; coordinating projects to fit community partner's timeline and maintain their involvement over multiple iterations of a course offering. Moreover, it is also challenging to bring outside experts into class to coincide with when students need information [4]. Thomas [4] framed that in teacher-initiated PBL, it takes enormous amount of time to find and incorporate community partners to develop authentic problem scenarios.
- College students are unable to stay engaged and collaborate effectively. Students are often less engaged in the project when they find less interests and value of the project, when students' perception of incompetence to complete the project and the fact that grades and outcome are not that important for them. Also, researchers found that students are frustrated when they are not sure their roles and responsibilities in a project, and sometimes reluctant to accept responsibilities for their learning [5].
- College-level teachers find themselves inexperienced on how to assess students' work and confused with their roles in a PBL setting. The difficulties of assessing student work coming primarily from of a) the challenges assessing the products of project through which students demonstrate their understanding; b) teachers' post-project realization that using intermittent benchmark would assist students' progress [2].

EXISTING SOLUTIONS

There are existing online PBL solutions that aim to help students find projects, connect experts and work collaboratively. Below are a few examples.

Project Foundry is the leading SaaS solution for managing PBL for grades K-12. It manages the complex workflow of teachers and students to plan, access, report and showcase PBL [6]. It is more like a computer-supported tool to support PBL in a small school setting, rather than a framework to facilitate people from all over the world working on a specific project and learn collaboratively through the process.

Novare focus on deeper learning through PBL and provides student process tracking, analysis, performance based assessment and communication of a student's learning to families in a holistic approach [7]. Again, the primary audience are still K-12 teachers and students. Novare does a good job in promoting learning through reflection and revision, but it does not have the capability to incorporate community partners and experts in a specific field in a project.

Educurious is a website with supplemental apps that combines PBL technology and makes connections with real-world experts. It indeed includes projects from different fields and connections with real-world mentors [8]. However, the projects are not in depth enough for college students. Moreover, it doesn't provide solution for effective project assessments.

There are some other web-based project management applications that let users work more collaboratively and enable users to organize and prioritize the projects efficiently, such as Trello.com and Jira.com. However, the purpose of using these platforms is to get the work done, rather than learning. A PBL system should have explicit learning objectives, learning curves and learning outcomes.

DESIGN PRINCIPLES
PBL reflects a learner-centered environment that focuses on student's use of knowledge, tools and technologies, [9] the design of PBL prototype should be centered around learners in all phases- project initiation, planning, tracking, developing, assessment etc. Dr. Barron et. al. described 4 design principles in project-based learning (PBL) field to ensure that projects can lead to understanding, rather than just doing [10].

1. Define appropriate learning goals that can help approach deep learning objectives.
2. Provide scaffolds to support learning for both teachers and students. For example, students, with the help of teachers, should exploring authentic problems collaboratively to understand the big picture before going too far into the potentially ill-defined, complex and open-ended projects.
3. Provide frequent opportunities for formative assessment and revision. It is very important to emphasize here that the frequent assessment is from both students and teachers.
4. Support learning through social mechanisms, including small group interactions, peer review and review from outside audiences.

To meet the criteria of PBL, the project designed must have five features: centrality, driving question, constructive investigation, autonomy, and realism. [3] This means the projects are central, not peripheral to the curriculum. Also, it needs a driving question or an essential to "drive" students learning. Dr. Bereiter and Dr. Scardamalia [11] further emphasized that the design of PBL must involve the transformation and construction of knowledge (new understandings or new skills) in the central activities of the project on the students' side. Autonomy means that projects are student-driven and not teacher-led. Finally, PBL incorporates real-life challenges that focuses on authentic problems, not school-like [12].

SYSTEM DESIGN
The audience of *Projedemy* are college level students, undergraduate or graduate, regardless of on campus or online settings, with purpose of helping create and develop projects as well as sharing learnings through the processes. The capability of online collaborations is one of the keys to improve the adoption of PBL in tertiary education. Also, with increasing number of courses provided online (e.g. MOOCs), the capability of online is a must for courses admitting students all over the world and with different backgrounds.

The system design is built on the design principles and is depict as project initiation, project enrollment, project approval, frequent assessment and learning curves. The following paragraphs describe how the detailed designs align with the principles and provide solutions to the difficulties of adopting PBL stated earlier.

In the project initiation or creation stage, *Projedemy* provides two solutions to the difficulties to find community partners. First, the online environment makes it possible for students and teachers find community partners and outside experts globally. Thus, it becomes easier to find qualified partners and experts. Web-based technologies facilitate matches between college students/teachers' needs and community partners' requirements, and it is two-way process that makes the matching much fasters. Outside experts, who are willing to contribute to higher level education, can also connect to students and teachers easily through an online environment. The second solution is learner initiative. Students have the freedom to create their own project. This solution eliminates the require of a community partner. There are successful PBL cases that students being encouraged to provide their own essential questions. [2] [10] In this way, student found the question more meaningful to themselves, and thus are more motivated to complete the project.

Projedemy enables user registration in different roles - student, teacher, outside expert or community partner. The scopes of each role are described in Table 1. Note that, community partner and expert are both external resources outside universities or academic institute, but they differ in their roles. Community partner weighs more on providing the real-world problem to be solved rather than the following learning support actives. Expert is someone that has strong background and experience in a field and is interested in supervising a project. Expert should weigh more on supervising and be much more supportive in students' learning. Instructors doesn't need to be serve in a university or academic institute, but he or she must have

strong teaching experience in order to give fair assessment and gradings.

User Role	Definition	Scopes
Student	Online or on campus learners	Create projects, submit/update deliverables, make peer feedbacks, submit learning summary
Instructor	Professor, TA, teachers	Create projects, approve or reject project, assign learning goals, give feedbacks, assign scores
Community Partner	Company, organization or individual	Create projects, provide feedback, provide external resources
Expert	Expert in a field	Create projects, provide feedback, assign learning goals, provide additional resources

Table 1. User role definition and scopes.

Project enrollment is the stage when learners who are interested in the project sign-up for the project to form a team. More importantly, it is when exploring authentic problems collaboratively happens. The team, should working closely with project creator to understand the problem, add or update project requirements, details and breakdowns before diving too far into the project itself. Instead of going deeply, analysis should be done for contrasting cases and existing solutions. The social mechanism of the web app also enables students interactive with experts and instructors to obtain advise from them. A project proposal with team info, breakdowns, timeline and necessary analysis report should be delivered at the end of this stage. Note that, not only students can sign up for a project, if an instructor or expert is interested in supervising a project, he or she can sign up as well.

Before a project can be launched, it must be approved by an instructor. In this phase, the role of the instructor is to evaluate all the work done prior to diving into the project itself, including

o Evaluation of the project description and make sure it has the essential features to meet PBL field's consensus about PBL design criteria, i.e. centrality (project centered), driving question, constructive investigation, autonomy (student-driven), and realism (real-life challenges) [3].
o Alignment of the depth and breadth of the project and make sure it matches the learning goal of the course.
o Feasibility assessment to ensure the project can be completed on time.
o Communication with students for any doubts they have and provide advice for project refinement.

As mentioned previously, frequent assessment is critical for PBL. *Projedemy* provides variety of ways to conduct intermittent benchmark and feedbacks to ensure student receive ample feedbacks and advise through the progress, and to ensure instructors have clear guidelines to assess student's work and clear understandings of their roles. Using *Projedemy*, users can find the following avenues for assessment.

o Progressive or intermittent assessment and feedbacks from students (peer feedback), teachers or experts and community partners. As the project is designed, it should elaborate project breakdown- a detailed list of tasks, subtasks, deliverables and timeline. The project should have several milestones throughout the time, when the periodical feedback and assessment can be provided. Researches have demonstrated that these intermittent check-in points and progress checks are helpful to assess the project [2]. The detailed intermediate deliverables serve as clear guidelines for instructors to judge student's work.
o Two-fold evaluation mechanism. Instructor is the one to grade student's work for each intermediate milestone and final project. However, expert and community partner will also provide their feedbacks, which are used as criteria for instructor to grade the work. The second mechanism is through quizzes, which are set to check students' knowledge and how well they learned through the project. Quizzes can be given by instructors, experts or provided by *Projedemy*. *Projedemy* also features a ranking board to encourage student compete each other to maximum students' engagement in learning through projects.
o Scoring based on weighted grades, with grades assigned for work quality, completeness, ethic, collaboration and quizzes.

The last but not least piece I would like to discuss is learning curves. Learning functionalities can be see everywhere in *Projedemy*. At the project creation phase, instructor or expert is required to provide detailed learning goals to project participants, as well as related learning resources. *Projedemy* will also provide internal resources for students to assist learning activities. Users can leave comments to learning goals, project deliverables, various assessments and feedbacks and many other places in the system, which allows students to learn from each other or their mentors, and also allows for efficient colorations with other users.

APPLICATION ARCHITECTURE

Projedemy is built on a client server architecture and needs an internet connection. The web hosting infrastructure is through hostgator.com, including its database, frontend and backend APIs. The databases, codes, APIs are managed using WordPress. A list of tools, languages and resources used in this project is as follows.

- Front End: HTML5, JavaScript, CSS, WordPress themes
- Backend: PHP
- Database: MySQL
- Framework: WordPress (PHP framework)
- Other resources: WordPress Plugins (Ultimate Member, User Role Editor, WP Job Manager, WP User Frontend, WP-Pro-Quiz, Code Snippets)

From a high-level design perspective, the web application consists of four types of users as mentioned previously. The high-level design and architecture of the system are demonstrated below as a Use Case diagram and an EER diagram.
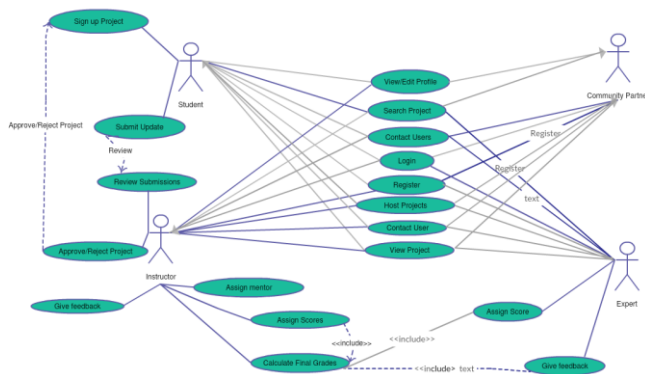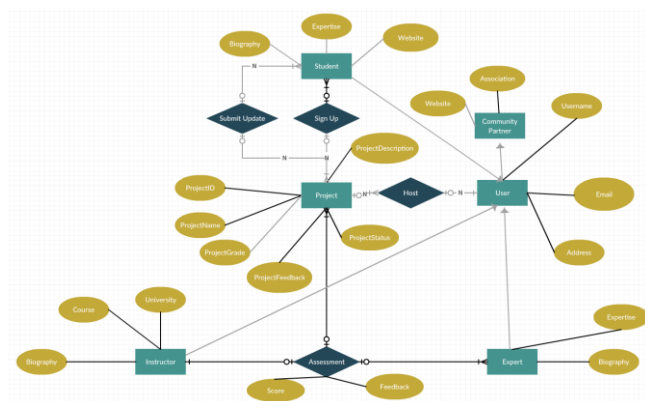

Figure 1. Use Case diagram

Figure 2. EER diagram showing database schema

APPLICATION INTERFACES
From a high-level perspective, *Projedemy* consists of a user portal, a "create project" interface, a "my project" dashboard, a "search project" portal, a learning portal, an individual project view, widgets for edit profile and a list of signed-up projects. Please go to *projedemy.org* for viewing these interfaces.

User Portal
User portal includes interfaces for new user sign up, edit or view profile and "Account" page. At home page, new user can click "CREATE AN ACCOUNT" for user sign-up, where user can choose his or her role from the dropdown list.

Create Project Interface
Once a user is logged in, he or she is redirected to "Create Project" page. In this page, there are two sessions, one is the project basic information (name, location, and field of discipline) and description, and the other is project requirements (group size, deadline, knowledge required, etc).

My Project Dashboard
After project is created, users can review it from "My Project" page, where they can edit this project, duplicate it, or delete it (Figure 3). This dashboard lists all the projects that have been created by this user, along with projects' deadline, creation date. If the creator clicks "Mark close", the listing for this project will be closed and a closed mark will be shown.
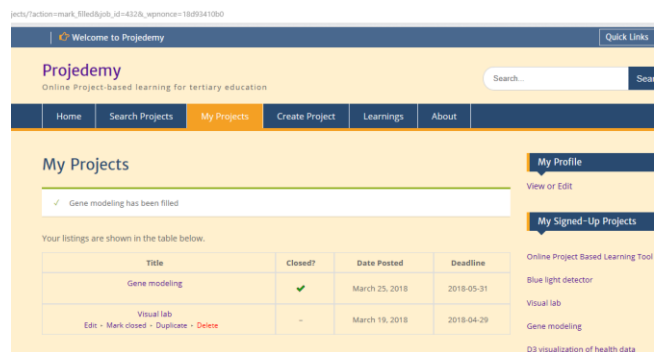

Figure 3. My project dashboard

Search Project Portal
Search project portal allows user to search by any word, such as location, key word, title, group size, field, etc (figure. 4).
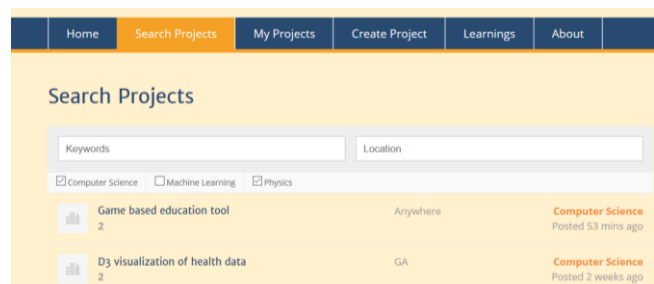

Figure 4. Search Projects

Individual Project View
This is the Core of *Projedemy*, where user can access different portion of the project, such as deliverables, assessments and learning goals. Figure 5 illustrates a project view of a fresh project with no breakdowns, assessment or learning goals added yet.
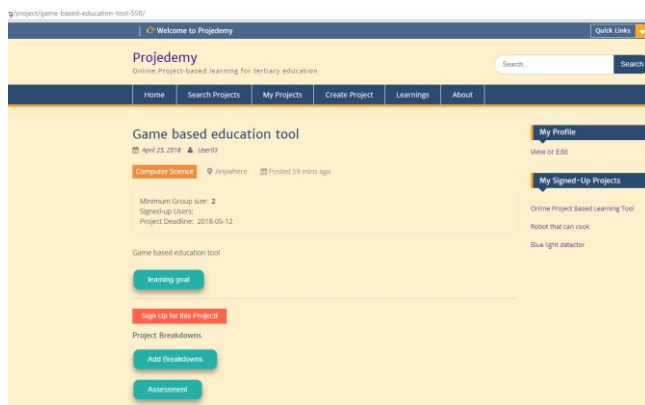
Figure 5. Exemplary fresh project

Figure 6, on the other hand, shows a project with breakdowns/deliverables, assessments and learning goals. In the paragraph below, I will show some functionalities about this project portal.

Once users click "Add Breakdowns", it will lead them to a form where they can add project deliverables, breakdowns, due date and make file submissions, etc. In the project portal, they will also see submitted "Project Breakdowns". Clicking individual breakdown (deliverable), they will see page for that particular deliverable where they can review the content or leave comments.

Users can click Sign-up button in Project View to sign up the project. Signed-up projects will be listed on the right side (through a widget "My Signed-Up Projects"). Students need to sign up to submit deliverables; instructors and expert need to sign up to add learning goals and make assessments.
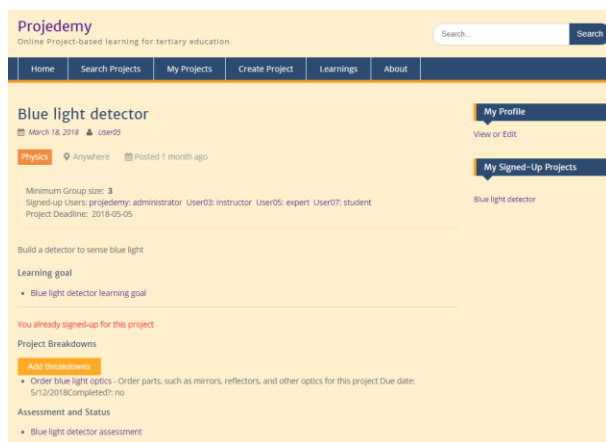

Figure 6. Example of a project with learning goal, breakdown and assessment added.

Students can submit their deliverables by clicking individual breakdown (clicking "Edit"). They can mark it completed and upload files if needed. Other users can leave feedback to a deliverable submission as well.

Project approval, deliverable assessment, quiz grading and final score release are all in the assessment functionalities,

which can be accessed by clicking "Assessment" button in the Individual Project View. Instructor can approve or reject project and assign scores to each deliverable (figure 7). In this way, other users are able to track the process of the project easily by checking the "Project Status". Once assessment is created, users can view it in the project portal under "Assessment" session. Only instructor can create new or edit existing assessment. When an instructor approves a project, he or she can also check if the project meets the requirement of the project. For example, the instructor can check if the number of signed-up students exceed the minimum group size from the project page where lists all the signed-up users and their role. Furthermore, the instructor can also click on any of the user to view their profile, such as location, expertise, etc, and see if it fits the needs of the project.

Learning Portal

Learning is the goal of PBL. Each project needs a learning goal which is set up by either instructors or experts through the Individual Project View. Students who participates in a project should use learning goal as a guideline and focus for learning activities through the project.

To further assist and enforce student learning, Projedemy features a "Resources" and a "Quiz" session under "Learning" tab. The resources can also be navigated by clicking the key words. Quiz is a quick and straightforward way to assess student's learning. Instructor or expert can provide an external link for quizzes or they can simply use quizzes provided by *Projedemy*. Students can obtain credits/scores credits/scores for the quiz as part of assessment of the project. Besides the quizzes, A leaderboard (ranking) is
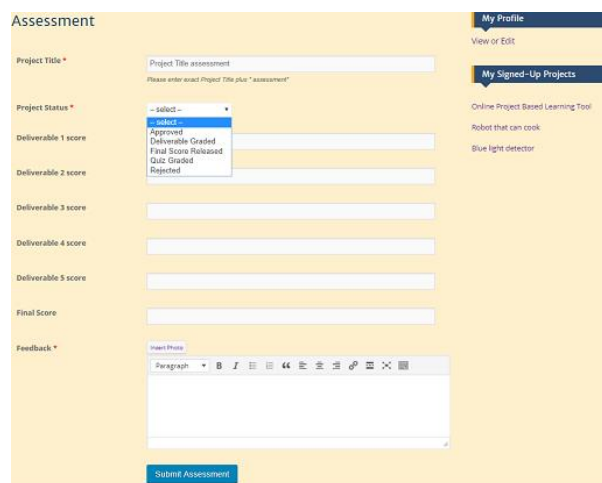

Figure 7. Page for instructor to create a new assessment, approve or reject project, grade deliverables or quizzes, give final scores and change status.

added to encourage student to compete to improve their engagement.

Another valuable part for to ensure student master the knowledge or skill is the requirement of submit a

knowledge graph (figure 8). The knowledge graph not only helps student organize their learnings and show off what they mastered through the project, but also ensure they know how knowledge are connected, originated so as to inspire deeper discussions and researches.
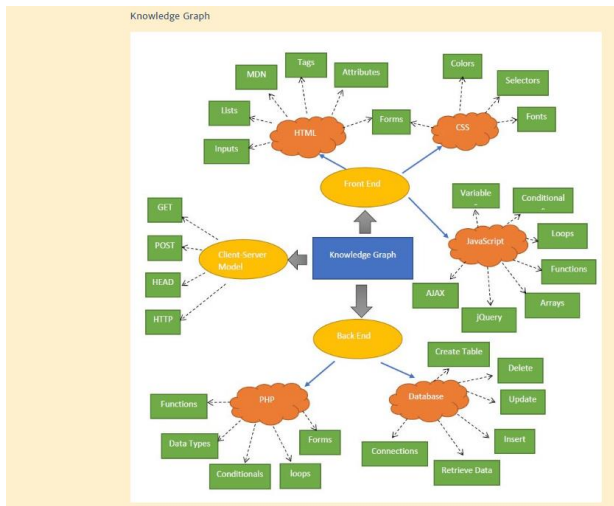

Figure 8. Example of knowledge graph, which is in the Individual Project View. Automating the process of generating the graph might be interesting future implementation.

SUMMARY

Projedemy is inspired by Project Based Learning, in which learners obtain knowledge and skills by working on a project. Learning is the goal, project are the scaffolds and students are the driving force. Project is the center for this system, which integrates various resources and roles/parties. There are mainly four user roles in this system, student, instructor, community partner and expert. The social nature of this web app makes the connection to real word problem bidirectionally, which overcomes the difficulties for university instructors to find proper authentic projects. This web wireframe is consistent with Barron's 4 PBL design principles [10], emphasizing frequent assessment and learning through social mechanisms. Below illustrates a project's life cycle. The project is the core, learning activities are surrounding the project, which ensures learning goals are satisfied.

There are quite a few improvements and new functionality for to be implemented in the future. One of them is a reward and competition mechanism to resolve the engagement issue from the students. Once a project is created, the host can publish it as a competition and has the option to associate it with a reward. The reward winners must share the outcome and learnings to the all competition participants. The reward and competition (e.g. cash) mechanism can greatly ensure participates stay engaged as the project progresses. This could be like a "Kaggle", but in a broader discipline, that will be beneficial for both community partners and students.
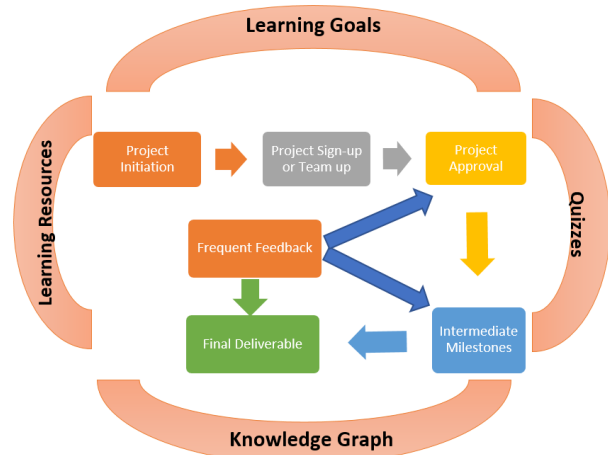

Figure 9. *Projedemy*'s project life cycle.

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