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Assessment for Project-Based Courses

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ABSTRACT

A project-based course is where students engage in a series of projects, which help lead students to a defined level of skill as specified in the course goals. Unlike a traditional lecture course where students are given examinations to assess the level of student knowledge and understanding, a project-based course may not include any formal examination. The assessment of student progress is often based on the quality of course projects. For this research, students in project-based courses were given a formal exam at the end of the course. The objective of the exam was to determine if there was a discrepancy between student performance on the exam and their projects. While the majority of students performed remarkably similarly on their exam and projects, a number of students (25%) did perform quite differently. This study demonstrated that examinations are still a critical tool for assessing student skill level in project-based courses.

Keywords: project-based learning, PBL, assessment, examination, SOTL.

INTRODUCTION

One of the key functions for a college instructor is to observe and assess the process of learning in which their students are engaging. Without the ability to conduct an accurate assessment of student learning, the teacher would have little ability to judge the effectiveness of the education

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in the classroom. "Classroom Assessment helps individual college teachers obtain useful feedback on what, how much, and how well their students are learning. Faculty can then use this information to refocus their teaching to help students make their learning more efficient and more effective." (Angelo & Cross, 1993, p. 3) Without evidence that substantive student learning has taken place, then the teaching experience has been incomplete. "Teaching without learning is just talking." (Angelo & Cross, 1993, p. 3)

For many college courses, the general classroom pedagogy has been moving away from traditional lecture classes and towards a more stimulating and hands-on learning environment. This trend will likely continue as studies show that active learning methods are significantly more effective than lecture courses. (Freeman, et al., 2014) In a project-based learning (PBL) course, lectures and examinations are minimized or eliminated altogether, and student assessment is largely based on the quality and accuracy of students' project work.

A broad description of project-based learning, developed in 1975 by Adderley et al., is still in use today. To summarize, PBL involves initiative by the students and various activities, which commonly result in an end product such as a report, design, or presentation. The project varies in length from one class period to several weeks, and the instructors are often involved in an advisory role, rather than an authoritative role. (Adderley, et al., 1975)

In 1983, educator Alistair Morgan developed three general models of project-based education. First is the Project Exercise model, where previously acquired knowledge and skills are applied to a project. This model is typical for a capstone course where students demonstrate and utilize knowledge and skills that they developed in previous coursework. The second model is the Project Component, which is taught in parallel with traditionally taught courses. Here, students are given an opportunity to apply information from other courses to real-world problems, thus reinforcing the information students have learned. The third model is the Project Orientation model, where the entire course is delivered in a project-based format. Students gain knowledge and skills through the variety of tasks related to the project. To the extent that direct instructional teaching occurs, it is only used to supplement the requirements of the project. (Morgan, 1983)

The motivations for adopting a PBL-oriented curriculum are varied. Gunter Heitmann identified four general motivations for engaging students in a PBL environment. The first motivation is to mimic real-world practice, where students experience problems-solving situations that they may encounter on a job. Second, PBL gives students experience working in a democratic situation, where students must work together in a spirit of cooperation and conflict resolution in order to accomplish a task. Third, students engage in tasks that will foster critical thinking skills, by requiring students to analyze a problem and to apply an appropriate solution. Fourth, PBL is pedagogical, where students accomplish their learning and skill development through hands-on experiences. (Heitmann, 1996)

In addition to the models and motivations for project-based learning, one must also consider the types of projects in which students will engage. In 1921, a pioneer in PBL, William Heard Kilpatrick, distinguished four types of PBL projects. The first type encompasses experiential learning. These projects provide students with the experience of doing, making, or affecting something to embody an idea in a material form. The second type simply involves students in the purposeful enjoyment or appropriation of an experience. The third type is one whose primary purpose is to solve a problem. Students apply their existing knowledge and experience to a problem situation and develop a solution. The final project type is the learning project, where students acquire new knowledge or skill through their engagement with project tasks and assignments. (Kilpatrick, 1921)

The Computer Aided Drafting Technology (CADT) program at the National Technical Institute for the Deaf (NTID) delivers most of its technical courses in a studio, using a project-based learning format. Of Morgan's three models of project-based learning (Morgan, 1983), the CADT program uses the Project Orientation model. Students learn specific skills by engaging in project assignments, either individually or with a group. The motivation for this model is Heitmann's Pedagogy Motive, where the students are learning their skills through direct hands-on experience with the software. Finally, the project type used for this program is Kilpatrick's Learning Project, where the purpose of the project is to teach specific skillsets.

Because of the PBL nature of the CADT program, the assessment of student learning is largely based on the students' projects. The projects may last only one or two class periods, or they may be larger projects lasting up to half the semester. Traditionally, the CADT program does not give any type of formal testing of student skills. Instead, a student's course grade is mostly based on submitted projects, with a smaller percentage calculated from attendance and various homework assignments.

Throughout the semester, the students receive formative assessments from the instructor for each of their projects. A formative assessment provides the student feedback that is used to guide him or her on subsequent projects, as opposed to a summative assessment, which is simply a judgment on the quality of the student's work. (Taras, 2005) Traditionally, the CADT program does not conduct a summative assessment at the end of the semester to determine a more precise determination of the students' level of skill. Instead, the semester's formative project assessments are generally deemed to be sufficient information.

The question addressed by this paper is whether or not relying only on project assessments tells the complete story of the student learning that took place during the course. The course grade should provide a reasonable indication of the student's skill level achieved during the course. But does it? Is it possible that the grade earned by the student does not give the complete picture? Are the student's project grades alone sufficient to determine the student's skill level

as reflected in his or her course grade? To answer these questions, an experiment was conducted on several project-based courses.

METHOD

Participants

Six courses were selected over a two-year period for this study. These courses were identified as specifically using project-based learning, and relying on assessments based almost entirely on the quality of student project work. Four of the six courses were taught in the CADT program at NTID with only deaf and hard-of-hearing students, and the other two courses were taught in the Interior Design program in the College of Imaging Arts and Sciences (CIAS) at RIT with mostly hearing students. The participants were first-year and second-year college students. All of the courses taught various computer applications, including Autodesk AutoCAD, Autodesk Revit, SketchUp, Adobe Photoshop, and Adobe InDesign. The typical class format included a brief introduction and a demonstration by the instructor, followed by an in-class assignment to be completed independently by the students. Students then applied these skills to a project, to be completed either individually or as part of a team. The projects also varied in length of time, from one to several weeks. The projects were evaluated and graded, and the students' course grades were largely based on the accumulated project grades.

Procedure

As part of this research, the students were given a formal examination at the end of the term. The examination asked students to complete a small project using many of the skills learned during the term within a two-hour time frame. The format of this exercise was similar to the 'triple jump' assessment, which was developed to assess both knowledge and problem solving abilities. (Painvin, et al, 1979) During the first stage of the 'triple jump,' students received the problem description and requirements. No more than fifteen minutes were needed to determine a plan of action and the appropriate software tools needed for the solution. The second stage involved the execution of the solution, which consumed the bulk of the exam time, approximately one and a half hours. The third stage, for the final fifteen minutes of the exam period, students documented their solution by printing and submitting their drawings.

The exam's project was carefully created to mimic the type of projects on which the students had worked previously, albeit on a much smaller scale. It was important to avoid the kind of "mismatch between assessment and learning" that sometimes plagues PBL assessments. (Savin-Baden, 2004, p. 230) In this case, the key differences between the exam project and the semester projects were that the exam project had to be completed independently and within a two-hour time limit.

The purpose of this additional assessment was to see how well the students performed on the exam compared to the quality of their course projects. If there was a difference of more than a few percentage points, an attempt was done to ascertain the reason for the discrepancy. A grade difference of at least 10% (i.e. a full letter grade) was thought to be significant enough to warrant further investigation to determine the reason for the inconsistency. Table 1 shows a summary of the results of this experiment.

Course	*Course Name*	*Number of Students*	*Number of Students Affected*	*Percentage of Students Affected*
A	Construction CAD I	14	5	36%
B	Interior Design AutoCAD Elective	14	3	21%
C	Engineering Graphics in AEC	8	1	13%
D	Graphics for CAD	6	3	50%
E	Construction CAD I	7	1	14%
F	Interior Design Elective	18	4	22%
	Total	67	17	25%

Table 1 Summary of Results: Students Impacted by Formal Exams in Project-Based Learning Courses

RESULTS

For Course A, as shown in Table 1, the final exam grades were substantially different from the course projects grades for five of the fourteen students (36%). Four students performed poorer on the final exam compared to their course project grades, while a fifth student performed better. Two of the four students who performed worse were students who worked hard, but relied heavily on assistance to complete their projects. When asked to perform independently on the exam, they struggled. The other two students appeared to do well on their course projects, but did not perform well under the time limit constraints of the exam. Conversely, the student who performed better on the final exam was a student with strong skills, but got behind and frequently turned his work in late.

In Course B, two of the students affected by the final exam did noticeably worse on the final exam than their project grades, and one student did better on the final exam. The other eleven students received grades within three percentage points of their project grades, which shows that the skills demonstrated on the assignments accurately reflected their actual skillset. The two students who did poorly on the final exam required a significant amount of assistance, and they were persistent in getting the help they needed to complete their projects. The one student who did better on the final exam was a capable student who slacked off during the second half of the course.

The data for Course C showed a remarkable correlation between the students' project grades and their final exam grade. There was only one student who had a marginally significant difference. This student was a strong student who likely did not give much effort for the final exam with the knowledge that it would not have much impact his final course grade.

The three students impacted by the final exam in Course D requested a lot of assistance on their projects, and they often insisted that their projects be "pre-graded" before actual submission. The final exam demonstrated that they had not developed sufficient independent skills; instead their project grades tended to overemphasize their effort, rather than their actual skills.

The results for Course E were similar to Course C in that there was little difference between the final exam and the project grades. The one student who was impacted by the final exam was a hardworking student who would spend many hours in the CAD lab outside of class to work on her projects. She struggled with many of the concepts taught during class, but, to her credit, she would persevere with the course projects on her own time, while frequently requesting assistance. This student was unable to complete her final exam given the time limitations.

In the final course listed in this study, Course F, three of the four students affected by the final exam were also students who most frequently requested assistance to complete their assignments. Thus, they struggled when asked to complete the final exam independently. The fourth student did surprisingly poorly on the final exam even though she was an exceptional student during the course. Perhaps she did not take the final exam seriously since she already had a high course average.

Summary of Results

The above research shows a somewhat consistent result. Of the sixty-seven students in six courses included in this study, seventeen of them (25%) performed considerably differently on the final exam than they did on their course projects. Many of these students worked hard, but they found the material challenging to comprehend, and because they wanted good grades, they frequently requested assistance from their instructor or their classmates. However, when the final exam required them to work independently and within a limited time frame, they were unable to complete the work at the same standard that they met on their course projects.

The majority (75%) of the students in this study completed the final exam as would be expected based on their course projects. 'A' students earned an 'A' on the final exam, 'C' students earned a 'C' on the final exam, and so on. For these students, the final exam served to validate the student's skill level. For the other quarter of the students, however, the final exam did illustrate some valuable information about their skill level. In a few cases, students performed considerably better on the final exam, which indicated that they have strong skills, but they did

not take their course responsibilities seriously. For most of this group, however, students demonstrated less skill development than they apparently showed in their project work.

One student who did not perform up to expectations on the final exam admitted that if the final exam had been emphasized during the semester, he would have applied himself more earnestly to learn and internalize the skills being taught. In other words, his focus was not on the acquisition of skills but on simply completing the projects for a grade. Without an impending requirement to demonstrate the skills, some students simply lacked the will to develop their skills at a higher level. The self-motivation of the student to commit oneself to success is an important component of a PBL curriculum. (Van Berkel & Schmidt, 2000).

DISCUSSION

An important consideration for determining the appropriate type and level of classroom assessment is to clarify the meaning of the course grade. For the CADT program, the desire is that the student's course grade should reflect their skill level as well as their effort. However, using the program's traditional method of basing the course grade largely on project grades, the grade emphasized the student's effort too heavily, and it did not necessarily reflect the student's actual skill level. A prospective employer rightfully would expect that an 'A' student should be capable of performing superior work on the job. Therefore, the course grade ought to accurately reflect the student's actual skill level.

Admittedly, too much emphasis on the course grade can become problematic for PBL courses. A singular focus on grades "can encourage students to adopt methods of learning which ensure they pass the course with high grades, rather than to adopt learning approaches that would be in their best interests." (Savin-Baden, 2004, p. 231) Nevertheless, when the primary objective of the PBL course is to acquire a defined skillset, a means to assess that acquisition becomes a critical component of the course grade.

The other key lesson from this research is the importance of assessing students' ability to work independently. A valuable employee is one whom the supervisor can rely on to complete a task correctly, quickly, and independently. An employee who relies too heavily on the assistance of others can be seen as a burden to a company rather than an asset. In the CADT program's project-based courses, students are typically free to assist each other as they work on their assignments. Indeed, many of the projects are team-based where students are required to work with each other. Team work is an important skill, but if a student never makes the leap to be able work independently, then his or her value to a future employer will be limited.

Related to the ability to work independently is being able to work diligently. Completing tasks within a reasonable amount of time is a requirement for an effective technician. The job market is competitive, and if students are unable to accomplish their work productively, they will be at

a distinct disadvantage. Thus, time management and speed are an important part of the assessment process.

A formal means of assessment is very valuable in determining the students' true independent skills. Furthermore, relying on a final exam for this information may not be enough, because it would be too late to address the students' weaknesses during the course. Ideally, a series of formative assessments should be given to the students throughout the course. This would provide the instructor with important information about the student's independent skill development and allow for adjustments to provide students with more independent practice. Ultimately, the instructor has the task of preparing students for a successful career. Part of this responsibility is to accurately assess the students' progress towards this goal, and to make adjustments as needed. Even though a course may be project-based, providing formal means of assessing students' independent skills remains a critical part of the educational process and should not be dismissed as unnecessary or too burdensome.

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