LEVERAGING PBL AND GAME TO REDESIGN AN INTRODUCTORY COURSE

By

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ABSTRACT

The purpose of this paper is to discuss one instructional design that leverages problem-based learning and game structures as a means of developing innovative higher education courses for students as responsive, lived experiences. This paper reviews a curricular redesign that stemmed from the evaluation of an introductory course in computer applications that had high drop, failure, and withdrawal (D/F/W) rates. Interviews with students and faculty in this course revealed that students were not engaged with, motivated by, or satisfied with the instructional methods, which were often frustrating and difficult to navigate. Using data collected from students and faculty, we describe the full redesign of the course, which included ill-structured problems for students to solve, multiple forms of learning assessment, and a contextual framing stemming from a digital, alternate reality game design. When comparing the new design to the original, the first iteration research indicated decreased failure rates, increased achievement on standardized assessments, and a range of individual student experiences from high praise of the design to some disappointment.

Keywords: Undergraduate, Computer Literacy, Problem-based Learning, Course Redesign.

INTRODUCTION

"Many students graduate having accumulated whatever number of courses is required, but still lacking a coherent body of knowledge or any inkling as to how one sort of information might relate to others. (A)ll too often they graduate without knowing how to think logically, write clearly, or speak coherently…(t)he university has given them too little that will be of real value beyond a credential that will help them get their first jobs." The Boyer Commission on Educating Undergraduates (1995).

It has been more than a decade since the Boyer Commission (1995) suggested that post-secondary learning in the United States is failing our undergraduate students by not preparing them for the world of work that follows their academic studies. Further, it has also been suggested that the teaching methods used by course instructors may not have kept pace with the needs of an advancing society or the demands of the emerging world economy (Carini & Kuh, 2003; Fritschner, 2000; Kuh, 2001). An important area of weakness in the preparation of undergraduate students has been that their critical thinking abilities are not adequately developed, resulting in poor application of appropriate strategies to solve problems in different contexts (Ironside, 2003; Kallenbach & Viens, 2004).

With this weakness in mind, one particular effort to enhance the quality of the undergraduate experience in large, introductory courses at a mid-sized Texas university was developed in order to address troubling findings revealed by institutional data. By the spring of 2006, the university had identified several hundred sections of large enrollment undergraduate courses from which a significant number of students dropped within the first seven days, withdrew prior to the mid-semester deadline, or earned a grade of D or F. In most instances, these classes had enrollments larger than 150 in traditional lecture classes or greater than 30 in those that required computer laboratories.

To address this problem, institutional leadership initiated a program for redesigning courses delivered through large group instruction (LGI). Course redesigns were required to

include technology and teaching methods, specifically small group activities, that made large classes seem smaller or better engaged students in meaningful interactions with peers and instructors than the traditional lecture format. The goals of each course redesign was to improve student satisfaction, thereby reducing the Drop/Failure/Withdrawal rate, factors often adversely affected by LGI (Peterson & Miller, 2004). Enhancing critical thinking or problem solving skills was also a primary goal of these redesign efforts.

One course that underwent redesign was CECS 1100: Introduction to Computer Applications. This laboratory class (<33 students) was taught through the College of Education. The course introduced students to the history of the Internet, Microsoft Office Suite, and basic web tools. In addition to the university's goals, our purpose with the course redesign was to better prepare undergraduates for their future work beyond the classroom as professionals in the workplace, using technology tools to communicate effectively with peers and future employers.

Theoretical foundations

The course redesign leveraged elements of Problem-based Learning (PBL) (Albanese & Mitchell, 1993) and constructivist learning environments (CLEs) (Jonassen, 1999; Jonassen & Hernandez-Serrano, 2002) because of their reported impact on critical thinking and problem solving skills (Meyerson & Adams, 2003; Sage, 2002; Willis, 2002; Yip & Gafarian, 2002). This choice stemmed from the fact that the course emphasized skill acquisition and neither critical thinking nor problem solving were addressed in the previous design, which focused instead on acquisition of surface level skills and memorization.

Research has shown that PBL encourages learners to hone a variety of thinking skills:

- analyze and synthesize data;
- develop hypotheses;
- apply deductive reasoning to a problem situation;
- draw conclusions after analysis, synthesis and evaluation of new information;
- synthesize strategies/solutions; and
- monitor and evaluate own thinking process" (Tiwari & Lai, 2002, p. 2) .

In order to support this further, other designers have combined a PBL approach with proven critical thinking strategies that have been developed outside of PBL to enhance the existing strengths of the approach while providing additional scaffolding for learners (DiPasquale, Mason, & Kolkhorst, 2003; Elder & Paul, 2002; Everett & Zinser, 1998; Keller, 2002; Willis, 2002) such as the use of stories and narrative to contextualize experience and the inclusion small group tasks.

Thus, the framework for the redesigned course included elements from Savery and Duffy's (1995) PBL design principles, particularly an authentic, interactive learning environment, cognitive conflict, and opportunities for social negotiation, because according to these authors, "(i) Understanding is in our interactions with the environment … (ii) Cognitive conflict or puzzlement is the stimulus for learning and determines the organization and nature of what is learned … and (iii) Knowledge evolves through social negotiation and through the evaluation of the viability of individual understandings" (p. 1-2). The design team relied on Jonassen's (1999) criteria for creating the ill-structured problems, which shape the core of PBL environments. These criteria include unstated goals and constraints, uncertainty about which concepts and principles are necessary for the solution, as well as multiple criteria for evaluating problem solutions (Jonassen, 1999).

Interactive learning games

Not only has PBL been correlated with a propensity for enhancing critical thinking skills (Tiwari & Lai, 2002) and improving post-secondary learning experiences by providing authentic tasks (Bonk, Kirkley, Hara, & Denned, 2001), it also compels students to engage in story-driven learning tasks much like those found in video games. PBL makes sense as a basis for developing a form of game scenario at the post-secondary level (Albanese & Mitchell, 1993; DiPasquale, et al., 2003; Elder & Paul, 2002; Keller, 2002; Kolodner, 2002; Willis, 2002; Zembal-Saul, Blumenfeld, & Krajcik, 2000) because this instructional model requires the presence of rules governing student and instructor interaction and roles, artificial conflict in the form of ill-structured problems, and "win scenarios" in which

students have successfully or sufficiently developed a defensible solution to the problem or conflict. Compounded by the fact that post-secondary learners tend to be motivated by internal self-esteem, recognition, need for a better quality of life, and self-actualization rather than extrinsic rewards (Rachal, 2002; Shank, Winchell, & Myers, 2001; Terehoff, 2002), the learning activities were packaged in such a way that they mirrored real-world tasks contextualized by the narrative overlay common in computer and video games that has been found to motivate learners, particularly those that require additional feedback, peer support, and motivations that they may not find in more traditional classrooms.

However, given the complications and expense of designing immersive game worlds that include both the narrative plot and the requisite scaffolds to facilitate learning (Warren & Jones, 2008), alternative media that leverage these elements may be used (Jones & Warren, 2008). One such alternative is to embed game activities that reveal enabling information and resources in a variety of media, distributed across the Internet rather than a fully integrated, stand-alone product. This approach maximizes resources, such as MySpace, web logs, podcasts, YouTube, and the three-dimensional digital environment of Second Life that students use as part of their daily lives (Dondlinger & Warren, 2008; Warren & Dondlinger, 2009). As such, it creates an open system of resource distribution that more authentically mirrors the context to which learners will transfer the skills and knowledge gained in the learning activities.

Alternate Reality Games (AltRGs)

A fairly new genre of game, the Alternate Reality Game (AltRG) does just that: distributes game challenges, tasks, and rewards across a variety of media both digital and real. As described by the International Game Developers Association (Martin & Chatfield, 2006), "Alternate Reality Games take the substance of everyday life and weave it into narratives that layer additional meaning, depth, and interaction upon the real world" (p. 6). CNET staff writer, John Borland (2005), depicts them as "an obsession-inspiring genre that blends real-life treasure hunting, interactive storytelling, video games and online community" (para. 4).

Although the AltRG as a game genre has emerged quite recently, web sites like unfiction.com and ARGNet have links to several past and current AltRGs, such as cathysbook.com and iamtryingtobelieve.com. Some AltRGs have served a marketing function, such as ilovebees.com that supported the release of Microsoft's Halo 2 video game. Others have an educational focus; Hexagon Challenge and Never Rest Game are billed as instructional AltRGs and claim to "address decision-making skills, after-action report generation, and adaptation to performance" (Bogost, 2007). Yet others, while not explicitly educational, deal with social, economic, or environmental justice and aim "to change the way people think, and feel, and live" (Strickland, 2007). Jane McGonigal, who masterminds AltRGs for their capacity to construct "collective intelligence," maintains that the purpose of her 2007 ARG World Without Oil (Ernst, 2007) was to "play our way to a set of ideas about how to manage that crisis [a dramatic decrease in oil availability]". (cited in Strickland, 2007, p. 1) McGonigal observed that players not only generated strategies for coping with a peak oil crisis, they also changed their real world behavior: planting trees or converting their cars to run on biodiesel (Strickland, 2007). Thus, the simulated problem presented through the ARG yielded practical solutions and prompted real world applications of the knowledge constructed in the simulated play space.

Analysis of Existing Course Materials

The original course was designed to teach the basics of computer parts, Internet use, online security, and the use of Microsoft Office as implemented in Adobe Flash-based Computer Assisted Instruction (CAI) program called SAMS 2003 Computer Literacy™ (Thomson Course Technology, 2007). Analysis of the course materials and notes from interviews with students in the existing course revealed several issues that led to dissatisfaction with the existing curriculum and instructional methods used in the course. The design team identified the following problems:

- Functions in one program were not linked to others. Understanding how the programs can be used in a complementary fashion is an important objective that wasn't addressed in the existing curriculum. Students

found learning the same skills in four different programs boring and repetitive, since many students were already familiar with these basic actions from previous computer applications courses in high school.

- Computer-based assessments and instruction were too rigid. There are commonly three to five ways to perform an action in a program; however, the program often recognized only one. In some instances, the practice exercise asked a student to complete a task in one manner, while the assessment compelled another.
- Applications of knowledge were decontextualized and unrealistic. Based on students' current life experiences, the applications of learning expected in both the training practice and exams don't fit well with an undergraduate's life experiences. Students saw little relevance between course content and their future work. They also found the constant drill and practice tedious.
- Computer-based instruction provided weak feedback. The system provided weak feedback during both training and often none during exams. The amount of feedback did not increase or decrease dependent on how many correct or incorrect answers students provided for a specific objective.

Based on this analysis, the design team determined that the following measures be taken to address the underlying problems:

- The number of discrete learning objectives should be revised from 750 to 150. Given the length of the course, the sheer number of objectives was overwhelming to students, and should be collapsed to eliminate redundancies from unit to unit. For example, the objectives "The learner will be able to open an MS Word document" and "The learner will be able to open an Excel spreadsheet" should be consolidated to read, "The learner will be able to open documents within MS Office."
- Requirements for the course should be stable across sections and semesters, but revised yearly to incorporate innovations in the field. With rapid changes in information technology and differing needs of students, course requirements should be updated regularly. An examination of state technology requirements for K-12 learning should take place yearly to ensure that the course does not simply re-teaching the same concepts students learned in high school.
- The course should be centered on larger learning projects and problem solving using the software, not around disembodied learning tasks. The nature of the computer applications introduced in the course readily lends them to a project-based or contextual learning approach. To better engage students with these tools in the manner for which they're intended, the learning tasks should leverage them as a means to solve an ill-structured problem, design a project, or effectively communicate ideas to others. Development of appropriate, rubric-based assessments rather than multiple-choice tests is also warranted.

Instructional Design

The university's retention goals, the research literature, and analysis of the existing course supported a redesign using problem-based learning methods. Furthermore, the use of story-like scenarios typical of problem-based learning (PBL) (Savery & Duffy, 1995) is a prominent element in digital games, and media products known to engage players for hours on end. However, given the challenge and cost of designing an immersive game world, alternative media that leverages that both narrative plot and the requisite learning scaffolds to facilitate learning is necessary. One such alternative is to embed game activities and resources in a variety of media, distributed across the Internet using Alternate Reality Game (AltRG) structures (Martin & Chatfield, 2006; Terdiman, 2008), rather than a fully integrated, stand-alone product. This approach maximizes resources, such as MySpace, generic web logs, Podcasts, YouTube, and the three-dimensional digital environment of Linden Labs' Second Life.

Teamwork and learning game resource distribution

Within the course curriculum, students were expected to work in small teams of 3-4 students to solve problems posed by fictional clients similar to those they may encounter in a video game that last for two weeks; it is

during this time they explore the resources provided to them or uncover more as they play the game. This helps create an open system of resource distribution that authentically mirrors the contexts to which learners will transfer the skills and knowledge once they are done with college and working in the real world. This concept also allows designers to exploit many free online resources while merging them with PBL methods to give learners a situated, coherent narrative to contextualize their learning experience while concurrently providing cognitive scaffolds from which to retrieve knowledge and skills necessary to their future work and learning. In order for students to cognitively transition from an acquisition model to knowledge construction requires curricular and instructional innovation.

Hybrid course format and technology tools

Students in this class met face-to-face four to ten times during the semester, depending on instructor and student preference, to practice the basic skills needed to complete coursework. The remainder of the time, the class met in small groups online in the Second Life digital environment, which is free to download and enter. Visual imagery and audio provide information, tasks to complete, and a larger narrative structure within which students may situate their learning. Rather than listening to lectures and taking large multiple-choice tests, students will hone their technology skills by solving ill-structured problems that they encounter in the 3-D environment. They worked in small groups, using productivity tools to develop products that solve posed problems, and take part in support one another using a complimentary courseware tool called Moodle. The goal of this instruction was to provide students with a general set of skills that will allow them to use any word processor, spreadsheet program, or presentation tool and adapt to new versions readily. Problems were contextualized within a larger narrative structure that takes students along through a linear story within which their understanding was be situated. Game structures such as an overarching conflict, objectives to complete, clues to seek out and interpret, and feedback from the 3-D system were expected to increase student engagement with the learning of basic computer skills and knowledge.

PBL and AltRG design

Both problem-based learning (PBL) and alternate reality game structures were used to redesign the computer applications course. Rather than listen to lectures, complete practice exercises, and take frequent multiple-choice tests, students hone their technology skills by solving a series of ill-structured problems posed by fictional clients using the very tools they are expected to learn. Students work on each task or problem in small groups of two or three, using a variety of productivity and communication tools. The redesign made use of a hybrid or blended learning format. Face-to-face class time was dedicated to delivering instruction and to facilitate group problem solving. Online resources, support, and collaboration tools were also provided through the free courseware platform, Moodle. However, students were encouraged to make use of whatever productivity and communication tools best fit the dynamic of their groups. Emphasis was placed on communicating with peers, in class and online, to develop viable and deliverable solutions, rather than enforcing conformity to a specific version of a designated proprietary software program.

The goal of this instruction was to provide students with a general set of skills that would allow them to use any word processor, spreadsheet program, or presentation tool and adapt to new versions readily. It also addressed some of the issues cited previously that frequently accompany online learning and digital collaboration, compelling students to negotiate solutions to issues of accessibility, software compatibility, and file management in their own teams. For example, if one team member could not afford the latest version of Office, the team might use Sun's Open Office or Google Docs. These broadened objectives were expected to better prepare students for their future world of work.

Alternate Reality Game (AltRG) course structure

The Door AltRG was designed with a two-tiered narrative structure that framed course activities and provided the context for problem solving. The first tier of this narrative engaged students with fictional clients who "hired" student teams to complete authentic tasks — a problem-based narrative approach. The second tier engaged students in game structures that included puzzles, codes, and ciphers

that must be solved, retrieved or used correctly in order to gain access to materials, information, and resources that provide additional scaffolding and narrative support to the first tier learning tasks. In essence, each of the clients and characters in the six, problem-based learning scenarios had alternate personas, hidden beneath their client identities, and all of them were embroiled in an underlying conflict with each other as well as the unsuspecting student players. Within the top-level story of The Door, students are asked by "clients" to solve complex, ill-structured problems that require them to use all the major components of Microsoft Office. The problems students faced ranged in complexity. In one instance, students had to provide directions to an inept old coach and gym teacher for how to construct a properly functioning grade book spreadsheet in order to allow him to keep his job at a middle school. In another instance, students develop an improved web site for a local nightclub that included appropriate use of basic color theory and space usage.

At the same time, clues appear indicating that a software program called the Autumnal Equinox Firewall has disappeared which may have dire consequences for both the students and the world. Through these clues, the second tier of the story is revealed. The Puppet Master character of the game, Hester, offers students rewards for locating relevant game information. Further, she notes that additional resources to improve their problem solutions will be revealed if they obtain these rewards, such as a video that students can locate in YouTube (link here) if they put together a web address correctly.

In this way, the Puppet Master, played by the instructor, provides soft scaffolding and additional resources for students who may be struggling either to solve the ill-structured problems or locate game resources. Game characters also act as gatekeepers, judging the quality of student solutions and preventing them from moving to the next problem until the last has been adequately addressed. As students move through the story at both levels, clues and minor puzzles are revealed. If students are successful at piecing this information together, they may discover that the clients are intended to be the ancient Greek gods seeking to reclaim followers and power by harnessing the power of the Internet, a power these students seek to understand. This included web sites we created, Ning, Moodle, and e-mail all linked together as shown in Figure 1.

Visual imagery and audio were used to provide objective information about the ill-structured learning tasks and to spur communications among students, instructors, and game characters. Further, the two-tiered narrative framing provided the means for students to situate their learning in a more meaningful and engaging context (Warren, Stein, Dondlinger, & Barab, 2009). It also encouraged students to interrogate the inconsistencies between the two plotlines and was leveraged to challenge students to rethink their surface-level understandings of what was presented to them by the game.

Student learning outcomes and assessment. As noted earlier, student learning outcomes (SLO) were reduced from more than 750 separate outcomes/learning objectives to 150, mainly by eliminating those that were repetitive from one MS Office program to the next. The objectives that emerged may be found here. These outcomes were only those specifically related to surface-level learning related to either memorization of facts or application of skills based on rote memorization.

Rationale for the study

Existing literature indicates that students are motivated by video games to engage in tasks that they are traditionally

Figure 1. Distributed resources, clues, and communication tools for the ALTRG.

resistant to in school. Few studies have engaged undergraduates in game-based curriculum tied to ill-structured problems requiring high levels of group knowledge construction and problem-solving and most that have indicate no significant gains on achievement tests when compared with traditional, direct instruction curriculum. The authors expected that merging game and problem-based learning elements into an immersive experience should result in both not only learning gains on an objective test, but also lead to improvements in student experience with the course that in turn reduce drop, failure, and withdrawal rates when compared with others that do not employ this pedagogical and curricular approach.

Purpose of the study

As with any new instructional methodology, it is as important to discover the specific answers as to why it was more effective than another method as it is to learn that it is effective at modifying behavior, improving achievement, or engaging learners in reflection associated with improvements in critical thinking. Therefore, the purpose of this study was to discover whether the game and PBL-based CECS 1100 undergraduate curriculum could improve student achievement, drop, failure, and withdrawal (D/F/W) rates, and general satisfaction with the CECS 1100 course when compared with a course that continued to use the old computer-based instruction curriculum.

Research Methods

Participants and site

Eighty-nine students at a large southwestern university who enrolled in the introductory computer literacy course participated in the study. These students came from a wide range of colleges and majors ranging from Education and Business to Arts and Sciences. Sixty-one of these students were female and 28 male. The study took place in a computer classroom at the College of Education where students either took part in the experimental curriculum or the traditional curriculum depending on which section they chose to enroll in with no prior knowledge of the pedagogical or curricular approach.

Data collection and analysis

This study employed a quasi-experimental, posttest comparison design to measure the effect of a digital game-based, problem-based curriculum in a hybrid course on student achievement as compared with student achievement in the existing course curriculum. The posttest questions used the shared learning objectives for each section of the course as a means of developing common test items that would be given to students on both the pretest and final exam, which would act as the posttest. In the instance of the achievement questions, students were randomly assigned to a condition dependent upon the section of the course that they signed up to take with no prior knowledge of the research questions and with no undue influence by the researchers. One section engaged in the existing face-to-face curriculum and served as the comparison group. A second section, developed specifically as a hybrid course with six total face-to-face meetings combined with learning tasks and activities to be completed online using open-source and no-cost Web 2.0 tools. This section acted as the treatment condition.

Research Questions

The following were our main research questions linked to overall goals of the course:

Question 1

Can the use of a game-driven, problem-based learning curriculum for post-secondary learners that leverages existing and developed distributed learning resources should improve the achievement of learners at a statistically significant level more than those learners in the existing drill and practice-based course?

In order to address this question, students in the two conditions engaged with either the treatment or comparison curricula over the course of the semester. At three points during the semester (pretest, midterm and final), each group then completed exams based on the same learning objectives shared by each curriculum. For the purposes of the report, we only report the pre and posttest scores, as the midterm did not meet requirements for adequate validity as a testing instrument.

Question 2

Can the use of a game-driven, problem-based learning curriculum for post-secondary learners that leverages existing and developed distributed learning resources improve the level of satisfaction expressed by learners more than those learners in the existing drill and practice-based course at a statistically significant level?

This question was addressed by providing students with a survey of learner satisfaction with the overall course, the means of instruction, means of assessment, and learning activities similar to the means of course quality assessment that will be provided by the College of Education. While summative, this survey was more in-depth than the traditional five-question survey provided by the university. It asked specific questions about the delivery of instruction by the game and online systems, attitude toward instructor, attitude towards instructional style, self-report of instructional style, attitude towards individual learning components and activities, attitude towards peers, as well as general satisfaction with the course.

Results

The analysis of scores from first, Spring 2007, implementation of the experimental curriculum had mixed, but promising results on measures of retention, satisfaction, and achievement as shown in Table 1.

The results indicate an 8.55% difference in the percent of students who dropped, failed, or withdrew between the comparison course and the treatment, which, while not significant, shows some improvement in raw numbers, though the groups are to small to reach the needed t-score. However, satisfaction with the redesigned course, as gauged by the college course evaluation which is the main measure used by the university to measure student satisfaction with a course, was statistically significantly higher than in sections using the existing course design. Finally, student achievement, as measured by post-test in both groups, and compared using a two-sample t-test assuming unequal variances showed statistically significant improvement in the treatment group the comparison group, indicating that students retained more of the reified knowledge the authors expected them to learn than the old course curriculum.

	Comparison *n=57*	Treatment *n=32*	Differences
Retention (% DFW)	21.05%	12.50%	-8.55%
Drops	1	2	
Failures	2	0	
Withdrawals	9	2	
Satisfaction	3.64	4.2	*alpha=.05, z(6)=6.86, p=1.64
Achievement	M=78.83	M=85.96	*t=3.90,crit=1.67

*statistically significant

Table 1. Quantitative results for student retention, satisfaction, and achievement.

Limitations

In the interests of space and scope, the report of the study here focuses on the quantitative findings while the qualitative findings may be found elsewhere so that they can be reported fully. This removes a major element from this particular report that provides additional context for the findings from this study. Further, instructor influence may have been a factor in the outcomes when comparing student outcomes on the achievement and satisfaction scores as they play a large role in student success. Had another instructor been chosen for the comparison course, it is possible no statistical significance would have been found. However, this is a major challenge in all research employing comparison and treatment groups. In order to address this in future research, the experimental course section will be compared against several different sections employing non-experimental methods.

Sustainability and replication

The course continues to be taught in different forms each semester. These differences stem from data collected each semester from students and faculty teaching the course. Upon reviewing the qualitative data collected to contextualize the quantitative findings, communication problems among students in their groups was paramount, indicating that this is a skill entering freshman substantially lack. This also had roots in the design of the course that required high levels of communication using digital tools as a means of completing work and asking questions. Problems of communication were further exacerbated by the size of some of the groups that ranged from three to five, depending on student choice. Finally, a lack of student experience with group communication and problem

solving that they brought with them to the course from high school and other undergraduate courses further complicated matters.

Problem-based learning and communication

In addition, while the problem-based learning component was challenging for some students, interviews conducted with students, as reported elsewhere (Warren, 2010; Warren & Dondlinger, 2009), they made clear linkages between problems they were solving in the course and those they would have to solve in the future. However, while several students reported disliking working in groups to complete tasks, they did recognize its necessity in their future careers and that excellent interpersonal communications skills are necessary for their future success. The next iteration of this course will undergo a full redesign in order to specifically target each of these communicative goals and allow for the evaluation of student and instructor success at reaching them. The authors will also redesign the problem-based aspect of the course and some game aspects so that students must complete the game in order to successfully complete the course, which we hope will result in more voluntary play and higher student satisfaction rates amongst students.

Future research

Future research will seek to confirm the findings of this particular study as well as to more deeply explore a large number of student experience by employing a number of different research tools including student web log (blog) reflections, bi-weekly interviews, and other forms of data collection to capture student experience as they work through the course. In addition, they will specifically focus on the mediating and aggravating roles of group communication, student self-regulated learning, problem-based learning methods, and the degree to which the game elements help or hinder learning.

Conclusion

While the instructional methods have yielded mixed results in the pilot research stemming from the use of problem-based learning and its accompanying reliance on students to self-organize and solve ill-structured problems, it has provided a wealth of data and results related to improving student experience with experimental and innovative instructional methods that push towards the edges of what our students are capable of as they enter college. Overall, the results of the research related to this course redesign leave the researchers hopeful that the hybrid course and use of an AltRG combined with PBL methods to frame the problem-based learning tasks and group interactions were responsible for the improved test scores. While the statistical findings of this study were mixed in terms of student retention, the increased post-test and ratings scores are promising and will be followed up with additional studies on future iterations of the course.

Students were often not prepared by high school for the innovative curricula they should expect in college. Therefore, we must work more closely with professionals in K-12 settings and at state agencies to better prepare students and instructors for the critical thinking and creative tasks they should expect in college and beyond. Developing innovative curricula in high school that both targets acquisition of knowledge and skills while challenging students to solve ill-structured problems and be prepared for self-direction, ambiguity, and critical thinking will require that instructional designers and educators on both sides of the secondary/post-secondary line challenge the fundamental objectives of schooling. By doing so, we prepare our students for the future world of work in meaningful ways that allow them to be successful in the 21st century Conceptual Age economy rather than be left behind because they are not prepared to adapt to the rapidly changing world around them.

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