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Student Engagement in a Large Classroom: Using Technology to Generate a Hybridized Problem-based Learning Experience in a Large First Year Undergraduate Class

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Abstract

Large first year undergraduate courses have unique challenges in the promotion of student engagement and self-directed learning due to resource constraints that prohibit small group discussions with instructors. The Monthly Virtual Mystery was developed to increase student engagement in a large (N = 725) first year undergraduate class in anthropology at the University of Toronto Mississauga. The teaching challenge was to develop a participation component (worth 6% of the final grade) that would increase student engagement without incurring any additional resource costs. The goal of the virtual mystery was to incorporate the principles of problem-based learning to engage students in self-directed learning through an online medium. Groups of approximately 50 students collaborated on a series of "virtual" case studies in a discussion board. Students submitted comments or questions each week to identify the information they needed to solve the mystery. A facilitator oversaw the discussion board to guide students in collaboration and resource acquisition. The final grades of students who participated in the virtual mystery (N=297) were compared to students who participated in a passive online learning exercise that involved watching weekly online videos and answering questions in a course reader (N = 347). Student self-selection determined group participation. Participation completion for both the virtual mystery and the course reader were high (78.8% and 91.6% respectively). There were no significant differences in the distribution of final grades between the participation options. The high completion rate of the virtual mystery demonstrated that an active learning project can be implemented using problem-based learning principles through an online discussion board; however, the large online group collaborations were problematic. Students were frustrated with repetition and inequitable participation in such large groups; however, students evaluated the monthly mystery as a valuable learning tool that engaged them through the practical nature of the case scenarios.

Au premier cycle, les grandes classes de première année présentent des défis uniques en ce qui concerne la promotion de la participation de l'étudiant et de l'apprentissage autonome en raison des contraintes au niveau des ressources qui empêchent les discussions par petits groupes avec des instructeurs. Le Monthly Virtual Mystery (Le mystère virtuel mensuel) a été créé afin d'améliorer la participation des étudiants dans les très grandes classes (N = 725) d'anthropologie de première année, au premier cycle, à l'Université de Toronto Mississauga. Ce défi en matière d'enseignement avait pour but de développer une composante de participation (qui valait 6 % de la note finale) qui allait permettre d'augmenter la participation des étudiants sans que cela entraîne des coûts supplémentaires en ressources. L'objectif du mystère virtuel était d'incorporer les principes de l'apprentissage par problèmes afin d'engager les étudiants dans un apprentissage autonome grâce à un support en ligne. Des groupes d'environ 50 étudiants ont collaboré à une série d'études de cas « virtuelles » dans un forum de discussion. Les étudiants ont envoyé chaque semaine des commentaires ou des questions afin d'identifier les renseignements dont ils avaient besoin pour résoudre le mystère. Un animateur contrôlait le forum de discussion afin de guider les étudiants dans leur collaboration et leur acquisition des ressources. Les notes finales des étudiants qui avaient participé au mystère virtuel (N = 297) ont été comparées à celles des étudiants qui avaient participé à un exercice d'apprentissage passif en ligne qui consistait à regarder des vidéos hebdomadaires en ligne et à répondre à des questions figurant dans un recueil des textes du cours (N = 347). L'auto-sélection des étudiants avait déterminé la participation aux groupes. La participation, tant pour le mystère virtuel que pour le recueil des textes du cours, a été très élevée (78,8 % et 91,6 % respectivement). Aucune différence significative n'a été notée entre les deux options de participation

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en ce qui concerne la répartition des notes finales. Le taux de réussite élevé du mystère virtuel a montré qu'un projet d'apprentissage actif peut être mis en place si on utilise les principes de l'apprentissage par problèmes dans un forum de discussion en ligne. Toutefois, les collaborations de grands groupes en ligne ont posé quelques problèmes : les étudiants se sont sentis frustrés par la répétition et la participation inéquitable dans de tels grands groupes. Pourtant, les étudiants ont évalué le mystère mensuel comme un outil d'apprentissage utile qui leur a permis de participer grâce à la nature pratique des scénarios des études de cas.

Student engagement is a key factor in successful learning. Smith, Sheppard, Johnson, and Johnson (2005) define student engagement as "the frequency with which students participate in activities that represent effective educational practice" (p. 87). Several large scale studies at post secondary institutions have supported the idea that student engagement in response to the delivery of the curriculum is as important as the actual content of the curriculum in determining student outcomes (Astin, 1993; Light, 2001; Pascarella & Terenzini, 2005). The unique problems of engaging students in large undergraduate classes have been noted in many publications (e.g., Allen, Duch, & Groh, 1996; Klegeris & Hurren, 2011; Long & Qin, 2014; MacGregor, Cooper, Smith, & Robinson, 2000; Murray & Summerlee, 2007; Pastirik, 2006; Reid, 2012). Several pedagogical practices have been used to increase student engagement such as problem-based learning, small group collaborative problem solving, and undergraduate research (Macgregor et al., 2000). All of these practices required increased instructor to student contact and material resources. The cost of these resources is often prohibitive for large classroom settings. In order to reduce these costs, technological devices such as "clicker technology" have been used in large classrooms to increase student participation and problem solving (DeBourgh, 2008; Revell & McCurry, 2010; Skiba, 2006). Online discussion boards and blogs have also been used in large classes as a way for students to communicate ideas (Chhabra & Sharma, 2013; Gibbings, Lidstone, & Christine, 2015). Savin-Baden (2014) suggests that more research is needed on the effectiveness of learning through connectivity (i.e., online technology) in problem-based learning.

Problem-Based Learning (PBL) is a teaching strategy that promotes problem solving as a key tool for critical thinking and self directed learning in real life situational settings (Dolmans & Schmidt, 1996; Loyens, Jones, Mikkers, & van Gog, 2015; Wood, 2003). It provides students with an opportunity to apply theoretical learning to practical situations. Proponents of this teaching method originate in the medical profession where multidisciplinary clinical skills are imperative for a successful medical professional (Barrows & Tamblyn, 1980). PBL has subsequently been successfully implemented in other professional undergraduate settings such as engineering (Woods, 1996), architecture (Maitland, 1998), and nursing (Tiwari, Lai, So, & Yuen, 2006).

PBL is based on a seven step process (Bate, Hommes, Duvivier, & Taylor, 2014; Schmidt, 1983; Wood 2003). Students are given a scenario that is rooted in knowledge that they have previously acquired (Sockalingam & Schmidt, 2013). They work in small groups as a collaborative and motivational process. In these small group interactions, students brainstorm the particular problem. Group members become self-directed learners as they use available resources to determine the missing elements of the scenario. They hypothesize the problem and identify the information that they need to successfully solve the problem. Students work independently to gather the information, and then they reconvene to discuss the learning outcomes and test the hypotheses using their new shared information (Klegeris & Hurren, 2011; Norman & Schmidt, 1992). PBL rests on the belief that students learn best when they are active participants in their learning rather than passive recipients of information (Barrows, 1996; Bate et al., 2014; Loyens et al., 2015). The collaborative nature of the PBL groups has been shown to increase student motivation, and self-directed learning (Berry, 2008; Dolmans & Schmidt, 1996; Greening, 1998; Schmidt, Rotgans, & Yew, 2011; Smith et al., 2005). Instructors act as guides and meet with group members to facilitate their discussion and supervise the investigation (Loyens et al., 2015; Wood, 2003). Studies have found an increase in student satisfaction (Blumberg & Eckenfels, 1988; Klegeris & Hurran, 2011; Prosser & Sze, 2014; Smith et al., 2005), problem solving skills

(Raiyn & Tilchin, 2015; Schmidt et al., 2011) and self-directed learning skills (Norman & Schmidt, 1992; Prosser, 2004; Yew, Chung, & Schmidt, 2011) associated with PBL methods.

Hybridized PBL utilizes the principles of PBL in combination with other conventional teaching and assessment techniques, such as integrating traditional lectures as scaffolding to provide fundamental concepts (Klegeris & Hurren, 2011; Murray & Summerlee, 2007). Jonassen (2011) discusses different forms of cognitive scaffolding to support students in their problem solving skills (e.g., "simulations, worked examples, structural analogues, case studies") (p. 100). Savin-Baden (2014) outlines nine different constellations or hybrids of PBL based on the goals and tasks of a particular course or discipline. These constellations all involve problem solving at their core but they vary according to the "problem type, form of interaction, knowledge focus, form of facilitation, focus of assessment and learning emphasis" (Savin-Baden, 2014, p. 197). In this anthropology course, students were tasked with PBL through activity. In this constellation, students focus on a particular problem to increase their engagement in the course material. It also serves to allow students from diverse backgrounds to collaborate and adapt to a novel learning environment. The hybridized PBL "encourage(s) (the students) to develop self-directed research capabilities" (Savin-Baden, 2014, p. 205).

Self directed learners must be motivated to take responsibility for their education in order to pursue independent learning (Allen, Donham, & Bernhardt, 2011). This takes on a dual challenge in first year introductory courses with large classrooms of several hundred students. In first year undergraduate courses, the majority of students are not familiar with teaching techniques such as PBL. In addition, it has been recognized that in these large courses, resources for materials and facilitators is a deterrent to teaching techniques that utilize small group collaboration with a supervising facilitator (Klegeris & Hurren, 2011; Murray & Summerlee, 2007; Robinson, Harris, & Burton, 2015). This study addresses two important gaps in the PBL literature. Firstly, most PBL studies examine class sizes of 100 students or less, and secondly the use of technology to facilitate PBL has not been widely studied (Allen et al., 2011; Chapman, Keller, & Fournier, 2002; Klegeris & Hurren, 2011; Murray & Summerlee, 2007). In this project, PBL principles were applied to a large classroom of several hundred students using an online discussion board to act as the forum for group discussions. Secondly, the course outcomes of this active learning experience (N=297) were compared to a passive learning option in the same student population (N=347).

Method

At the University of Toronto Mississauga (UTM), there is a maximum of 800 students in the introductory first year undergraduate course entitled the Introduction to Biological Anthropology and Archaeology. The course has been designed to include two weekly one-hour lectures and one weekly 50-minute laboratory session in which the students work in small groups to complete laboratory assignments. All teaching assistant hours are allocated to the weekly laboratories. The virtual mystery was developed in 2010 to engage students in self-directed learning by presenting them with a practical anthropological problem for them to collaborate on an ongoing basis. The student feedback was positive on student opinion surveys, and it was tested against an alternative option during the spring session in 2014.

The teaching challenge was to develop a participation component that would increase student engagement in the lecture and lab material without incurring any material or resource costs (including the costs of additional teaching assistant support, ongoing technological

maintenance, infrastructure, and teaching support). Costs were not incurred because the Virtual Mystery was set up through the University of Toronto Blackboard Discussion Board by an IT specialist in the library at UTM, and monitored by the instructor and a head TA throughout the course. The allocation of the head TAs hours to the mystery was offset by the set up and take down of the labs amongst the other teaching assistants. The mysteries were adaptively released so that set up was only required at the beginning of the course. The primary obstacle was the large group sizes (N =50 students). This was significantly larger than standard PBL group sizes (N = 8-10 students). This was a cost and resource limitation. The number of available mystery scenarios limited the number of mystery cases that could run simultaneously. Additional funding would be required to build a mystery data bank so that several cases could run simultaneously to smaller groups of students. This was not a technological issue as Blackboard is capable of adaptively releasing many forums simultaneously, as well as archiving their comments and grades.

The Monthly Virtual Mystery was an anthropological problem that appeared in the discussion board of the course website. The mystery was presented as a case scenario with a series of photographs that related to lecture and reading material for that week. Students then entered questions and comments onto the discussion board to identify the information that they needed to solve the mystery. The students used the weekly clues to form more questions and submit comments based on information that they had acquired from course resources (e.g., textbook, lectures, labs, online resources). Students saw the comments of the members of their group after they had entered their comment. The discussion board was monitored by a facilitator, who deleted comments that did not relate to the mystery, and posted questions to guide students to the appropriate resources. In addition, students were able to see the actual specimen on display in the lab. At that time, they could discuss the mystery with other group members. There was a different mystery posted for different lab sections so that collaboration could be limited to groups of 50 students. The system automatically saved all the students' comments and a grade of one mark was automatically added to the Blackboard grading system once a facilitator had approved the comments. Students were given one mark each week for their comments and questions (for a total of 6% of their final grade). They were not graded on their ability to solve the mystery per se but on the thoughtfulness and validity of their question or comment. At the beginning of each month a new mystery appeared and the process began again.

In order to ensure student engagement, the students were given a choice for their participation grade for the Spring 2014 course. They chose between this PBL option and an alternative passive learning option where they watched 12 short online video segments from a course reader. In this alternative video option, students watched a 5-minute online video each week and answered a series of online questions about that video. Each video summarized a different chapter of their textbook. The students received 0.5% for each video if they answered all the questions correctly (for a total of 6% of their final grade). Correlation coefficients were measured between a student's participation grade and their final grade for both learning groups. An independent t-test ($p<0.05$) was performed to see if there was a significant difference in the means of final grades between the students who successfully completed the virtual mystery versus those who completed the course reader. This study fell within section 2.5 of the Tri-Council Policy Statement on Ethics, and it was therefore approved as a program evaluation review within normal educational requirements.

Example of a Monthly Mystery

January Monthly Virtual Mystery: Week 1 clue. This specimen was discovered on an isolated sandy beach in Tobermory, Ontario by two local cottagers. The remains were passed on to the Ontario Provincial Police and they were taken to the Toronto Coroners' Office for further investigation. A biological anthropologist from the University of Toronto Mississauga was called in to identify the specimen, and determine if it is of forensic interest. You are the biological anthropologist. What are the first questions that you would like to address?

January Monthly Virtual Mystery: Week 2 clue. You have many thoughtful and valid points but remember that an investigation such as this occurs in stages. Find at least two references in your readings to help you identify if these are human remains. What methods can be employed to narrow down the identification of this individual? How would you determine parameters such as sex, age, general features, ethnicity?

January Monthly Virtual Mystery: Week 3 clue. Well done everyone. Many of you found methods to narrow down the identification of this individual. Now let's look closely at the damage to this specimen. Is there evidence of trauma? Find methods to examine the elements of this trauma to determine if this is of forensic interest.

January Monthly Virtual Mystery: Week 4 clue. Now you can write up your report for this forensic case. Use information from the course materials and the references that you have found to answer the key components of forensic interest, possible trauma, and the circumstances surrounding the death.

Let's Solve the Mystery!

Results

In the Spring 2014 Session, there were a total of 725 students who completed the course. 347 students chose the course reader option, and 297 students chose to participate in the virtual mystery. 81 students did not participate in either option (See Table 1). In both participation options, the majority of students successfully completed the tasks and received 6/6 in participation (N=318 course reader participants and N=234 mystery participants); however, there was approximately 12% higher participation completion among students who chose to watch the videos (91.6%) over students who chose the virtual mystery (78.8%) (see Table 1).

Table 1
Participation Grade (Out of Six): Students who Chose Course Reader or Virtual Mystery

Participation Grade	Course Reader	Virtual Mystery	Total Students
0			81
1	3	9	12
2	3	9	12
3	5	14	19
4	7	14	21
5	11	17	28
6	318	234	552
Participation total	347	297	644
% completion	91.6%	78.8%	

An independent t-test was run on the data for the mean difference between the final grades. No significant difference in the mean of the final grades of students who completed the course reader (X = 69.9 $\pm$ 12.58) from students who completed the virtual mystery (X = 68.6 $\pm$ 12.97) (p = 0.196) was found. There also was not a significant difference in the overall distribution of final grades of students who successfully completed the course reader exercise versus those who successfully completed the virtual mystery (See Table 2 and Figure 1).

Table 2
Final Grades of Students Who Received 6/6 in Participation

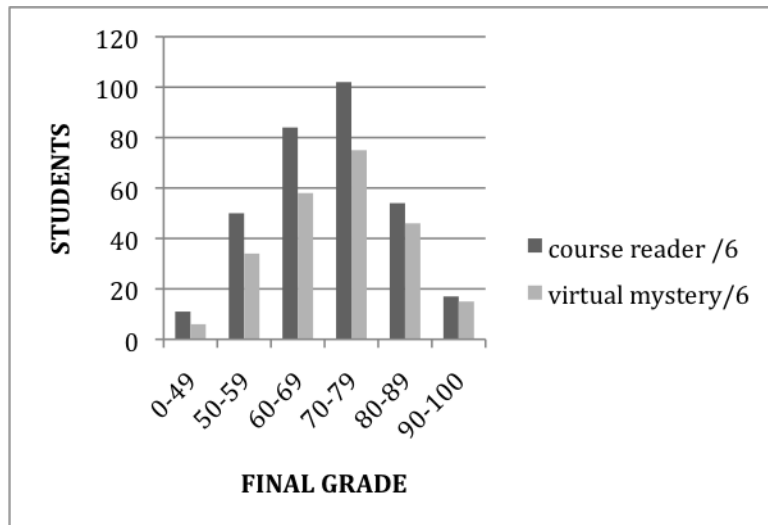| Final Grade	Course reader (N)	Mystery (N)
0-49	11	6
50-59	50	34
60-69	84	58
70-79	102	75
80-89	54	46
90-100	17	15
Student total N	318	234
Final Grade Means	69.9	68.6
Std deviation	12.38	12.97
Independent t test (p<0.05)	p value = 0.196	

Figure 1. Final grades of students who completed the participation.

Students positively evaluated the virtual mystery as an effective learning tool at the end of the Spring 2014 session (See Figure 2). Students evaluated the Monthly Virtual Mystery under the following categories:

1. Not a worthwhile learning tool
2. Could be a worthwhile learning tool if it were administered in a different way
3. Took too much time to be worthwhile
4. An adequate learning too but needs revisions
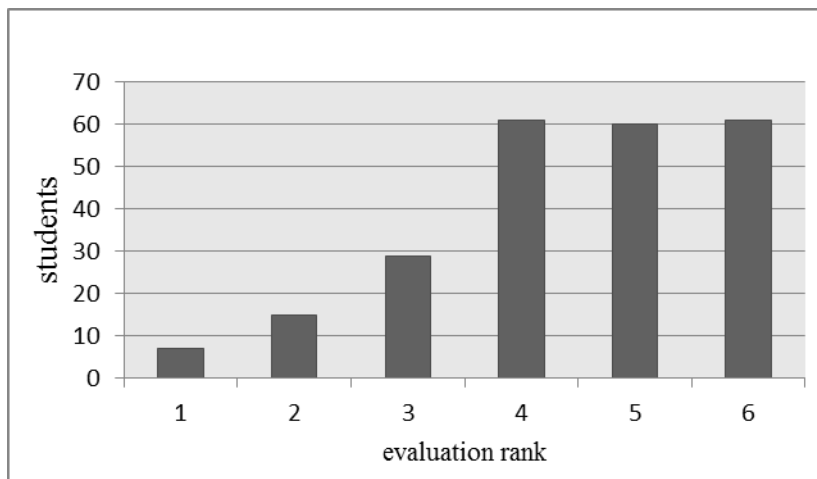5. A worthwhile learning tool
6. An excellent learning tool

Figure 2. Student evaluations of the Monthly Virtual Mystery (N=233).

Students who ranked the Virtual Monthly Mystery as 4 or greater (N = 182) commented that the mystery was a fun exercise in which they learned "how to think like an anthropologist" and "understand what an anthropologist does". Others commented that it was a "fun and easy way to get extra marks" and that "they can't wait to get in the field". Students who evaluated the Virtual Monthly Mystery as 3 or less (N = 51) commented that the exercises "took too much time on information that was not needed to pass the course". Others commented that the mysteries were "too difficult to figure out" and that their fellow students "repeated the same comments and questions" without obtaining any answers from the facilitator.
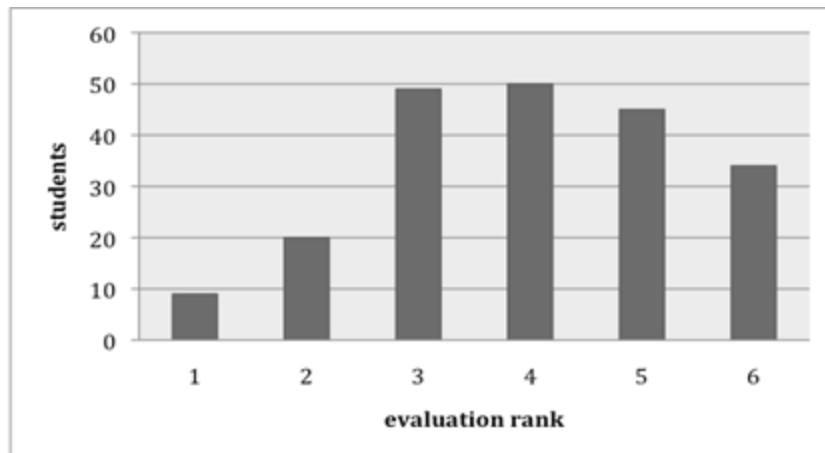
Figure 3. Student evaluations of the course reader (N=207)

1. Not a worthwhile learning tool
2. Could be a worthwhile learning tool if it were administered in a different way
3. Took too much time to be worthwhile
4. An adequate learning too but needs revisions
5. A worthwhile learning tool
6. An excellent learning tool

Students who ranked the Course Reader as 4 or higher (N = 129) commented that they liked the "convenience of watching the videos" on their own schedule, and they felt that the videos helped them learn the information from the textbook. Students who ranked the Course Reader as 3 or lower (N = 78) commented that there were "too many videos" to watch and "too many questions" with each video. Other students commented that the "videos were boring," and they did not help them learn the textbook material.

Discussion

PBL has been identified by many educators as a teaching technique that encompasses the key components of successful learning such as critical thinking, self-directed learning, and collaborative problem solving (Klegeris & Hurren, 2011; Loyens et al., 2015; Raiyn & Tilchin, 2015; Smith et al., 2005). Murray and Summerlee (2007) demonstrated that the implementation of PBL in undergraduate introductory classes increased all of these components in successful learning, and these skills were transferrable to other courses for these students. In a large classroom setting the use of technology has been suggested as a way to enable large collaborative student groups without draining resources (Chhabra & Sharma, 2013; Gibbings et al., 2015; Szewkis et al., 2011). These two issues were investigated in this study. First the use of technology was investigated as an effective mechanism to deliver active learning to a large audience and secondly the active learning project utilized PBL principles in order to engage first year students.

PBL: Student Engagement

The Monthly Virtual Mystery revealed that PBL can be administered in a large classroom setting (N=297) through an online discussion board. The successful completion of the mysteries for the majority of the students (N = 234) supports the idea that first year undergraduates with limited experience in the anthropological field can learn self directed and collaborative learning. This introductory course involves students from diverse academic backgrounds. Many students take this course as an elective and they are not initially motivated to delve deeply into the content of the course. It has been suggested that prior knowledge in the field is an important factor in the success of PBL (Jonassen, 2011; Sockalingam & Schmidt, 2013); however, in this course students seemed to be motivated enough by the case scenarios to research possible avenues of investigation in their course textbooks and online resources. It should be noted that many students did not arrive at the "correct" solution but they were graded on the thoughtfulness of their comments and questions and their ability to find appropriate resources to address the problem. This supports Loyens et al. (2015) who suggest that transformative learning experiences involve activities that integrate everyday life experiences with classroom learning. Student engagement was the primary goal in this large classroom environment. A key component to the successful completion of the PBL scenario was student motivation (Hawkins, Herweck, Goreczny, & Laird, 2013). Students who did not feel that the virtual monthly mystery was a worthwhile learning tool commented that it was too much work and that not enough guidance was given to direct them toward the correct answer. Although most students completed both participation options, there was a significantly higher participation completion rate in students who chose the course reader. Students who chose this passive learning option also gave it high evaluations. They appreciated the convenience of viewing the videos online and the way that the information reinforced ideas from their textbook.

Grade Outcomes

Overall students' final grades did not differ between students who chose the virtual mystery versus the course reader option. This may reflect the introductory nature of the course, and the fact that the participation exercise was only 6% of their final grade. The absence of a beneficial effect on PBL grade outcomes in comparison to traditional methods supports previous studies that have found that PBL does not increase a student's knowledge of the course material (Albanese & Mitchell, 1993; Larin, Bucciere, & Wessel, 2010; Vernon & Blake, 1993). Klegeris & Hurren (2011) point out, however, that most studies measuring course outcomes are based on observations in small class sizes. In addition, other studies have suggested that the traditional measures of course outcomes do not necessarily reflect the deeper benefits of PBL (Engel, 1992) such as self directed learning skills (Newble & Clark, 1986; Prosser, 2004), communication skills (Koh, Khoo, Wong, & Koh, 2008), critical thinking (Raiyn & Tilchin, 2015; Tiwari et al., 2006), and the ability to transfer concepts to novel problems (Dochy, Segers, Van den Bossche, & Gijbels, 2003; Norman & Schmidt, 2006). Long term learning outcomes should be measured to address the academic success of PBL exercises in first year introductory courses. This emphasizes the importance of PBL as a long term learning process that builds on skills through the undergraduate years. As students gain knowledge in the field and practice self -directed learning they will improve their critical thinking skills over time (Yew et al., 2011). This is supported by several studies where PBL benefits were seen in long-term information retention

(Loyens et al., 2015; Prosser & Sze, 2014; Strobel & Van Barneveld, 2009; Van Blankenstein, Dolmans, Van der Vleuten, & Schmidt, 2011).

Technology: Group Size

The Theory of Connectivity involves learning through networked communications, information and resources (Savin-Baden, 2014). The challenge of successfully implementing PBL in a large introductory course meant that collaborative groups of approximately 50 students were formed through an online discussion board. This proved to be too large for a focused discussion between the students, and some of them expressed frustration over the repetition of student ideas and questions. In addition, they felt that there was variable student effort within groups. Students felt that less motivated students did not contribute equally to the development and research of ideas. This addresses one of the key aspects of PBL and that is the importance of group dynamics in the successful collaboration of a problem (Hommes et al., 2014; Robinson et al., 2015; Wallace, Scott, Stutz, Enns, & Inkpen, 2009). The large group size and the nature of online discussions did not allow for students to effectively collaborate as they would in smaller face-to-face groups. Technology allows convenience but hinders collaboration due to delayed postings and the lack of personal connections between individuals (Chhabra & Sharma, 2013). Chhabra & Sharma (2013) suggest that online communication may have some benefits in that introverted students are more likely to communicate ideas and there is less intimidation among students. The convenience factor also encourages student participation (Sankey & Hunt, 2014). Szewkis et al., (2011:564) recognized that "silent" online collaboration involves different group communicative dynamics than in person "spoken" collaboration. This relationship is further explored in the discussion of technological determinism. Pedagogy should shape technology for more effective teaching instead of the tendency toward adjusting teaching methods to adapt to technology (Savin-Baden, 2014).

The logistical aspects of implementing this PBL initiative should also be mentioned. Considerable hours were put into effectively monitoring the groups and facilitating their progress without directing them toward the answers. The students were particularly focused on getting to the solution instead of concentrating on the process of acquiring the proper resources and integrating ideas through collaboration. Jonassen (2011) discusses extensively the importance of context scaffolding in directing students toward appropriate problem solving. He emphasizes that solving problems alone cannot teach students how to properly solve problems. The PBL environment must also be tailored to the nature in which the collaboration is occurring. This is particularly true in an online environment where the facilitator may need to take an active role in encouraging self-directed learning and proper collaboration (Gibbins et al., 2015; Jonassen, 2011). There was no mechanism on this discussion board to monitor how much interaction was occurring between specific individuals. It may be beneficial to have a series of tutorials on PBL and effective researching prior to the case scenarios; however, this would require additional resources. Smaller group sizes would also benefit group collaboration; however, smaller online groups on the discussion board would require increased facilitator resources, training and surveillance hours.

Limitations of this project

The large group size (N=50 students) was a major limitation of this study, and it was well beyond the recommended size for effective PBL groups (Barrows & Tamblyn, 1980; Klegeris & Hurran, 2011; Norman & Schmidt, 1992). This was an issue of cost as added resources would be required to build a databank of mysteries to run several mysteries simultaneously. This was not a technological issue as blackboard was capable of adaptively releasing several forums simultaneously. Also, it must be kept in mind that the mystery used the principles of PBL and did not administer a classical implementation of PBL. Students were guided in their research in that they were given a set of questions to address and they did not necessarily have to determine the relevant questions themselves. The course reader as a passive learning option may also be problematic. Since the students were required to answer a series of questions about the video content, they were participating in an active learning experience, albeit a limited one. In addition, the fact that they answered questions on video material may have introduced a "testing effect". This phenomenon has demonstrated that testing increases the retention of information (Toppino & Cohen, 2009).

Conclusion

The implementation of a PBL initiative in a large classroom setting was attempted using technology to overcome material and resource constraints. The Virtual Monthly Mystery was an online anthropological case scenario that posed weekly problems for students to collaborate on in groups of approximately 50 students. This PBL initiative composed 6% of the students' final grades. Student motivation was encouraged by allowing students to choose between the virtual mystery and an alternative passive online learning experience. The passive experience allowed students to watch a series of short online videos in a course reader and answer a series of short questions. The completion rate of students in both participation options was very high, and both options were also highly rated in student evaluations as a valuable learning tool. There were no differences in the overall final grades between students who successfully completed the virtual mystery and those who viewed the videos. Students who rated the Monthly Mystery as a valuable learning tool also commented on the practical experience that they gained through the case scenarios. The benefit of PBL principles in first year undergraduate courses then, is that it plants the seeds of self-directed learning that can be nurtured in higher years. In this context it is a mechanism to increase student engagement in large introductory courses.

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