PROJECT-BASED LEARNING AND STUDENT ENGAGEMENT

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ABSTRACT

The purpose of this study was to determine how Project-based Learning (PBL) influenced students' behavioural, cognitive, and emotional engagement in a secondary Chemistry class. Most previous research studies refer to behavioural engagement when speaking of student engagement. This research was an attempt to distinguish between the various types of engagement and the use of different teaching pedagogies. This study compared twenty-five students' behavioural, cognitive, and emotional engagement during two different chemistry units: one using PBL and the other without PBL. Levels of engagement were determined using checklists, surveys, attendance records, and test results from both units. Two of three instruments indicated a slight decrease in behavioural engagement during the PBL unit as compared with the non-PBL unit. Results were inconclusive in displaying an effect of PBL on cognitive engagement. Three instruments all showed different cognitive effects produced by using PBL. Emotional engagement remained high during both units. There was no indication that the use of PBL affected students' emotional engagement. Recommendations are provided for both classroom teachers and school departments to improve PBL teaching pedagogy and complete future research as PBL becomes more widely used in our schools. Suggestions are also made to consider different types of engagement and not solely behavioural engagement when reflecting upon student engagement levels.

Keywords: *Project based learning, student, engagement,*

INTRODUCTION

Student disengagement has become a topic of interest among schools and education communities. The number of students who drop out of school has elevated the concern of student disengagement (Elmore & Huebner, 2010; Huizenga, Admiraal, Akkerman, & Dam, 2009; James & Simmons, 2007; Wurdinger, Haar, Hugg, & Bezon, 2007). Teachers have tried to entertain students to gain their attention and hook them into their lessons; however, this interest in lessons is short-lived. Once the entertainment to interest students is over, they often return to a disengaged state, waiting for the teacher to perform for them to make them interested again. The idea behind PBL is to engage students in their learning by encouraging them to investigate their passions and "create projects that result in meaningful learning experiences" (Wurdinger et al., 2007, p. 151). "Harnessing students' passion to solve local versions of (these) global issues that define our quality of life may be one of the best ways we have to fully engage students in their learning" (Trilling & Fadel, p. 156). If students investigate their passions by using PBL, the role of teachers becomes that of a facilitator rather than an entertainer (Cook, 2009). By facilitating learning, teachers pass the responsibility to students to learn and transfer skills to areas in their life outside of school. The number of disengaged students in school reflects a need for restructuring our education systems (DiLullo, et al., 2011; Harris, 2010; Harris, 2011; Hug et al., 2005; Huizenga et al., 2009).

Our education system was developed during the industrial revolution when there was a need for standardization with a production-line mentality (Robinson, 2011). There is a need for our education system to evolve to reflect the times of the 21st century rather than the Industrial Revolution (Trilling & Fadel, 2009). Skills such as problem solving, critical thinking, collaboration, and presenting ideas are essential in today's society due to the many careers that are now available that were not in society during the last century. According to Trilling and Fadel (2009), our education system is based on society's needs at the turn of the 19th century. This includes the length of the day, subjects taught, and methods of teaching. During the Industrial Revolution, there was a need for factory workers and labourers. The education system reflected this: mass production of students being taught the same way with little to no room for individuality and creativity. In modern society, there has been a shift from learning facts to being able to think critically as facts are now readily available to everyone. Learning to think is a skill lauded by 21st century employers. Students who actively think about what is being learned are engaged in their learning.

Research Rationale

Thijs and Verkuyten (2009) suggested that the more engaged students are, the more successful they will be in their learning. "Engagement is associated with positive student outcomes – including higher grades and less dropping out" (p. 269). This research supports the theory that if we can engage students, we can influence their achievement, resulting in a higher graduation rate.

Literature also linked teaching methods with student engagement. Harris (2010) suggested, "Teaching influences student thinking" (p. 133). A more student-centered delivery of education engages students more than a teacher-centered classroom. "When students were given significant input into their own learning, pupils take ownership of it, demonstrating a student-centered approach to teaching" (p. 146).

Demir (2011) proposed that more engaged teachers result in more engaged students. Teachers who are motivated to learn and incorporate student-centered practices have experienced better student-engagement. Demir (2011) states:

"It is a common research finding that teachers show lower levels of motivation and higher levels of stress than other professional groups. Teachers' motivation appears crucial because it predicts not only teachers' engagement and well-being but also students' outcomes such as engagement" (p. 1398).

Thus, supports are needed to help teachers with this task. As Demir (2011) concluded, "principals should be aware of the supporting needs of teachers and methods of providing assistance in order to enhance their motivation" (p. 1405).

Significance of the Study

If engagement improves achievement, teaching strategies that engage students not only behaviourally, but also emotionally and cognitively must be used. PBL is one type of teaching pedagogy that research suggests improves all three types of engagement (Zyngier, 2007). Schools can implement change to incorporate a PBL approach. One such reform school is High Tech High in San Diego, California. Reform schools have been successful in their implementation of PBL because they are progressive and use curricula that "promote critical engagement, interactive meaning-making, and self-realization in the context of real-world experiences" (Ravitz, 2010). If student engagement is to be improved, project-based learning may be a practical alternative to historic teaching practices.

THEORETICAL FRAMEWORK

There is no single definition for engagement, but researchers agree that student engagement correlates with successful high school completion and student self-efficacy (Harris, 2010; Thijs & Verkuyten, 2009). It is easier to engage students behaviourally and cognitively if they are first emotionally engaged. When students are emotionally engaged, they are more likely to become behaviourally and cognitively engaged. Thus, it is important to engage students behaviourally, cognitively, and emotionally. There are different pedagogies that promote student engagement in their learning.

Zyngier (2007) states that "an engaging pedagogy should include: connecting with students, ownership of work by students, responding to students' experiences, and empowering students with the belief that they can make a difference". PBL encompasses all these components. PBL is "a student-centered approach to learning in which students collaborate on sequential authentic tasks and develop a final project" (Mills, 2009, p. 607). This supports the idea that using more student-directed teaching methods will improve student engagement. "PBL type instruction has been shown to improve attitudes and motivation" of students (Ravitz, 2010, p. 294). PBL incorporates the pedagogies of student-centered learning, collaborative learning, and inquiry-based learning.

DESIGN AND METHODOLOGY

This action research project used a quantitative approach of data collection. It encompassed a co relational approach. Using attendance records, test results, surveys, and checklists during and after a unit taught without using PBL and a unit taught using PBL allowed me to see if there was a relationship between the use of PBL and student engagement.

Selection Process

The participants were students from a first semester Chemistry 11 class. I investigated the effect Project-based Learning (PBL) had on student engagement. There were a total of 80 students in the school taking Chemistry 11; however, there were only two classes in the first semester of the school year. Thus, one of the two classes occurring in the first semester was randomly selected by the vice principal to participate in the study. The two classes were written on separate pieces of paper and she selected one for the study. Twenty-five of the 29 students from the class participated in the study. Two students did not participate because parental permission was not obtained.

Data Collection and Analysis

At the beginning of the September, 2012 semester, one of the two Chemistry 11 classes was randomly selected to participate in the research. The vice principal selected one of two classes that were written on a piece of paper from a container. Permission letters were sent home to parents and/or guardians to obtain consent for students to participate in the research. On September 19, parents of two students who did not return their permission forms were telephoned and verbal permission was obtained. The conversations with the parents were recorded in my daybook.

The third unit of the course was taught using traditional lecture-style teaching. This unit took approximately two and a half weeks (11 classes). At the beginning of the unit during a non-PBL class, students completed a checklist to self-assess their engagement. Midway through the unit, students completed a Likert-type survey to identify the degree of engagement in the unit. Then, students completed the checklist for a second time during this unit. At the end of the non-PBL unit, students completed the survey yet again. The attendance of the participants

was recorded throughout the unit. Students wrote the non-PBL unit test and their test grades were recorded.

The following unit was approximately four weeks long (15 classes, two of which were presentation days) and taught intentionally using PBL teaching pedagogy. This strategy emphasized the development of critical thinking skills such as problem solving, collaboration, critiquing, and presenting. Students had three classes of lectures, but the remainder of the unit encouraged students to investigate an organic functional group they were interested in. This outcome fell within the parameters of the curriculum. Students developed a project using a technology of their choice and presented their learning to an audience consisting of their classmates and school staff. The same experimental procedure was followed during this PBL unit as in the previous non-PBL unit. Students completed a checklist self-assessing their engagement during a class at the beginning of the PBL unit. The survey was completed halfway through the unit and then the checklist was done for a second time during this PBL unit. At the end of the PBL unit, attendance records and unit test scores were recorded and students completed their final survey.

The quantitative data collected was entered into a spreadsheet to await analysis upon completion of the research. The data from the checklists were sorted into the three research questions. The percentage of students that responded affirmatively to each question, suggesting that they were engaged, was recorded for each administration of the checklist. Upon completion of the study, the percentages during the four phases of the research were compared.

The quantitative data collected by the survey that was administered four different times were recorded into a spreadsheet. The survey consisted of 30 questions: ten questions for each of the types of engagement: behavioural, cognitive, and emotional. The median and mean were calculated for each type of engagement for each of the four times the survey was administered to indicate a degree of engagement.

At the end of each unit, the attendance of each student was recorded into a spreadsheet, including each student's unexcused and excused absences during the unit. Because the two units varied in length, absences were then converted into percentages of the total classes during each unit. The attendance data from the non-PBL unit was then compared to the attendance data from the PBL unit to determine if the use of PBL influenced behavioural engagement.

Finally, the unit test scores for each student were recorded for both the non-PBL unit and PBL unit. Test scores were recorded as a percentage. From these percentages, a class average test score was calculated for each test. These class averages were then compared to indicate if PBL had an effect on cognitive engagement.

Research question one asked what effect PBL had on student behavioural engagement. Results from the checklists students completed suggested that there was a decrease in behavioural engagement during the unit that used PBL as compared to the unit that did not use PBL. Three of the five questions pertaining to behavioural engagement showed significant decreases in behavioural engagement. The two questions that pertained to participation in class discussions and giving their best effort showed relatively consistent results for three of the four checklist completions. One of the four reporting periods showed a significantly different result. The survey results reflected a somewhat constant median of 1.0 (often) during both units of study, suggesting that PBL did not influence behavioural engagement. Absence records showed an increase of 3% of classes missed during the PBL unit, suggesting a minimal impact of PBL teaching pedagogy on behavioural engagement.

One of the three research instruments indicated a significant decrease in student behavioural engagement, while the other two instruments indicated either a small decrease or no difference in behavioural engagement.

Research question two asked what effect PBL had on student cognitive engagement. The checklist results were inconsistent. A significant decrease in cognitive engagement was detected in the PBL unit indicated by students' responses to being encouraged to attain in-depth knowledge about the concepts they were learning. There was a small decrease in students' perceptions of whether they learned anything in class and their ability to locate and use resources. There were inconsistencies in students reporting of their ability to relate the content from other subjects to the information they were learning in chemistry. Both the lowest and highest results were recorded for the PBL unit. The highest indicator of being able to relate information was at the beginning of the PBL unit and the lowest score was at the mid-point of the unit. I learned from the checklist that interaction with the teacher to reflect on student progress and provide support is significantly lower than all other indicators of student engagement, no matter which teaching pedagogy was used. The survey results indicated no change in the students' cognitive engagement. The median scores remained at 1.0 (*often*) for all four reporting periods. The mean scores of the survey also remained constant at 1.2. Test results indicated a 12% increase in median exam marks for the PBL unit, suggesting an increase in cognitive engagement. One research instrument suggested a small decrease in students' cognitive engagement during the PBL unit, one instrument suggested no change in engagement, and one instrument suggested an increase in cognitive engagement.

The final research question asked what effect PBL had on student emotional engagement. The checklist results indicated that three of the five questions had approximately the same amount of students who enjoyed class, enjoyed the work they did in class, and enjoyed the learning environment in both units. There were decreases in the percentage of students who felt encouraged to learn more and would like to repeat the learning experience of the day during the PBL unit. The median survey results remained constant for three of the four reporting periods during the two units, stating that students felt they were almost always emotionally engaged. At the beginning of the PBL unit, there was a decrease in emotional engagement, but students still reported that they were often emotionally engaged. The mean scores of the survey suggest the decrease in emotional engagement during the third survey distribution was less significant than the median suggests.

FINDINGS

Research Question One

Question one investigated the effect of using PBL teaching strategies on students' behavioural engagement. The questionnaire, survey, and attendance records were used to determine whether or not PBL impacted behavioural engagement. Behaviours such as staying on task, allowing others to stay on task, and attending class are examples of behavioural engagement. Results of the questionnaire suggested that students were not as behaviourally engaged during the unit that was taught using PBL as they were in the non-PBL unit that was taught using a lecture and practice style of teaching pedagogy.

Results of the behavioural engagement portion of the Student Engagement Survey inferred that students were behaviourally engaged during both units of the study. The median score of 1 resulted three out of the four times the survey was administered, suggesting that students were often behaviourally engaged in both units. At the end of the non-PBL unit, the median score of 2 indicated that students were almost always engaged. This may have been due to the fact that students were at the end of the unit and were anticipating the unit test. Thus, they

were on task to ensure they did not miss any information that might be on the upcoming test. The mean score indicated a less significant increase in behavioural engagement during the second survey collected during the non-PBL unit. It showed an increase of 0.3 from the mean of the first survey distribution. The mean scores reflect less variance in behavioural engagement than the median scores suggest.

Behavioural engagement was also evaluated using student attendance records. Analysis of student absences showed there was an increase in both excused and unexcused absences during the unit that used PBL. There was a 3% increase in the total absences during the PBL unit. The non-PBL "Atomic Theory" unit was taught during the month of October. The PBL "Organic Chemistry" unit was taught towards the end of October, into November. Students may have begun to disengage from school after the initial two months of school. Traditionally, there has been a lull in student attendance and motivation halfway through a term, which was the time in which the PBL unit was implemented.

Triangulation of the behavioural engagement instruments used in this study showed two of the three instruments' results suggest behavioural engagement decreased with the use of PBL. The questionnaire suggested behavioural engagement decreased during the PBL unit, the survey showed that behavioural engagement remained relatively constant in both units, and attendance records showed a decrease in behavioural engagement.

Research Question Two

Question two addressed the effect of using PBL on students' cognitive engagement. Results of the questionnaire indicated students did not feel they learned as much during the unit that used PBL. There were minimal lectures, and a lot of time in which students were responsible for completing tasks with their group members. The freedom students experienced to investigate information with their peers may have led them to believe it was more socializing than learning. Students were held accountable for their use of time by having individual and group conferences. They were free to organize their time in a way they felt they could accomplish the assigned task.

Results of the survey indicated no difference in cognitive engagement between the non-PBL unit and the PBL unit. The median of the Likert-type survey was 1 for all four implementations of the survey, suggesting that students were often cognitively engaged in their learning during both units. The mean scores of the surveys supports this finding that the cognitive engagement levels students reported was consistent throughout both units.

The unit test results showed that students had higher scores on the PBL unit test than they did on the non-PBL unit test. There was a 12% increase in the median test score for the PBL unit. The tests were created to reflect the teaching style during each unit. The Atomic Theory Unit Test did not allow for much choice in answers, whereas ten percent of the Organic Chemistry Unit Test gave students choice in response to the content of what they learned.

Triangulation of the three instruments used to determine the effect of PBL on students' cognitive engagement is inconclusive. One instrument indicated cognitive engagement decreased with the use of PBL, one instrument reflected no change in cognitive engagement, and the third instrument suggested an increase in cognitive engagement. When examining the data from this study, the effectiveness of the use of PBL on student cognitive engagement is not evident.

Research Question Three

The final question investigated the impact of PBL on students' emotional engagement. Results of the questionnaire indicated that students consistently enjoyed classes and the learning environment in both units. However, the results suggested that students did not enjoy the work completed during the PBL unit as much and did not as readily wish to repeat the learning experience. This may be due to the fact that the students in Grade 11 Chemistry have previously been quite successful in their educational career, so, a change in teaching pedagogy may be somewhat stressful for them as they are unclear about how to complete assigned tasks in this new learning environment. Some students were scared to take risks and be creative for fear that they were not completing tasks "correctly". There was some discomfort in the freedom students were given when selecting a format to present what they had learned. Suggestions were given to students, but some felt the need to have more teacher influence and less student choice. There was also some frustration felt by students as they were conducting research. They sometimes had difficulty finding information that was required for their project. This may have led to a decreased satisfaction in the learning experience.

The survey results showed that students felt almost always emotionally engaged during both the non-PBL and PBL units three of the four times the survey was distributed. During the middle of the PBL unit, there was a decrease in the median emotional engagement. Students still felt emotionally engaged, but "often" rather than "almost always".

In general, both instruments indicated students were emotionally engaged in both the non-PBL and PBL units. The effect of the use of PBL on students' emotional engagement is inconclusive.

Unique Contributions

The findings of this paper are unique because most research has compared behavioural engagement with PBL. This research analyzed not only the effect on behavioural engagement, but also PBL's influence on cognitive and emotional engagement. Not only should students be on task in school (behaviourally engaged), but they should also participate in their thinking and self-regulation of learning (cognitive engagement), and show personal interest and enjoyment in what they are learning (emotional engagement).

RECOMMENDATIONS

Student engagement is essential to the learning environment. Research suggests that the use of PBL can positively influence student engagement (Ravitz, 2010). Based on my findings, the use of PBL has the potential to increase cognitive engagement. Schools should consider implementing PBL as a way to improve students' cognitive engagement. This in turn may improve students' academic performance. This study was implemented amidst the growing need to improve student engagement. PBL is a teaching pedagogy that may be used as an alternative to other teaching pedagogies. With the recent recognition of the impact of inquiry-based learning, PBL is one teaching strategy that could be used to re-engage students who have disengaged from their learning as a result of the monotony of teachers using only one teaching strategy.

Recommendations for Classroom Teachers

Many teachers in our school district are showing interest in learning how to use PBL to make learning more meaningful and relevant for students. Upon reflection of the results of this study, I recommend that teachers implement PBL as part of their teaching repertoire. The use of PBL may not have influenced students' emotional engagement, and may have reduced the

behavioural engagement slightly, but one instrument showed that cognitively, students performed better with than without the use of PBL. Using a variety of teaching strategies may engage students more than just using one type of teaching method, regardless of what that pedagogy is.

When implementing PBL learning strategies, teachers need to carefully plan the time allotment to complete assigned tasks throughout the project. Too much time may lead to behavioural disengagement as reported by some students during the PBL unit of study in this research. Mini-conferences with individual students and groups of students were conducted throughout the PBL unit, but it was difficult to meet with all students in a timely manner. The conferences were meant as check-ins to assess each student's and each group's progress on the project. Some students did not have their student-teacher conference until the third class of the PBL unit. Conferences were meant to be short, but some students needed more help than others and required more feedback on their progress or lack of progress. This delay resulted in some students not receiving timely feedback at the beginning of their project. If teachers are able to incorporate an assistant, or have students do some peer-to-peer conferences, students may engage in the task more readily when first presented with the assignment.

Furthermore, when assessing whether students are engaged or not, do not rely solely on behavioural engagement. Students may not look engaged during collaboration time, but cognitively, students may be more engaged and remember concepts better with the use of PBL.

Department and School Level Recommendations

When schools are first introducing PBL, the incorporation of Professional Learning Communities (PLC's) may assist in the development of collaborative PBL units. Research shows that implementation of collaborative multi-disciplinary PBL units can enhance student learning (Chang & Lee, 2010). By providing teachers with collaboration time built into their work schedule, teachers may be more willing to implement PBL pedagogy.

It is further advised that teachers who are less experienced with PBL pedagogy be paired with more seasoned PBL teachers. This could assist in reducing the limitation concerning teacher lack of PBL experience. Schools could assist teachers in developing their confidence in using PBL by providing professional development opportunities in which staff could receive PBL training or time to learn strategies and practice with each other.

CONCLUSION

The purpose of this action research study was to compare the behavioural, cognitive, and emotional engagement of students in a non-PBL unit with a unit that used PBL teaching pedagogy. This study took place in a grade 11 Chemistry class in northern British Columbia.

Based on a review of current literature, low student engagement levels were determined to be a global problem. Project-based Learning was shown to improve engagement in a variety of settings. As a result, I decided to implement PBL in my own classroom and study its effects on students' behavioural, cognitive, and emotional engagement. Three types of engagement were incorporated because most research refers only to behavioural engagement when reporting students are disengaged. I was not only concerned with the behaviours of my students, but with their learning and enjoyment of the learning process as well.

The rationale for conducting this research was predicated on the need to increase student engagement in order to improve learning. Improving student achievement and reducing dropout rates were also considered in carrying out this study.

My data demonstrated that when I implemented PBL, behavioural engagement decreased slightly. However, cognitive engagement improved significantly in one data collection instrument. Emotional engagement remained high regardless of the utilized teaching method.

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