THE EFFECT OF PROJECT BASED LEARNING ON STUDENT ENGAGEMENT IN A MIDDLE SCHOOL SETTING

by

Adam Sia

A Paper
Presented to the Gordon Albright School of Education
In Partial Fulfillment of the Requirements
For the Degree of Master of Education
EEA655 Thesis
March 2016
The Effects Of Project Based Learning On Student Engagement In A Middle School Setting

APPROVED:

[Signature]
(Faculty Advisor)

[Signature]
(Charles Scott)
(Program Director)
Acknowledgements

I would like to acknowledge Heather Henderson, Dave Khatib and Paul Stewart for their continued support and assistance throughout this process. Their continued open communication, encouragement and understanding have been paramount in the success of this work. I would also like to acknowledge the hard work and dedication of all my students who participated in the study, which moved the study forward.

To my mother-in-law, who sacrificed her time to help with our new baby while I worked to complete course work.

The biggest acknowledgement to address is for my loving wife, who has supported my decision to complete a masters program. She has sacrificed with me in order to reach this goal at the same time our family was growing. She has given me time when I needed it most, and always found ways to show me the light at the end of the tunnel when my school and work load seemed too much to complete. I love you Jocelyn; thank you, I could never have done this without you.

Kennedy, education is important at any age. I hope you read this study some day and understand that even when things are difficult, or are out of your comfort zone, they are worth seeing through to the end. You are a gift to our family and bring a smile to my face, I love you my little princess.
Abstract

Student engagement continues to be an issue in today’s classrooms, and for this reason educators must explore creative ways to engage students. As teachers are restricted to the curriculum they are asked to teach, engaging students can be difficult. Adding to the complexity of instruction are the many needs of students in today’s inclusive classrooms. This research is designed to assess a possible correlation between project-based learning and student engagement. Data collected for the study was used to compare engagement levels of students in a traditional classroom and the engagement level of students in a project-based environment. The comparative research presented was gathered through feedback from students in a traditional classroom and a project-based classroom. The survey questions presented to students in both classrooms were chosen to compare levels of engagement of students at key points in curriculum instruction. The study was conducted in a rural community with students accustomed to a traditional method of instruction. Two different classrooms were used in the study, as well as two different instructors. Data collected from surveys revealed an increase in student engagement within the project-based classroom when compared to the results from the traditional classroom.

Keywords: project-based learning (PBL), collaboration, 21st Century Learner, 21st Century classroom, increased student engagement, science, curriculum, inquiry based learning, traditional classroom, pen and paper, technology, student engagement, disengaged, problem solving, critical
thinking, innovation, creative thinking, independently problem solving, life skills, limitations of curriculum, educational strategy, course delivery, ministerial order, Alberta Education, student learning, student perspective, student voice and choice, independent learning, changing global landscape, industrial revolution, teaching methods, changing educational needs, curricular outcomes, deeper understanding, middle school, learning by design, Inspiring Education, inclusive education, inclusive classroom, student needs, differentiated instruction, solving real world problems, concrete objective connections, educational philosophy, history of PBL, PBL essentials.
Table of contents

Page

Chapter 1 ........................................................................................................................................ 1
Introduction................................................................................................................................... 1
Statement of the Problem.............................................................................................................. 4
Purpose of the Study .................................................................................................................. 5
Research Question of Hypothesis ............................................................................................... 6
Importance of the Study............................................................................................................... 7
Definition of Terms.................................................................................................................... 7
Scope of the Study .................................................................................................................... 10
Summary .................................................................................................................................... 10
Chapter 2 .................................................................................................................................. 12
Review of Literature .................................................................................................................. 12
Chapter 3 .................................................................................................................................. 21
Method ...................................................................................................................................... 21
Chapter 4 .................................................................................................................................. 31
Results and Discussion .............................................................................................................. 31
Chapter 5 .................................................................................................................................. 49
Summary, Conclusion, Implications, and Recommendations .................................................. 49
References ................................................................................................................................. 57
Appendix A ............................................................................................................................... 1
Appendix B ............................................................................................................................... 1
List of tables and figures

<table>
<thead>
<tr>
<th>Table/Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td>Questions Presented For The Classroom Surveys</td>
<td>35</td>
</tr>
<tr>
<td>Figure 1</td>
<td>Achievement Levels Of Participating Students Prior To The Survey</td>
<td>33</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Gender Demographics Of The Grade 9 Students Surveyed</td>
<td>34</td>
</tr>
<tr>
<td>Figure 3</td>
<td>Baseline Survey Results Collected From The PBL Classroom</td>
<td>36</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Baseline Survey Results Collected From The Traditionally Instructed Classroom</td>
<td>37</td>
</tr>
<tr>
<td>Figure 5</td>
<td>Survey One Results Collected From The PBL Instructed Classroom</td>
<td>39</td>
</tr>
<tr>
<td>Figure 6</td>
<td>Survey One Results Collected From The Traditionally Instructed Classroom</td>
<td>40</td>
</tr>
<tr>
<td>Figure 7</td>
<td>Survey Two Results Collected From The PBL Instructed Classroom</td>
<td>41</td>
</tr>
<tr>
<td>Figure 8</td>
<td>Survey Two Results Collected From The Traditionally Instructed Classroom</td>
<td>42</td>
</tr>
<tr>
<td>Figure 9</td>
<td>Survey Three Results Collected From The PBL Instructed Classroom</td>
<td>43</td>
</tr>
<tr>
<td>Figure 10</td>
<td>Survey Three Results Collected From The Traditionally Instructed Classroom</td>
<td>44</td>
</tr>
<tr>
<td>Figure 11</td>
<td>Survey Four Results Collected From The PBL Instructed Classroom</td>
<td>45</td>
</tr>
<tr>
<td>Figure 12</td>
<td>Survey Four Results Collected From The Traditionally Instructed Classroom</td>
<td>46</td>
</tr>
<tr>
<td>Figure 13</td>
<td>Survey Five Results Collected From The PBL Instructed Classroom</td>
<td>47</td>
</tr>
<tr>
<td>Figure 14</td>
<td>Survey Five Results Collected From The Traditionally Instructed Classroom</td>
<td>48</td>
</tr>
</tbody>
</table>
Chapter 1

Introduction

Project-based learning (PBL) classrooms have been proven to be more effective in increasing student engagement compared to that of a traditional pen and paper classroom (Jurow, 2005). Students in a traditional pen and paper classroom become disengaged as students are not permitted to explore and demonstrate their learning (McParland, 2004). Project-based learning however, “is a dynamic classroom approach in which students actively explore real-world problems and challenges to acquire a deeper knowledge.” (“Project-Based Learning | Edutopia,” 2015). The importance of problem solving in the world, and the skills needed in the 21st Century, are now a focus for educators (Trilling & Fadel, 2009). Critical thinking and problem solving are essential in today’s evolving world (Lovell, 1994). In order to keep pace with the changing labour environment, students need to be prepared for unpredictable challenges and possess the ability to solve problems (D’Amico, Morgan, Katsinas, & Friedel, 2015).

As highlighted through global news agencies, a major event in 2010 demonstrated the need for critical thinking and problem solving. Near the capital city in Chile, 33 miners were trapped 700 meters from the earth’s surface in a gold mine. They survived underground for 69 days before all were safely retrieved. Their safe return to the surface was mainly due to the innovative use of a cable system that was modified and used for the retrieval (CBC, 2010). This is only one example of why companies are looking to keep their share of today’s markets by hiring young, creative and innovative individuals who will push the boundaries of products currently on the market (Workforce, 2006). Much like the need for creativity and innovative
thinking involved in the Chilean mine disaster, students cannot always rely on textbook answers and will be required to solve problems with no clear or easily discoverable resolutions (Trilling & Fadel, 2009).

**Background to the Problem**

The working environment continues to change at unpredictable rates (Osborne, Carpenter, Burnett, Rolheiser, & Korpan, 2014); education is vital to the development of the global workforce and worldwide changes. Education is taxed with the task of developing competent employees who are prepared for changing demands (Rojewski & Hill, 2014). In the scope of this, education seems to remain stagnant, almost resistant to these new developments (Madsen, Schroeder, & Irby, 2014). Public education needs to transform as its original design was to suit employment needs during the Industrial Revolution; society’s needs have since changed (Calis, 2006). The model of educating students using lecture format with individual seatwork, has seen limited evolution, even though studies indicate students do not learn best in these conditions. The needs of society and students no longer fit the mold of the Industrial Revolution (Galvin, 2003).

As the world changes, so do the demands on the educational system; education must provide a workforce prepared for societal needs (Friesen, 2010). With the release of the workforce document that outlines the skills students will need to successfully graduate in the 21st Century, more emphasis is being placed on solving real world problems. Focusing on this document has resulted in a movement toward authentic learning which is beginning to take place in today’s classrooms (Workforce, 2006).

The limitations of curriculum, which mandate teaching outcomes, along with maintaining student engagement throughout the year, can be challenging. Connecting curricular objectives to
real life challenges and allowing students the opportunity to independently problem solve, in the development of student’s futures (Alghasham, 2012). Stand alone facts presented to students have less relevance than if students are able to discover the relevance while working through problems (Lombardi & Oblinger, 2007).

A deep understanding of curricular concepts is directly linked to student levels of engagement (Alberta, 2006). Associated with this understanding is a suggested methodology being used to re-engage students in their own education, while combating boredom; this strategy is known as project-based learning (Xiuping, 2002). Studies indicate that when PBL is implemented, students were able to meet the curriculum expectations while re-engaging their interest in the subject content. Students demonstrate better retention of information and connect curriculum content to real world issues thus making the learning authentic and relevant to each student (Ferreira, Maria M. Trudel, 2012).

With the release of the Inspiring Education document and the adoption of the Ministerial Order on Student Learning, education has been provided with a clear framework for Alberta school divisions until the year 2030 (Johnson & McDonough, 2010). This release was in response to the data collected from the “Tell Them From Me” student surveys. As the Inspiring Education document outlines, diminishing student engagement and a disconnection from the curriculum objectives, underlines issues in education from students’ perspectives (Friesen, 2010) to meet the ever changing landscape of the Alberta workforce (Alberta, 2011).

Moving away from traditional classroom organization allows students the freedom to explore interests they would not traditionally have the chance to discover (Parson & Beauchamp, 2012). The real world need for innovation and collaboration was again witnessed in 2012 with the true story of a heroic effort to save three grey whales trapped under arctic ice (Mauer, 2012).
The story explained how the collaboration of multiple agencies and the innovations of small independent inventors saved two of the whales. The invention of a small water bubbler machine developed by two businessmen from Minnesota had the most significant impact on freeing the trapped mammals. Without their resourcefulness this story could have ended very differently.

As the expectations of the global market change, so must the expectations of the workforce. This expectation must transfer to our educational system. Continual use of a system designed for the Industrial Revolution does not fit the changing landscape awaiting students in the real world. Embracing innovative ways to provide students a platform to explore their ideas stimulates engagement and creativity within the classroom and prepare them for unpredictable challenges in the every changing work force.

**Statement of the Problem**

With the changing demands on our workforce and these demands being passed on to our education system, finding a way to engage students and encourage creative thinking has became a focus for some educators. Educators are attempting to address questions like: How does a curriculum developed in the past prepare students for employment opportunities that have not yet been developed? How do current teaching methods encourage students to think independently and creatively? How do educational facilities encourage students to dig deeper than simply answering questions from a textbook or worksheet? Project-base learning addresses educators’ questions and 21st Century employers’ considerations.

Diverse needs within the classroom have given rise to addressing issues voiced by students (Parson & Beauchamp, 2012). To address these past issues, traditional teaching practices are giving way to hands-on methods of instruction. Studies conducted, involving the use of PBL, have indicated higher levels of engagement and better retention of information.
(Kanter, 2010) demonstrating a possible answer for educators in addressing these trends. Kanter (2010) concluded that by allowing student autonomy within current curricular objectives, PBL stimulates interest in all subject areas while meeting the expectations mandated by educational governing bodies.

Moving away from traditional methods of instruction to a more project-based approach develops interest and engagement within subject areas. Students engaging in subject areas, in turn, develop a deeper and longer lasting understanding of curricular outcomes. This in-depth understanding, sparked through engagement, empowers students to apply previously learned knowledge to new situations thus meeting the needs of 21st Century employers.

**Purpose of the Study**

Project-based learning has been identified as a way for educators to utilize curriculum outcomes in an engaging way. This can be witnessed at all levels of education while developing 21st Century skills such as problem solving and critical thinking (Magee & Flessner, 2012). The focus of this research is to compare student engagement levels when taught in a traditional manner as compared to a PBL approach. The data collected allows the researcher to examine the impact of PBL on student engagement compared to students learning the same curriculum via a traditional method of instruction.

Data collected during this study is meant to assist teachers’ understanding of the influence PBL will have in classrooms. Because PBL fosters engagement in a positive way, it assists teachers by changing the methods in which teaching and learning occurs. This in turn, will allow students to take a more active role in their education. PBL provides opportunities for all students to explore areas and within all subject areas they find interesting and relevant for their futures (English & Kitsantas, 2013).
Teachers in middle schools have historically used traditional teaching methods and seatwork to teach curricular outcomes (Kanter, 2010). This study identified and compared levels of student engagement between students learning in a traditional way and a group of students learning within a project-based learning environment.

**Research Question of Hypothesis**

Student engagement and motivation are key areas of interest for preparing students for the 21st Century. This study identifies how engagement levels of students, within a core subject area, are influenced by the method of instruction. The central research question addressed by this study, can project-based learning increase student engagement within a middle school setting?, will be examined using data collected from students.

To find answers to this research question, an anonymous Likert Scale survey was administered to 9 students in both a project-based classroom and a traditional classroom. Both classrooms were taught the same curriculum objectives during the course of the study. The survey was administered a total of six times throughout the study; the first survey was administered as a base line to compare results from both classes. To ensure the results were comparable and not influenced by the specific topic being taught, the survey was administered at the same key points during curriculum delivery.

The Likert Scale survey asked students to respond to each question in regards to engagement with Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree or Opt Out. The data collected from the survey ensured that the identity of the student was not compromised. The only identifying factor between the two classes was the indication of which type of instruction was being used.
Importance of the Study

Schools in central Alberta have adopted an inclusive classroom instructional model; this model coupled with student interest diminishing has forced a change in classroom environments. Inclusionary classrooms draw strength from education delivered to all students with or without developmental disabilities within a regular classroom rather than from pull out programs, that have been used in the past (“In The Classroom - K-12 - Inclusion Alberta,” 2015). PBL could a viable option for students and educators to practice skills and develop strong interests in areas students need to succeed in the 21st Century (Kohlhaas, 2011).

Gathering feedback from students about their level of engagement provides educators the opportunity to develop lessons that will engage and challenge students. Potential benefits of this information could include deeper levels of curricular understanding and more concrete connections to real life for students. With 21st Century expectations of employees, students need to solve problems that have not occurred in the students past. Students must be able to work collaboratively with diverse groups and be motivated to explore innovative options (Scott, 2015). Solving real world problems in the classroom can engage students and allow them to take charge of their own education as well as prepare them for the real world.

Definition of Terms

**Project-Based Learning (PBL).** A methodology of instruction that poses a complex question to students. Students are then asked to answer the question anyway they like.

**21st Century learner.** This term refers to core competencies of the learning; these include such things as collaboration, critical thinking, problem solving and integration of technology.
**Moodle.** A safe and secure learning environment that allows educators to deliver courses information and content. Students are able to collaborate with one another through a digital environment. This server is controlled completely by the educators who use it.

**Inclusive education.** An educational model where children with developmental disabilities are welcomed into regular classrooms. Students are no longer pulled out of their age appropriate classroom to work on curricular objectives or modified instruction. These students work within the classroom using the same information presented to their classmates. Modification for success, in regards to students with disabilities, takes many forms including fewer questions or different expectations for assessment and class work.

**Traditional teaching methods.** A teaching methodology where students are expected to sit in rows, think independently and work silently. This form of instruction uses textbook response to questions, as well as the use of worksheets to regurgitate information delivered during the class lectures.

**Real world problems.** Issues that are facing society. These are issues that are not made up but rather taken from the environment outside of the classroom.

**Student engagement.** The level of curiosity, interest, passion, drive and attention that students demonstrate while they are learning within a classroom.

**Pencil and paper instruction.** Students are asked to take notes on important information presented as the instructor provides information in a lecture format. Students are then asked to answer questions based on what notes they took during the lecture for assessment.

**IPP.** This stands for individual program plan, these are documents used to outline specific needs of struggling students as well as anecdotal notes of success. Students using IPP’s tend to have a code assigned to them regarding a learning disability or behavioral condition.
**Deliverables.** Any documents presented to students by the course instructor, of the course, in order to provide information or gather information from students.

**Middle school philosophy.** This philosophy for student development can be defined as the intellectual, social, emotional, and physical development of students. This philosophy is generally used with students between the grades of six and nine. Educators working within these years and with this philosophy focus on the needs of each student and use these years to assist students in the transition into high school. The main focus of this philosophy founded in the needs of students in these in-between years.

**Seven essentials to PBL lessons.** In order for a lesson or unit to be considered project based learning it must contain seven essential elements. These elements are: (a) A need to know, this is usually tied to an entry event and provides students the opportunity to ask what is required to complete the project. (b) A driving question, this is a question that can be answered with a yes or no and is not easily discovered by using an Internet search. (c) Student voice and choice, students need to be able to take the project in a direction they see fit in order to answer the driving question. (d) Must involve 21st Century skills, these are skills outlined as important for students to learn for the 21st Century. These skills include but are not limited to collaboration, co-operation, and problem solving. (e) Inquiry and innovation, students are encouraged to solve issues or roadblocks as they arise with minimal guidance from the teacher. (f) Feedback and revision, students are asked to review and revise their work through the process of sharing and questioning from classmates. (g) A publicly presented product, at the end of the project a public audience is established to present the students findings and ideas, making the learning authentic.
Inclusionary classrooms. These are classrooms that draw strength from education delivered to all students with or without developmental disabilities, within a regular classroom rather than pull out programs, as used in past educational models.

Scope of the Study

This study was conducted in a small rural school; two groups of Grade 9 students were included. All Grade 9 students enrolled in the school were approached to participate. Thirty students ranging in age from 14 to 16 were placed in each classroom. The teacher, who was not participating in the study, administered the surveys in both classrooms.

The study was conducted within a rural community and at a Grade 9 level within a high school setting. This may be considered a possible limitation due to the fact that these students are not fully immersed in the middle school teaching philosophy adopted by Alberta Education. The study was conducted in one unit of study within the Grade 9 science curriculum and within the regular school year. All of the deliverables were provided to the students through the use Moodle learning management system and students used school provided Chromebooks to assist with projects and gathering information from the Internet.

Summary

In response to information gathered by Alberta Education regarding student engagement and the needs of Alberta employers, Alberta Education released the Inspiring Education document in 2009 (Johnson & McDonough, 2010). This document outlined the importance of student engagement and authentic learning within classrooms. With the diverse needs of students in each classroom and based on the information issued by Alberta Education, schools are looking for a form of delivery that addresses concerns such as student engagement and
deeper understandings within the classroom. These concerns are directly linked to student engagement and 21st Century skills. PBL is a teaching methodology, which provides opportunities for students to explore interests within current curricular objectives. Comparing two classes as they work through the same unit of study, one class completing the curricular objectives in a traditional classroom and the other using a PBL approach may provide insight into what motivates and inspires students. Both classes completed the same survey questions to address their level of engagement. These questions were presented to students at the same key points in the unit of study. The results reveal that student engagement increased during project-based learning.
Chapter II: Review of Related Literature

The start of learning by doing

Thousands of years ago scholars such as Aristotle and Confucius used project-based learning as their instructional method. These well-known scholars believed students benefitted from exploring their world, rather than simply reading about it (Smith, 2001). Moving forward, and after much experimentation in inquiry-based lessons, John Dewey emerged providing the learning by doing educational theory (Jordan, 2009). Dewey believed that education was not to prepare students for real life, but rather learning was real life (Gaido, 2005). Gaido (2005) used Dewey’s work to challenge education practices and give life to other researchers with similar beliefs. One such researcher, Maria Montessori, challenged early childhood educators and their educational norms. Maria’s message outlined that children do not learn simply by listening, but by experiencing their environment and interacting with one another (Firestone, 2006). Since these early adopters began implementing a learning by doing model, a refined form of education centered on students needs was created. This educational methodology was labeled project-based learning. Since the conception of PBL, studies have provided support for the positive benefits of learning by doing and the lasting effects on student motivation and engagement (Dochy, Segers, Van den Bossche, & Gijbels, 2003).

Support for and development of PBL

Since it’s start in the 1960’s, project-based learning has developed into a complete educational theory (“Project-Based Learning: A Short History | Edutopia,” 2011). Studies dating
back to the early 1980’s shed light into some PBL deficiencies, as well as data supporting its strengths (Blumberg, 2000). PBL builds on students’ interests and engages students to seek a more in-depth understanding of the area of study. Student motivation and engagement are linked to longer retention as students have the ability to connect learned experiences to new problems. These cornerstones of PBL demonstrate the power of hands-on learning compared to that of traditional pen and paper instruction. This study is designed to support the importance of PBL in a rural community and directly compare it to a traditional pen and paper type of delivery.

**Elements of PBL**

A more comprehensive understanding of PBL and how to implement these strategies will assist in the comparison of it to a traditional classroom. To successfully implement PBL and to witness benefits within the classroom, correct use of the seven essential elements is imperative (Larmer & Mergendoller, 2010). Trilling and Fadel (2009) summarize the essentials of PBL: students are presented with a question or problem that they are expected to work together to solve. By allowing autonomy and a voice, PBL fosters motivation and interest in the issue. The teacher in a PBL environment is simply a facilitator of the process and allows students the freedom to explore their own learning. During the process students are expected to work together for creative solutions to problems as issues are encountered. The seven essential elements are designed to mimic the conditions students will face after the completion of high school and as they become active contributors in the 21st-Century society. These skills include group collaboration, communication, and critical thinking (Trilling & Fadel, 2009).

The teacher’s role in the PBL classroom is just as important as the role of each student. Teachers must identify clear values and expectations for students to practice throughout the process; these expectations support the realization of the value of PBL. The teacher’s emphasis
should not focus on the completed project, but rather the continual demonstration of improvement throughout the project (Debra, Turner, & Spencer, 1997). Mergendoller, Maxwell, and Bellisimo (2006) supported these findings in their 2006 study which showed evidence suggesting that PBL was a more effective instructional approach than traditional teaching methods (Mergendoller, Maxwell, & Bellisimo, 2006).

**Support for PBL**

Support for a PBL methodology was highlighted in a study conducted at University College London; strong indications that a PBL methodology was more successful than that of a traditional one were noted (McParland, 2004). This study was conducted during the fourth year of a five-year undergraduate psychiatry program. Two cohorts, one working from a PBL curriculum, the other using a traditional curriculum with no PBL components were examined. Participating in the study were a total of 379 students, 191 of those students were involved in the PBL curriculum while the remaining 188 used the traditional format of lesson delivery. The results of the study indicated a significant increase in both a surface level and in-depth level of understanding in favor of the PBL curriculum (McParland, 2004). McParland (2004) also suggested that a switch to a more PBL approach would be beneficial to both the university and the students of psychiatry.

Not unlike the previous study, Ferreira and Trudel (2012) conducted a study with 48 students who took part in the introduction of PBL in three different chemistry classrooms. The study, in a large city, was completed in an all-male Jesuit Catholic School. This study was not to identify if PBL would increase understanding of chemistry, but to identify if PBL would help students understand what kind of learners they were. At the conclusion of the study, it was expressed that the use of PBL had a significant impact on student attitudes and more specifically
in regards to science (Ferreira & Trudel, 2012). This study demonstrated that PBL develops confidence in students’ abilities in difficult subject areas.

As outlined by the seven essentials to PBL, lessons should be designed with real world applications to draw on student interests and experiences thus enhancing student motivation and engagement. PBL supports the creation of independent learners, allowing them to take charge of their learning and explore options that would not have been previously presented to them (Bell, 2010). PBL not only tests what students know but it also calls into use any previous knowledge they have gained by drawing on what they already know and understand (Wilhelm, Sherrod, & Walters, 2008). The use of PBL in a classroom allows for greater retention of information and has a motivational effect on students that may be otherwise disconnected from a subject (Barron & Chen, 2008).

Positive effects of PBL methodology were also documented with regards to students demonstrating low levels of achievement through Mehalik’s (2008) findings. This study focused on middle school science students of African-American descent, who had been identified as having low academic achievement levels (Mehalik, Doppelt, & Schuun, 2008). The study spanned four weeks utilizing the seven essential steps needed for PBL with an extended focus on the scaffolding aspect of PBL. Students reported they were able to use the scaffolding as a roadmap for the completion of their projects. This process allowed for clear expectations by focusing students on small pieces of the problems rather than attempting to tackle the project all at once. The use of scaffolding allows instructors in a PBL classroom to redirect students through the use of mini lessons and keeps the focus of students on the original issue presented. Scaffolding increases students’ ability to stay focused and complete the project with a deeper understanding of the topic. Students struggled with staying focused when a scaffolding model
was not used (Schultz & Christensen, 2004). Schultz and Christensen’s (2004) study illustrated an increase in students understanding after experiencing in-depth PBL methodology compared to those only using some facets of the PBL methodology.

**Connection of PBL and 21st Century needs**

PBL has the potential to engage students and spark interests through the opportunity to work on complex problems (Oberg, 2009). This in turn, supports students to make connections between what they study in classrooms and what they experience outside the school (Thomas, 2000). Thomas (2000) concluded that student engagement has influenced the use of PBL and subsequently, has encouraged high school reform in small high schools. Ravitz (2010) utilized data collected from 395 high school teachers who have used or are using PBL instructional methods. For the purpose of more in-depth learning and student engagement, the teachers who participated in this study were using PBL methods within academic core subjects. A variety of school communities, including large and small reform schools, were the focus of the study which indicated that the use of PBL, regardless of school sizes, communities, or subject areas promotes growth and student engagement (Ravitz, 2010).

Ravitz (2010) concluded his research with a close inspection of teachers’ journals, which focused on the group dynamics during PBL projects. Teachers’ journals highlighted the importance of groups during the PBL lessons. Development of student groups into student chosen, teacher chosen and student interest groups were examined during the study. Ravitz (2010) expressed that collaboration in a variety of settings stimulates idea sharing and conversation within the classroom, mimicking 21st Century needs within the workforce. These findings were supported with data collected through the Consortium Of Readiness To Work conducted for the United States (Workforce, 2006). Teaching to the needs of a 21st Century
workforce, with a focus on group work and collaboration, is a cornerstone to the reform of education (Trilling & Fadel, 2009). Ravitz (2010) also found that the culture within the PBL classroom became collaborative and nurtured an understanding of others' views during group work on projects. This cultural shift allowed for a diverse view of problems presented and encountered as well as multiple solutions for each problem. Chegn, Chan, and Lam (2008) identified similar groupings while investigating PBL. The groupings were examined to determine the effects of PBL on motivating students in mathematics. Results of the students' mid-term examinations, in conjunction with student and teacher journaling, were used as indicators of motivation and understanding of course content. As hypothesized in the study, variety and dynamic grouping, fosters student motivation and a deeper understanding of expected outcomes (Shui-fong, Wing-yi, & Choy, 2010).

Kolodner (2003) pointed out that a deeper understanding of content and the application of these lessons in everyday situations is one of the most significant trademarks of PBL. Furthermore, a learning by design approach fosters the ability to translate classroom education into life-long learning situations (Kolodner et al., 2003). Kolodner (2003) identified that teachers who presented students with design building challenges, reported students demonstrated a stronger connection to real world applications of learning in class. These challenges were intended to develop middle years students abilities to become successful thinkers. Kolodner (2003) also identified a successful framework for implementation and success using a strict PBL approach to instruction. Meticulous planning and implementation are not enough for the successful adoption and meaningful learning. Classroom culture, specifically in the area of communication and group development, is key to observing lasting results when classroom instruction utilizes PBL (Utecht, 2003).
21st Century skills, such as critical thinking and flexibility, are becoming more vital to the success of students entering the workforce (Friesen, 2010). Students graduating with a traditional type of education are experiencing difficulties due to the demands presented by today’s society (Finn & Rock, n.d.). To address this gap, educators are researching ways to make learning in the classroom more authentic, and therefore linked to the real world. One such method of addressing the future needs of students is project-based learning. When executed correctly, PBL encourages students to develop skills that are directly transferable into the workforce (Edens, 2010). PBL emulates the skills identified as essentials for success in the 21st Century (“Gold Standard PBL: Project Based Teaching Practices (by BIE) | Project Based Learning | BIE,” n.d.). When using PBL, students are presented with real-world problems and required to use 21st Century skills, including, communication, collaboration, and problem solving to find solutions. These problems are based in the real world and link the classroom to relevant needs of society.

Comparing PBL classrooms to traditional ones

When compared to traditional pen and paper environments, PBL classrooms demonstrate increased test scores in addition to enhanced motivation, deeper levels of understanding, stronger classroom culture and longer-lasting retention of information (Sungur & Tekkaya, 2006). To measure self-regulation of students, Sungur and Tekkaya (2006) compared 61 Grade 10 students in two different biology classrooms. Textbook centered content compared to structured problems demonstrated stronger student self-regulated work, a higher level of intrinsic goal setting, critical thinking, and effort regulation. Enhanced levels in these areas are deemed essential elements for a contributing member of the 21st Century workforce (Trilling & Fadel, 2009). Students
exposed to successful implementation within PBL classrooms develop these 21st Century skills while using curricular outcomes as the basis for the problems to be solved.

Student achievement and understanding can be influenced by many factors. The underlying theme presented through many studies indicates that student motivation and self-regulation are strongly linked to achievement (Yunus & Wan Ali, 2009). PBL identifies this relationship and uses it to develop student interest in subject content at a concrete level of understanding (Ferreira & Trudel, 2012). This motivation and desire to learn through real problems creates an authentic learning environment and enhances all levels of academic success regardless of previous levels of achievement (Achilles & Hoover, 1996).

Student motivation has been strongly linked to higher achievement and a deeper understanding of concepts being taught (Yunus & Wan Ali, 2009). Students at all levels, as well as within a variety of subjects, have been noted to have a stronger understanding of concepts if they are engaged in their learning. In addition to these findings, research has indicated that student learning needs are different; providing a traditional pen and paper format for the delivery of information reaches a limited number of students at a surface level of understanding (Hake, 1998). Students engaged in PBL have identified a stronger connection to the learning and a self-regulation of how they learn (Sungur & Tekkaya, 2006). This self-regulation allows students to draw on previous experience as well as intrinsic motivation for solving problems. Student engagement triggers past experiences, stimulates motivation, and in turn, leads to deeper understanding of course content (Voke, 2002).
Summary

The research reviewed for this study supports the belief that the level of student engagement in a PBL classroom is higher in comparison to that of a traditional classroom. Studies indicate that student engagement levels in any classroom should stimulate intrinsic motivation and a deeper understanding of course content. Student disengagement is linked to a lack of motivation, thus hindering the desire to explore the topic fully and only learning the content at a surface level. PBL introduced to a variety of students ranging from middle school to university have revealed higher levels of engagement and stronger final results. PBL instruction fosters more engaging opportunities for all types of learners than that of a traditional classroom.

When educators adopt a PBL approach in their classrooms students have responded with better understanding and have developed a deeper desire to explore course content. PBL instruction also addresses the current needs of the 21st Century workforce. A key component of PBL is making classroom learning relevant and real by addressing current societal issues with a focus on solutions. When administered correctly PBL incorporates key elements of what workers in today’s workforce need to possess in order to be successful. By making the learning relevant and real, students are not only able to draw on past experiences and knowledge but also connect new learning to prior experiences. The aim of education is to prepare students for their futures and with the ever-changing landscape of society students need more than facts, they need to know how to learn independently and to creatively solve problems that have yet to be seen. PBL’s strength comes from its ability to stimulate learning and problem solving rather than delivering content for retention.
Chapter 3

Method

Introduction

The purpose of this study was to determine how PBL would affect student engagement in a Grade 9 science classroom. The comparative research examined two classrooms learning the same curriculum delivered with either a PBL or a traditional approach. The sample used in the study consisted of 42 students divided into two classrooms. Students in one classroom were instructed in a traditional pen and paper format with an emphasis on textbook and lecture work. Students in the other classroom were instructed using PBL with a focus on the seven elements of a PBL classroom and an emphasis on 21st Century skills. Students in the PBL class were presented with problems based in the real world with ties to curriculum objectives. This study was performed in a small school and all enrolled Grade 9 students were approached to participate in the study. The study was designed to gather information about what engages students and sparks intrinsic motivation for students.

All participants of this study were students enrolled at the same small rural high school. Each group of students was instructed by a different teacher, in different classrooms, and at different times of the day. There were 47 students enrolled in Grade 9 for the 2014/15 school year, and 42 students returned the required consent forms to be official participants of the study. The data presented in this study is that of those students who returned the appropriate consent forms with signed permission to participate. Student data from the traditional classroom consisted of 23 students, while the remaining 24 students make up the a PBL focus, the 7 remaining student data was not shared.
Students who participated in this study had a range of abilities from high academic achievers to those in need of an educational assistant on a regular basis. Using teacher assessment prior to study, students were ranked based on their previous in class achievement. Nine students were ranked as low achievers, 34 students were ranked as average achievers, and four students were ranked as high achievers. Of the nine lower achieving students, three students were assisted by an educational assistant as required through their IPPs. All of these rankings pertain to science and no other information was considered.

For this study, the researcher used a quantitative experimental research approach—specifically, a student survey conducted at predetermined points in the science curriculum. Students involved in the traditional method of instruction were surveyed using the same criteria and at the same curriculum points as that of the PBL classroom. Prior to the start of the study, all those participants were given the same baseline survey from which to compare results throughout the remainder of the study.

**Description of Research Methodology**

A quantitative evaluation was utilized for this research project leveraging a Likert scale as the method for collecting data for review. The survey was issued a total of six times throughout the study to both the PBL classroom and the traditional classroom. One survey was administered before the start of the study and used as a baseline results. The remaining five surveys were administered on the same day and curriculum points to both classes. The survey was administered through an anonymous on-line format to ensure students’ identities were not revealed. Questions presented in the survey were designed to determine the level of engagement students felt as they worked through the Alberta curricular objectives. A quantitative approach is
valuable to the study as it compares student engagement in subject matter between the two methods of instruction.

Once the data was collected the researcher and the instructor of the traditionally instructed class completed an analysis of the results. This data was reviewed both for the purpose of the study as well as for future instructional method options for science. Throughout the time of the study both instructors took anecdotal notes of the process and made observations associated with the interest levels of students, but these records were not used in the study. The school also completed a review of the provincial exam results comparing the unit of study used in this study for future consideration of instruction methodology. These results and comparisons will not be considered for this study.

**Methodological Assumptions**

It is the assumption of the researcher that project-based learning should stimulate student interest in the course content at a higher level than that of the traditionally instructed class. Drawing on students’ prior experiences and building previous knowledge should allow for deeper levels of interest and retention of subject matter. Prior studies of similar methodology provide support for these assumptions. The data collected for the study should reveal that students provided with the opportunity to apply subject content to authentic problems will increase intrinsic motivation and student engagement.

**Data Collection and Recording**

The survey, which was prepared for the purpose of this study, consisted of eleven questions on a Likert scale. All students were given the option to rate each question with one of the following descriptions: Strongly disagree, disagree, neither agrees nor disagrees, agree, strongly
agree, and opt out. The questions were chosen to identify the level of engagement students felt in regards to the activity they were expected to complete during class.

**Research Design**

Once the baseline survey had been completed and participating teachers understood the requirements of the study, both classes embarked on a four-week chemistry unit in accordance with the Alberta curriculum. Within the traditional classroom, students were given student directed learning booklets consisting, in large part, of short answer questions. These questions were directly linked to Alberta Education’s expectations for this unit of study. Students were expected to complete the answers in the booklet using required Alberta resources. Students were also expected to use lecture notes and knowledge gained from three experiments that were completed during class time.

Prior to the study students in the PBL classroom were introduced to the seven essential elements of project-based learning. This measure was taken to ensure that once the study began, students would not be learning the elements but rather putting their understanding of PBL into practice. When students had a strong understanding of PBL and how each of the seven elements fit together, the researcher moved into the curriculum. In the PBL instruction classroom, students were given five problems; each problem was chosen for its correlation to the curriculum as well as prior interest areas expressed by students.

Every third class students in the PBL classroom were given a mini lesson designed specifically to help guide students in solving the problems presented. These lessons were targeted to ensure students were staying on track and allowed assessment opportunities for the teacher. It was made clear to students that parts of the project would require them to work alone while other sections would need to take place in group settings. Each time a new group was
formed, students were expected to find new members within the class. At times throughout the study students were given the opportunity to build their own groups. When this occurred the instructor established key roles within the group; students were expected to adhere to these roles and expectations.

As with all project-based learning, mini lessons were associated with scaffolding related to both instruction and assessment. Scaffolding is the process of building on each lesson; additional information assists in problem solving but does not give away the solution. During the scaffolding, feedback was also provided to students, allowing them to make small adjustments to their project. These “check-ins” provided information to the teacher and, based on this information he could then adjust the lessons according to what the students needed as they continued working on their problems.

An important component of the PBL structure, and of this unit, involves students developing their own science experiments, thereby demonstrating their own learning. These experiments were conducted at the end of the unit to highlight all of the learning and sharing they had engaged in throughout the unit.

To allow students to research information as needed, they were provided school owned Chromebooks. This technology allowed students to research ideas that had already been explored in their attempts to solve the problems presented. The Chromebooks were also used by the students to develop their presentations in any media format or style they chose.

Students were expected to work in groups as well as on their own as directed by the instructor. During the project, the instructor required students to work with different individuals. The purpose of working with a variety of individuals was to gather information and feedback on their projects. This feedback was used to enhance the group project or idea. When assigning
groups for the projects, the instructor used a heterogeneous application. In addition to the heterogeneous approach the instructor considered students’ interest and talents as best fits for best group development. Students understood that some of the project outcomes would not require group work and that groups would only be developed when the instructor deemed them necessary. Adjustments to groupings were ongoing and observations of each group allowed for the best pairings. This information was used for consideration of future groupings.

During the study, both classroom teachers made observational notes regarding classroom engagement and on-task behaviors. The information documented in these journals was not reviewed for the purpose of this study, yet the school administration considered the information and drew their own conclusions about the affects of PBL on student behaviors. Even though this information was not used in the study the school administration believed it to be valuable information in the creation of future classroom structures.

Other observations included submitted homework assignments, completed in class work, the level of completed work, and assessment scores. Both classrooms were given the same assessment pieces, yet the results were not used for this study. These scores were used for a school-based understanding of how project-based learning can affect student understanding of the curriculum. Once the projects were complete, students were asked to present something they found interesting about the process used for solving problems. This information was also used at the school level to develop future lessons.

Just as the assessment and curricular objectives were being taught at the same times, so were the times and dates of the surveys. Students from both classes were asked to complete the surveys at the end of the class. This allowed for a correlation between both sets of collected data. This data was then analyzed to assess the level of student engagement in regards to the
information being taught. During the classes, students were encouraged to express how they felt about the work they were doing with the use of conversation and feedback forms. These comments were recorded in the teacher journals, but were not used for the purpose of the study. The information gathered in these journals influenced the direction of the projects and the mini lessons. In order to ensure students were learning the required elements of the science 9 curriculum, regular exams, including the unit final were part of both classes. The unit final contained the same questions for both classes; results were compared at the school level, yet the results were not used in the data for this study.

**Ethical considerations**

Prior to the study, a letter from the researcher was sent home to all Grade 9 students enrolled for the 2014/15 school year. The letter outlined the scope of the research and explained that participation in the study was not mandatory and that it would not affect any student’s grades. It was made clear that students participating in the study would not be issued any additional work and the Alberta curricular outcomes would be covered in accordance with the program of studies. Participants were given the opportunity to opt out of the research at any time and with no repercussions.

Letters of consent for student participants were returned to the researcher and those documents were stored at the home of the researcher. The home of the researcher was located in a different city than where the study had taken place. The documents were stored in a locked cabinet with the combination only known to the researcher.

To ensure that all ethical concerns regarding the identity of the students and their responses to the survey questions, an anonymous on-line survey was administered. Students used school-issued Chromebooks for classroom use as well as to complete the anonymous survey. These
Chrome books were not managed by the division IT department; this was done to ensure that no personal information from the student was required to access the computers or the Internet. When the surveys were administered, the instructor for the class was not present and an impartial adult supervised the class.

The questions chosen for the Likert scale did not contain any bias and were not specific to any gender. The questions were chosen to directly correlate and show the engagement level students felt toward the lesson content.

**Limitations**

There were a number of limitations associated with the research design. One limitation involved the time of day during which the science classes were held. Students of both sections had science each day, but the time of the class was different. The PBL class was held in the morning while the traditional science class took place in the afternoon. Students absent levels were greater in the afternoon classes compared to that of the morning classes.

A second limitation identified by the researcher was the personality of the teachers. The PBL teacher was described as an outgoing individual who is a lively presenter. The PBL instructor was asked to speak and instruct at numerous events involving large numbers of participants while the traditional teacher has only delivered instruction to her classroom.

A third limitation is that the PBL instructor was well versed in the use of technology. Students in the PBL classroom utilized a number of different technologies on a regular basis. In contrast to the PBL teacher, the traditional classroom teacher was self-described as an individual with a limited understanding of technology who relied heavily on paper recourses to support topics covered in her lessons.
A fourth limitation for this research was the fact that students involved in the study were middle school students instructed in a high school setting. Students in a traditional middle school are instructed using a middle school philosophy that is not easily adapted into a high school setting. The grade configuration of the rural school used in this research was a Grade 9 through Grade 12 institution limiting the complete implementation of the middle school philosophy.

In order to ensure correct PBL methodology a strong understanding of the required elements is needed. The PBL instructor had completed more than two years of professional development specifically in regards to project-based learning. He also had completed a number of projects in various schools and at various grade levels. In addition to his understanding of PBL he has been teaching middle school science for more than eight years. The traditional classroom instructor had focused much of her professional development in the area of science content, as this was her main teaching load within the high school science department. In contrast to the PBL instructor she had only taught Grade 9 science for two years.

**Summary**

This study is comprised of a number of components. All of these components are designed to identify if project-based learning increases the level of student engagement when learning the science 9 curriculum. The anonymous survey provided points of comparison between a traditional class and a PBL class. The data is expected to provide evidence indicating that PBL promotes a higher level of engagement and, in turn, contributes to a higher level of understanding and the retention of information. The Likert scale results provide the researcher with information on which activities provided the greatest level of engagement in both traditional and PBL instructed classrooms. In addition, the researcher will be able to identify key areas
within the methods of instruction that encourage students to be motivated, and thus, achieve higher levels of understanding. The results of the surveys demonstrate if PBL methods of instruction truly engage learners and identify methods of instruction that can be adapted for future best results.

This research may lead to more extensive questions about what methods of instruction students prefer in science as well as what methods of instruction lend themselves to a better understanding of curricular outcomes. Students in a future study will also identify what activities within the PBL classroom provided them with the highest level of engagement and interest. Questions surrounding group instruction and assessment could also be identified for future studies.
Chapter 4

Results and Discussion

The focus of this research explored whether a project-based learning method of instruction will increase the engagement level of students in a Grade 9 science class compared to that of a more traditional one. PBL leads to student engagement, which fosters a deeper understanding of curriculum objectives and longer retention of information learned. This research study began with one instructor’s concrete understanding of PBL and its’ correct delivery within a middle years classroom. His training included workshops and collaboration with peers. This instructor ensured that correct administration of projects and feedback regarding the projects used for this study, were in accordance with the essential elements of PBL. The data collected for this study was done with an anonymous survey using a Likert scale. The questions developed for the survey were designed to gauge the level of engagement at key points within one unit of the science curriculum. The same criteria were used to gather information from a class working through the same curriculum, but using a traditional pen and paper style of instruction. This comparison was used to identify if students were more engaged in the PBL classroom or the traditional pen and paper classroom.

All participants of this study were students enrolled at a small rural school at the beginning of the 2014/15 school year. There were 47 students enrolled in grade 9; 42 students returned the required consent forms to be official participants of the study. The data presented in this study is that of those students. The study was conducted for one unit of science that took place in February of 2015. At the time of the study, students had been working together as classmates for five months.
Figure 1 consists of information based on teacher assessments prior to the start of the study. Student academics in science were considered; these considerations were those based on teacher assessment prior to the start of the study. Teachers identified, through their classroom assessment, that nine students were ranked low achievers, 34 students were ranked average achievers, and four students were ranked as high achievers. Three of the nine low achievers were assigned an Educational Assistant as part of their IPP. All of the information presented in Figure 1 pertains to student achievement in science.

Figure 1

*Achievement Level Of Participating Students Prior To The Survey*

Specifically, in regards to the science curriculum and this study, each group of students was taught by two different teachers. Teacher A used a PBL method of instruction to deliver the Alberta science curriculum while Teacher B deployed a traditional method of instruction. The science classes were conducted at different times of the day and in different rooms. Gender demographics comparison of both classes is outlined in Figure 2. Students in the PBL classroom
consist of 23 students, 10 boys and 13 girls. In the classroom with a more traditional focus, there were 24 students, 12 boys and 12 girls.

Figure 2

*Gender Demographics of The Grade 9 Students Surveyed*

For this study, the researcher used a quantitative method of data collection. Data was collected by a survey and conducted at key points in the science curriculum. Collaboratively, teachers, who taught the Grade 9 students involved in the study, determined dates for completion of the surveys. Students involved in the traditional method of instruction were surveyed using the same criteria and during the same curriculum points as those in the PBL classroom.

A baseline survey was given to both student groups prior to the start of the study. The remaining surveys were administered after a review discussion about the learning since the last survey. This was administered on January 28th, 2015. For the charts presented in this study, the following legend identifies the questions found on the Y-axis and the student numbers on the X-axis.
Students’ genders were not distinguished during the surveys for this study. All students were given the option to rate each question with one of the following descriptions: strongly disagree, disagree, neither agrees nor disagrees, agree, strongly agree, and opt out. The questions were chosen to identify the level of engagement students felt in regards to the activity they completed during class.
Figure 3

Baseline Survey Results Collected From The PBL Classroom

11: I participate in class discussions and other activities.
10: The activities we do in class help me to learn.
9: I look forward to seeing what we will do in class each day.
8: The activities we do in class are fun and exciting.
7: The activities we do in class provide me with choices in how...
6: The activities in class make me want to learn more about a...
5: The activities in class challenge me to think differently.
4: I am very interested in my schoolwork.
3: My schoolwork allows me to demonstrate what I already...
2: My teacher listens to my suggestions and I am able to add to...
1: I think the things we do in class will help me in the future.
Once the baseline survey was complete and teachers had an understanding of the study and how it was to be presented to the students, both classes embarked on a four-week chemistry unit; this unit was in accordance with the Alberta curriculum. Within the traditional classroom, students were given booklets consisting of short answer questions. These questions were directly linked to Alberta education’s expectations for the chemistry unit. Students were asked to complete the answers in the booklet using required Alberta resources in addition to the lecture notes and expected knowledge gained from three in-class experiments. During the same period...
of time, the PBL directed class was to choose from three real world problems. Throughout the four-week unit, the majority of class time was spent working on the problems both in groups and individually.

Approximately every third class a mini lesson was presented to the PBL class. These mini lessons were used as directed by the scaffolding requirements in a PBL classroom. Students in the PBL classroom also completed five science experiments. These experiments were completed with a PBL methodology; rather than give step by step instructions for completion of the experiment students were only given appropriate safety instructions and a list of ingredients. They were then expected to complete the experiment with a specified outcome using the tools they had learned during the chemistry unit.

Both classes used the same assessment tool and at the same points of instruction. These results were compared for the purpose of future classroom instruction yet those results were not included in this study.

During the four-week chemistry unit, students from both classrooms were asked to complete the same survey five different times. The survey results represented by table 5 and 6, was administered for both classrooms on February 5th, 2015. The PBL classroom after they were introduced to the project and had completed the need to know list, with some class time to begin the planning process for their projects, students completed the first of the five surveys For the PBL students, this survey was administered in the mornings during the first block of the day.

For the students involved in the traditional classroom, students completed their first of five surveys after they completed the introduction lesson for chemistry. When comparing the data collected and displayed, the students working in the PBL classroom were more engaged in their learning throughout the chemistry unit. This lesson consisted of completing the introduction
section from their textbook as well as participating in a class discussion about how chemistry is used in the real world. Students of the traditional classroom completed this survey the last block of the day.

Figure 5

Survey One Results Collected From The PBL Instructed Classroom

11: I participate in class discussions and other activities.
10: The activities we do in class help me to learn.
9: I look forward to seeing what we will do in class each day.
8: The activities we do in class are fun and exciting.
7: The activities we do in class provide me with choices in...
6: The activities in class make me want to learn more about...
5: The activities in class challenge me to think differently.
4: I am very interested in my schoolwork.
3: My schoolwork allows me to demonstrate what I already...
2: My teacher listens to my suggestions and I am able to...
1: I think the things we do in class will help me in the future.
The survey results represented by Table 7 and 8, was administered for both classrooms on February 12th, 2015. The PBL classroom completed the survey after their first group section of the project. The survey was completed during the first block of the day. The traditional classroom completed the survey after they finished short answer questions in the classroom-administered textbook. This survey was completed during the last block of the day.
Figure 7

Survey Two Results Collected From The PBL Instructed Classroom

11: I participate in class discussions and other activities.
10: The activities we do in class help me to learn.
9: I look forward to seeing what we will do in class each day.
8: The activities we do in class are fun and exciting.
7: The activities we do in class provide me with choices in how to learn concepts or topics.
6: The activities in class make me want to learn more about a topic.
5: The activities in class challenge me to think differently.
4: I am very interested in my schoolwork.
3: My schoolwork allows me to demonstrate what I already know.
2: My teacher listens to my suggestions and I am able to add to assignments.
1: I think the things we do in class will help me in the future.
The survey results represented by Table 9 and 10, was administered for both classrooms on February 17th, 2015. The PBL students completed the survey after their first peer evaluation and check-in of the project. The survey was completed during the first block of the day. The traditional classroom completed the survey after they completed a short review class and quiz on
the first section of the unit as outlined in the classroom-administered textbook. This survey was completed during the last block of the day.

Figure 9

Survey Three Results Collected From The PBL Instructed Classroom

11: I participate in class discussions and other activities.

10: The activities we do in class help me to learn.

9: I look forward to seeing what we will do in class each day.

8: The activities we do in class are fun and exciting.

7: The activities we do in class provide me with choices in how to learn concepts or topics.

6: The activities in class make me want to learn more about a topic.

5: The activities in class challenge me to think differently.

4: I am very interested in my schoolwork.

3: My schoolwork allows me to demonstrate what I already know.

2: My teacher listens to my suggestions and I am able to add to assignments.

1: I think the things we do in class will help me in the future.
Figure 10

*Survey Three Results Collected From The Traditionally Instructed Classroom*

The survey results represented by Table 11 and 12, was administered for both classrooms on February 24th, 2015. The students in the PBL classroom completed the survey and evaluation checklist after their one-on-one meeting with the instructor. The survey was completed during the first block of the day. The traditional classroom completed the survey after completing a set
of chemistry experiments they had been preparing for since the February 17th survey. This survey was completed during the last block of the day.

Figure 11

*Survey Four Results Collected From The PBL Instructed Classroom*

11: I participate in class discussions and other activities.

10: The activities we do in class help me to learn.

9: I look forward to seeing what we will do in class each...

8: The activities we do in class are fun and exciting.

7: The activities we do in class provide me with choices...

6: The activities in class make me want to learn more...

5: The activities in class challenge me to think differently.

4: I am very interested in my schoolwork.

3: My schoolwork allows me to demonstrate what I...

2: My teacher listens to my suggestions and I am able to...

1: I think the things we do in class will help me in the...
The survey results represented by Table 13 and 14, was administered for both classrooms on March 6th, 2015. The PBL classroom completed the survey after they presented their projects to an audience of their parents and local individuals whose chosen profession involves chemistry on a daily basis. The survey was completed during the first block of the day. The traditional
classroom completed the survey after finishing their final project for the unit. This project consisted of a demonstration of what they found most interesting in the unit and a review booklet of the content covered in class. This survey was completed during the last block of the day.

Figure 13

*Survey Five Results Collected From The PBL Instructed Classroom*

11: I participate in class discussions and other activities.  
10: The activities we do in class help me to learn.  
9: I look forward to seeing what we will do in class each day.  
8: The activities we do in class are fun and exciting.  
7: The activities we do in class provide me with choices in how to learn concepts or topics.  
6: The activities in class make me want to learn more about a topic.  
5: The activities in class challenge me to think differently.  
4: I am very interested in my schoolwork.  
3: My schoolwork allows me to demonstrate what I already know.  
2: My teacher listens to my suggestions and I am able to add to assignments.  
1: I think the things we do in class will help me in the future.
Survey Five Results Collected From The Traditionally Instructed Classroom

<table>
<thead>
<tr>
<th>Survey Question</th>
<th>Opt Out</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Disagree or Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: I think the things we do in class will help me in the future.</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2: My teacher listens to my suggestions and I am able to add to assignments.</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>10</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>3: My schoolwork allows me to demonstrate what I already know.</td>
<td>3</td>
<td>11</td>
<td>10</td>
<td>10</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>4: I am very interested in my schoolwork.</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>8</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>5: The activities in class challenge me to think differently.</td>
<td>6</td>
<td>10</td>
<td>10</td>
<td>8</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>6: The activities in class make me want to learn more about a topic.</td>
<td>5</td>
<td>8</td>
<td>11</td>
<td>10</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>7: The activities we do in class provide me with choices in how to learn concepts or topics.</td>
<td>3</td>
<td>15</td>
<td>6</td>
<td>9</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>8: The activities we do in class are fun and exciting.</td>
<td>3</td>
<td>10</td>
<td>14</td>
<td>11</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>9: I look forward to seeing what we will do in class each day.</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>10</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>10: The activities we do in class help me to learn.</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11: I participate in class discussions and other activities.</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Summary

The data collected through the Likert scale survey was designed to provide insight into students’ engagement levels while learning science 9 learning outcomes. Students’ were introduced to curriculum objectives for this subject area in two different and distinct teaching methods. One group worked through a PBL method using the seven key principles of PBL while
the other was taught using a more traditional pen and paper method. Students survey results were anonymous allowing them the opportunity to answer freely. All students were given the opportunity to opt out of each question. The intent of the researcher was to identify if a traditional or a PBL method of instruction enhances student engagement in the science curriculum. Student engagement is evident in the data gathered during the month long research project.

The data collected during this study indicates that students’ engagement level was higher in the PBL classroom. In contrast students in the traditional classroom expressed a disconnect between what was being taught and their interest level. Students in the traditional classroom expressed a higher level of engagement than that of the PBL classroom when they were involved in the experimental portion of the chemistry unit.
Chapter 5

Conclusion

This study investigated the effects of project-based learning on student engagement in a middle school. Project-based learning is a instructional methodology involving 21st Century skills with a focus on solving real world problems. PBL moves away from the traditional pen and paper classroom, which focuses more on retention than on a deep meaningful understanding of course content. Wilhelm, Sherrod, and Walters (2008) suggested that student engagement is directly linked to student motivation. Further support, through McParland’s (2004) study, indicated that motivation leads to greater retention or depth of meaning for students. Increasing motivational levels of students leads to a deeper and more meaningful understanding of the topics covered in class.

By comparing levels of student engagement, which is being taught with two different methodologies, this study hopes to distinguish between which teaching method is more engaging for students. This study is comprised of data collected through an online survey from students of two different classrooms. One classroom consisted of 24 students and was taught in a traditional pen and paper environment. The comparison class of 23 students used a PBL approach to learning. Both classes were surveyed on the same curricular outcomes during the Grade 9 chemistry unit. The survey consisted of 11 questions on a Likert scale, for each question there was an option to opt out. This survey was delivered in an anonymous format with the only distinction identified as that of the different classrooms and method of instruction. The same survey was administered a total of five times throughout the study.

Within the traditional classroom a reliance on the recommended resources, as well as classroom notes and in-class lectures, was used to deliver content information. Assessment
within the classroom comprised of in-class multiple choice and short answer questions as well as
worksheets and assigned textbook questions. Twice, during the month of this study, students in
this classroom were given science experiments to complete and lab reports to submit. These
reports were used for assessment in regards to student understanding of the lab experiments.

The PBL classroom covered the same curricular outcomes as that of the traditional
classroom but the delivery and assessment of understanding were conducted differently.
Students rarely used the recommended resources and relied heavily on the Internet to gather
information they needed. Rather than deliver content through reading and a lecture format,
students were presented with problems to solve. These problems were presented to the class then
students were asked, as individuals and as groups, to work cooperatively for solutions. Students
were assessed throughout the process as they demonstrated their learning while solving the
problems presented. The teacher took on a facilitator’s role and interjected with mini lessons
targeted to the needs of the class. These mini lessons were chosen and designed to provide
students information as needed while they continued to work on solving their chosen problems.

The baseline survey administered to all participating students indicated that students of
both classrooms struggled with engagement in subject content. As represented in Figures 3 and
4, students expressed their discontent for what they learned in class through the results of
question 7 of the survey. A total of 22 students disagreed that the activities in class provided
choice in how they learn concepts and topics. Furthermore, the baseline survey demonstrated
that students felt that work completed in class did not allow them to demonstrate their prior
knowledge as highlighted by question 3 of the survey. A total of 14 students disagreed that
schoolwork allowed them to demonstrate and apply prior knowledge. These baseline results
provided a strong point of comparison for the change that took place in the PBL classroom.
After analyzing the results of the surveys, it is clear that students in the PBL classroom expressed more engagement in the learning, than those in the traditional classroom. Students in the traditional classroom expressed much lower levels of engagement throughout the process yet expressed the highest level of engagement after completing the science experiment. In contrast, to these results, the PBL students expressed a more consistent level of engagement throughout the process, with small fluctuations during classes that involved group or individual presentations.

Supportive Data For The Research Hypothesis

Figures 5 and 6 represent enhanced levels of engagement in support of PBL instruction over that of the traditionally instructed classroom. Blumberg (2000) highlighted the importance of relevance of information to student engagement; the data collected from question 6 of the survey administered on February 12th, 2015 supports this view. Of the 23 students in the PBL classroom, 15 strongly agreed that the activities in class encouraged them to want to learn more about the topic presented. This is in contrast to the traditionally instructed class, with only 4 students strongly agreeing with the same question.

As Thomas (2000) concluded, student engagement is sparked through connections within the classroom to what they experience outside of the school. Figures 11 and 12 demonstrate that students within the PBL classroom felt the information taught in class would help them in the future. Of the 23 students, 12 strongly agreed that this was true; while of the 24 students in the traditionally instructed class, only 2 strongly agreed to this statement.

Student motivation has been strongly linked to their interest level of what is being taught as demonstrated through the data collected by Yunus and Wan Ali (2009). Even though the same curriculum objectives were being covered in both classrooms of this study, question 4 of Figures
13 and 14 reveals a larger number of students who reported a lack of interest in the traditional classroom compared to that of the PBL classroom. When asked if they were interested in their school work 5 students in the traditionally instructed class strongly disagreed, compared to the 1 student in the PBL classroom who also strongly disagreed.

A deep analysis of the complete survey results demonstrates differences between the two classes and students’ level of engagement and interest. When asked if students felt their school work allowed them to demonstrate what they already know results indicated that students in the PBL class were better able to use prior knowledge to aid them in understanding concepts covered in class. This study supports Wilhem, Sherrod, and Walters (2008) who suggested that students building on prior knowledge aids in the intrinsic motivation for students to explore subject matter. Students in the traditional classroom found it difficult to relate information presented in class to things they already knew.

Another noteworthy divide between the PBL classroom and the traditional classroom related to motivation can also be extracted from the data collected during the research. Students were asked if the activities in the class made them want to learn more about a topic, students in the PBL classroom expressed that the activities and lessons motivated them to want to learn more than what was introduced in class. In comparison, students in the traditional classroom did not express interest in learning anything more about the subject other than what was taught to them. As Sungur and Tekkaya (2006) explained, motivation drives students to explore topic areas developing a strong understanding of information introduced in class. This interest develops into lasting and meaningful understanding.

Christensen (2004) suggested that students who are excited to learn are more intrinsically motivated to participate in class work and extend their learning past a surface level of
understanding. Students from both classes were asked if they looked forward to seeing what they would be doing in class each day, the results were clear. Students in the traditional class did not look forward to the time spent in the science classroom while those in the PBL classroom eagerly attended class. Allowing students a voice in how they learn and how they express their learning provides a level of excitement and makes the subject matter much more desirable for students.

**Data Challenging The Research Hypothesis**

Students expressed their excitement for hands-on learning within the traditionally instructed class above those expressed at the same time in the PBL classroom. Question 8, Figures 11 and 12, asked students if they found the activities in class fun and exciting. Within the traditionally taught classroom 11 of the students strongly agreed to this statement compared to 9 students within the PBL classroom. These results were gathered during the week of experiments in the traditionally instructed classroom. During these classes students expressed the highest level of interest and motivation within the traditionally instructed classroom. Students who are provided the opportunity to apply information learned in class with a hands-on approach, show higher levels of motivation within a traditional classroom.

**Identified limitations during the research**

During the study, four limitations were identified. The first of the four limitations may be the lack of understanding or proper execution of a PBL methodology within classroom. The instructor of the PBL classroom had a clear and thorough understanding of the many facets of PBL. If any of the seven essential elements are not carried out correctly and continually, including assessment, the students’ motivation for the project may begin to fade. This was illustrated in the third set of survey results when a substitute teacher instructed the class twice
during the week. Without a clear understanding of the process, students were directed away from the established process of learning. The survey results recorded at the end of the week were the lowest scores of motivation and engagement recorded within the PBL classroom.

The second limitation identified was the enthusiasm of the instructor. The instructor of the traditional classroom expressed that the chemistry unit was not one of her favorite topics to teach. She explained that most of the content provided to the students had not been updated since the first time she had taught this unit three years ago. The instructor relied heavily on the recommended resources to assist in her teachings. In contrast, there was excitement for the content as well as the process of teaching that took place in the PBL classroom. The instructor was motivated in the PBL environment to seek out current issues or problems in the field of chemistry; this excitement, to assist in the facilitation of this unit, endeavored to make the learning authentic and real. Excitement for the content delivered through the instructor had a positive influence on how students learn and engage within the classroom.

The learning environment for each of these classrooms is identified as the third limitation. The traditional classroom was held in a small room filled with individual desks placed in rows and perhaps making group work cumbersome and difficult. The PBL classroom took place in a large room with movable tables. The teacher or students could configure the tables for group or individual work as needed at any time. This mobility was not available in the traditional classroom, as it was held in a science laboratory. Students were only able to use the lab tools and equipment for a total of two days during the month this study took place.

The final limitation identified in the study was that the PBL classroom held a number of technologies that students had access to each and every day during the study. Having the ability
to change or manipulate the environment to suit the needs of students as they learn contributed to how motivated students are to work and think differently.

**Concluding Statement**

The research presented in this study was intended to investigate if PBL could be used to increase motivation levels of students in Grade 9 science. Achilles and Hoover’s (1996) study linked motivation for better retention and the understanding of curricular objectives. For schools looking to increase provincial results, they only need to increase the motivation of students in classrooms (Mehalik et al., 2008). One possible way to motivate students and build confidence in students’ learning abilities would be to implement project-based learning school wide.

With the use of student surveys throughout one unit of study within the Grade 9 science curriculum, the data collected favorably supports PBL instruction as a way to engage students within the classroom. PBL also addresses the changing landscape of the work force and the 21st Century skills students will need to become productive members of society. Making instruction relevant to students, while connecting it to past experiences, enables students to develop a deeper understanding of content introduced.

PBL allows students to 1) have more choice in how they demonstrate their learning and 2) explore areas of the topic that would not normally be introduced to the class if taught using a traditional pen and paper delivery. Survey results indicate that students value the ability to take charge of their learning and demonstrate what they have learned throughout the unit.

**Recommendations for Further Research**

Further research of this study could involve comparing the Grade 9 science provincial examination results. Identifying if PBL instruction allows for longer retention and better recall within students could be identified with the comparison of these results between the two
approaches of instruction. If one were to review the results of the provincial examination, focusing on the questions related to the chemistry unit, one may gain insight regarding students’ lasting understanding of the curricular objectives taught with the use of project-based learning.

A more in-depth study of the two teaching methodologies would be to compare data collected after a full year of PBL and traditional classroom instruction. After collecting and analyzing the provincial exam results of these two classes, rather than that of only one month of PBL, one would demonstrate if students’ level of engagement was elevated for the year. Comparing these results may also indicate if students were able to apply the learning done in class to a variety of exam questions and areas of study.
References


doi:10.1080/00098650903505415


Ferreira, M. M., & Trudel, A. R. (2012). The Impact of Problem-Based Learning (PBL) on Student Attitudes Toward Science, Problem-Solving Skills, and Sense of Community in the Classroom. *Journal of Classroom Interaction, 47*(1(c), 23–30.

Ferreira, Maria M. Trudel, A. R. (2012). The Impact of Problem-Based Learning (PBL) on Student Attitudes Toward Science, Problem-Solving Skills, and Sense of Community in the Classroom. *Journal of Classroom Interaction. 2012, 47*(1).


implement project-based learning. *Learning and Instruction*, 20(6), 487–497.


http://psasir.upm.edu.my/7008/1/European_Journal_of_Social_Sciences_%E2%80%93_Vo
lume_7%2C_Number_4_%282009%29_2.pdf
Appendix A

Appendices:

Dear Parents or Guardians,

In addition to being a teacher at St. Dominic High School, I am also a student in a masters program provided through the City University of Seattle. As part of this program, I will be conducting a research study to learn more about how project based learning affects student engagement in science. This study will be conducted using all the grade 9 students at St. Dominic high school specifically within the science 9 classroom.

This study will not add any work or change any curriculum expectations for the course. I would like to invite all grade 9 students within our school to participate in the study. No names or personal information will be gathered as the study is based on the information shared through online surveys only.

At any time during the research you do not wish your son/daughter to participate they will have the option to opt out without any negative repercussions or consequence. Below is some information to help you make an informed decision if you would like your son/daughter to participate:

What is Project Based Learning:
Project Based Learning is a teaching method in which students gain knowledge and skills by working for an extended period of time to investigate and respond to a complex question, problem, or challenge. For more information on Project Based Learning please visit the buck institute at www.bie.org

Are there any benefits or drawbacks of being involved?
The study will not influence any marks or provide any reward for participation. The information gathered from the surveys will provide valuable feedback on the best way to teach and engage students in science classes. This will not add any additional work to the science class and all surveys will be done during science class.

Is this study mandatory?
This study is NOT mandatory and you are able to opt out of the study at any time without any negative repercussions or consequence what so ever.
I am asking for your informed consent for your child to participate in the study. Even with you giving informed consent and your child giving their assent, you will both have the option of withdrawing from the research at any time.

Questions?
Being informed is vital to this project. If at any time you have any questions or concerns please contact me and I will be happy to answer any questions or meet with you at any time. The best way to reach me is via email.

E-mail: adam.sia@rdcrs.ca

In you have concerns about this research, you can also contact my advisor, Heather Henderson who will be supervising this research:

E-mail: hhenderson@cityu.edu

To participate in this study, I need to know that you are willing to participate and that your choice to do so is entirely voluntary. Please review your rights at the bottom of this page and sign below if you agree to participate.

Sincerely,

Adam Sia

IF YOU AGREE TO PARTICIPATE IN THE STUDY, PLEASE SIGN BELOW

Signature of the Student ________________________________

Date __________________________

Print Student name: ________________________________

Signature of the Parent or Guardian ________________________________

Date __________________________

Print Parent name: ________________________________

The rights below are the rights of every person who is asked to be in a research study. As a research subject, you have the following rights:

1) To be told what area, subject, or issue is being studied.
2) To be told what will happen to you and what the procedures are.
3) To be told about the potential risks or discomforts, if any, of the research.
4) To be told if you can expect any benefit from participating and, if so, what the benefit might be.
5) To be allowed to ask any questions concerning the study, both before agreeing to be involved and during the course of the study.
6) To refuse to participate in the study or to stop participating after the study starts.
7) To be free of pressure when considering whether you wish to be in the study.
Research Ethical Review Approval Protocol

Project Title: Student engagement in a core subject areas using PBL in a rural school.

Researcher’s Name: Adam Sia
School: St. Dominic

University of Study: City University
Advisor’s Name: Patrick Hughes

1. Does this research involve human participants? Yes X No

2. Has University ethics approval been applied for? Yes No X Given? Yes No

3. Abstract (Lay Summary):
   This study is designed to gage the student engagement on a group of grade nine students with the introduction of PBL. The students being studied have not been introduced to PBL and for the most part have been learning in a traditional manner in regards to paper and pencil assignments and worksheets. The study is designed to enhance engagement in Science and Math grade 9 to help with the excellent level in student’s achievement exams.

4. Description of participants (age range, number, location, special characteristics):
   Students win the study will consist of Grade 9 students enrolled at St. Dominic catholic high school in Rocky Mountain House. 57 students will be involved in the study and the information gathered will be done so in the subject areas of Math and Science. This is a diverse group of students with 26 females and 31 males. A large portion of the group comes from St. Mathews middles school, the remaining students came from Pioneer middle school in Rocky Mountain House.

5. Describe how participants will be identified or recruited: One group of students will be part of my math and science classes and the other group will be enrolled in the same subjects with two different teachers at the same school. Students will not be identified as individuals other than the differences in how the class was taught. Students will be asked the same questions about the information learned in their respective classes.

6. How will the confidentiality of the participants and data be protected? Students will be answering survey questions on line in a anonymous manner. There will be no log in or indefinable way to track who answered the questions with the use of Google forms. The same will be true when students are asked to comment in a journal format. These students will not be identified in any way.

7. Describe the Informed Consent process: All parents of the students in the group will receive a letter of consent allowing them the option of opting out of the study. Parents will be able to view all of the material used to gather information from the study.

Signature: ________________________________ Date: __________________________
Submit to Dr. Paul Stewart, Associate Superintendent
Appendix B

Atomic Structure

- elements are organized by their atomic structure
- all atoms have three key components called subatomic particles — protons, neutrons, and electrons
- there are also units called quarks but they are not a focus for us at this time

1. Complete the following table using information on page 120.

<table>
<thead>
<tr>
<th>Subatomic Particles Comparison Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charge (positive, negative, neutral)</td>
</tr>
<tr>
<td>Electron</td>
</tr>
<tr>
<td>Proton</td>
</tr>
<tr>
<td>Neutron</td>
</tr>
</tbody>
</table>

2. For each scientist listed, briefly describe the model of the atom he was responsible for and draw a simple diagram illustrating the model. Please point out the differences between the models. (p. 118 – 120)

Atomic Models Through History

<table>
<thead>
<tr>
<th>Description / Key Contribution(s)</th>
<th>Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>John Dalton (8 – ball)</td>
<td></td>
</tr>
<tr>
<td><strong>J.J. Thomson (Raisin bun)</strong></td>
<td></td>
</tr>
<tr>
<td>--------------------------------</td>
<td>---</td>
</tr>
<tr>
<td><strong>Hantaro Nagaoka (Solar system model)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Ernest Rutherford</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Neils Bohr (Energy Shells)</strong></td>
<td></td>
</tr>
</tbody>
</table>

3. What did James Chadwick add on to Bohr’s energy shell model of the atom?
Title: Unknown Clean Up in Aisle 5

Project Idea: Students will collaborate and report how to remove unknown chemicals from an old chemical stock room in a defunct school building. Students will classify substances as mixtures, compounds, and elements as well as propose safe ways to clean up and dispose of unknown chemicals.

Entry Event: Each group of students will receive a memorandum explaining the task of cleaning out a chemical stockroom in a school that is either closed or will be closing. The unknown chemicals must be classified through physical and chemical properties.

### Assessment

<table>
<thead>
<tr>
<th>Rubric(s):</th>
<th>Collaboration</th>
<th>Written Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Critical Thinking &amp; Problem Solving</td>
<td>Content Knowledge</td>
</tr>
<tr>
<td>Oral Communication</td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Foldable Media Production</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lab Report Rubric</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other Classroom Assessments:</th>
<th>Quizzes/Tests</th>
<th>Practice Presentations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Evaluation</td>
<td>Notes/Lab Activities/Analysis</td>
<td></td>
</tr>
<tr>
<td>Peer and Self Evaluation</td>
<td>Mixtures and Pure Substances Lab</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unknown Substances Lab</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Metal, Nonmetal, or Metalloid Lab</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Peer Evaluation</th>
<th>Checklists/Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peer and Self Evaluation</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Online Tests and Exams</th>
<th>Concept Maps</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frayer Model</td>
</tr>
</tbody>
</table>

Reflections:

<table>
<thead>
<tr>
<th>Survey</th>
<th>Focus Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discussion</td>
<td>Task Management Chart</td>
</tr>
<tr>
<td>Journal Writing/Learning Log</td>
<td>Other</td>
</tr>
<tr>
<td></td>
<td>Lab Report Format</td>
</tr>
<tr>
<td></td>
<td>Group Observation Checklist</td>
</tr>
</tbody>
</table>