Evaluating Student Achievement Through Rigorous Project-Based Learning in Secondary Science Education

Mickayla Rose Timberlake

A thesis

submitted in partial fulfillment of the

requirements for the degree of

Master of Arts in Teaching

Western Oregon University

2025

Reading Committee:

Rachel Harrington

Rebecca Chitkowski

Program Authorized to Offer Degree:

College of Education

MASTER'S DEGREE FINAL EVALUATION REPORT

Completion Term: Summer 2025

Type of exit requirement: Action Research Project

The supervisory committee met with the candidate for a final evaluation in which all aspects of the candidate's program were reviewed. The committee's assessment and recommendations are:

Recommendations:

- ✓ Degree should be awarded

Recommendations:

- ✓ Exit Requirement has been approved

Western Oregon UNIVERSITY

WE, THE UNDERSIGNED MEMBERS OF THE GRADUATE FACULTY OF WESTERN OREGON UNIVERSITY HAVE EXAMINED THE ENCLOSED

Action Research Project Title:
Evaluating Student Achievement Through Rigorous Project-Based Learning in Secondary Science Education

Graduate Student: Mickayla Timberlake

Candidate for the degree of : Master of Arts in Teaching: Initial Licensure

and hereby certify that in our opinion it is worthy of acceptance as partial fulfillment of the requirements of this master's degree.

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Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

From this, decreasing the emphasis on standardized testing allows students to develop

ACKNOWLEDGMENTS

I would like to begin by saying thank you to the Western Oregon University faculty for the encouragement, and guidance through the process of completing the MAT program. Thank you to Rebecca Chitkowski who not only was my second reader, but was also my WOU supervisor and mentor. Your feedback, suggestions, advice, and support during the completion of this program has been invaluable toward helping me become a better educator in science. It was a pleasure to work with you.

Additionally, I would like to thank my clinical teacher Janelle Detweiler and my building principal Robby Gilliam. Both of you have provided me with support in the completion of this program and from the both of you, I have learned more about classroom management that fosters student relationships. You have encouraged me through the higher and lower points of when I felt discouraged. Thank you both for your flexibility and grace throughout the completion of this program.

To my family, thank you for your support and patience throughout the multiple school years. I am done! Thank you for always being steadfast, understanding, loving, supportive, and

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encouraging of my education. To my parents, thank you for always supporting and loving me with all of my decisions, even though you might question why I chose to teach chemistry. Thank you for making me laugh during the hardest times of my life and problem solve with me during this process.

Lastly, and certainly not least, my Lord and Savior, Jesus Christ. Thank you for your never-failing love, it is through your love and plan for me that I was given this opportunity to serve you and your kingdom. I would not be here with this program if it weren't for you. This honor is contributed to you in full. Amen.

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Chapter 1. Introduction

My experiences in Oregon's education system have demonstrated positive and negative influences on my education both as a student and a future educator. These experiences led to the development and understanding of my philosophy of education. Some positive experiences include overcoming my fear of skeletons in anatomy and physiology, becoming exposed to different branches of science like chemistry and biology for the first time in public school, and having teachers that encouraged and inspired me to pursue a career in a STEM related field. However, my negative experiences started with a teacher skipping important math curricula, a teacher refusing to take action against bullying, a male student teacher telling my classmate and I that we would fail the science class, a teacher denying me a 504 accommodation during the pinnacle of my brain injury, and an increased emphasis on standardized testing with higher standards.

The most significant experience in my education occurred during my transfer from a private to a public middle school. Due to being bullied, my parents allowed me to make an

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educated decision of where I wanted to go to school; so I chose to go to a public middle school. Not only was I adapting to a new environment, but I was also adapting to new standards and curriculum.With this curriculum, my family and I discovered how far behind in math I was in comparison to my peers. While the struggle with math made its entrance into my education, I was experiencing culture shock of meeting new people that came from different backgrounds than me, and a push towards developing skills to contribute to the economy and corporations. With this, I encountered state-standardized testing for the first time and the pressures and stress of performing well. I remember taking tests often and how much weight they held on my grades. During this time, it was difficult to be a student. I felt that my classes did not have meaning to them, that we were memorizing facts without applying the skills we need to function in society. This way of teaching and learning was not student centered and focused on students regurgitating facts. Rury (2019) discusses this concept of increased test priority and excellent scores comparing it globally from his “Education and Social Change: Contours in the History of American Schooling”. With this increased priority of test taking, it lacked meaning and created a

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] stressful learning environment for my peers and I. At the time I wished that there was another way to prove to my teachers that I know the material.

It was discovered at a younger age that I had a mild case of test anxiety. During tests I either froze due to the time restraints or I panicked because I lacked confidence in the material. I wanted to show my teachers that I knew more than what the test scores showed. Whenever one of my teachers created a project to complete, I excelled. To me, projects were not only fun, but allowed me the time to think, problem solve, and see the bigger picture in my life. These projects challenged me to make a creative solution and to work through a process that required critical thinking. These experiences are what I aim to implement into my classroom for my students.Through my experiences with high stakes testing via Smarter Balance, I am able to provide my students with an additional way to show their understanding of the content they are learning.

However, during 2012 when Smarter Balance was transitioned from the Oregon Assessment of Knowledge and Skills (OAKS) testing, this educational reform regarding Smarter Balance was in position to fix the system that had gone array. Government funding was reliant

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] on schools using the No Child Left Behind Act (2002) and our test scores so that students with diverse backgrounds could receive the help and support they need.While the attempt was a positive step in towards providing support for students, the stress placed on the teachers, administrators, parents, and students was evident. The goal was to reach the benchmarks and many of my peers and I were not meeting those marks and my test anxiety was elevating. Teachers and administrators felt pressured to get through the curriculum at a fast pace. Sometimes I could see the frustration and aggravation on the faces of my teachers. The money that meeting the benchmarks would bring due to test scores would allow student support for families that needed it the most. Into high school, my test anxiety skyrocketed once more, however, under different circumstances.

During the beginning of my junior year in high school I acquired a Traumatic Brain Injury (TBI) and I developed anxiety that intensified to the point of requiring a 504 accommodation. With this 504 accommodation, I was allowed to be given more time to take my tests in a quiet environment under supervision from staff. Tests became a significant trigger of my anxiety, it was difficult at times with taking tests. I knew that I could not escape from taking

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] tests the rest of my life. However, similar to middle school, whenever my teachers in all subjects created a project to complete, I was able to show my teachers that I understood the material. It is through this concept that has directly influenced my classroom behavior, curriculum, and approach in measuring student achievement and mastery.

From my experiences in both private and public arenas of education, I have learned how to take tests at a young age, how to manage test anxiety, economic demand influences the education system, and recognize the differences between private and public schooling. Whether it be instruction or curriculum. It is through these experiences that aided my direction of implementing Rigorous Project- Based Learning (McDowell , M., Hattie, J., & Boss, S.,2017) into my classroom. This method has greatly influenced not only how I structure my classroom routines and activities, but also how I measure student achievement in mastery of scientific and mathematical principles in chemistry.

As of 2022, the United States was below in mathematics but above average in science (Kennedy, 2024). This particular statistic led me to wonder about the differences of how science and mathematics are taught. With this statistic, and my experiences during my brain injury, have

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] set the tone of my research to evaluate how scientific and mathematical principles are taught together in the same classroom. Although my undergraduate degree is in chemistry, as a private school teacher I have had to stretch myself into teaching multiple disciplines when needed from my administrators. In addition to teaching chemistry, I have taught physical science, biology, forensic science, sixth grade mathematics, and Spanish language. From teaching these additional disciplines involving mathematics and science, an increased comprehension and application of scientific and mathematical principles has made its way into my classroom via Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). Due to the implementation of performance tasks, projects, and specifically designed experiments, students perform higher mastery when given one of these assessments. For this research scope, I want to explore teaching mathematics with scientific principles, evaluate how science and mathematics are taught, and its impacts on student achievement.

Guiding Pedagogical Theory

The framework that is guiding my study is Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). Rigorous Project-Based Learning (McDowell, M.,

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Hattie, J., & Boss, S.,2017) is an educational approach that uses students' background knowledge and experiences to explore real-world problems. In addition, this model adds rigor and meaning into the projects and exploration for students to gather meaning and apply their knowledge to a real-world situation. The four main tenets of this approach include implementing relevant and purposeful experiences (p.95), deepening core ideas from content (p.58), creating and maintaining supportive relationships (p.113), and using evidence-based practices for assessments and instruction (p.21).

The reason to use this framework includes, increasing engagement with students, building on their funds of knowledge, and promoting community building amongst students and myself. Another reason for implementing this into my science classroom is the idea of relating mathematics to scientific concepts that are outside of the classroom for my students. As a science educator, for me it is crucial to teach and incorporate inquiry to promote critical thinking and problem-solving in students via experiences and thinking about science. By utilizing this framework, it allows me to spark curiosity in my students and promotes exploration.

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This framework is a perfect guide to my study because, according to the George Lucas Educational Foundation (2021), it should focus on utilizing peer collaboration, prior knowledge of students, and creating authentic connections with the environment and community around students. This is a drastic change from my personal experience from standardized testing to building community, funds of knowledge, and developing skills that are essential outside of the classroom. By decreasing the emphasis on standardized testing, students are developing knowledge that will be remembered, utilized, boost self- autonomy, and appeal to Gardner's multiple intelligences model (1987) where an individual can exhibit more than one type of intelligence.

The first tenet indicates that in order to create relevant and purposeful experiences that an implementation of culturally relevant practices is required. Students' lives and experiences need to be taken into consideration and the work needs to be authentic and meaningful to them. Some aspects of authenticity include workforce, community, location, and extending outward towards the world. Additionally, these experiences are not selected at random but are sequenced to

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] deepen meaning and aid the development of skills that were discussed and practiced prior to a new set of experiences.

This can be utilized in the form of projects and should be authentic and provide students with choices and "the opportunity to address audiences through public performances and products, and access to and instruction on the use of authentic tools that people use in a contemporary life outside of school"(Lucas Education Research, 2021, p.5). Once this occurs the rigor of Project-Based Learning(PBL) "deepens student engagement, and increases the likelihood of achievement gains"(Lucas Education Research, 2021, p.5) and students begin to deepen their understanding of the content, and develop skills that are relevant to them and their community.

The second tenet of this method emphasizes the importance including specific learning goals. These goals will help aid the development of content of knowledge and provide experiences in which students can learn the interdisciplinary skills in that content for application. This also helps students apply their knowledge from core classes into addressing the problems that occur beyond their community. Combining content between core subjects adds to the

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] toolbox that is developing to prepare students for applications both in and outside of the classroom for later in their lives outside of high school.

Creating and maintaining meaningful and supportive relationships is the third tenet of this method. This student- centered approach to learning promotes student involvement, engagement, collaboration, and a strong classroom culture. By creating a strong classroom culture students are encouraged to "work through challenging material and take intellectual risks, and makes meaningful collaboration the norm"(Lucas Education Research, 2021,p.13) among their peers and teacher. In this, students are building the necessary skills to make educated decisions based on their knowledge, and the knowledge they receive like experts. In addition to building decision making skills, students are also held accountable for the collaborative and individual work they produce through driving questions.

Lastly, using evidence-based teaching and assessment practices contributes to the premise of this tenet. Data and evidence are important for any educator. Collecting evidence of practices that work allow teachers to make the necessary changes that are needed to help students learn content. It also aids teachers in making decisions on the designs of projects that promote critical

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] thinking " and encourage students to engage with disciplinary content and practices"(Lucas Education Research, 2021, p.18). To do this, teachers might be pulled out of their comfort zones and encourage students to share their thoughts, opinions, views, and positions on topics that connect to additional ideas from their work to the world around them.

Connection to InTASC Standards

The InTASC standards that will be addressed to this research include Standards 1,3, 4, and 5. The "Learner Development"standard will be included in this research because it addresses a teacher's understanding of the learner's individual growth in all aspects of their life. It is important to understand that each student learns singularly. The "Learning Environments" standard is applicable because it directly relates to creating " environments that support individual and collaborative learning" that includes and implements engagement and social interaction. The standard, "Content Knowledge" will be applied due its implications of tools, concepts, and outline of the discipline that is taught. Giving students the tools and opportunities to practice and apply the content, make their learning more meaningful to them. The last standard that is interwoven in this research is "Application of Content". With this standard,

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] students are actively using their knowledge, skills, and tool sets to solve a problem with critical thinking. It becomes the educators job to "connect concepts and use differing perspectives to engage learners in critical thinking, creativity, and problem solving". For this to work, an application of knowledge is required for local and global constructs.

For this action research project, I have two goals that I want to accomplish. The first goal I have is creating an open, safe learning environment where students can express their thoughts, beliefs, and perspectives in a way that challenges them to see multiple perspectives and ways of thinking. Both InTASC standards 1 and 3 connect to this goal and Rigorous Project- Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) by recognizing how students learn and creating challenges according to their skill set. My second goal is to provide multiple representations and resources to make learning more meaningful for my students as they connect the content to local and global issues. This directly implements InTASC standards 4 and 5 because I want to provide my students with the resources necessary to function in a project where they can show me their understanding of the material and apply it to a live example and or a situation students are currently experiencing.

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In all, these standards fit in with Rigorous Project- Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) because the framework requires teachers to take into careful consideration the instructional strategies, resources, challenges, and meaningful work that is given to the students is authentic based on experiences from students. Another aspect of this framework is the strong incorporation of collaboration amongst students in creating a safe and open environment where students can express themselves free of judgment. It can be difficult to learn, apply, and develop collaboration skills if students feel that they do not have a voice in the classroom. Finally, the standards described interweave with the framework because of the special consideration it takes to implement evidence-based practices that are important towards potentially modifying teaching methods for students. It is also important because it allows teachers to evaluate the effectiveness of adding to a student's fund of knowledge, if it was successful in execution, and if students are finding the content meaningful.

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Summary

Although my experiences in Oregon's education have not always been exceptional; with a teacher skipping important math curricula, being bullied, a teacher denying me a 504 accommodation, to an increased emphasis on standardized testing and higher standards. I have discovered that an alternative form of testing and teaching may be implemented when it comes to teaching science and mathematics. To implement this alternative form of testing, a Rigorous Project- Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) method will be implemented.

Rigorous Project- Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) requires the teacher to carefully evaluate the instructional methods, resources, and authenticity of fabricated experiences either in or outside of the classroom for a specific purpose. This method also requires that teachers use evidence-based practices and continue to modify as needed to accommodate as many learners as possible and to eliminate an activity that does not provide any meaning or relation to students whatsoever. When students are engaged in the content through

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] meaningful and authentic content there is a high probability that students will result in higher levels of achievement, a better understanding of the material, and a development of skills that they can use both inside and outside of the classroom.

Chapter 2. Review of Relevant Research and Scholarship

A combination of good and bad experiences in Oregon's education system related to science education, has led me towards studying and examining the Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) system at a deeper level. With deeper examination I hope to learn about the impacts and effects its implementation has on students

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From this, decreasing the emphasis on standardized testing allows students to develop learning science. STEM in general has multiple fields of study that contain a large quantity of components that appeal to logic and connections between disciplines. The traditional model, which I am accustomed to, does not function well; it contradicts the purpose of STEM. The purpose of STEM is to challenge students, having students build community with other learners, and develop both critical thinking and problem solving skills. In addition, STEM is supposed to nurture curiosity and inquiry. These characteristics are the baseline for STEM related careers.

The process for reviewing literature was a little difficult. While trying to find Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017), there were only a couple articles that used the exact name and title of the method I am pursuing. So to solve this problem, not only did I use multiple search engines such as EBSCO, Sage Journals, JSTOR, and EBSCO Ghost, I also tried Google Scholar and I changed my search to rigorous instruction in science. From this search I noticed an increase in literature that appealed to my pursuit. It contained data and multiple references in the study itself. In my research I wanted data as a form of evidence towards this specific instruction that I am pursuing.

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The major goal for Assaf (2023) was to determine the influence of a rigorous curriculum, its Project-Based Learning system, and its implementation on middle school students' achievement in science and MAP progress at an American school in Abu Dhabi, United Arab Emirates. Assaf implemented a more quantitative approach through post-positivistic paradigms. Through this quasi-experimental study of roughly 955 middle school students, data was collected using the Science Standard Knowledge Test (SKKT) and Measure of Academic Progress (MAP) scores during September 2021 through June 2022. Their results were analyzed through descriptive and inferential statistics to compare the Measure of Academic Progress scores and the Science Standard Knowledge Test scores. The author concludes that through the implementation of Rigorous Curriculum Design-Project Based Learning, the results have demonstrated an increase in student achievement in the SKKT's scores, increased MAP scores, and it allows students to meet the international standards associated with growth. Lastly the implementation provides a way to include students' culture, belief, and perspectives to be valued and further continues to entice policymakers to train teachers to implement this type of design and learning system into their classrooms.

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

From this, decreasing the emphasis on standardized testing allows students to develop

This article was very impactful on my teaching and understanding of how Rigorous Project Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) and teaching may be used in educational settings because the foundations of the method includes building relationships not only between students and teachers, but students with other students as well. Encouraging and implementing a students' culture, beliefs, and values contributes towards recognizing student experiences and their pertinence in their education. Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) increases student interest in STEM, builds on the skills that they currently possess, and shows the importance of providing students with timely feedback.Within this article are a few tables and a couple graphs that show the progress and mathematics of the study. The author does an excellent job with diction and explores in depth behind meanings, definitions, and possible implications for the future. However, the article could have included data within the high school setting. Since there are different age groups, it is possible that not all the results would translate and transfer into high school scores. If high school was included, then a greater population would serve a larger percentage of the application in secondary education.

Conclusion

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DeWaters et. al (2014) evaluated and identified relationships in middle school and high school students with the characteristics of a Project-Based Climate model in hope of increasing climate literacy through climate change project modules. DeWaters had 20 science teachers both middle and high school in the 2011-2012 academic school year develop or refine a Project-Based Climate Change Module to use in their classroom. These modules would vary in the number of days and selected topics that would provide students with a solution to an overarching problem. In this quasi-experimental study, pre and post questionnaires were administered to the middle school and high school students via Zoomerang. Through statistical analysis, the authors discovered that their findings are limited by the prior knowledge, background, and experiences that students have; which influence their performance. In addition, the authors discovered that a rigorous and relevant project based model supports significant improvements towards achieving climate literacy. The authors added more details about the impacts on students; more specifically that students were more engaged in their learning, they were taking more ownership of their work, and they built stronger connections between school and outside of the classroom in a real world scenario.

Conclusion

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This article was very impactful on my teaching and understanding of how Rigorous Project Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) may be used in my educational settings because the study that was conducted appealed to both middle school and high school students in science; more specifically climate change literacy. Climate Change Literacy is a topic that is required as of the Next Generation Science Standards that was added roughly around 2013, according to the authors. Something that was interesting about this article were the examples of climate change modules. It was interesting to see the differences of information per teacher and subject that were implicated in the classroom in addition to the quadrants which contained specific activities for the teacher and the students to complete. The authors do an excellent job with showing the reader the data, graphs, tables, and educational modules that were implemented. A weakness however, is that the authors did not include the questionnaire they created for data purposes. In addition, the authors, although they did not test for it, could conduct an experiment or include a column in their questionnaire about student experiences with the related content. Forgetting to do this seems contradictory to a Rigorous

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] Project-Based Learning environment where students' experiences need to be taken into consideration.

The goal for Edmunds et. al (2017) was to add to previous research concerning the implementation of effective strategies of Project- Based Learning by exploring the relationship between Project- Based Learning and rigor in ten STEM- oriented high school classrooms. To observe this, the authors conducted a study that included evaluating students' perceptions of their learning through surveys, observations from the student, having teaching observations, utilizing teacher logs, and asking students to explain or present their results of a project. From this study, the authors discovered that Project-Based Learning can be an approach that teachers can use to seek and implement rigor in their classrooms. In addition, it is mentioned that rigor is not guaranteed in the classroom and the authors recommend that in order for the development of a high quality Project-Based Learning implementation requires the presence of rigor. To accomplish this, the authors recommend that the content of projects would need to be complex and reflect core concepts of the discipline, and involve teachers in engaging , yet collaborative examination of the implementation of a rigorous instructional lens.

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop

This article contributed greatly to my research because the authors conducted and focused on utilizing students' experiences and interests, In addition, the study itself included teacher data as well and therefore makes this article a valuable piece of research that aids and proves with substantial, quantitative data, and evidence that there is a significant influence of including Rigorous Project- Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) into a science classroom. Additionally, this article does a wonderful job with explaining and introducing both Project- Based Learning and Rigor in a way that is easy to read for the audience. However, this study was only conducted for an entire year and prioritized schools that were organized around a STEM- related schema, small schools, and or early college high schools with campuses that are located on community college or university campuses. While the results are interesting and accomplish most of what the authors' wanted, a larger sample of students should be compared to schools and in different locations in New York.

The goal for Kim et. al (2018) was to collectively use the past experiences of female students in STEM settings from previous literature to make recommendations to construct an open, safe, and welcoming environment that not only encourages young women in middle and

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] high school to pursue STEM outside the classroom, but also to develop a STEM identity. To accomplish this goal, the authors used nine databases in their search. During their search the authors looked for empirical work focused on comparisons of gender, women with disabilities, women of color, and students that were in the U.S. From their research, the authors found that topics like policy, lack of interest programs, and relationships greatly influence young women thinking about going into STEM courses and fields. To conclude, the authors propose that continuing to support female students as they go through STEM coursework is imperative, and the need for changing perceptions of people currently in the "in group" of members in STEM related careers.

This article was chosen because as a part of my research, I would like to explore how different genders view science as well as approach science in the classroom. A strength of this article is that the authors do an excellent job with thoroughly researching different literature pieces from past experiences of women in the field of STEM and young women who would possibly pursue STEM related courses and careers. However, there is not a formal study that was conducted or data that relies on graphical and statistical evidence.The evidence that is mentioned

Conclusion

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and shown includes behavioral and psychological evidence from previous literature. Although, it is mentioned and shown in a table the numerous studies that were examined, the grade levels, sample size, and examples of situations that were placed and summarized in a coherent and cohesive manner.

Mehta et.al (2024) discusses the different mental and physical statuses and stature of both men and women. The authors mention that with time and hormones both men and women start to distinguish priorities, processes, and use information differently. From their findings and psychological observations, they found that women tend to think holistically, understand feelings better, have better hearing, focus on relationship building, and have greater intelligence when it comes to the intentions of others. Men on the other hand tend to think more logically, they have more consistent hormone levels, overestimate their abilities, can only receive music not music and white noise, they grow through resistance, and they tend to be more competitive.

This article was chosen because it is important not only for my research, but also for my educational strategies that I use for both men and women in my classroom. Although this article does not include a case study or statistical and quantitative evidence, this article does an

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] excellent job at summarizing information that has been collected by psychological evaluation. A weakness of this article is that it does not include any form of data or methodology for how they received their information. However, this article does include sources and references that they researched for the audience's reference in the making and writing of this article.

The overall goal for Rahmawati et. al (2021) was to analyze the thinking skills of students through integrating dilemmas stories through STEM Project Based Learning. The location of the study was at a public high school in West Java province with a class size of 47 seniors. To research, the authors deployed a qualitative method to obtain classroom data through observations, journal reflections, interviews with students, and a conceptual test. These results and data were collected, analyzed, and assessed using a combination of Bloom's Taxonomy (1956) and Webb's Depth of Knowledge known as Hess's Cognitive Rigor Matrix.

The results of this case study showed that most students understand or recall the content information.The authors also mention that students reach the C2 level of Bloom's Taxonomy (1956) and a level one of Webb's Depth of Knowledge. In addition, these results show that integrating dilemma stories with STEM Project Based Learning engages students, providing

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] students the tools necessary to explain using simple sentences, prior knowledge, an opportunity for students to develop critical thinking, creativity and argumentative skills with problem-solving and projects.

This article greatly contributed to my research because the study includes not only Project Based Learning, but also a combination of Bloom's Taxonomy (1956) and Webb's Depth of Knowledge. Bloom's Taxonomy (1956) plays a fundamentally crucial part in instruction for Project Based Learning. Seeing it in action with the implementation of dilemma stories is a great way to show evidence of student comprehension, see student cognitive, critical thinking, and problem-solving development within the classroom. Also, this case study includes student integrity, honestly, and overall includes them into the observations, journal reflections, and interviews to get to know students and their background; which appeals to rigorous activities in the classroom using Project Based Learning.

The overall objective for Sax et. al (2015) was to address the changing prominent or noticeable ability of math self-concept (MSC) as a predictor of potential STEM major selections within biological sciences, computer science, engineering, math, statistics, and physical sciences

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] for college students. This research utilized data from the Cooperative Institutional Research Program which contains the longest longitudinal study of higher education in America and the CIRP Freshman Survey. In addition to this data, college students were asked a series of questions that pertained to demographics, high school experiences, career aspirations, self-concepts, values, and life goals. The authors then split these answers into variables for research. From using binomial logistic regression analyses, they discovered a gender gap within the math self-ratings in the 5 STEM subfields and math self-concept is a positive predictor of students making decisions to major in STEM fields.

This article has contributed to my research by providing additional information about students and their perspectives, attitudes, and decisions to go into STEM are changing from 1976 to 2011, and is still continuing to change. Some strengths of this article include the statistical regression quantitative data, qualitative data, and the author's choices in showing graphs from previous literature and creating new graphs with the new data that has been collected and analyzed. Additionally, this article takes on a mathematical perspective that can be an indicator for some, but not all students have a role in the decision making process.

Conclusion

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Overall, the goal for Lucas Education Research(2021) was to advocate and reveal to the public the success stories that the Lucas Education Research Foundation has sponsored the use and implementation of Rigorous Project Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017).This article provides a summary of four success stories at different age group levels. From these success stories, the following were discovered; adding Rigorous Project Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) to Advanced Placement courses increase scores on exams, elementary science students improved on social, emotional, and science learning, early elementary students made more progress in social studies and informational reading, and middle school students overachieved in their performance in science, additional coursework, and group work. From all of these success stories, the Lucas Education Research Foundation sets a positive tone and shows the impact of integrating Rigorous Project Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017).

This article is important to my research because it summarizes four stories and additional success stories that teachers have encountered since implementing Rigorous Project Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) into their classrooms. From what has been

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] deduced from these stories is that students enjoy working with their hands, exploring, and when their education and learning have meaning to them. In addition, from some of these success stories, students with diverse backgrounds can also be influenced by Rigorous Project Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) and in doing so makes an effort in promoting equity in U.S schools. While this article shows success stories, it does not provide any form of quantitative data or in depth analyses, limitations, and or implications of specifically how to incorporate Rigorous Project Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) into STEM content.

Wismath et. al (2015) discusses the importance of developing problem solving skills. In their research they aim to use a metacognitive lens with more process oriented class in comparison to content-oriented course content. This study is part of a class called “Problems and Puzzles” at a university where 100 college students participated in the course and in the study. To complete this research, the authors used in class observations and written and oral comments from students. From their data collection, the authors discovered that students experienced a shift in confidence and self efficacy. The authors recommend that in order for students to master these

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] concepts, a specifically tailored learning experience must be facilitated and constructed in order for development to occur. Modeling is also another technique that the authors recommend to promote and increase student awareness about problem solving being a journey and not a destination.

This article was chosen because as a STEM educator, it becomes imperative to teach students how to problem-solve effectively and fully. Problem-solving is a skill that is used on a daily basis, and the authors have a great start and show some promise for the remaining two years in the project. Their findings concerning effective methods such as modeling is a technique that is used quite frequently in education as a means of guiding students through the process of thinking critically and becoming a problem solver. Once students have that foundation, the student will not forget it according to the authors. The reason being that when students finally understand that one concept after having misconceptions about a topic, they are forming new patterns and trends within their brain to establish and apply to the content. Although there was not any quantitative data, the qualitative data proved to be helpful in observing and reflecting on what is seen or appears to be a characteristic of problem-solving. Something that would help

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make this article better, would be the inclusion of tables, or graphs with trends based on responses.

In this article, Zhang and Ma (2023) explored the effect of Project Based Learning on the effectiveness of learning and to explore additional potential factors that may influence this effect. To conduct their research, the authors use a meta-analysis quantitative method that takes and organizes data from experimental or quasi- experimental studies. Using the meta-analysis method, the authors continued their search in literature regarding Project Based Learning from 2003 to 2023. From this, their results demonstrate that Project Based Learning can significantly influence and increase students' learning, and the effects of Project Based Learning are indeed affected by multiple factors and variables. The authors conclude by comparing the differences in education to different countries like Asia, Northern Europe, and North America and suggest that Project Based Learning is the most effective with small groups of 4-5 students.

This article has contributed greatly to my research because it provides a similar perspective about Project Based Learning and its effects on student learning. Something that I found to be particularly interesting was when the authors suggested that Project Based Learning

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] is more suitable for 4-5 students in a group from a teaching perspective. This is interesting because out of all of the sources previously mentioned, an author or authors have not suggested a group size that Project Based Learning would be the most suitable. While this article has great images, tables, and frameworks embedded into the work, it would have been nice to see these 4-5 ideal situations for implementing Project Based Learning in comparison to a larger class of 25 or more students.

Chapter 3. Methods

According to Sagor (2000), the definition of an action research process "is the disciplined process of inquiry conducted by and for those taking the action (p.3)". In this the author depicts the importance of the action research process to prompt the conductor of research to enact research that appeals to their interests. For educators, it is an exciting experience to evaluate their teaching methods for the sake of their students' learning and evaluate how well students are learning in their classroom.

Conclusion

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In essence, the action research process requires multiple steps. The first step in the action research process is selecting a focus; educators are asked to reflect on their current teaching styles or identify topics that interest them. Action researchers will ask themselves about a specific aspect of student learning that they would like to investigate. Once action researchers have this concept, researchers will begin to identify "the values, beliefs, and their theoretical perspectives"(Sagor, 2000, p.4). The next step in the action research process involves identifying research questions that will generate a specific direction the researcher wishes to go. These questions are meaningful and guide the inquiry of educators to explore. The fourth step in the action research process is collecting data. When collecting data, researchers will ensure to collect data to justify that their actions and methods are reliable, meaningful, and valid. Collecting data can be tricky and overwhelming for some researchers. In this step it becomes important to collect a large amount of data from multiple sources.

The fifth step of the action research process, analyzing data is quintessential to understanding what is being expressed by the data and how it applies or relates to what they were originally trying to investigate in their classrooms. Data in this step includes

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The sixth step of an action research process involves reporting the results that occurred in the classroom. With this step it is easy for educators to leave out information concerning the results of their research. According to Sagor (2000), the most common places that share data and action research with peers include faculty meetings and teacher conferences. As educators it is important to share information and collaborate with one another. This sixth step allows and encourages educators to share their research findings via publication and or in an informal manner. The last and final step in the action research process is taking informed action.With this action, teachers are applying their knowledge from what they learned from their research and incorporate it into their lessons. This is a form of learning from the educational mistakes that teachers make and further prevent them from occurring.

The action research process is a perfect model for my study because it allows me to go into a math classroom, as well as utilize the information that I use and teach on a daily basis by combining mathematics and scientific principles. Additionally, this model is perfect for me to further develop as an educator with my methodology and pedagogy for the results of how students learn math better with scientific principles intertwined, and meeting the needs of my

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] diverse student body. The research questions that I would like to explore in this research are what does teaching mathematics with scientific principles look like; and how does this impact student achievement and engagement in science and mathematical classrooms? In this study I aim to discover why many of my students perform upper division calculations in my chemistry class and yet many of my students do not perform well in math class. I propose that some of the students in my class are similar to me in the sense that a number or a letter must have an association with a physical part of the three- dimensional world. Also, I propose that many students do not see the meaning behind learning upper level division mathematics even after asking their teacher. Students want to know why they should learn the material and how it directly applies to their lives.

Contexts of the Study

On the outskirts of rural Lebanon Oregon, East Linn Christian Academy has grades starting from preschool and ending with twelfth grade. The school sits on top of a hill with a gorgeous view of forest, wild turkeys, and green landscape of land that is unused by its neighbors. Although, on the way up the hill there is construction happening in the efforts of

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] building two homes for new families. The student demographics for this data collection will involve nine junior students taking chemistry and are currently taking algebra two. Since this is a private Christian school, the data collected is minimal in comparison to the public sector of education. The reason for the lack of data collection is that it is not a priority, reflection is prioritized. This does not mean that data is not collected by the staff and administrators, but it is not always shared with staff. In this chemistry class there are two females, and seven males. Roughly 56% of students are Caucasian/ White, 33% identify as having mixed ethnicities (for example " American and Mexican"(Student 1) and "White and Black"(Student 2), "Italian and Portuguese"(Student 3).), and 11% for a student that comes from a Russian-Hawaiian background. Since this is a private Christian school, the primary religion is Christianity. All together there are about 50 different Christian denominations represented. None of my students are Emergent Bilingual Learners and are not from a different country. Therefore, teaching English as a second language will not be included in this research.

Using the scores from the ASVAB (Armed Services Vocational Aptitude Battery), an exam that determines potential qualifications for a variety of military occupations; I found that

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] many of my students in my chemistry class had higher scores in engineering, scientific reasoning, automotive knowledge, and some electrical knowledge. Some additional strengths and funds of knowledge that my students bring into my classroom is that they are mostly hard workers and I can push them towards work that challenges them to think more critically and deeply towards a topic. Additionally, I noticed that the majority of students had high vocabulary, reading comprehension, and literacy skills that were either meeting or above the standards set by the ASVAB program. This means that incorporating challenging texts for students to read will help my students develop scientific literacy skills.

Prior to this year, I have worked with this group of students when they were freshmen in high school for a couple months starting from March and ending in June. However, for the current academic year, I have worked with these students from the beginning of the school year. I have continued to further develop my relationship with them from when they were freshmen. A strength that I share with my students that has been mentioned during observation is the rapport that I have with my students. Overall these students are wonderful and mostly respectful to me and they feel comfortable asking me questions. To continue to build rapport with my students. I

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

From this, decreasing the emphasis on standardized testing allows students to develop [illegible] try to go support them at their sporting events, or talk with them in the halls. Something that I strongly believe that I need to work on as an educator is challenging the students a little bit more. Currently, I feel as though they are not properly challenged to further grow their critical thinking and problem solving skills. Another area of improvement is classroom management for a particularly bright student that does not always participate, focus on the content, stop talking, and or turn in their work. With communicating with this student, the content knowledge is acquired and applied through verbal and written communication when they participated in activities, labs, and on tests.

Data Collection and Analysis

Research Questions	**Data Source #1**	**Data Source #2**	**Data Source #3**	**Data Source #4**
What does	Teacher	Teacher	Assessments	Lesson Plans

Conclusion

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teaching mathematics with scientific principles look like?	observations from math class #1.	interviews		
How does teaching mathematical principles with scientific concepts impact student achievement	Student Feedback via Google Forms or Exit Tickets.	Student Scores	Lesson Plans	Assessments

Conclusion

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and engagement?				

Table 3.1 This table includes the research scope of this Action Research Project, and the types of data collected

For data collection purposes, lesson plans, exit tickets, assessments, informal observations, feedback from students, and feedback from my mentor teacher will be gathered and evaluated as data. Sagor states in chapter 7 that "various kinds of teacher records are valuable as sources of data"(Sagor, 2000, p.76). The lesson plan will be a great source of data because it shows the arrangements of events and activities. By collecting the information of the lesson plans, an evaluation of mistakes within the lesson plan could be modified for improvement in the next lesson. This concept can reach out towards unit plans and curricula. Collecting data from these examples can show weaknesses or gaps that need to be filled for further implications.

Informal observations, verbal feedback from students, and assessments are also wonderful tools to collect data. Using a journal will help keep track of what occurred in a

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] particular situation instead of relying on memory. Trying to focus on remembering issues, behaviors, or any notes concerning how the day went should be recorded at the educator's earliest convenience. This also is a wonderful organizing strategy that can be used to keep the data collected in a somewhat organized manner. Assessments are also part of collecting data about comprehension and viewing areas where students excelled in. Exit tickets and informal observations also function similarly to assessments because they take note of what content is acquired, what content to review, and take note of student behavior, mindsets, and attitudes towards the content material.

Receiving feedback from a mentor teacher and the students are a great tool for educators to use. Not only does another set of eyes provide validity and reliability in the data so that it is not skewed, but it also allows the educator to have an additional perspective of what is happening in the classroom that an educator might not see. In a way it keeps bias from forming. This will keep the educator honest about results, and it allows educators to make adjustments to lesson plans, curricula, assessments, and exit tickets. For students, providing feedback allows the

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] voices of students to be heard, validated, and allows an educator to make educational decisions about the direction of their class with the curriculum and content.

For data analysis, the traditional qualitative analysis procedure was followed because informal observations for both students and the educator were conducted, feedback for the educator was recorded on a sheet of paper for documentation, and evaluation. The data that was collected was sorted based on validity, reliability, and patterns in emotion, before and after marks for assessments, behavior, exit ticket comprehension, and feedback given by the students. With these codes, patterns and trends were observed with my class of nine students.

However, the sample size of the chemistry class is too small to identify the impact on the effectiveness of implementing Rigorous Project Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) in a larger class setting. Since there is a small sample size , it is easier to focus on the data present. In order to maintain congruency with the theory proposed earlier in Chapter 1, additional data was collected via students feedback on Google Forms and a collaborative discussion with students. Overall, the data appears to connect through a variety of data from observations, assessments, lesson plans, student interviews, and feedback from another

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] experienced educator. This data was further reviewed by the experienced educator providing feedback to compare their observations with the data present.Their input removed potential bias and validated the data through their insight on the students and their performance. This teacher had taught them years prior. Sometimes it can be easy to skew data, just for the sake of making the data seem effective and fantastic. My mentor teacher is always honest and has approached this data with great care and detail. All of these actions proved to greatly influence the analysis of this data.

Researcher Positionality

My journey in education as a student and now educator has not always been the smoothest. I faced difficulties with teachers not providing legal accommodations during my brain injury, bullying, and being told that I would fail in a science classroom. My brain injury led to a disability that I have learned how to manage. According to the Social Security Administration (SSA)(“11.00 Neurological - Adult | Disability | SSA”), my traumatic brain injury is considered a disability. Although I have learned to manage it well with time, during the infancy of my

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situation and filing documentation, I struggled with accepting the concept that I have a disability and this greatly influenced how I viewed myself, my interactions with others, and my education. Through my struggles in education, I have found that I am more sensitive towards my students that have a disability, or in recognizing brain injuries based on student behavior. Due to this, my approach in my classroom has changed from my previous view of education toward a collection of experiences that can be used to help the students that walk into my classroom.

These experiences have guided my scope of studying the inner workings of mathematics and science. When I was in high school, I always wondered why I could not understand calculus, but whenever it was applied to something in the real world, I could always understand it. For me, and for many of my students providing meaning and purposeful activities will help combat the attitudes against learning the content material. From my experience I was more attentive towards completing my work because it was giving me the opportunity to practice and apply the material in a way that made it come alive in my life. These experiences further encourage me to utilize and structure my classroom with experiences using Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). As a researcher and educator with background in

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both public and private education, I understand and recognize that my experiences have shown me the importance of tailoring my curriculum that provides meaning, develops knowledge of the content, and gives students the opportunities to practice and apply their knowledge to their previous experiences and to develop new skills.

Conclusion

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Chapter 4: Findings

Introduction

The objective of this study was to evaluate how teaching mathematics with scientific principles would look like through a Rigorous Project-Based Learning format (McDowell, M., Hattie, J., & Boss, S.,2017) and its effectiveness to improve student achievement and

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] engagement. To accomplish this objective, a collection of different forms of data were collected as mentioned in Table 3.1 from the previous chapter. These various forms of data connect with Sagor's (2000) consideration that multiple types of records from the teacher are considered to be "valuable as sources of data"(p.76) (See Table 1 in Chapter 3). From the collected data, three themes emerged. They are collaboration, authenticity, and practice. I used the evidence from this research to show how teaching mathematics with scientific principles through Rigorous Project-Based Learning format increases student achievement and engagement in the classroom.

Before the original data was collected and analyzed, an evaluation of student scores from the Armed Services Vocational Aptitude Battery (ASVAB) test were used as a starting point to evaluate the knowledge of students in science, mathematics, and arithmetic reasoning categories. These scores were collected from the previous academic school year. The results are as follows in Figure 1.

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

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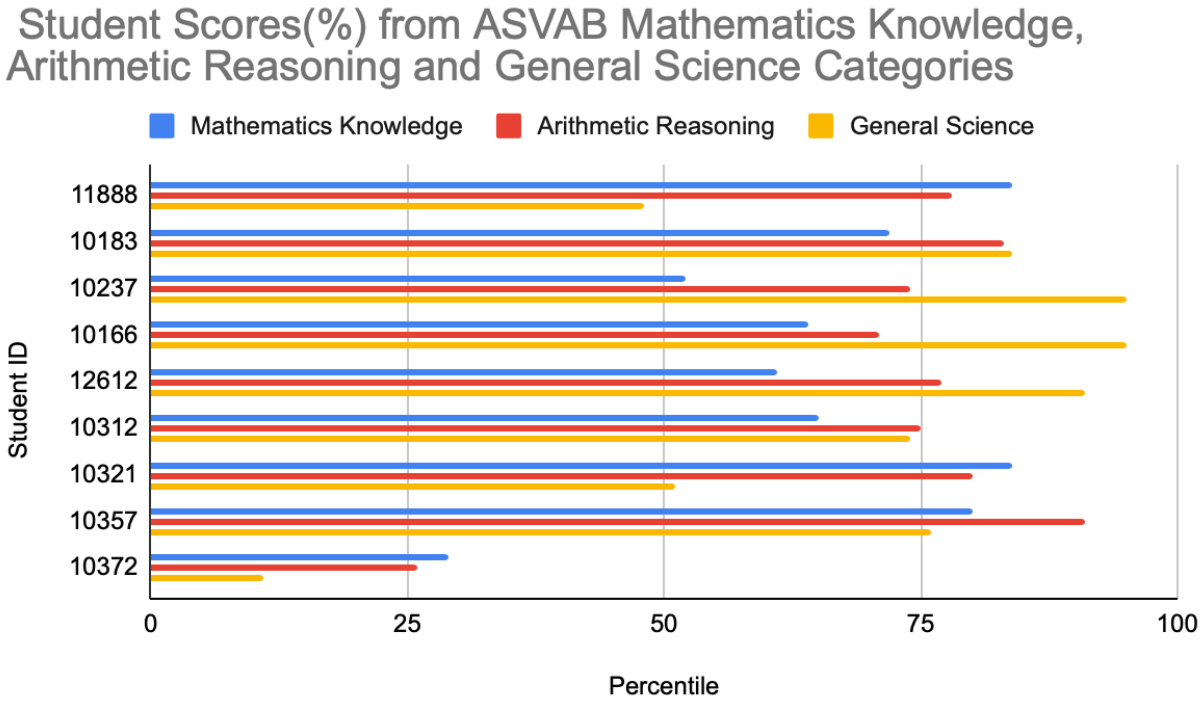

Figure 1. Student Percentile Scores from the Armed Services Vocational Aptitude Battery (ASVAB) Mathematics Knowledge, Arithmetic Reasoning, and General Science Categories

Conclusion

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In this bar chart, the reader will notice that individual students' scores for each category are represented with a different color for all nine of my chemistry students. Mathematics Knowledge is represented with blue, Arithmetic Reasoning is represented with red, and General Science is represented with yellow. From this chart it is possible to see scores from different categories of the Armed Services Vocational Aptitude Battery (ASVAB) test. The purpose of Figure 1 is to show the wide range of knowledge and application of mathematics and science, and show the students' strengths and weaknesses in these categories. Once strengths and weaknesses were identified, I tailored my classroom strategies and instruction to use students' strengths and focused towards building in the areas that needed further assistance.

Average Percentile Scores From ASVAB

Average % Mathematics Knowledge	Average % Arithmetic Reasoning	Average % General Science
66	73	69

Table 1 Average Percentile Scores From the Armed Services Vocational Aptitude Battery Test

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The reader will notice the percentile scores for each category per student, and the percentile average to indicate which category scored the highest. From Table 1, the reader will note the average class percentile score for Arithmetic Reasoning scored the highest out of the three categories. Arithmetic Reasoning involves solving problems that use the basic operations such as addition, subtraction, multiplication, and division. This table was chosen to evaluate the categories students performed well in. The results of those categories were used to form classroom instructional decisions such as giving extra time, chunking, practice with both science and math principles, and application during units that required complex mathematical concepts.

The two visual aids show the same data, but highlight different attributes. Table 1 refers to the average scores for each category of the entire class, where Figure 1 shows a more accurate description of where individual student needs are located within those categories. From these scores I determined my students on average would need further assistance with mathematical and scientific principles. The results of the data influenced my pedagogical and methodological decision to include scaffolded instruction and chunking as instructional ways to promote confidence and autonomy in students with mathematical chemical concepts.

Conclusion

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Collaboration

The first theme that emerged from the data was collaboration. Involving student collaboration in lessons proved to be successful towards implementing a Rigorous Project-Based framework (McDowell, M., Hattie, J., & Boss, S.,2017). While implementing this framework, collaboration became important for my students to learn from one another during a scaffolded practice time. This correlates to Vygotsky's (1978) Sociocultural Theory where students develop understanding of course content through their peers. McDowell (2017) agrees that "learning is very much a social experience"(p.13). This means that students are learning and are being supported not only by their peers, but also their teacher. To foster collaboration with peers, the implementation of Think-Pair-Teach activities were used.

Think-Pair- Teach activities combine whiteboard learning with Think -Pair- Share. In this activity, students grab whiteboards. First students will think about the problem and work on it within a specific timeframe, then students will pair up with another student and lastly, students will teach their peers how they got their answers.

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Through this process, it is intended that students become the experts regarding the material and are developing their understanding through the support of their peers. This connects to the different, essential levels of knowledge in the essence of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). The three levels include surface, deep, and transfer levels of knowledge. McDowell (2017) describes surface level knowledge as being capable of comprehending both single and multiple ideas. Deep level knowledge requires students to compare and contrast between skills related to the underlined discipline. Transfer level knowledge asks students to apply both complex understanding and skill sets to problems in different contexts (McDowell, M., Hattie, J., & Boss, S.,2017, p.15). With these aspects of knowledge, McDowell (2017) mentions that teachers should design learning activities that combine both surface and deep levels of knowledge and incorporate an extended transfer knowledge activity. This extended transfer knowledge activity would encourage content development in students to apply what they have learned outside of school. Think-Pair-Teach appeals to the surface and deep levels of knowledge. However, an extended transfer of knowledge activity could be implemented but would need a longer time frame for completion.

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Not only was this activity helpful towards learning the material for students, but it was also a wonderful way to engage students in the classroom. Whenever this activity was introduced to the students, roughly 78% (7 out of 9) of students were actively engaged throughout the activity. This observation was also noted by a mentor teacher. To be actively engaged in this activity means that students were required to write down their thoughts on the whiteboard during the thinking portion of the segment and students needed to be discussing with their peers about content related information and showing them how they got their answers. Evidence of active participation and engagement was observed through monitoring and looking at each students' whiteboard. From implementing this activity into the week as a review routine, many students have openly and verbally expressed their preference for this activity in comparison to a Kahoot or practice test. Some students from chemistry stated that the Think-Pair- Teach activity "helps me know what to study"(Student A). Another comment from a different student in that class period stated, "I feel like I understand the material better and I feel more confident about the content"(Student B).

Conclusion

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This activity prioritizes and utilizes micro-conversations. These types of conversations were fostering collaboration with students and by students. Jones (2023) describes micro-conversations to be exchanges of informal interactions between teachers to students, and students among their peers (p.33), these types of interactions can occur at any time; but can be meaningful towards fostering respect and promoting students' voices in the classroom. These micro-conversations were observed through verbal exchanges and monitoring. During my observations, I noticed the type of academic vocabulary that was used by the students was relating to the vocabulary and content that was learned in their verbal responses. This shows that students are using the vocabulary to explain their thought processes.

Through this environment, students were actively practicing and making mistakes without harming their grades. This activity further demonstrates another aspect of Rigorous Project- Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017), the learning challenge. With the learning challenge students are able to struggle in the material.When students get stuck in their learning, it is part of the learning process and students can use tools and resources, reflect

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] and or gain feedback to help them get out of the state of confusion. Once students leave this state of confusion, students learn from their mistakes.

In conjunction with collaboration via Think- Pair -Teach, additional data was collected from a student questionnaire and a student survey. The student questionnaire was given towards the beginning of the year as a way to get to know my students. On the student questionnaire, a question was asked to the students (See Appendix G). The question asked students, "What can teachers, adults, or other adults do to better support you in your learning?" Roughly 55% of students responded that they feel they learn better with their friends. Similar responses were observed and collected a few months later in February as shown in Figures 3-5 (See Appendix A). Tables 3 and 4 also show the results from the February survey.

Question 1: What helps you learn the best?

Main Themes	Number of Student Responses Out of 9	Percent (%)
Physical Learning /Activities	7	77.78

Conclusion

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Social Learning/ Small Groups	2	22.22
Other	3	33.33

Table 3. February Online Survey Question Number One

Question 2: How do you prefer to learn something?

Main Themes	Number of Student Responses Out of 9	Percent (%)
Physical Learning/ Activities	6	66.67
Social Learning/ Small Groups	3	33.33
Other	3	33.33

Table 4. February Online Survey Question Number Two. This shows the data for 2 questions that were given to the chemistry students to give honest opinions, voice, and feedback about the classroom atmosphere and how I, as their teacher, could improve.

The reader will notice two major themes were predominant in the student responses, physical learning and social learning. Physical learning was categorized by the students' terms, "hands-on", "physically doing it", and "practice"(See Appendix A). Social learning was categorized in a similar manner, however the student responses included "learning with my

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] friends", "small groups", "discussions", and "social learning" (See Appendix A). It should be noted that more than one theme was mentioned by some students and were counted in this total. However, there were student responses that did not address the two main themes (See Appendix A). All student responses that did not mention any form of learning or did not involve the two main categories were placed into the "Other" category in Tables 3 and 4. From these results, it was evident that my students wanted activities and our classroom content to include more hands-on, practice, and physical learning that would get them out of their seats. These results and their feedback told me about what was working for them in my class and what were some ideas that could help them learn better. This feedback was important during this research because I used this feedback to build and revise the instructional strategies, projects, and activities that I included into my classroom.

Based on the feedback and classroom observations made throughout the academic school year, it has been observed and discovered that utilizing peer collaboration has benefited many students and their understanding of the content and their performance on tests and quizzes. Table

Conclusion

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5 shows the identification numbers of all the students taking chemistry, the points they received, the point average for the entire class and the class average in percent.

Student ID	Ch.3 Quiz (Out of 12)	Chapter 2 Test (Out of 31)	Chemistry Final (Out of 49)
11888	11.75	26	53
10183	11.5	24	32.25
10237	10.75	28	41.5
10166	9.75	25	27.5
12612	11.5	31	38.75
10312	9	25.75	37
10321	11.25	22	39.5
10357	11.25	22	43
10372	11	22.75	25.5
Class Average	10.86	25.17	38
Class Average %	91	81	77

Table 5. Formal Assessment Results from the Chapter 3 Quiz, Chapter 2 Test, and the Chemistry Final.

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

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From Table 5, the reader will notice the differences of the results of three formal assessments. In preparation of the Chapter 3 Quiz, a peer-focused, collaborative review was implemented over two days using the Think-Pair-Teach strategy before the formal assessment was given. However, in reviewing content for the Chapter 2 Test and the Chemistry Final a peer-focused and collaborative review was not implemented. Due to the incorporation of a collaborative review between peers, the overall class average was higher with the Chapter 3 Quiz in comparison to the Chapter 2 Test and Chemistry Final scores. This data shows that students perform better on tests and quizzes when there is a review component in a lesson prior to the test day as a means of teaching their peers the material as a study technique. This table was made to show the differences between individual test scores and class averages as a way to show the reader the effects of implementing the peer-collaborative learning strategy, Think-Pair-Teach. This data shows that collaboration is a key tenet in implementing a Rigorous Project Based Learning(McDowell, M., Hattie, J., & Boss, S.,2017) environment for students.

Authenticity

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

From this, decreasing the emphasis on standardized testing allows students to develop

The second theme that was observed was authenticity. This theme addresses some of the common questions that many students ask their teachers such as, “why do I need to learn this?”, and “when am I going to use this in my life?” Students want to know the purpose of learning the course content and how it applies to their lives. It was in this study important to make assessments and activities clear with the expectations that are required of them and be closely authentic. Making activities and assessments authentic was crucial in this study for addressing these questions. So, to make some authentic activities, authentic labs, PHET simulations, and creative projects for students were implemented. This also refers back to the feedback that was given from a couple students that said they wanted projects that allowed them to be creative.The results of these authentic activities, labs, PHET simulations, and projects proved to be beneficial in developing researching skills, understanding of the content, meaningful connections to the content, and students had fun completing them.

Many students in my classroom have expressed their thoughts and feelings verbally through classroom discussion that they will never use the information and lessons they are learning at school in general. They feel as though what they are learning does not have an

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] influence or affect in their lives. Implementing projects that focus on mastery of the material is another important aspect towards a rigorous curriculum for teaching mathematics with scientific principles. It allows students to have choices in how they want to demonstrate or show their learning. The author created a teaching timeline for a lab safety project that students were given to show their understanding of lab safety and the rubric for the lab safety project (See Appendix B and C). In this project students could create safety videos or create a slideshow presentation to teach their peers about lab safety. It was their choice to complete this activity with groups or individually. All students opted for a collaborative project with their peers. While they were working in class, observations were made to ensure that everyone in their groups were participating and contributing equally. During the making of the videos and presentation, students were engaged, actively participating, and having fun. A rubric was used for the Safety Saga Lab (See Appendix C) and the results of this activity showed student mastery of lab safety as shown in Table 6 and Figure 3 .

Conclusion

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Figure 3 Student Lab Safety Example Presentation Sample Slide.

This slide is an example of a theme that a team of students made to teach their peers about lab safety. The students that created these slides did a wonderful job and showed mastery of important lab safety concepts both on this lab and on the lab safety quiz.

Conclusion

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Table 6 shows a comparison of scores between the Lab Safety Saga Project and the Lab Safety Quiz. The Lab Safety Saga Project served as a way for students to teach their peers about lab safety. In this project students were given the opportunity to create either a video or a presentation that shows the importance of lab safety while also leaving room for their creativity to show visually what lab safety means to them and summarize the lab safety rules crafted by the Flinn Scientific Company. During the filming days, students were actively communicating with each other about how they could make the presentation or comical videos that their classmates could enjoy. From observation and monitoring, students were enjoying creating videos and presentations; my classroom was filled with joy and laughter. It was evident in the videos that students turned in that they took this project seriously and were passionate and excited about making their peers laugh. The videos and presentations that were turned in showed attention to detail and demonstrated lab safety accuracy. From the project, when the Lab Safety Quiz was given, students performed well as shown by the 90 percent class average.

These results show that when students are passionate and excited about an assignment, task, or challenge, that students will spend more time and effort to make something that

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] showcases the students' strengths and motivation, both intrinsically and extrinsically. The intrinsic motivation comes from within the student in which they motivate themselves. In the case of the Lab Safety Saga, students were excited and wanted to work with their peers to make their assignment unique and comical.Extrinsic motivation refers to external factors to motivate students. This concept is demonstrated by the great scores that all students received on the project.

Lab Safety Saga(Project)	Point Value Out of 50	Lab Safety Quiz	Point Value Out of 14
Average Points for Entire Class	48.00		13
Class Average %	96		90

Table 6. Safety Saga Lab vs. Lab Safety Quiz Data

The data scores for each student in Table 6 show the individual results of each student, the point value, and the overall class average percent. This table was created as a summary to compare the Safety Saga Lab and the Lab Safety Quiz.

Conclusion

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In addition to the Lab Safety Saga Project, additional labs and projects were implemented such as a Red Cabbage Lab (See Appendix F) in which students tested common household products for acidity and alkalinity. With this lab students were able to see whether or not red cabbage was an effective pH indicator for household items. Another project that students completed was building an atom of an element with research about the element of their choosing (See Appendix E) and conducting research about a scientist that sparked their interest (See Appendix D). In addition to these labs and projects students expressed their thoughts and opinions via weekly discussion boards. With the discussion board all students expressed their thoughts and opinions about proposed questions that require students to think about and observe the community they live in and how it pertains to a scientific worldview. Students that participated in this discussion board developed communication skills and were asked to respond to a peer that was kind and respectful.

The discussion boards that were implemented involved questions that asked students their thoughts and opinions concerning a topic in science. These discussion boards were used as a way

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] to instruct my students in how to respond online to their peers and how to express their thoughts and opinions from an ethical point of view and give students a voice in the classroom.

The first question on the discussion in Google Classroom that was asked was “Is there a prevailing ‘scientific’ worldview? If so, what is it?” Since this was the first discussion board I asked my students to only write in full and complete sentences. Gradually throughout the year I asked them to find sources, and have them cite these sources in either ACS or APA format as evidence to support their view or opinion. Out of 9 students, 7 responded in the discussion. From this discussion students expressed and shared their experiences and opinions about the question asked. Student A stated that “I think that there are split views on science depending on the person and their background. Some people use science as a religion, like Scientology, other people like scientists, use it as a form of income. Some people may have had a bad experience with a project or some sort of scientific error, and now they don't like it”. Another example came from Student B, who wrote, “ I think it is a statistical more in depth answer and reasoning to everything that is in the world. I think this because basically every time there is a question, people rely on science for the answer”. Although these are only two statements from students, there were additional

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] opinions and thoughts that were shared. All the students that participated in this discussion formed responses from their experiences and observations of the world around them. This activity was important to implement, not only to get to know the background of my students, but also to provide students a way to share their thoughts and opinions in a safe and open environment that sparks thinking, increases engagement, and forms a positive environment..

All of these projects or labs contributed to the understanding of the content that many students enjoyed and found them to be important and meaningful. Providing my students with the meaning as to why they were learning the material greatly influenced my students to engage positively in my class with the activity and were motivated to complete the activity. Zhang and Ma (2023) add that student- centered activities like Think-Pair -Teach online discussion boards, and implementing projects that are authentic and perks the interests of students can increase student engagement, motivation to learn, and is more effective in developing socio-emotional values and thinking skills.

Practice

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

From this, decreasing the emphasis on standardized testing allows students to develop

The last theme that will be discussed further is practice. In this, students were given multiple attempts to practice the concepts and calculations learned in class through assignments, labs, PHET simulations, and in class activities that are located in the Appendix listed below. Additionally, implementing a Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) framework takes time and practice on my part as the teacher to fully implement effectively and efficiently. Students need to practice the material they are learning outside of the classroom for mastery of the skills being developed.

The type of practice becomes important for not just producing products, but also thinking about the skills and knowledge required to create the product (McDowell, 2017, p.60), this is a part of turning the classroom content into creating experiences and opportunities for students to learn and comprehend the material. By creating labs and activities that provide experiences for students and allow them to have a voice in the classroom, students are building autonomy and a community of learners that contribute to the overall classroom environment and experience. With these experiences, students are able to refer back to and allow for proper

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] communication with students about the objectives of the class and the expectations that are required of them with the content.

Incorporating scaffolded practices have been beneficial in aiding students in their comprehension of the content. During a stoichiometric unit as shown in the timeline with Table 7 below, the audience can see the chunking of course content happening within the unit as well as a slower progression of each type of calculation per day. This was to ensure that students did not feel overwhelmed with learning a large amount of complex chemical calculations at once.

Description	Date
Introduction to the Mole	April 17th
Mission Moles Activity	April 21st
Types of Formulas and Percent Composition	April 22nd & 28th
Calculating Empirical and Molecular Formulas	April 23rd & 29th
Stoichiometry	April 30th
Mass-Mole Conversions	May 1st

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

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Mass-Mole, Mole-Mole Conversions	May 6th
Remaining Stoichiometric Calculations	May 7th
Stoichiometric TPT(Think- Pair- Teach)	May 8th
Stoichiometric Clue Test	May 9th

Table 7 Chemical Calculations Unit Timeline

Table 7 shows the progression of each type of chemical calculation per day during the week as a way to gradually introduce additional calculations that become more complex.With this unit in particular, it is a prime example for showing the chunking of complex chemical calculations that students need further assistance and scaffolding.

	Moles to Particles WS	Moles to Grams WS	Moles, Moles & Grams WS	% Composition	Mole-Mole, Mole-Mass WS	Mass-Mass WS	Ch. 11 Practice Test Assignment	Stoichiometric Clue Test
Class Average %	80	75	75	79	76	80	79	46

Table 8. Chemical Calculations Student Homework Class Average Percentages.

Conclusion

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Table 8 shows the average class scores during the Chemical Calculations Unit. The purpose of this table is to show the in class work that was completed to eliminate a large load of homework that could be completed within 15 minutes outside of class as it is stated in the employee handbook. During this unit, in class homework was given as a form of practice. Students were able to discuss the problems together in small groups and would actively help one another. Breaking down the types of calculations proved to be helpful for students' comprehension. However, the test scores were not the greatest, a potential reason could be due to the amount of time, struggling with maneuvering a source to help them with the calculations, the abnormality and slight gamification of the test, and students leaving a majority of the test blank. The Stoichiometric Clue Test was structured in a way that required students to solve the problems for a clue to see who, where, and what the murder weapon was in a fictional scenario. Upon verbal discussion with students after the test, some students had expressed to me that they liked the format, but time and some of the wording of the equations seemed to trick them unintentionally.

Conclusion

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As part of data collection, teacher interviews and classroom observations were conducted in both high school math classrooms for comparing the differences of teaching math with scientific principles. This was a way to evaluate cohesiveness between math and science instruction and its effectiveness towards student engagement and achievement. The first math class that I went into was an algebra two math class that had all of my chemistry students. Some observations that I noticed include short 10 to 15 minute lessons, minimal homework, great implementation of micro-conversations between the students and the teacher, and there was an ample amount of time to complete practice problems in class with the teacher. However, from observations, I noticed that this type of instruction adhered to a more traditional style of teaching. The routine of the classroom involved a warm-up, homework check, a lesson, then students worked in groups to work on the class worksheet for the remainder of the period. Another observation was that Math Teacher A did not include projects or activities that provided context or application practice outside the classroom.

After observing Math Teacher A, I then followed up for an interview. In this interview I asked Math Teacher A how they combat the questioning of learning concepts from algebra two.

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

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Math Teacher A expressed that "students only really need to know the basics of pre-algebra to function comfortably outside of the classroom". Math teacher A described an experience that almost allotted them a good paying job if they knew how to calculate upper division mathematics. From this experience, Math Teacher A reminds their students that "you don't know what's going to happen in life where these concepts might come in handy".

Another math teacher was interviewed and asked for their thoughts on the matter of adding meaning to mathematics. Math Teacher B expressed how they try to create meaning that has worked effectively for their engineering and geometry classes. They state that their teaching style "tends to do more Project-Based Learning" that promotes positive encouragement and builds resilience. Math Teacher B focuses on building Dweck's (2006) growth mindset towards solving problems and overall attitudes towards math. This teacher implements projects as a way for students to show mastery of the material. Some projects that students have participated and applied in include building model rockets, wind tunnels, and calculating the dimensions and expenses for making a gaga ball pit for their fellow students during lunch time. These projects focus on the Math Teacher B's objective for math to "focus on applications in settings that

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] students have not seen yet". Implementing projects that focus on mastery of the material is another important aspect towards a rigorous curriculum for both science and mathematics, it allows students to have choices in how they want to demonstrate or show their learning.

From observing both math classrooms and watching not only how my students taking chemistry learn mathematics, but also seeing a Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) framework from a mentor teacher that uses scientific principles to teach mathematics was helpful in shaping my lesson plans to focus on creating challenging tasks and activities that would be authentic to students and their interests for them to solve. I also learned more about how I can better support my students as they are learning math and science together in chemistry through peer- collaboration, small group work, and designing specific experiences and experiments that would require my students to actively use the content outside of class.

Conclusion

All of these themes directly relate to the research questions listed because the purpose of the research questions is to evaluate the relationship between mathematical and scientific

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] education in regards to teaching execution and its influence on student engagement and achievement. These themes address key components of a Rigorous-Project-Based (McDowell, M., Hattie, J., & Boss, S.,2017) approach in teaching mathematics with scientific principles because of the focus towards creating meaningful experiences, adding purpose to the content students are learning, and creating a classroom environment that students feel comfortable learning and making mistakes. From specifically designed classroom activities, students can develop and practice their skills outside of the classroom.

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

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Chapter 5. Discussion, Limitations, & Conclusion

During data collection and implementation of the Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) model in this study; there were some similarities with the four main tenets that were evident in my teaching. The first similarity that was incorporated was the continuation of building relationships between students and staff. Additionally, in this, the incorporation of students' culture beliefs and values contributed to the experiences and discussions in my classroom. Since I have taught these students previously, I have already developed a relationship that is high-quality with them.With this high-quality relationship, students know my character, classroom routines, and expectations of their behavior. This was accomplished through discussions outside of my classroom during breaks, passing periods, and attending sporting events since all of them are athletes. Although, one student did

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] not participate in a sport this spring due to their part time job and showing their cattle at competitions. The rapport with my students has been noted by my Western Oregon University supervisor, a veteran teacher, the building principal, and the superintendent who has observed my interactions with my students in my classroom.

From the rapport that I have built with my students, it is clear that my students feel comfortable asking questions about the material, school related topics, and topics outside of the classroom. Since this is a private Christian establishment, the belief that we as a staff, students, and administration share is Christianity. Christian beliefs act as a framework as to how I talk and guide my students with spirituality and content. Evidence of this includes the types of conversations that happen in my classroom. Throughout the school year, there have been conversations discussing worldviews in their Bible classes and worldviews pertaining to chemistry. This is a topic that many of my students enjoy discussing and want to discuss in our classroom. This concept helped boost the grades from the first semester of the academic school year. This result was similar to a study that Assaf (2023) conducted with middle school students. Although the brain chemistry for middle school students differs from high school students; the

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] results concluded from the study showed that students improved their academic performance from fall scores at the American school in Abu Dhabi, United Arab Emirates with the use of a Rigorous curriculum model. The implementation of a Rigorous curriculum model that uses student's beliefs and experiences showed an increase in performance between fall and spring scores. In grades 6-8, sixth grade students improved 57%, seventh grade improved 36%, and eighth grade improved 32% in the spring.

Edmunds, et al. (2017) argue that rigor is not guaranteed in the classroom and recommended that in order for the development of high quality Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) to occur, the implementation requires the presence of rigor. Adding rigor would allow students to be exposed to authentic scenarios that would not only challenge them, but also allow students to apply the skills and content that would be required outside of the classroom. To accomplish this, the authors' recommended that the content of projects would need to be complex and reflect core concepts of the discipline, and involve teachers in engaging, yet collaborative examination of the effectiveness of a rigorous instructional lens. Although the study mentions that teacher data as well as student data was

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] collected, teacher data was not collected in this study. Collecting teacher data is crucial and pertinent to the experiences that happen in the classroom. By collecting data both from the teacher and students it allows a more educated decision for either removing or including a particular strategy that influences student learning.

Modeling and scaffolding problem solving was another similarity that was implemented into this study and is part of teaching with a Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) model. From the article "Threshold Concepts in the Development of Problem-solving Skills" Wismath and her co-author MacKay discuss in summation that modeling is a recommended technique to promote and increase student awareness about problem solving being a journey, not a destination. It is through the struggle that students learn perseverance towards challenges. The authors also recommend that in order for students to master these concepts, a specifically tailored learning experience must be facilitated and constructed in order for development to occur. If these learning experiences are constructed with applying the material to a scenario outside of the classroom, students are going to show a greater understanding of the material.

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

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Modeling was a technique that was implemented during one of the math focus units in chemistry this year in conjunction with chunking, and scaffolded instruction. From experience with my students, scaffolding the mathematics in chemistry has proven to be beneficial in aiding their comprehension of the particular chemical calculations. Their homework assignments and their Stoichiometric Clue game test, mentioned in Chapter 4 allowed students to apply the chemical calculations in scenarios that occur in a laboratory, scenarios outside of the classroom, and solve the mystery of the murder that happened on campus. Although this is a fake scenario, many of my students expressed that the gamification of a test seemed to lower their stress levels and make the test “slightly less annoying”(Student A). Another example of modeling includes breaking down each type of calculation with moles to focus on one type of calculation per day. If students are bombarded with multiple types of calculations all at once, then students will feel discouraged, panic, and have low confidence in their abilities to solve the calculations. This method was implemented to give students practice with each type of calculation to build their confidence and autonomy.

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

From this, decreasing the emphasis on standardized testing allows students to develop

An evident difference between the strategies that I used during this study differed from Rahmawati (2021) Bloom's Taxonomy (1956) (1956). From the study, all the authors mention that students reach the C2 level of Bloom's Taxonomy (1956)(1956) when they understand or recall the content information when they are engaged, their background knowledge is utilized, and when students are given the opportunities to create, argue, and develop skills that will help them outside of the classroom. Using Bloom's Taxonomy (1956)(1956) is an important aspect towards implementing Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) so that students can work with their hands, create, argue, and overall develop the critical thinking, and problem solving skills that are needed for students to succeed outside of the classroom. Bloom's Taxonomy (1956) was lightly integrated into the learning objectives that I share and express with my students, but many activities were not designed with a specific verb from Bloom's Taxonomy (1956) triangle (1956). By implementing this into a lesson; it promotes Rigorous Project -Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) because it addresses the three levels of knowledge that are mentioned in chapter 4 and are needed to be acquired by students to apply them to multiple crossing avenues for life and the classroom.

Conclusion

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Theoretical Limitations

The four main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) include implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction (Lucas Education Research, 2021, p. 3). All of these tenets summarize a type of pedagogy that takes additional time to reflect and build lessons, projects, and experiences with purpose for students. Out of the four tenets, only three are worth mentioning for this project. The only tenet that was not addressed or represented well in this action research project was implementing relevant and purposeful experiences. The lack of evidence related to this tenet was revealed through an examination of my teaching from referencing lesson plans, assessments, and classroom activities. This particular tenet was not met and lacked purpose and influential learning from students. The other tenets however were accomplished.

Currently, I am a full time teacher and so I had the same students in my chemistry class this entire year. Previously, I had my current students as Freshmen and now I get to continue to

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] create and maintain the relationships that I have with my students. With the pacing, extra practice, scaffolded instruction, explicit instruction, and peer assisted learning strategies, I was able to deepen the core ideas from the content and use the evidence based practices mentioned previously, which are in the essence of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017).

Methodological Limitations

There were only nine students in total in my chemistry classroom. This was a significant limitation to the study that greatly influenced the data that is presented in this project. In addition to having only nine students in chemistry, another limitation was how long the study was conducted. The study was conducted for a single academic school year for one class. A more accurate representation of this implemented Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) practice would be better suited across multiple grades of students with different levels and throughout the entire year. For the private school setting, a recommendation would be to evaluate the same students over the years that teachers have had in their classes previously. This concept is more applicable and more common in the private school

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] sectors. East Linn Christian Academy is a small school and does not include a large math or science department. Since I have had these students multiple times throughout their high school career, it would be applicable for me to analyze and cross reference the data that they learned during their freshmen year to their senior year in multiple mathematical and scientific classrooms. If this is not a possible avenue for secondary educators to make, then a proposal of utilizing quarter or semester grades as part of a measurement as to how students are comprehending the content in the class would be preferable.

Practical Limitations

From my experiences in my classroom and due to the fact that my data could be considered skewed due to the improper sample of student enrollment in chemistry. Teachers that implement this pedagogy might see and experience different results to what is shown here. The reasoning behind this is due to the fact that the average class size could potentially be different in comparison to East Linn Christian Academy. Most, not all class sizes in the public sector contain numbers of roughly 20 or more students in one class period. For private schools like East Linn Christian Academy, class size depends on student enrollment and class sizes tend to be smaller

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] than public education. However, this is not to be generalized. Class sizes depend on the demographic of students, the location of the school, and attendance rate.

An area that I could have done better for this project was utilizing and going in depth my personal reflection of how I teach my students. A common theme for Rigorous-Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) is the emphasis on reflection. Reflection allows a meaningful examination of the strengths and weaknesses of the school year, an assignment or project, and serves as a way to think and plan to improve. Lastly, another area that I could have done better or improved on is the incorporation of the engineering class that is offered for students. This class would be a perfect addition of data that would show the effectiveness of Rigorous Project- Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) in action. However, with this class, none of my chemistry students are taking this class and the student data represented would be invalid.

Implications

For implementing Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) in the future, something to implement would be to take some time to complete a proper

Conclusion

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From this, decreasing the emphasis on standardized testing allows students to develop [illegible] evaluation of the units that are created in the curriculum by the teacher or by the Dean of Curriculum. Additional meetings with departments would also be beneficial for analyzing how effective specific evidence based learning practices are affecting students' learning and achievement in the classroom. For Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017), teachers should evaluate and use the three different levels of knowledge such as “surface level, deep level, and transfer level.”(McDowell, 2017, p.14) as a guiding framework for lessons, projects, and labs. With these three levels, it becomes imperative that educators are providing students with the content they need to apply their knowledge and skills to scenarios outside the classroom and additional academic domains.

In addition, it would be wise to review the main tenets of Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) and to discuss in discourse about meaningful experiences that educators can give their students that put them into the situations in which they would apply the knowledge they learned from school to a situation outside of school. This would provide students with the purpose, meaning, and opportunity to grow in their understanding of the content and build the skills necessary to function outside of the classroom.

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Appendix A

Student Feedback Survey

This survey was conducted in February, after the second semester had started and so students were asked the following questions. This survey was for students to give me feedback on how they felt the class was going and if there were any modifications or recommendations to make the chemistry class better.

Conclusion

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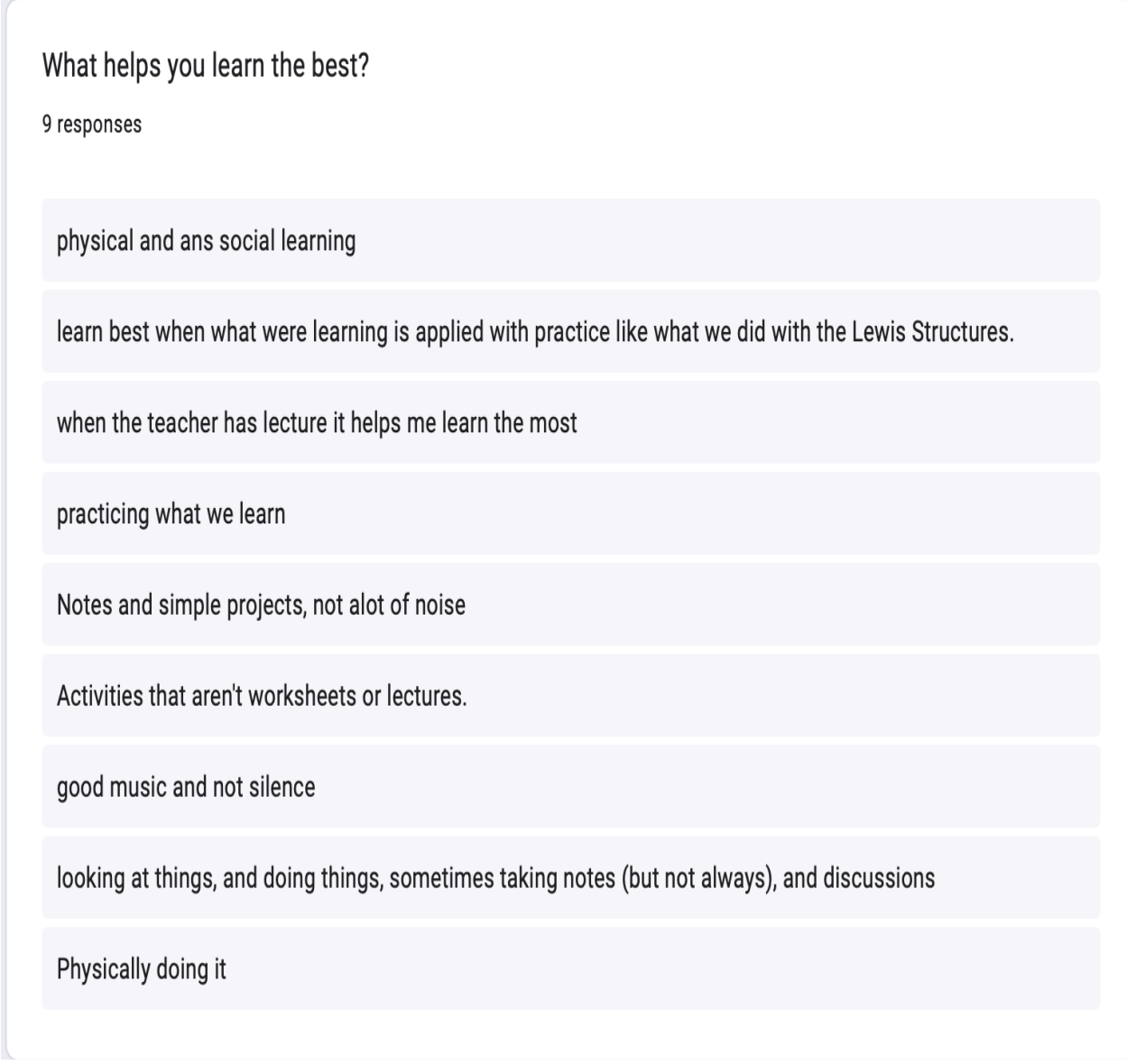

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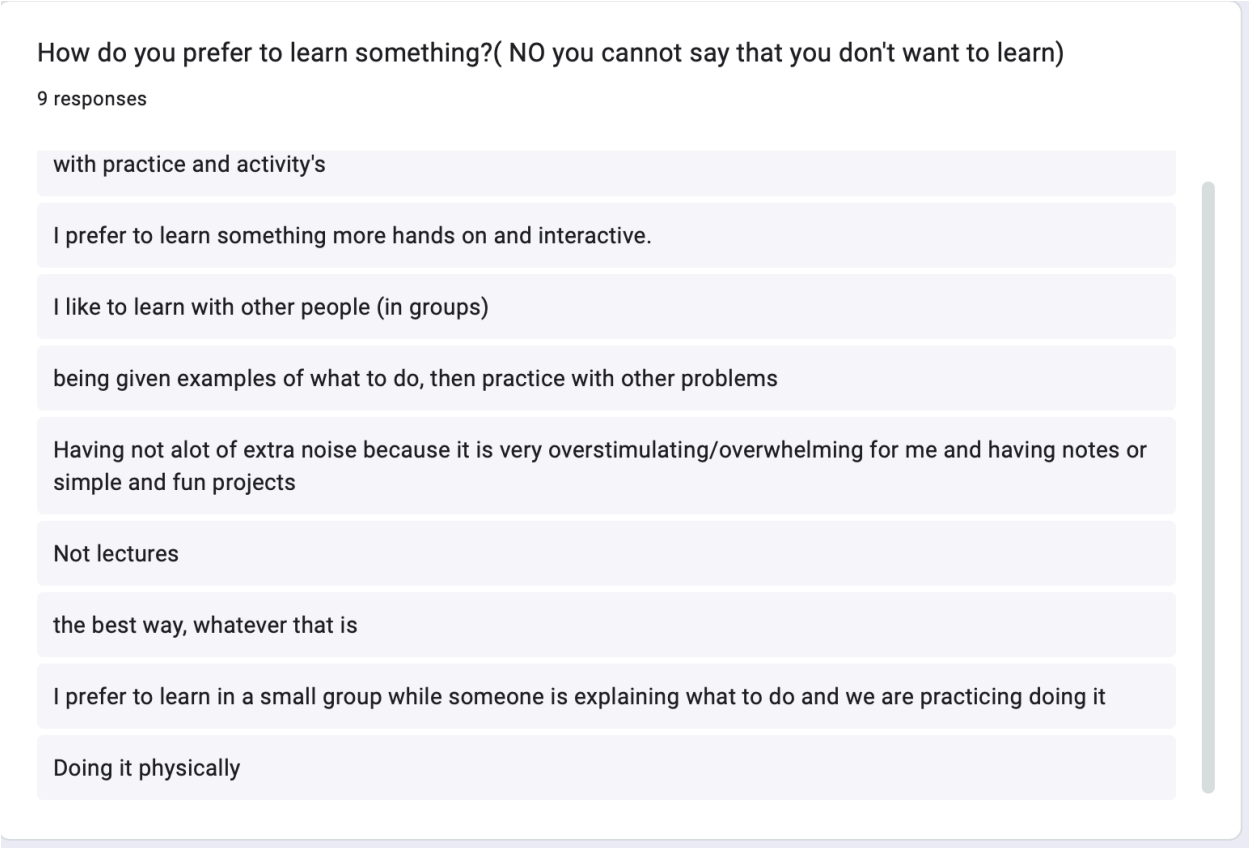

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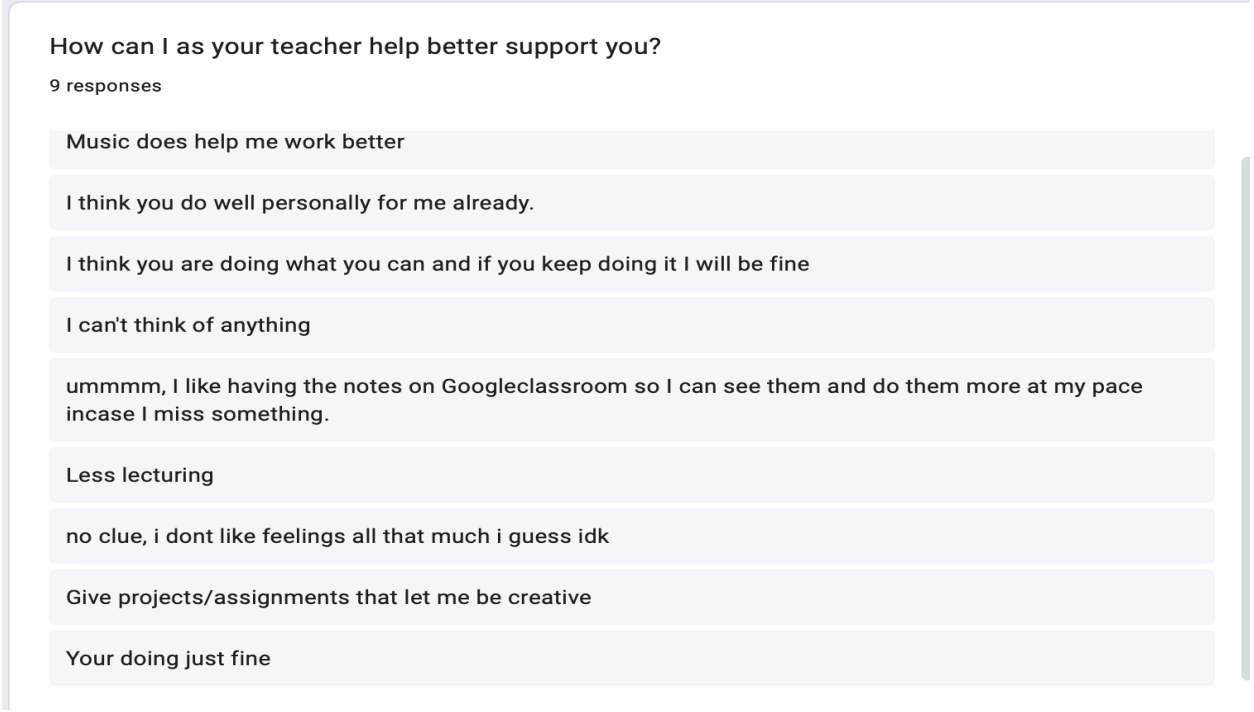

Appendix B

Lab Safety Teaching Timeline

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

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The purpose of this table is to show the progression of teaching lab safety and to show the time frame of the Lab Safety Saga Lab.

Description	Date
Lab safety introduction and project introduction	September 9
Lab safety instruction and group formation	September 10
Lab safety groups work on collecting photos/ creating videos.	September 12
Lab safety groups make the finishing touches on their videos/ slideshow.	September 13

Conclusion

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Appendix C

11th Grade Laboratory Safety Video / Slideshow Assignment

This rubric was used to grade students on their Lab Safety Saga (The Lab Safety Video/ Slideshow Assignment). With this rubric, it shows the criteria of what is expected and needed for mastery of this topic.

Criteria	3 - Exceeds Expectations	2 - Meets Expectations	1 - Needs Improvement

Conclusion

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Accuracy of Safety Content	All ten safe laboratory skills and behaviors are clearly and correctly demonstrated or explained.	Most (7-9) of the safe laboratory skills and behaviors are correctly demonstrated or explained.	Fewer than 7 safe laboratory skills and behaviors are correctly demonstrated or explained.
Visual Representation	Each question is addressed with 2 clear, relevant photos or video segments showing safe practices.	Each question is addressed with 2 photos or video segments, though some may lack clarity or relevance.	Some questions have fewer than 2 photos/video segments or visuals do not clearly represent the topic.
Safety Demonstration	Safety equipment is demonstrated pretending to activate it, following instructions precisely and safely.	Safety equipment is demonstrated but with minor inaccuracies or lack of clarity in pretending activation.	Safety equipment demonstration is missing, inaccurate, or shows unsafe handling.
Response to Safety Questions	All safety saga questions are fully answered with detailed and accurate information linked to visuals.	Most safety saga questions are answered with generally accurate information linked to visuals.	Few or incomplete responses to safety saga questions; information may be inaccurate or missing.

Conclusion

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Creativity and Engagement	Slideshow/video is engaging, creative, and clearly designed to teach classmates effectively.	Slideshow/video shows some creativity and is generally clear and understandable.	Slideshow/video lacks creativity and is difficult to understand or unengaging.
Group Collaboration	Clear evidence of equal participation from all group members in creating videos or slideshows.	Most group members participate, but contributions may be uneven or unclear.	Limited participation from group members; work appears unevenly distributed.

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

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Appendix D

Options for Project 1 Assignment: Collecting Research about a Scientist of Their Choosing

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

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The purpose of this rubric is to show different aspects and criteria regarding influential individuals in the science and mathematical fields.

OPTION A & OPTION C: Presentation/ Slides & Poster/ Brochure

Out of 75	**1**	**2**	**3**	**4**	**5**	Pts
Name & Discovery (5pts)	Student has the name of their scientist only	Students have the name of their scientist and the name of their invention/ discovery.	Students have the name of their scientist, the name of their invention/ discovery and describe it at an elementary level.	Students have the name of their scientist,the name of their invention/ discovery and describe the discovery, and its function more in depth. -Students use one source to support their answer.	Student has the name of the scientist, name of the invention/ discovery, describes the function of the discovery and its implementation in science and how it relates to application in our society. -Students use one source to support their answer and correctly cite it.	
Faith Background / Faith in Work (10pts)	-Student doesn't have question 3 answered, they only have half of	-Student have most of the questions for #3 answered but the thoughts are either not in	-Student has the questions answered but does not go in depth about the influence of	-Student is mostly clear with answering the questions and providing textual evidence to support their answer.	-Students have clear and concise answers to the questions. -Student describes and supports their answers with cited	

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

From this, decreasing the emphasis on standardized testing allows students to develop

	the questions for #3 answered.	complete sentences or the process is hard to follow (understand)	faith in the scientist's work and does not provide some textual evidence.		textual evidence.	
Background (10pts)	-Student does not mention anything relating to the scientist. -Students provide 2-3 facts about his background.	-Student includes 3 or more facts about the scientist but does not include any sources to provide textual evidence.	-Student includes 3 or more facts about the scientist and includes a source and provides textual evidence. -Students also add an interesting unknown fact.	-Student includes 3 or more facts about the scientist, and provides textual evidence with 2 or more sources. -Students go into a little more depth about scientists' experiences.	-Student includes 3 or more facts about the scientist, and provides textual evidence with 2 or more sources. -Students go in depth about scientists' experiences and how it shaped their perspective about science.	
Challenges (10pts)	Student do not incorporate the challenges of the scientist.	Students barely include the challenges the scientist faced.	Students include the challenges of the scientist with textual evidence from a source.	Student includes 2 challenges the scientist experienced and how it affected their work with 2 sources of textual evidence.	Students include multiple challenges the scientist went through and how it affected their work with 2 or more sources to support their answers.	
Why this Scientist?	Student does not describe	Student responds in a	Student gives a reason for why	Students give a reason why they	-Student gives a reason.	

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

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(10pts)	why they chose this scientist.	basic format like ¨ I chose ____ because I thought he/ she was cool.	they chose a scientist but does not go further in explaining why and does not provide evidence.	chose a scientist and go further in their reasoning/ explaining with textual evidence.	-Student describes in detail why with examples from evidence. -Student relates to the scientist.	
Sources (10pts)	Student does not provide any sources.	Students provide 1-2 sources, but do not source them properly.	Students provide 2-3 examples and source them almost completely in their work.	Students provide 3 sources and cite them correctly and completely in their work using ACS Format.	Students provide 3-4 or more sources, correctly in the reference page and in their work. -Student cites using proper ACS format	
Format (10pts)	The format is barely there. There are barely any slides or information. -It does not follow a distinct organization	The presentation/brochure is slightly organized but does not have pictures or breaks in material into separate slides or sections.	-The presentation/ brochure are somewhat organized. –The content is displayed in a theme, with some pictures, but does not add meaning to	-The presentation/ brochure is organized. -The content is displayed in a theme, with many pictures that add meaning to their scientist or answers to questions.	-The presentation/ brochure is organized. -The content is displayed in a theme, with many pictures that add meaning to their scientist or answers to questions. -Has a reference	

Conclusion

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		(Too many words on one slide) -Or too little on a slide	their scientist or answers to questions. -Has a reference page, but does not follow the ACS format of citing sources.	-Has a reference page and has almost all references in the ACS format. - When citing a source, a student uses the correct format per ACS guidelines mostly.	page and has all references in the ACS format. - When citing a source, a student uses the correct format per ACS guidelines.	
Creativity (10pts)	The presentation / brochure is not alluring.	The presentation/ brochure contains a picture but is all black and white.	The presentation/ brochure is somewhat colorful containing 2-3 pictures.	The presentation/ brochure is colorful and has 3 pictures. -The content is displayed in a colorful fashion and is easy on the eyes to look at.	The presentation/ brochure is colorful and has 3 or more pictures. -The content is displayed in a colorful fashion and is enticing to look at.	
TOTAL	<44	45-52	53-59	60-67	68-75	
Grade	(59.99% or less)	(60%-69.99)	(70%-79.99%)	(80%-89.99%	(90%-99.99%)	

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

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Appendix E

Rubric for 11th Grade Hanging Particle Model and Research Report on an Element

The purpose of this rubric is to not only show the criteria for this project, but to promote creativity, problem solving skills, researching skills, and build written communication skills.

Conclusion

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Criteria	3 - Exceeds Expectations	2 - Meets Expectations	1 - Needs Improvement
Element Selection & Originality	Element chosen is unique with no repeats, and clearly typed name on the document; demonstrates thoughtful selection based on interest or significance.	Element chosen is unique with no repeats, and name is typed on the document.	Element selection is repeated or name is missing; element choice appears random or lacks consideration.
Hanging Particle Model Construction	Model is creatively and accurately constructed using household materials; clearly represents the particle structure of the chosen element; stable and visually clear.	Model is constructed with household materials; generally represents particle structure with minor inaccuracies or lack of clarity.	Model is poorly constructed or does not accurately represent the particle structure; materials and effort appear minimal.

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

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Research Report Content	Thoroughly answers all required questions with detailed, accurate, and insightful information; demonstrates deep understanding of physical and chemical properties, applications, and theological reflections.	Answers all required questions with accurate information; shows understanding of most physical and chemical properties, applications, and theological reflections.	Responses are incomplete, inaccurate, or superficial; missing key information or reflections.
Essay Format & Writing Conventions	Essay is exactly 1 page, single spaced, 12-point Times New Roman font; well-organized with clear, concise writing; no spelling or grammar errors; includes a correctly formatted ACS reference page.	Essay follows formatting requirements with few minor errors; writing is generally clear; reference page included with minor ACS formatting errors.	Formatting requirements not followed; essay is disorganized with multiple writing errors; missing or incorrect references.
Use of ACS Citation Format	All sources cited correctly in ACS format both in-text and on reference page; demonstrates excellent academic integrity.	Sources are cited mostly correctly in ACS format with minor errors; academic integrity maintained.	Sources are missing, incomplete, or incorrectly cited; academic integrity compromised or unclear.

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

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Connection to Creation Mandate & Faith	Insightfully connects element's use to fulfilling the Creation Mandate and glorifying God; reflections are thoughtful and well articulated.	Provides a basic connection between element's use and Creation Mandate and God's glory; reflections are clear but less developed.	Fails to make a meaningful connection to the Creation Mandate or faith; reflections are missing or unclear.

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

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Appendix F

Red Cabbage Lab Introduction Page

The purpose of this Red Cabbage Lab was to show my students the importance of indicators, to spark curiosity about acidic, basic, and neutralization reactions, to test Red Cabbage as an indicator, and to evaluate how acidic or basic a common household item is. This is so that students will become aware of the pH of foods, beverages, and cleaners and how they work so they can be safe.

Conclusion

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Red Cabbage Lab: Acids and Bases

Introduction:

Liquids all around us have either acidic or basic (alkaline) properties. For example, acids taste sour; while, bases taste bitter and feel slippery. However, both strong acids and strong bases can be very dangerous and burn your skin, so it is important to be very careful when using such chemicals. In order to measure how acidic or basic a liquid is, one must use the pH scale as illustrated below:

The strength of the pH scale is determined by the concentration of hydrogen ions (H+) where a high concentration of H+ ions indicate a low pH and a high concentration of H+ ions indicate a high pH. The pH scale ranges from 1 to 14 where 1 to 6 is classified as acidic, 7 neutral (neither a base or an acid) and 8 to 14 is classified as basic.

In this lab, you will use the juice from red cabbage as a pH indicator to test common household liquids and determine their pH levels. You will mix cabbage juice with different household liquids and see a color change produced by a pigment called flavin (an anthocyanin) in red cabbage. Through this color change, you will be able to successfully identify the approximate pH of common household liquids using the table below:

Color:	Pink	Dark Red	Violet	Blue	Blue Green	Green Yellow
Approx. pH	1-2	3-4	5-7	8	9-10	11-12
Acid/ Base	Acid	Acid	Acid/Neutral	Base	Base	Base

Strength increases at extremes of this scale .

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

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Appendix G

Student Questionnaire

This student questionnaire was designed to get to know my students at the beginning of the year and to learn about their preferences for learning. It became important to use and collect data about my students and their interests. Once I know their interests, I can tailor classroom activities, labs, and lessons to suit their needs and wants in a classroom. This is a way that I am giving my students a voice in my classroom from the first day.

Conclusion

The Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017) format includes multiple components such as implementing relevant and purposeful experiences, deepening core ideas from content, creating and maintaining supportive relationships, and using evidence-based practices for assessments and instruction. From this study, peer collaboration, using prior knowledge of students, and providing students with practice via modeling and scaffolding were implemented in relation to the main tenets of Rigorous Project-Based Learning (McDowell, M., Hattie, J., & Boss, S.,2017). All of the tenets were accomplished except implementing relevant and purposeful experiences.

From this, decreasing the emphasis on standardized testing allows students to develop

Student Questionnaire

Name:_____

1. Do you have a nickname or a different name that you would like me to call you? If so, what is it?
   _____
2. How old are you?_____
3. What is your favorite color?_____
4. Do you have any siblings? If so, how many?_____
5. What is your favorite subject?_____
6. What is the subject that you struggle with the most and why?_____
   _____
7. What do you like to do in your free time?_____
   _____
8. Do you play any sports? If yes, which one(s)?_____
   _____
9. What is a unique talent that you have? _____
   _____
10. When you feel stressed, what is something that you do to relax?
    _____
11. What is something that you are excited about this school year?
    _____
12. What is something that you are worried about this school year?
    _____
13. What is something that you want to learn about at school?
    _____
14. What can teachers or other adults do to better support you and your learning?
    _____
15. How can your teacher help you if you are feeling down?
    _____
16. What makes you feel the most appreciated and understood?
    _____