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Effective Teaching Strategies for an Up-and-Coming Science Teacher

Daniel Lampe

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

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Graduate Student: Daniel Lampe

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

Committee Chair:

Name: Melanie Landon-Hays & Amy Bowden Signature:_____
Date: 06/06/22

Committee Member:

Name: Brock Ferguson Signature:_____
Date: 06/06/22

Dean of Graduate Studies and Research:

Name: Dr. Hillary Fouts Signature:_____
Date:_____

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Abstract

For a science teacher beginning their career in teaching, there are a multitude of what are considered to be good teaching practices they will need to know. It can be overwhelming for an individual to hone in on the best practices to focus on first. For this action research project, I combed through these practices and selected a few major themes that I believed to be effective teaching strategies for an up-and-coming science teacher.

I first started by addressing my own philosophy of teaching, and what I believe are the characteristics and actions of an effective teacher. From there I reviewed a plethora of literature regarding teaching and focused on three major themes: differentiation in the classroom, effective teaching practices, and effective teaching practices specific to a science teacher. I then conducted research and collected data on these three themes through my lesson plans, journal reflections, and feedback from my cooperating teacher and supervisor. I then concluded the project with my own analysis and reflection of the data, which showed just how invaluable these three major themes are for effective teaching for a new science teacher.

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Chapter 1

Philosophy of Education

Defining what teaching is should be an easy task. It is a basic word that most people can define on the spot without much research or consulting a dictionary. Once you share your definition with other people, however, you will soon find that there is quite a large variety of ideas behind what teaching is and how you do it. Taking it a step further, you will find the same situation for defining learning and how someone can learn. It seems that when it comes to the educational world, there is quite a large discrepancy about the concept of teaching and its meaning. In this introduction to my action research project, I will be going over my personal philosophy of teaching and my thoughts and experiences on the educational world. I will take into account the different ideologies, prominent philosophies, and current issues of our time as well as the type of classroom atmosphere I wish to promote, my thoughts on the school system, and my beliefs of being a teacher. I hope that by the end of this chapter, both the reader and I will walk away with a firm grasp as to my views on teaching and the teacher I want to be. I will also dive deeper into what it takes to be the effective teacher that I want to be, focusing on topics such as differentiation, and effective instruction both generally and specifically with a focus on science.

To begin with, it is important to understand what my education was like growing up so that you can understand some of the factors that shaped the foundations of my beliefs. From a young age, I was diagnosed with ADD. This led to some behavioral and attention problems inside the classroom. My classroom size was small, so my actions were quickly noticed and addressed by the teachers. Although it was beneficial to have smaller class sizes so that each student could get more attention and feedback from their teacher, it also meant a smaller faculty

size where everyone knew my name and my reputation. A frequently used tactic by my teachers was to send me out of the classroom for a set amount of time. Not only did I miss crucial educational content, but I also felt ostracized by my teacher and fellow peers. Due to the small size of the school and its faculty, most of my teachers knew of me long before I would take their class. This created a preconceived notion as to who I was and how to discipline me. It was not until a new teacher came to school that my path began to change. This is mostly because that new teacher did not have that predisposition of who I was as a student, and because of that he used different strategies for handling my behavior. He was more patient, and instead of sending me out of the classroom when I was being disruptive, he talked to me one-on-one and helped me realize how my actions were negatively affecting what he was trying to accomplish in the classroom. This helped me learn as a teacher that you should never have preconceived notions of how a student will be. It also helped me learn that if a certain tactic or discipline is not successful, then it is time to approach the matter in a new way as opposed to continually using the same style of discipline.

My transition from middle to high school was in some ways fairly dramatic. My education went from close (although somewhat toxic) relations with my teachers and peers to feeling like just another number. This had its benefits in that I did not feel ostracized; however, it also took away the community and comradery aspect of the small class size. Much of my education was focused on preparing and memorizing information for tests including the Scholastic Aptitude Test. Due to my high school's expectations for success, many of the classes were geared more towards learning how to get into good colleges as opposed to truly analyzing and examining the material we were learning in class. My time in college was a similar experience as high school; however, I found that my professors delved into topics more as

opposed to just memorization. There was much more writing, analyzing, examining, and dissecting of the material learned. I found that out of all my education, it was those classes where material was covered at a deeper level are that I remembered the material the most. This helped me realize as a teacher that having students memorize the material is nowhere near as impacting or eye opening of an experience as when you have them analyze it and make it more relevant to them.

Now that you are familiar with my educational background, I will break down some of the teaching ideologies and philosophies that resonated throughout my educational past. It is important to start at the beginning, in my elementary/middle school learning, as that was one of the biggest influences that shaped my idea of what teaching was supposed to look like. I went to a small private religious school, therefore much of my education was centered around the religion that was practiced there. This meant that most of my studies came with a connection to God. This is important to note because in matters of God, students are seen as uneducated and unable to come to an answer unless given by an instructor. What this means in the classroom is the teacher carries all the knowledge, and the students must be quiet and listen. Students don't know any better, they do not know how the world works, and most original ideas they bring to the discussion are brushed aside if they do not meet the specific standards in place. The students are disciples, meaning that "someone who has been punished by someone else—or at least to someone who has surrendered his or her own authority to someone else's" (Davis, 2004, pg. 58). Indeed, this was the case with my education throughout elementary and middle school. During my time there I felt like I had lost authority and independence of knowledge. What I thought and believed as a student would only be considered true if it matched exactly what the teacher said. Lessons did not involve much free thinking and analyzing but instead involved stringent

workbooks and heavily supervised activities. Much of the education and discipline in the classroom was dictated around religious style teaching. Not to be confused with teaching about religion, but rather this simply means I was taught that I could not find truth, I had to be taught it. In this way, religious style teaching was more like mastering and discipling, of which I do not agree with. It would come as no surprise that I was not interested in becoming a teacher during this time.

Moving on to high school, there was a definite switch in the type of teaching philosophy and style that only makes sense given our current educational system. Just like my elementary/middle school, my high school was also religious and practiced the same religion. In this way, the religious teaching style was similar in that a teacher's job was to shepherd the students to the right way of thinking and be a master over them. There was a slight switch, however, in the style of teaching. I noticed that due to the larger class sizes and multitude of teachers, I was not so easily recognized every class. My teachers interacted with the class, but there was no close relationship and knowledge of each individual student like there was before. There was a general disconnect, almost forced, and I found the teacher and faculty's role was more of supervision as Davis talks about: "The task of the teacher within these structures, again paralleling life on the assembly line, came to be framed in terms that reflect the empiricist concern with control of processes and predictability of outcomes" (Davis, 2004, pg. 84). This empiricist style teaching made more sense as I continued through high school. It soon dawned on me that my school was one of the better ones in my city, and that a majority of the graduating students went on to colleges at the UC level. So much so in fact that any student who went to community college was looked down upon, and those that did not wish to continue to college at all was presumed to be intellectually incompetent. Grades were becoming a big deal and started

to determine a student's social status. As time wore on, more and more of the assessments revolved around multiple choice or short answer responses. I did not realize it then, but the high school teaching experience was more so a conditioning experience, churning out students who could successfully pass their important tests to get into college. It is no surprise then that most students did make it to college. Although much of my time there was spent under empiricism teaching, there were a few teachers who went deeper into the material and challenged students to think beyond what was taught in the lesson and to look at the big picture. Those were the classes I remember the most, and frankly what inspired my love of science and statistics. These were classes that were taught with a gnostic tone, which means that they helped open my eyes to larger and more complex systems that did not necessarily have a "right" answer that the teacher was directing me towards. Although religion and empiricism style teaching helped me become successful in my tests, it was the gnostic and mystic classes that helped me find my passion. I realize as a teacher that it is important to prepare students for standardized testing so that they have the opportunity for advance education opportunities. It is also important, however, that I teach in a way that inspires students to look at the big picture, to find meaning and curiosity for the way things are. It would seem that an ideal teacher would carry both of these traits in their classroom, something that I wish to do.

When I arrived at college, I was immediately under the impression that it was going to be a similar experience to my time in high school. Although it was not a religious facility, many of the first-year classes I took were structured and taught in the same empiricism style. It wasn't until the latter part of freshmen year, where my studies were becoming more focused on my specific study, that I noticed a change in teaching style. My classroom sizes were getting smaller, and teachers were able to interact with students more often and provide more personal feedback

on coursework. There was also a trend of moving away from multiple-choice style assessments to having more emphasis placed on writing and research papers. This change allowed for more creativity in my responses and gave me an opportunity to think more critically about what I was learning. There was also a large increase in group work, which allowed students to share their ideas, learn new ones, and generally gain a new understanding of the content from the view of someone else. This style of teaching follows the philosophy of structuralism where the teacher acts more as a facilitator, allowing students to come to their answers independently and providing assistance when needed. John Dewey's work strongly supports this style of teaching where "…learners must be allowed to explore, and that a key aspect of teaching is well-timed interpretive assistance…carefully designed learning tools…while they provided learners with relevant experiences" (Davis, 2004, pg. 134). This was the case for my college learning experience, as I found myself writing more essays, sharing my ideas, and taking on more internship work. As a teacher I wish to engage in teaching that promotes critical thinking and the sharing of ideas and experiences between students. As a student I felt like I was not only gaining a firm grasp on what was being taught but understanding its implications and having my view of the world change. No longer were my teachers trying to inform me how to think, but instead they gave me some base information and allowed me to come up with my own conclusions, a style that I wish to foster in my classroom because as a student I enjoyed this style of teaching and found that I gained significantly more insight into the world we have created and my place in it.

Looking back at my educational history, I have noticed some key characteristics of the teaching styles I experienced. For starters, because I went to a religious school, I was taught under religious teaching philosophy. My teachers were considered masters of knowledge and if I wanted to learn anything, I would need to learn it straight from them and how they know it.

During my time in high school, the school was under more of an empiricist philosophy. The classrooms were factories designed to churn out students who would be prepared to succeed at their SAT's and other college entry multiple-choice exams. Memorization and recitation were the focal points in my education, not analyzing the impact of the information and its relevance in my life. It was not until college, with its more structuralist style, did I consistently have opportunities to critically analyze what I was learning and its impact on my views of the world.

After I graduated from college, I stumbled across a job that explored new teaching philosophies that would become the core of my teaching beliefs. This job was working as an outdoor and environmental educator for a Montessori school. This school helped solidify my appreciation of structuralist style education where students are independently finding knowledge with the help of the teacher acting as a guide. It went even further, however, in teaching me about a new philosophy of education and that was interobjectivity. Interobjectivity focuses on how there are relationships between what we see in the world and our perceived knowledge of it. Davis writes, "An important principle here is that descriptions of the universe are actually part of the universe—and, hence, the universe changes as descriptions of the universe change." (Davis, 2004, pg. 101). This plays a large part in the understanding that humanity's actions play a large role in shaping our perceived universe. Having majored in environmental studies, this philosophy resonated deeply with me in that everything is connected and interdependent on each other. This philosophy can be broken down into two discourses of teaching which is complex science and ecology. Both strongly resemble the kind of atmosphere I wish to promote in the classroom and what my focus is as a teacher. Both also promote liberating constraints, which is the careful balance between giving students the freedom to discover while also placing certain guidelines to prevent chaos and misconceptions.

To begin with, the idea of complexity science acknowledges that classrooms are more like learning systems in that they are constantly changing, adapting, and filled with diverse individuals who create a working system. Something I wish to point out in particular is the importance of diversity. If you take a group of identically minded individuals, they may find it hard to figure out a complex problem. If you have a group of diverse individuals, however, you will find they are more likely to solve that problem. In the process, sharing of new ideas and mindsets is made possible and students will walk away with a plethora of new understandings and problem-solving skills. Much of my education growing up was surrounded by middle class/wealthy, white, Christian students. It comes as no surprise that discussion in the classroom was stale and rarely anything changed my worldview. When I went to college, however, I saw a much greater diversity of people in the classroom which led to new beliefs and viewpoints I had never considered. What I considered to be normal was challenged, and I believe I am all the wiser because of it. It is for that reason that I believe it is important to promote diversity in the classroom. As a teacher, it is my goal to work on creating an atmosphere in the classroom that promotes diversity. This can be done through my curriculum, which should be accessible and relevant to the different backgrounds of students in the classroom. I can also promote diversity in the classroom by having more group work and encouraging classroom discussion where it is mostly student led.

The second branch of interobjectivity is ecology, and it is this discourse that I have found the most relation to in my teaching philosophy. Where ecology focuses and thus differs from complexity science is what I have seen been missing from my educational experience and that is "…this conviction has prompted more of a concern for ethical know-how than practical know-how." (Davis, 2004, pg.174). Indeed, for most of my life I have spent my time in classrooms

memorizing facts and information but rarely having the time to interpret what that information means on a grander scale. In the past I was taught that any ethical explanation should come from religion, with no room for analyzing or coming to my own conclusion. It all had the mentality that schools were meant for practical action, not ethical action. In a sense, I could not create my own view of the world, but instead shape it according to what I was taught it should be. Ecology on the other hand embraces "personal and collective identities, culture, intercultural space, and the biosphere." (Davis, 2004, pg. 176) This is something that resonates strongly with me, as it empowers students and helps them create a better understanding of the world and how the lesson is relevant to them. In a sense, it promotes mysticism, where knowledge is found within oneself as opposed to brought from outside. I personally believe I learned more from finding knowledge through my own thinking as opposed to being taught by someone on the outside especially on matters of ethics and life. This is especially true when I was placed with a group of people with varying ideas and mindsets. To me, teaching should be more of a conversation rather than casting the teacher in a director role. What I mean is a classroom should be a place of discussion, sharing of ideas, solving problems together. The teacher should only be there as the conscience of the group, listening and creating new opportunities for new ideas and growth for students. Another one of my goals as a teacher is to create an open learning environment and to promote high leverage practices, which are instructional approaches educators can use to teach different types of learners and content.

Unfortunately, schools are still structured in an empiricist way with the focus of churning out students to be successful at passing their important tests. These tests do not truly verify the knowledge and wisdom of the student, but more so how good they are at multiple-choice problems and memorization. The statistics from these tests can hurt lower scoring schools in that

they could lead to firings, restructuring of classes, and potential loss of funding. It seems that in our government's eagerness to calculate educational success, it has failed at teaching. What's worse, our current teaching environment does not promote diversity of ideas and cultures in the classroom. It has made some progress to be sure, but we still have a long way to go to create a sense of equity amongst students. What I can do as a teacher to change these systemic issues is limited. That being said, I believe it is my duty as a teacher to be actively engaged in school board meetings so that I can voice my opinion on what I believe is right for my classroom and my school. I would encourage my peers to do the same, as the more diverse and larger our voice as teachers are, the more likely change will happen. Promoting discussion and engagement between students, teachers, parents, school administration, legislators, and more, is vital to encouraging a positive direction for our education system.

To conclude this paper, I will go over who I am as a teacher so that you can understand what I wish to achieve in my classroom and for my students. I wish to encourage my students to question everything, and to never come to a conclusion based solely on my response. I want to promote a classroom that is geared towards diversity, inclusion, explication, engagement, and possibility. I wish to create a classroom where students are excited to work together to solve problems, utilize hands-on activities, and share ideas that come from their own identity. I want to foster self-confidence, curiosity, empathy, and care amongst my students. In order to achieve these goals, I need to examine three main themes that will help me be more effective as a teacher. These themes are differentiation, effective instruction in the classroom, and effectively teaching science. After careful examination of these three themes, I will hopefully gain the knowledge necessary to be the teacher that I needed to have when I was a student.

Chapter 2

Purposes and Objectives for the Literature Review

My purpose in this review of the research was to discover how teachers and researchers have looked at effective teaching strategies and teacher growth in their discipline. To start with, I searched for research on differentiation in the classroom. To be an effective teacher, you want to reach all of your students. Today's students come from a variety of backgrounds, and therefore as a teacher you need to be prepared for a diverse classroom experience. I also searched for studies on effective instruction and methods of being a better educator. Reaching your students is important, and it also just as important to educate them with successful practices. It is imperative, therefore, that research be done in how to design and deliver effective instruction. Additionally, because I would be studying my own practice and focusing on these ideas in the field of science, I looked for studies that indicated the kinds of instruction that are effective for teaching science.

This literature review addresses my knowledge of these concepts as a foundation for my understanding so that I can set goals and grow in my own teaching experience. I especially looked for research that described effective strategies for each area, its importance, and gave examples of how they can work in the classroom. Application of this research was an essential part in building my own knowledge base for this project.

Procedures for the Literature Review

I selected literature for this review based on several specific criteria. For starters, I utilized readings and literature that has been assigned to me through my many classes I have taken so far to obtain my teaching license. While reviewing these readings I searched for content that covered my three major concepts which are diversity in the classroom, effective instruction,

and inquiry-based science teaching. From there, I moved on to finding additional online literature from the Hamersly Library at Western Oregon University, as well as utilizing databases such as EBSCO or JSTOR. Searching broad concepts such as "differentiation in education" produced over 1,000 articles or references. To avoid being overwhelmed, I created three sub themes for each major theme in order to be more efficient at breaking down the information as well as creating a general structure to my research. For the differentiation theme, I focused on diversity, culturally responsive teaching, and inclusive education. For the major theme of effective instruction, I broke that down into evidence-based practices, scaffolding, and high leverage practices. Finally, for my last theme involving teaching science, I used these sub-themes; inquiry-based teaching, using technology, and hands-on activities.

Differentiation in the Classroom

Today's classroom in the United States houses students from very diverse backgrounds. These different backgrounds include economic, social, cultural, linguistic, and ethnic to name a few. You cannot assume that any of your students came from a similar background as your own. As a teacher, you cannot assume that the same teaching style that worked for you as a child can be used as effectively with your own students. Teachers need to be aware of these differences and understand that reaching all their students will require being able to address all of their unique needs. A good teacher cannot address the unique needs of their students unless they know how to be effective at differentiation. Renowned differentiation researcher Carol Ann Tomlinson writes "In a differentiated classroom, teaching is evolutionary. Students and teachers are learners together. While teachers may know more about the subject matter at hand, they are continuously learning about how their students learn" (Tomlinson, 2017, pg. 10). Differentiation is vital to

ensuring that your diverse class of students are all equally being reached and connecting with the content.

Research Studies

This research study about differentiation combined strands of complementary research literature, centered on three sub-themes. For the first sub-theme, I will discuss diversity and its impact on the school system. Second, I consider research on culturally responsive teaching practices and ideas as these shape the way we interact with our students. Finally, I look at research on inclusive education as it is vital that all students feel respected and welcome in the classroom.

A Review of Research on Diversity

Over many years, the American classroom has become increasingly diverse. Classrooms can be filled with both rich and poor, literate and illiterate, native and foreign, Black and White and everyone in between. For example, between 2000 to 2017 the percentage of White students decreased from 62 to 51 percent while the percentage of Hispanic students increased from 16 to 25 percent (Brey, 2019). All of these students who come from such diverse backgrounds have very diverse ways of learning. What might work for one student who is literate, comes from a wealthy family, and speaks fluent English might not work for another student in your same class who is learning English, poor, and struggles with the English language. The same could also be said for the student who is wealthy but recently moved from a foreign country and although they can speak English fluently, they struggle with reading it. Yes, it would seem that the students in our classrooms these days are much more diverse then in the past (Brey, 2019). Yet how is our school system approaching this new diverse audience? Apple (1979) says we're doing poorly:

"The bureaucratic ethic and the moral mission of the schoolmen arose from the same problem--the rapid expansion and diversification of the population—and they tended toward the same result--a vigorously conformist system" (Apple, 1979, p. 67). Apple's quote still unfortunately rings true to this day. Much of the school's systems are geared towards standardized testing and other conformist systems that is treated as a "one size fits all" style. For example, most classes have materials presented in English-only text, which can result in an English Language Learner struggle to read at the same pace as their fellow peers. This leads to a domino effect of bad test grades, getting placed in special education, or worse, dropping out of school. In a differentiated classroom, this student would have been given material that would also be written in their native language, producing significantly different results leading to their success.

One style of teaching cannot possibly work for a classroom where students have such diverse backgrounds and learning needs. There cannot be a standardized test that would be applicable to a student who comes from a background of trauma and poverty while also being applicable to a student who comes from a wealthy and healthy family setting. So then who is the standardized test made for? Davis answers this question perfectly, "Formal education is argued to be wholly complicit in the maintenance of an economically stratified culture in which the middle-class, middle-aged, married, White, Christian male is the normal person" (Davis, 2004, p. 141). This is a system that will not be effective in properly teaching today's students as it blatantly ignores their diverse backgrounds.

It would also appear that we are taking a step in the wrong direction when it comes to issues such as segregation. Although today's classroom is much more diverse than it was in the past, it seems that certain schools located in either wealthy or poor neighborhoods are predominately one race, according to Kozol: "In a similar document, the school board of another

district, this one in New York State, referred to "the diversity" of its student population and "the rich variations of ethnic backgrounds." But when I looked at the racial numbers that the district had reported to the state, I learned that there were 2,800 black and Hispanic children in the system, 1 Asian child, and 3 whites" (Kozol, 2005). It is interesting to note that the school boasted about its diversity, while a majority of its student population was mostly one race. What's worse, it seems, is the wealth disparity between these types of schools, with predominately white schools providing more educational funding than predominately black schools. According to Kozol,"New York's Board of Education spent about $8,000 yearly on the education of a third-grade child…if you set her down in one of the wealthiest white suburbs of New York, she would have received as much as $18,000 worth of public education…"(Kozol, 2005). Unfortunately, this trend is all too prevalent across the country. On an individual level, teachers lack the power to make the large-scale changes needed to fix these issues. Instead, it is up the voters and politicians to tackle these system problems. Delpit makes a good point that, "No, I am certain that if we are truly to effect societal change, we cannot do so from the bottom up, but we must push and agitate from the top down" (Delpit, 1988, p. 292-293). However, I do believe that creating a classroom that is inclusive and culturally responsive can bring about great benefits to a diverse student audience. For example, utilizing immediate and supportive behaviors can create a positive and welcoming atmosphere for students, as Faulkner (2021) suggests "…referring to students by their names, asking how students are doing, using correct pronouns, and giving students the opportunity to articulate their thoughts and opinions". There is also research that has shown that not only supporting but perceived support is associated with more positive feelings and overall benefitting a student's psychological well-being (Eagle, 2019).

A Review of Research on Culturally Responsive Teaching

When working with students from diverse backgrounds, teachers will come across students whose cultures are very different from their own. It is wrong to assume during your teaching that if you use an example of what you would consider a typical cultural practice, that it would resonate with all of your students. To avoid these situations, it is important as a teacher to get to know your students better and to never assume that everyone has the same cultural experience growing up. There is a wealth of different cultures that can be found in the classroom, and Yossa (2005) says it is crucial that teachers recognize them: "CRT centers the research, pedagogy, and policy lens on Communities of Color and calls into question White middle-class communities as the standard by which all others are judged" (Yosso, 2005, p. 82). In this way you can deter the toxic "norm" perspective in the classroom and allow students from other backgrounds to participate and be valued. When you shift the focus away from one specific cultural group and allow room for others to be promoted, you are being culturally responsive and giving your students power and a voice.

One of the best ways to be an effective teacher with a diverse student audience is to make the content relate to their cultural backgrounds, as Banks explains: "Making teaching culturally responsive involves strategies such as constructing and designing relevant cultural metaphors and multicultural representations to help bridge the gap between what students already know and appreciate and what they are to be taught" (Banks et al, 2001, p. 198). Ormrod agrees in his book *Human Learning* where he states that, "Students from diverse backgrounds are more likely to be motivated to do well in school – and to actually do well there – when they perceive the school curriculum and classroom activities to be relevant to their own cultures" (Ormrod, 2020, p. 363). It may not always be easy, however, to have a firm grasp on a student's cultural background. If

the student is shy and is not very vocal in class, you can have a hard time getting to know them better. This can be especially true if the student lacks the self-confidence due to coming from a cultural background that is a minority amongst their classmates. There are thankfully several ways that you can get to know your students better, “Specifically, culturally responsive teachers demonstrate the following key characteristics: Communicate high expectations. Consistent messages— from the teacher and the whole school—emphasize that students will succeed based on genuine respect for students and belief in student capability" (Shealey, Callins, 2007, p. 196). Shealey goes on to mention that promoting student-controlled discourse, including small-group instruction and cooperative learning and having students assist in creating the curriculum are all effective ways to be culturally responsive with your teaching. These are just a short list of ways that you can promote equity and culturally responsive teaching in the classroom.

A Review of Research on Inclusive Education

Culturally responsive teaching can be an effective way to reach your diverse student audience, and it goes hand-in-hand with inclusive education. Inclusive education focuses on not just cultural backgrounds but also economic, political, ethnic, social, disabilities, linguistic backgrounds and so much more. The point of a classroom is to be able to have all of the students learn, and that is a challenge if any of the students feel like they cannot participate for any reason. Teachers should be careful to ensure that they are not producing barriers that would hamper the ability of a student to be active in the lesson or effectively complete the work assigned. For example, Show explains that English Language Learners (ELLs) may have a hard time with a short answer section or writing in a lab journal for your science class, “Participants agreed that word choice…was the chief writing difficulty” (Show, 2015, p. 4). Teachers need to be thinking of these kinds of difficulties their students might be experiencing and find solutions

to help them not only gain confidence in the class but to succeed beyond the classroom as well. Show Mei Lin suggests that teachers use vocabulary activities to help ELLs expand their vocabulary and also their writing fluency (Show, 2015, p. 9). Vocab activities are great not only for ELLs but also for the rest of your students who might find academic language difficult to understand.

One of the key ways to create an inclusive environment is having the right mindset. We as teachers can all agree that we do not know everything, but what we sometimes forget is that there is much to be learned from our students. Allen states an inclusive teaching environment is one where the teacher is learning from the student just as much as the student is learning from the teacher, "The task of obtaining knowledge involves challenging and removing ignorance and narrow restrictive regulatory conceptions and understandings" (Allan, 2010, p. 614). Indeed, we must remove all preconceived notions or misconceptions about our students before we interact with them. For example, you cannot assume that all of your students come from a wealthy background just because your school is in a wealthy neighborhood. Keeping an open mind and ear to what your students are saying and doing will help you recognize how to create an inclusive educational experience for your students. In the wise words of Delpit, "The teacher cannot be the only expert in the classroom. To deny students their own expert knowledge is to disempower them" (Delpit, 1988, p. 288).

Effective Instruction in the Classroom

When it comes to student's needs in the classroom, it is fair to say that each student has a unique way of learning. With a class size ranging anywhere from 15 to 30 students, it can be hard to meet every student's unique educational needs. Thankfully, there are certain techniques, actions, and methods that you can use in the classroom to effectively reach your students

regardless of their specific needs. What's even better is that these methods are relatively effective across all content areas. In order to be an effective teacher, it is crucial that I conduct research on these effective instruction methods and styles.

Research Studies

This research study about effective instruction combined strands of complementary research literature, centered on three sub-themes. For the first sub-theme, I will discuss evidence-based practices (EBPs) and how they are foundational practices in the classroom. Second, I consider research on scaffolding and how it can effectively prepare students for higher levels of thinking. Finally, I look at research on high leverage practices and how they can elevate my teachings skills.

A Review of Evidence-Based Practices

When I first ran across the phrase "evidence-based practices", it seemed like common sense. This was mostly due to my scientific mindset of utilizing research to base any facts and theories off. I realized, however, that for a long time, educational practices were not being evaluated from a scientific standpoint and therefore lacked previous "research" to prove the practices that were considered commonplace were indeed the best practices. If there is no prior research or data that can prove that certain teaching practices are effective, then how can teachers confidently use them in their classroom setting? In volume 35 of *Education and Treatment of Children*, Spencer makes a great point in that "Unless we know the benefits and risks of a treatment there is no basis of claiming it is a service. A treatment may cause harm to students and that harm may not be detected unless the treatment has been evaluated" (Spencer et al. 2012, p. 132). This means, therefore, that an effective teacher is one who bases their practices off

previous evidence and research. To not do so would risk being ineffective or even causing harm to your students.

It would be in any teacher's best interest to utilize evidence-based practices. To do so, however, does require the individual to conduct research on what these evidence-based practices are and how they can improve upon their own practices. This is especially true for new teachers going through teaching licensure programs such as the one I am currently attending at Western Oregon University. One way of doing this is through action research projects just like this one. Hunter states "Action research may well be the leading edge of a move toward introducing research to teacher education programs in Canada, as several other faculties have made some form of action research option available in recent years, often in the context of reflection on practice" (Hunter, 2017. P. 4). Action research is not solely for new teachers, however, as Hunter also states that the knowledge and skills of research projects are just as important for veteran teachers. It is there, in their own schools and classrooms, that their practice can be better informed via research in educational practices.

I have talked at length about why researching and using evidence-based practices can be important to both new and experienced teachers alike. But what counts as an evidence-based practice and what do they look like? Cynthia Farley gives a fantastically detailed explanation of what counts as one, writing: "EBPs typically must meet standards related to (a) the research designs used in the supporting studies, (b) the quality of supporting studies, (c) the quantity of supporting studies, and (d) the effect sizes of supporting studies" (Farley et al., 2012. P. 38). This may still seem vague, and I believe Trina Spencer addresses that with a medical analogy by saying "…it is important to understand that in our evidence-based practice framework best available evidence is sufficiently broad to inform selecting and adapting treatments, designing

treatments locally, and relying on progress monitoring data (practice-based evidence) to evaluate impact" (Spencer, 2012. P. 134). What this means is so long as evidence-based practice fits the necessary criteria it can include a broad spectrum of topics. Some examples include classroom management (Simonsen, 2008), emotional and behavioral disorders (Farley, 2012), reading and writing skills (Graham & Spencer, 2016), and more. Based on this research, it would be invaluable for me to rely on evidence-based practice to help not only better my skills while becoming a teacher, but long after as well.

A Review of Research on Scaffolding

The next part of my research on how to give effective instruction led me down the very important topic of scaffolding. When assigning your students with work, projects, and assessments, you need to make the material something they can accomplish and understand. It is our duty as teachers to get our students to think and act on a higher academic level than when we first began working with them. This cannot be achieved overnight, and you cannot just hand them challenging work without previously giving them the support and structure needed to reach that higher level of thinking. The word scaffolding in this case is borrowed from its construction meaning, where a temporary structure is built to help with building of a much larger and complex structure. Vygotsky relates scaffolding with the term "zone of proximal development" which he describes as "the distance between the actual development level as determined by independent problem-solving under adult guidance or in collaboration with more capable peers. The zone represents the potential for a child's development when aided by others" (Vygotsky, 1978, p. 86). It is important, therefore, to scaffold your content so that your students may attain that higher potential of learning.

But what exactly does scaffolding look like in the classroom? In truth it can come in all manner of ways, so long as it retains its definition of building students up to a high level of thinking.Janneke van de Pol says, “Because scaffolding is such a dynamic intervention finely tuned to the learner’s ongoing progress, the support given by the teacher during scaffolding strongly depends upon the characteristics of the situation like the type of task and the responses of the student. Therefore, scaffolding does not look the same in different situations and it is not a technique that can be applied in every situation in the same way” (Janneke van de Pol, 2010, p. 272). Scaffolding can be present in such a myriad of ways and situations that it almost has too broad of a definition. It is important, however, that it does not get confused with general support, as there is a key difference between the two terms. Scaffolding is meant to prepare the student for a much more challenging task or thinking level whereas support is simply aiding a student to complete a task that may not necessarily get them to a higher level of thinking. Morgan and Brooks explain this difference well, “Scaffolding is the assistance a learner needs, carefully balanced between too much support resulting in the task becoming too easy and too little support resulting in cognitively overloaded and frustrated learners, to succeed in the zone of proximal development” (Morgan & Brooks, 2012, p. 514). As Morgan & Brooks puts it, scaffolding is that careful balance between assisting a student too much so that they are not challenged and are required to think on a higher level and helping a student too little where the task seems overwhelmingly challenging and they start to lose self-confidence or overstress the activity.

When it comes to teaching science, scaffolding is crucial in getting students to work on thinking on a much larger or complex scale which is again similar to construction’s definition of scaffolding. Teachers can coach, model different problem-solving approaches, promote independent and group work, and encourage students to become less dependent on their teachers.

Scaffolding can also come in the form of hints, prompts, elaborations, reminders, and cues. Scaffolding is not having the teacher provide complete solutions, direct answers, advice on how to manage academic affairs when working independently or in a group, assigning tasks that require verbatim student responses, or not providing an instructional support at all and thus having students work in an inefficient and demoralizing learning experience (Holliday, 2001, p.68). Scaffolding in science is especially crucial as it gives students the freedom to find answers on their own in ways that can make them feel like they are a true scientist coming across a major discovery. While that may be a bit of an over-exaggeration, the feelings attached with that are important and necessary to drive students' passion in learning.

A Review of Research on High-Leverage Practices

When talking about certain methods and procedures that are effective in the classroom, many of my professors and peers have brought up the phrase "high leverage practices". After some research I found a proper definition by McCray who states "a critical set of practices that are essential to improving student learning and behavior and can be learned in coursework, deliberately practiced in field experiences carefully structured by faculty, and generalized to more loosely structured field experiences" (McCray et al, 2017, p. 1). This seemed like a reasonable definition for this term based on its usage throughout multiple texts and real-life conversations. However, I ran across a common problem with most of the texts that defined this term and that was that these practices were defined in a way that sounded identical to evidence-based practices. The key, and so far only, difference I have found between these two terms is that high-leverage practices are effective to use in any grade level or content area whereas evidence-based practices are useful for specific situations. Some examples of high-leverage practices are collaborating with professionals to increase student access, use student assessment

to improve student outcomes, establish a consistent and organized learning environment, and more.

When it comes to high-leverage practices, different organizations, researchers, and teachers have different lists of what they believe is considered a high-leverage practice (HLP). This does not necessarily imply that these people do not agree that something is considered an HLP, but more so that depending on the point of view there are certain practices that would make that list while others not so much. For example, the Collaboration for Effective Educator Development, Accountability, and Reform (CEEDAR) and the Council for Exceptional Children (CEC) identified 22 practices that they believed were foundational to effective instruction (Brownell et al, 2021). Meanwhile the SUNY Buffalo State Professional Development Schools (PDS) Consortium drafted a set of 17 HLPs to serve as a core curriculum for their student teacher teaching program (Maheady et al, 2019), while the book on High Leverage Practices for Inclusive Classrooms has around 20-21 HLPs (McLesky et al, 2019). Again, although these list sizes differ, much of what occupies them is relatively the same. Some of the common strategies I noticed were effective communication with students and parents, scaffolding, promoting student independence and also collaboration, providing high rates of feedback, promoting a safe learning space, adapting curriculum to better suit your student's needs, promote active engagement, and more. Capobianco explains that for a science classroom, there is a theme that mostly ties with open-ended questions and promoting student dialogue and inquiry: "…in-depth analysis of students' ideas through discussion and reflection, scaffolding students' science knowledge and skill development through open-ended problems that require in-depth explanations and the use of arguments and evidence, and encouraging growth in interpersonal skills through whole- and small-group work and oral communication" (Capobianco et al, 2018). It would be in any

teacher's best interest to study the many lists of HLPs and from there create their own list that they believe is suitable for the given teaching environment they are in. High-leverage practices appear to be the foundation of effective instruction in any classroom, and I would do well to recognize and promote them in my own.

Teaching Science in the Classroom

Up until this point, I have spent most of my research going over general classroom teaching strategies. These strategies would be invaluable in any classroom or teaching environment and can be effective regardless of the content being taught or age range of the students. I wish to now turn my attention to my content area of expertise which is science, and some of the strategies that will lead to me being an effective science teacher. Science is one of my greatest passions in life, and my goal is to hopefully pass on that passion of learning science to my students. In order to foster that passion in my students, I need to make science exciting, relatable, and most importantly interesting.

Research Studies

This research study about teaching science combined strands of complementary research literature, centered on three sub-themes. For the first sub-theme, I will discuss inquiry-based teaching and how it has become a foundation for science teaching. Second, I consider research on effectively integrating technology specifically in the science classroom. Finally, I look at research surrounding hands-on activities and their benefits in science education.

A Review of Inquiry-based Teaching

I am sure most of us are familiar with the old saying "Give a man a fish, and you feed him for a day. Teach a man to fish, and you feed him for a lifetime". The essence of this saying

in teaching terms is that if you give a student an answer, that will only solve their immediate question or problem. But if you teach the student how to find the answer on their own, then they will be able to answer future questions without needing your assistance. Not only that, but if you can get the student to be interested in the content, then you won't need to push them to pursue the answer, as they will be passionate enough to find it on their own. This is the teaching ideal, where we can teach students the means to find the answers and get them interested and skilled enough to find it out on their own. Teaching in this style can come in many different forms and techniques, but for this research project I will focus on a style that has been especially popular in science classrooms recently and that is inquiry-based learning. Inquiry-based learning is used to promote activity-oriented learning that reflects scientific investigation such as observation, experimentation, and reasoning (Chiappetta & Adams, 2004). These investigation strategies give students an inside look at what it's like to be a scientist working in the field. It is this kind of real-world experience that makes learning interesting and also meaningful to the students, especially those looking towards the future as Lonka states "inquiry-based learning helps the teachers to prepare students for the future challenges of work. In future workplaces, the skills of asking the right questions, defining and solving the most important problems, creating new knowledge, and making changes will be the most crucial requirements"(Lonka, 2018, p. 26). Thus, by focusing on inquiry-based learning, we are teaching the student how to "feed" themselves for a lifetime.

Another key usefulness of inquiry-based learning is how it makes the content more relatable to the students. Inquiry-based learning is more open-ended and less teacher-structured. This means the student must rely heavily on their own prior knowledge in order to accomplish the task, which makes the material all of sudden much more relevant to them (Kurten 2021).

Making content relevant to students sparks their curiosity and interest which gives them more confidence to want to find the answer and seek out more knowledge about the subject. It is important to note, however, that leaning heavily on a student's prior knowledge about a subject may hinder as opposed to help them. For example, if they have a misconception about a fundamental scientific idea, then that misconception will make finding the correct answer challenging for the student and can even lead them to the wrong conclusion, thus enforcing the idea of the misconception. It is important, therefore, that I pre-assess my students' prior knowledge before beginning an inquiry-based learning activity to ensure that it will be successful.

Finally, what makes inquiry-based learning an effective teaching strategy in science is how it can make learning fun and interesting. As I had mentioned previously, inquiry-based learning is more open-ended, giving students more autonomy and requiring them to rely heavily on prior knowledge. The opportunity to explore learning their own way gives students more motivation and engagement with the content, typically leading to enjoyment in finding the answer (Isik-Ercan, 2020). This also makes the students feel more accomplished and confident once they finish an activity, leading to not just academic growth but self-growth as well (Isik-Ercan, 2020). Along the way students realize the shortcomings in their own prior knowledge and have a better chance to self-reflect on their understanding of the material. Lastly, it gives the teacher a better look at your students' background and how they perceive science. All in all, there are good reasons why inquiry-based learning is so prominent in teaching science and I would do well to include it in my practices.

A Review of Research on Technology

Over the last 30 years the science classroom has completely changed. I remember my elementary school initially installing computers in every classroom and how exciting that was. Soon after educational video games were loaded on every one of them, and I found myself learning about science through a platform jumper game similar to Mario. By 7th grade we were learning how to make Power Point presentations. By high school every student had access to a microscope that could project that image onto a computer and be able to take notes off it. Since then, technology has become an integral part of the classroom, especially in science. Not only is it an integral part of the science classroom, but teachers and educators are encouraged to include technology in their teaching as a tool to facilitate learning or as a means of formative assessment (Straub, 2009). That makes sense given the ways technology improves content delivery, enhances labs, or conducts assessments with simulations attached. This is especially true for inquiry-based learning as students are utilizing tools that allow them to work as scientists and approach an activity in a myriad of ways that gives them some independence (Novak & Krajcik, 2006). It would seem that careful utilization of technology in the classroom can be largely beneficial for an educator.

Indeed, one of the biggest successes to integrating technology in the science classroom is accessibility of content. For example, it is difficult to explain or visualize in a few photos on a slide show the terrain of all of Jupiter's moons. However, with the help of technology students can access the internet and pull up multiple pictures, videos, simulations, and more. This creates an all-around more engaging experience for students and is one that cannot be replicated via textbook or lecture (Laux, 2018). For students to have the ability to see a cell under a microscope and examine its different parts creates an entirely more effective learning experience than having to view one in a textbook. This is also true for more dangerous or flat-out impossible labs in the

classroom. For example, if a teacher wishes to demonstrate to students a very explosive and volatile reaction, they would not attempt to replicate that in the classroom. They can, however, have the students go on a computer and interact with a simulation or video that goes over that reaction so that students can still grasp the content without putting anyone in danger (Laux, 2018).

Finally, having successful integration of technology in the classroom promotes student engagement and interest in the content. Students will be more inclined to watch a video of how our solar system formed than learning about it in a textbook or lecture. Having the ability to show pictures, videos, simulations, and animations helps visual learners, is more engaging, and promotes observation and inference skills (Laux, 2018). The ability for students to visualize and work with complex concepts through technology makes the content easier for them to work with and therefore gives students more confidence and enjoyment from learning. The use of technology also offers an easier method of sharing information and content between students, allowing for easier group work and more opportunities for students to share ideas amongst themselves which has ultimately led to increased student engagement (Forsyth & Schaverien, 2005). It is for these reasons and many more that I should also be integrating technology into my classroom teaching experience to enhance student learning.

A Review of Research on Hands-on Activities

When it comes to science education, most people picture a lab experiment that a class is engaging in. You typically see images of students either staring into a beaker that has a colored substance in it or looking into a microscope. People see these images and assume that students are learning, but are they really? Labs and hands-on activities in the science classroom can realistically come in a variety of different ways other than through a microscope or colored

liquid in a beaker. Some activities have involved making presentation poster boards with a model to match, going outside to take observations of certain natural events, creating a model that will be tested by some sort of outside factor, and more. This variety in hands-on activities allows for a myriad of ways to get students more physical experience with the content. One of the most important aspects to doing labs and hands-on activities is to get students connected with the science content in a way other than memorization, reading, and hearing a lecture. Abrahams & Miller state that "It has widely been agreed that the primary objective of using laboratory practicals in the science classroom is focused on allowing students to make the connections between the domain of concrete objects and the domain of abstract ideas" (Abrahams & Milller, 2008). This is crucial for the student's understanding of content matter as now they are taking what they have learned and interacting with it in person. This creates a stronger connection to the material for the student, ultimately leading to greater academic success and understanding (Satterthwait, 2010).

There are more perks for hands-on activities besides academic success. For lectures, note taking, and working on worksheets there is little to no student cooperation and engagement with each other. This is not the case for hands-on activities. These activities more often than not require students to either pair up or form a group in order to accomplish the task. This cooperative group work is important for effective understanding, enhancing interest, and better problem solving (Hattie, 2009, pg. 212). Students have the opportunity to not only learn from each other as far as accomplishing the task goes, but they can also share ideas, prior knowledge and experiences, as well as learn new ways of thinking about the content they are learning about.

There is also evidence that shows that students find hands-on activities and labs more useful and positive compared to other learning activities such as lectures and note taking.

Surveys have shown that students would rather choose doing an experiment in class and also found that experiments were the most enjoyable as compared to other learning activities (Cerini, Murrary, & Reiss, 2003). It is key to note this positive interaction students have with hands-on activities as it is a great way to break up the stress and anxiety that can come in an academically strong classroom, especially for students who struggle with science. It is also important to note that students are more likely to remember things that elicit a positive emotional response (Lunetta, Holstein, & Clough, 2007). Through the social interaction and enjoyment of these activities students are gaining a stronger and more positive reflection about the material being covered, thus overall proving the effectiveness of hands-on learning.

It is crucial to note, however, that there are some downsides to using hands-on activities in the classroom that must be addressed and understood in order for these activities to be properly effective. These activities can be called ‘discovery learning’ in the fact that students are given some instruction on how to do the task but ultimately, they have the freedom to come to a conclusion through their own understanding and learning done in the activity. This normally is a good thing as it produces a more lasting understanding of the scientific phenomena (Klahr & Nigram, 2004, p. 661); however, things can get lost in translation. Students may come to a conclusion that is in fact a misconception or incomplete or disorganized knowledge that can hinder them in their understanding of the content (Tan & Wong, 2012). This now makes things more difficult for the teacher as they will need to correct this misconception which has now become ingrained in the student. Teachers need to be very careful with how they structure the activity so that students walk away with the correct conclusion. This means making sure that the activity is not too open-ended for its concluding ideas, and that the teacher is constantly checking in with students to ensure that they are on track with the knowledge and skills they are acquiring

throughout the activity (Abrahams & Millller, 2008). If I can ensure this is done, then promoting hands-on activities in my pedagogy would lead to an all-around more successful classroom experience for my students.

Summary

As student bodies become more and more diverse, it has become crucial to be able to not only diversify teaching techniques but to also ensure that effective teaching strategies are being utilized. It is important to understand how to differentiate my teaching so that it remains culturally relevant and promotes an inclusive learning environment. Supporting this teaching with effective teaching strategies such as using evidence-based practices, high-leverage practices, and proper scaffolding will help ensure that my students are obtaining a quality education. Finally, by enhancing my teaching pedagogy with utilizing inquiry-based lessons, technology, and hands-on activities I will ensure my students have a firm grasp of their science knowledge and feel confident with taking on more advanced material.

CHAPTER 3

RESEARCH METHODS

The methods of inquiry for this study focused on the principles and practices of action research, using self-study aligned with professional teacher standards, teacher artifacts, interviews and observations from my colleagues, feedback from observations, and student work as a means of data collection. I will begin with a review of action research principles to establish the foundation for this study's method of inquiry. Second, I will review the choices and purposes

of data collection that helped to highlight my instruction and means for searching for improvement. Third, I will detail my context for the study, methods of data collection protocols, maintaining credibility and trustworthiness of the data, and acknowledge my limitations as a researcher. Finally, I will present the procedures used for studying my practice, while providing data and analysis that speaks to adaptations and adjustments made to my instruction as I implanted this study.

Research Questions

My focus for this research was to discover how teachers and researchers have looked at effective teaching strategies and teacher growth in their discipline. Specifically, I examined differentiation in the classroom, effective instruction, and inquiry-based science teaching. This focus aligned with the following INTASC Standards for teacher professional development. Additionally, I considered how studying my own practice in line with INTASC Standards could improve my own instruction and therefore, student learning. My purpose of this study was to learn effective teaching strategies and teacher growth in my discipline of science. The research questions for this study were:

1. How can I effectively differentiate in the classroom? By asking this question, I hope to learn how to reach the wide range of diverse students' needs in the classroom. Data gathered from a focus on this question was used to examine how diverse classrooms are today and what are the methods of reaching such a diverse audience.
2. What are some effective teaching practices I can use in the classroom? By asking this question, I hope to learn how to be an all-around effective teacher and know what best practices to use. Data gathered from this question was used to examine a wide

variety of practices that are used throughout all different types of classrooms and disciplines that have been proven to be effective at instruction.

3. What are some effective teaching practices specifically for teaching science? Although it is important to know some general good teaching practices, it is also important to know practices that are specifically designed for effectively teaching science. Data gathered from a focus on this question was used to describe different methods of science specific teaching practices.

INTASC Standards

The Council of Chief State School Officers (CCSSO), through its Interstate Teacher Assessment and Support Consortium (InTASC) developed model core teaching standards that outline what teachers should know and be able to do to ensure that every K-12 student reaches the goal being ready to enter college or the workforce. These standards are important because they describe the new vision of teaching needed for today's learners and what strategies teachers can employ to improve their practice both individually and collectively. These standards will be used as guidelines to help monitor and direct my learning and growth on how to be an effective teacher. For this study specifically I will be looking at standards 1 (learner development) & 2 (learning differences) to address my first research question as these standards pertain to differentiation in the classroom. For my second research question in regards to best teaching practices I will be looking at standard 7 (planning for instruction) & 8 (instructional strategies) as these pertain specifically to that question. Finally, for my last research question in regard to effective teaching practices for science I will be looking at standard 4 (content knowledge) & 5 (application of content).

Methods and Procedures

Because my purpose was to describe my own teaching practice as well as how I use data to improve my own practice in line with the INTASC professional standards, it was important to choose a method that could account for both what the standards are for teachers and how I was paying attention to my own practice through data collection to improve it. Accordingly, this study was designed as an action research study.

Action research is an approach to educational research that is used by teachers and educational researchers to examine and improve their pedagogy. This method is used to support educators in finding and improving upon their teaching practices by researching, utilizing, and assessing best practices. It is a cyclical process that involves first planning new teaching methods, acting out those new methods, observing and collecting the results of said actions, reflecting on the results, and then back to planning again. In this way teachers are able to create or try out new strategies of teaching and be able to reflect on the results and from there continue to perfect and modify the strategies. I personally believe this is an effective plan as it gives me the opportunity to research effective teaching strategies, try them out, collect results, and reflect on what did and did not work and why. In this way I will gain considerable experience on growing as an educator by researching best practices in the classroom and trying them out.

Chapter 4

Presentation of Findings

In this next chapter I will be reviewing the data I have collected throughout the course of this action research project. The majority of this data originates from my teaching and comes in the form of my lesson plans, supervisor feedback, mentor teacher feedback, and my own journaling over the course of the last several months regarding my teaching practice. I will also be going over how I organized and analyzed this data in reference to my three research questions. These questions are: 1) How can I effectively differentiate in the classroom? 2) What are some effective teaching practices I can use in the classroom? 3) What are some effective teaching practices specifically for teaching science? My hope is that the data I have collected will shed some light on answers to these 3 questions which in turn will help show me how I can better meet the needs of my students.

In science experiments, tests are made to collect data that will hopefully either answer the scientist's initial question or support their hypothesis. However, a scientist understands that even if their data does not correlate well with their hypothesis, something is still learned. I use this metaphor to explain that even if some of the data I collected may not necessarily answer my research questions specifically, I am still learning something about my teaching practice along the way. The best part about data is that it can have multiple uses. For example, even after this action research project is completed, I will still be reviewing the data collected and looking at it through different lenses or questions related to improving my teaching practice.

First, it is important to understand the kind of data I collected and where it came from. As mentioned before, my data is coming from my teaching in the form of lesson plans, supervisor feedback, mentor teacher feedback, and my journaling. Much of this data comes directly from the class that I did my edTPA on, which provides me with more tangible data to work with such as my own commentary and video recordings of my teaching. I have worked with this class since

October 2021, and I believe it best shows my progress over the course of this school year. It is important to note that this class was broken up into two subjects over the course of the school year. For the first half of the school year, it was an Earth Science class, and for this second half it was Physical Science. Although these are different subjects, the class consisted of the same students who were all freshmen in high school. I believe it is important to note this switch in curriculum mid-year, as this may have impacted some of the data that was collected.

Data Analysis on Effective Differentiation

To review, my first research question is "How can I effectively differentiate in the classroom?" Note the phrasing of this question. While I was looking over my data, I was not necessarily looking to see improvement over the course of my research, although I did hope to see that. Indeed, I do notice signs of improvement over the course of this school year as I learned quite a bit about being a better teacher. This can be seen in the feedback from my supervisor, and cooperating teacher, and my own journals. To answer this research question, however, I am specifically looking for data about ways my lessons showed differentiation and whether that differentiation was effective or not.

To start with, I collected all my lesson plans and highlighted in blue the sections dedicated to meeting the needs of my students. I was specifically looking at students on IEPs and 504s as well as the needs of English Language Learners (ELLs). From there I peered through my lesson plans to find sections where my lessons showed or allowed differentiation and highlighted these sections as well. I then went over feedback from both my cooperating teacher (CT) and my supervisor and highlighted parts where they mention my using or lack of differentiation. Finally, I went through my journal and highlighted all sections dedicated to differentiation, culturally responsive teaching, and inclusive education practices. I found that there was quite a bit of data I

had collected in regard to this topic. To be concise, I starred the sections that I believed were part of a larger pattern, theme, or were either a great success or failure. This is the data I will be referring to the most in this section, as I believe it most effectively answers the research question.

To begin this analysis, I looked at my first lesson plan I submitted to my supervisor and cooperating teacher. This was my first attempt at creating a lesson plan using Western Oregon University's lesson plan template. At this time, I was new to the process of filling one of these out, and so certain sections were certainly lacking in quality. This can be seen in my lesson plan data as the amount of detail increased in my plans over the school year. One of the key things I noticed from this lesson plan was the lack of specific context to my class in the section dedicated to addressing the needs of diverse learners, as seen in figure 1 below.

Figure 1

Sand, Silt, Clay Lesson Plan

How have you addressed the needs of diverse learners? (Ex: IEPs, 504s, linguistic & cultural diversity, students without prerequisite knowledge, etc.)
I will ensure that all students are understanding of the basic concepts of this lab before beginning it. I will ensure that vocabulary is repeated multiple times for those with different linguistic backgrounds. A part of this lab lets students choose something local to them, allowing them to share a little about themselves.

The Diverse Learners section of my Sand, Silt, Clay Lesson Plan.

Although what I listed are generally good practices for helping diverse learners, they were not specifically related to my students I was working with. My data shows that early lesson plans were not tailored well to fit the specific needs of my learners. For example, none of my students have different linguistic backgrounds. My early lessons also showed that I am not

addressing students who have IEPs. Feedback from my supervisor shows this when she wrote, "Try to be specific about how you are meeting the specific accommodations listed in any IEP's or 504s for your class". I address this data as I believe it is a good representation of what ineffective differentiation can look like. Something key to note, however, was feedback my CT had given me in regards to how the lesson was designed, "The class has struggled with tried and true grade-level activities throughout this school year. This custom lesson was a good fit for the group in these times". This reflection about catering lesson plans to suit the specific academic needs of students is seen throughout my cooperating teachers feedback.

Something key I noticed from my data was the effectiveness of making the content more personalized to the students' background and culture. When reviewing my journal from that unit series I noticed how students were thoroughly engaged and excited about the material, "A lot of students are talking about the specific type of soil they have for what they are growing. There are quite a few students who live on farms". This is in large part due to how important soil quality is for farming, which is a major industry in the school's area. Indeed, most of the students come from farming families, making this content very relatable. Students were so intrigued that they brought in their own soil samples from home to investigate. My lesson plan (see appendix 1) included an assignment where students were able to take an online soil survey of their own area. My journal reflects that the students were excited to do this and found the content more engaging this way, "Several students playing around with the map but also excitedly talking about the soil content around their homes". This trend of students being more engaged and enthusiastic about the material when it is relevant to their personal lives is seen in both journal reflections as well as feedback. For example, I conducted a lesson about earthquakes where I started off the lesson asking for students' personal stories where they were in an earthquake (figure 2). My supervisor

noted in her feedback (figure 3) that not only were students engaged with this discussion, but that I was able to obtain new information about their personal lives and backgrounds.

Figure 2

Earthquakes Lesson Plan #2

Motivation/Hook:
Engage: Ask the class when the last time they experienced an earthquake was and how it went. Follow up with questions like "Did you see the motion of the ground? What all moved because of it? What was damaged by the earthquake? What objects seemed safe from harm, and what objects were the most threatened by it?"

The Motivation/Hook section of my Earthquakes Lesson Plan #2

Figure 3

Fall Observation Summary Page – 11/30

Classroom Management • Awareness positive/negative addressed • Directions repeated examples/counter ex. • Pacing of lesson
• Opening hook got students interested and sharing aspects of their lives you might not have learned about otherwise. • Good work sharing stories of your own to build classroom community and trust • I would have addressed the girls being loud at the beginning of class - they did refocus themselves, but a quiet check in or use of proximity would have been positive.

My supervisor's notes (in blue) about my classroom management she observed from my lesson, taken from the Fall Observation Summary Page – 11/30.

Something else I noted from my journal data was the overall success of certain activities that allowed for students to be creative with their responses or products of understanding. These activities mostly came in the form of group tasks, projects, or presentations that gave students the

freedom to present their understanding how they wanted to within certain guidelines. This can be seen in the journal entries reflecting the success of the earthquake tower activity “Students were very creative and proud of their tower designs”, Rube Goldberg Machine activity “All of the class was on task with their machines today. Many asked me to come over and inspect their design, but also to show it off”, and homemade thermos project “I am surprised to see Kyler so involved with his thermos. He is taking the reins in making it, of which I had never seen such passion before from him”. These activities gave students a framework for what they needed to do to accomplish the task but were given the freedom to get there however they wanted to. My journal reflects that these activities not only made it more fun for the students, but it also reflected well in their scores and overall success in understanding the content. It gave students the opportunity to express themselves which helped me better understand them on a more personal level. It gave students with academic gaps a chance to catch up, while also giving students who had mastered the concept an opportunity to demonstrate their confidence in the material.

Earlier I mentioned a lesson I had done at the beginning of the school year that represented ineffective differentiation. Indeed I had noticed a trend in my data where if I did not make a specific plan for the lesson to address the needs of my students on IEPs and 504s, then they weren’t likely to be addressed. My supervisor wrote a comment touching on this exact observation: “The diverse learners section will be stronger if you talk specifically about how you will apply the accommodations in their IEP/504 each day. Then have those accommodations addressed in your lesson plan as well. This reads very generic right now". Looking over my data of lesson plans later in the school year, I see a much more refined and relevant section dedicated to addressing the needs of diverse learners. This can be especially seen in figure 4 where I

retyped and adjusted my plan to address the needs of diverse learners after receiving that previous feedback from my supervisor.

Figure 4

Energy Lesson Plan #2

How have you addressed the needs of diverse learners? (Ex: IEPs, 504s, linguistic & cultural diversity, students without prerequisite knowledge, etc.)

For students on IEPs and 504s, there will be an online copy of the notes taken during class. The instructions for the assignment handout will be given in writing and spoken by myself verbally. For certain students, a smaller workload will be provided should the assignment begin to look too challenging or they can turn in partial work. I will also check for comprehension of the instructions after I have given them. Students that need a quiet space to work on the lab can do so in an area deemed appropriate by the teacher as well as the special education counselor.

The Diverse Learners section of my Energy Lesson Plan #2

Without the context of what needs my students with IEPs and 504s have, this may seem vague. In truth it could be better written; however, this does in fact address the specific needs of several of my students. Once I started carefully planning and incorporating the specific needs of certain learners into my lesson plans, I noticed in my journals that I talked about having a larger success with these individuals as far as scoring and general understanding of the material went "Lenny had a much higher test score when she was able to utilize the supervised resource room. I am curios if she has anxiety when seeing people work through tests faster than she can". This also meant adapting my lesson plans to better suit the needs of my students. For example, early on in the school year I was handwriting my notes on the projector so students could take notes with me. Taking notes with students is generally a good practice; however, my handwriting made it hard for students in the back to read. My CT makes note of this in one of the feedback forms, writing, "I also recommend utilizing a slide show or pre-typed out text to aid in clarity/visibility.

The legibility from the back of the room was poor and probably made following along difficult for some students". My journal entries also reflect hearing complaints from certain students about not being able to read my handwriting. To correct this, I shifted to typing notes. I immediately noticed in my journal reflections a positive change in feedback from students as well as my CT for note taking, "Some students were relieved I was typing the notes, and Brock even said it was much easier to follow along as well as post on google classroom afterwards". Not only did this make note taking easier to read for students in the back, it also made it easier to put online for students with IEPs who need readily available access to online notes. This data shows that effective differentiation requires changing each lesson plan individually to suit the needs of my diverse learners.

Data Analysis on Effective Teaching Practices

For the next part of my analysis, I will be reviewing data that helps answer my second research question which is "What are some effective teaching practices I can use in the classroom?" Just like the previous section, I went through my lesson plans, feedback, and journals and highlighted the parts that focused on better teaching practices in yellow. My system was to highlight anything that mentions how I teach or structure the lesson, while making sure to not highlight anything that pertains specifically to science teaching as that will be the next section. Just like before, I starred the parts where I started to notice a trend or theme on important aspects.

To start this section of the analysis I wanted to look at classroom management. This data was geared more towards feedback from both my supervisor and CT, as they have a much longer experience in teaching than I do. Therefore, the data I collected from them helps discern certain aspects of my teaching that either were effective teaching practices or missed the mark. One of

the first themes I noticed with classroom management was my interaction with students. My CT has made comments on 4/5 lesson observation forms stating how good it was that I was checking in with students and walking around the room during activities. Figure 5 is one such example of that feedback and is similarly written on the other observation forms.

Figure 5

Winter Observation Feedback Form-CT-2

Does the candidate utilize research-based behavior management strategies to promote an optimal learning environment such as high engagement strategies, Grinder techniques, proactive procedures/routines, etc.

Yes. Daniel has excellent class management skills and employs a wide variety of techniques. He is very proactive. During this lesson he moved from group to group and redirected behaviors around him while simultaneously assisting students with working through the problems.

My Cooperating Teacher's feedback about my behavioral management from the Winter Observation Feedback Form-CT-2.

It is interesting to note, however, that I noticed a different theme with my supervisor regarding classroom management. For 3/5 lesson observation forms my supervisor mentions disruptions or talking in the classroom that were not being addressed. Figure 6 is one such example of the feedback she gave me regarding classroom management that is typical of her other feedback forms. This data from both my supervisor and CT tells me that as far as classroom management is concerned, an effective teaching practice would be to walk around the room during activities and address behavioral or disruption issues immediately.

Figure 6

Fall Observation Summary Page -11/3

Classroom Management
• Awareness positive/negative addressed • Directions repeated examples/counter ex. • Pacing of lesson
• Good clarifying statement on warm-up question about how long it takes soil to form. (nice awareness of potential confusion) • Nice work addressing students by name. • When a student says "not sure" on a cold call consider a "no opt out" policy - ask follow up questions that will help guide them to an accurate response. Or in this case consider "I think _____ would be the best option." Do you agree or disagree, why do you think it's a good option?" • Make sure students are not talking while you're giving instructions

Feedback from my supervisor (in blue) about my classroom management from a lesson she observed, taken from the Fall Observation Summary Page -11/3

The next key theme I noticed when it came to my data regarding effective teaching practices was scaffolding. The term scaffolding is mentioned in both observation summary pages from the supervisor as well as the observation feedback form that both my CT and supervisor fill out (see figures 7 and 8, below). Both documents have a section dedicated to talking about whether or not the lesson was scaffolded and how. It is also key to note that scaffolding can take place over the course of one lesson, and the unit as a whole. Whenever the subject of scaffolding comes up, my Cooperating Teacher typically refers to the lesson series as a whole as shown in figure 7. In several of his comments regarding scaffolding he mentions the importance of what was taught in the lesson(s) prior as well as what was next and how it all fits together. My supervisor also mentions this, however; her feedback is based on only the small snapshot of the unit she gets to observe and so her feedback on scaffolding did not often touch on how things fit as a whole.

Figure 7

Winter Observation Feedback Form-CT-2

Are lessons sequenced and scaffolded appropriately?

Yes. Newton's Second Law had been introduced prior. This lesson was designed to give students an opportunity to practice and work through the mathematical component of the concept on their own. The mathematical skills required for the types of problems have been practiced routinely throughout the course. Applying them to this specific law was something that students were well prepared for.

My Cooperating Teacher's feedback about my lesson scaffolding, taken from the winter observation feedback form.

Although my supervisor mentions scaffolding periodically as how the lesson fits in the overall unit, she mostly focuses on how the lesson itself is scaffolded. Some of the key themes I noticed from the data is her emphasis on careful planning throughout the lesson, clarifying instruction, and modeling which she explicitly mentions in 3 out of 5 observation summaries. This was especially present in a lesson series I had done about potential and kinetic energy. As shown in figure 8, she comments about the importance of modeling and how if improperly done can lead to student confusion and a rocky transition to independent student work. This data helps show me how vital scaffolding instruction is for effective teaching practices.

Figure 8

Lesson Plan Supervisor Feedback – Energy Unit

- Pre-planned questions and opportunities for students to engage in structured discourse to support the learning targets are limited and need to be further developed.
- When you are modeling kinetic and potential energy make sure that you come back to your definition of energy and that the demonstrations you do really provide concrete evidence for students of which has more kinetic or potential energy, not just that they dropped from different heights, but why does that mean it has more energy and where is the proof.
- Make sure to include gradual release and modeling in your lessons, don't rely too heavily on material form the textbook or prior lessons.
- Connections from one lesson to the next are not as strong as they need to be. Make sure to build a picture for students of how each of these lessons builds on yesterday.

My supervisor's feedback about my energy unit series lesson plans in regard to scaffolding and modeling.

Another key theme I noticed in regards to observations and comments on my lesson plans was using assessments to improve student outcomes and checks for understanding (CFU). These concepts were not only part of the observation feedback form, just like scaffolding was, but also part of the lesson plan template I would fill out for my lessons. This data already helps prove how invaluable assessments and CFUs can be, but it is important to understand how it can be done effectively. My data has shown me that both my supervisor and CT believe explaining the learning target throughout the class is vital to helping reach it. In this way the students and myself are reminded of what the goal for the lesson is that day and whether or not they are reaching it. In at least 3 of my lesson plans early on in the school year my supervisor made comments about coming back to my learning target at the end of the lesson. I noticed in my journal that as I started to incorporate that more over the school year that I had a much better idea at the end of each lesson as to whether or not my students met that goal. Figure 9 is a great example of this as it shows a lesson plan where I had students reconvene at the end of class and determine if they met the learning target.

Figure 9

Energy Lesson Plan #2

Learning Targets: Students will be able to manipulate a simulation in order to answer several questions that will help them understand the relationship between potential and kinetic energy.
Closure: Evaluate: Have the class reconvene, letting students know that if any did not finish they may have time to work on it next class. Ask the class if now after this lab they can solve the question posed at the beginning of class which was "Can potential energy have an effect on kinetic energy?" Have the students explain their reasoning based on the data and observations they made from the lab.

Learning Targets and Closure section taken from my energy lesson plan #2.

As mentioned earlier, CFUs appear to be a key concept when it comes to incorporating effective teaching practices. In almost every observation summary page my supervisor mentions opportunities I could have done a check for understanding. This is not necessarily to say that I am severely lacking in them, but more so demonstrates the importance of heavily incorporating them throughout the lesson. Figure 10 best illustrates what my supervisor is looking for when it comes to checking for understanding that will help my teaching be more effective. My CT mentions in his observations that I frequently walk around the room during activities and ask students questions that helps demonstrate their understanding. Figure 11 is an example of the typical feedback he puts in this category, which demonstrates how highly he values this type of CFU. Indeed, walking around the classroom was mentioned by both my CT and supervisor on numerous occasions in their feedback. My data makes it clear, therefore, that walking around the room and checking for understanding frequently is a vital effective teaching practice that should be heavily incorporated with every lesson. As shown in figure 5 previously, it not only helps with checking for student understanding but also with behavioral management.

Figure 10

Spring Observation Feedback Form-US-1

What are the next steps for the teacher candidate. Establish one or two specific and observable goals for the next scheduled observation.

Use more CFU's, think time, quick writes, turn and talks, and practice when you are going over notes to allow you to monitor student understanding more effectively during the lesson.

Feedback from my supervisor about what my next steps or goals are that I should focus on with my teaching, taken from the Spring Observation Feedback Form-US-1.

Figure 11

Winter Observation Feedback Form-CT-1

Are checks for understanding and differentiation used to meet the needs of all learners?
There was much informal checking on students and groups that occurred. I felt like you did an EXCELLENT job of moving from group to group posing questions that pertained to each group specifically. you have a knack for guiding students forward during activities by posing questions that lead them rather than telling them how to proceed.

My Cooperating Teacher's feedback about my checking for understanding, taken from the Winter Observation Feedback Form-CT-1

Data Analysis on Effective Teaching Practices Specific to the Science Classroom

For this final segment of my analysis I will be going over my third research question which is "What are some effective teaching practices specifically for teaching science?" Similar to the last two sections, I pulled data from my lesson plans, journal entries, and feedback from both my CT and supervisor. The data acquisition process was similar to the previous in the fact that I combed through the material highlighting teaching practices that were specific to teaching science in red. I then starred the highlighted sections that I noticed carried a certain theme or trend.

One of the first themes I noticed from my data was the importance of questions. What I mean by that is asking students questions to guide them to finding the answer, observation, or discovery. This is all part of inquiry-based learning which is a key teaching strategy for teaching science. Although I was already aware of this type of learning before this project, it was good to be able to see reflections in my journal documenting how often my CT used it in the classroom. This just goes to underline how vital inspiring curiosity in the science classroom is. Figure 12 demonstrates well the importance of asking students questions to build on the curiosity they may have on the topic. In this example my supervisor talks about using additional questions to help

better segue from the video students just watched to the activity they will be doing next. She already believed I did a good job with getting students curious and talking about the material but goes on to write about how there was more opportunity to promote inquiry.

Figure 12

Fall Observation Feedback Form-US-2

Lesson has an opening/hook? The hook was good. I think you could have asked for a little more information on what they saw/felt, but I loved that it got students sharing and you learned new information about your students through the hook. It directly tied to and supported the lesson. Could you have added a few sentences about how if they were concerned that the buildings would survive and how they could be designed better to link it to the activity more?

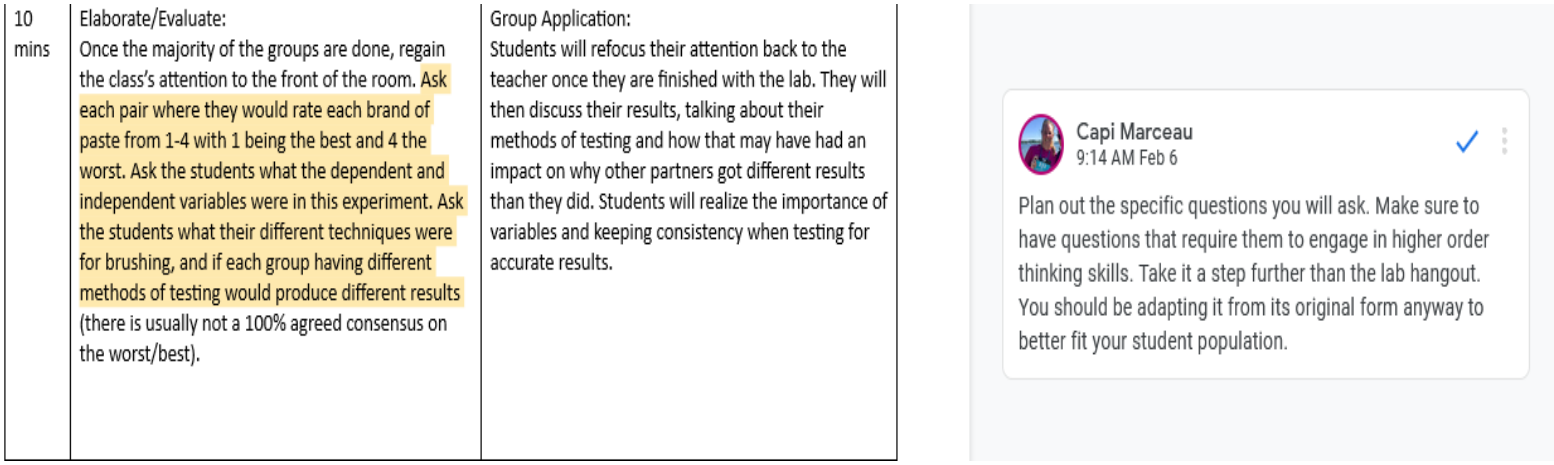
Feedback from my supervisor in regards to my lesson's opening hook, taken from the Fall Observation Feedback Form-US-2.

I also noticed that although the questions were important, it was more important that the questions pointed towards the core concept being taught. What this means is the questions should not only show students how to get to the answer, but also help them achieve that "lightbulb" moment where they now understand the how/why it is the answer. Figure 13 is a snapshot of a lesson plan where I did not properly set up higher order questions for the students. This means the questions I had prepared for the students were not deep or meaningful enough to engage them in the larger topic as a whole. Instead these questions merely scratched the surface of the topic, and if anything just led students to answer the specific question related to that lab. Data from my journal reflections also show that when I was able to engage students with how/why questions, they were more likely to grasp the big idea concepts better. My journal also reflects my CT using

how/why questions frequently in his assessments with students so that he can better gauge how well they are understanding the core concept.

Figure 13

Variables of Whitening Lesson Plan



10 mins	Elaborate/Evaluate: Once the majority of the groups are done, regain the class's attention to the front of the room. Ask each pair where they would rate each brand of paste from 1-4 with 1 being the best and 4 the worst. Ask the students what the dependent and independent variables were in this experiment. Ask the students what their different techniques were for brushing, and if each group having different methods of testing would produce different results (there is usually not a 100% agreed consensus on the worst/best).	Group Application: Students will refocus their attention back to the teacher once they are finished with the lab. They will then discuss their results, talking about their methods of testing and how that may have had an impact on why other partners got different results than they did. Students will realize the importance of variables and keeping consistency when testing for accurate results.

Screenshot taken from my Variables of Whitening lesson plan which shows a part of my lesson plan and my supervisor's feedback about getting students engaged in questions that lead to higher order thinking skills.

An interesting theme I noticed from my analysis of the data was the importance of demonstrations. I understood that demonstrations are a key part in helping students understand concepts as well as grab their attention and spark their curiosity, but I was surprised to find so many comments or feedback relating to these demonstrations from my lesson observations. These comments are not necessarily implying that I am doing bad demonstrations, but more so that there are so many ways I can add on to them and promote more inquiry from them with the types of questions I pose to students. Figure 14 is a good example of this as it shows my supervisor's comments on my chemistry demonstration. Note the first comment where she suggests asking the question why, which points back to inquiry-based learning as a key theme. I noted from my journal reflection from this particular demonstration that I did not have a long list

of questions that would help engage students with the core concepts being taught in class "Need to prepare more questions for these kinds of demonstrations. Too much silence, should have used sticky note with a list of topics". My data clearly shows that when I have practiced a demonstration and spent time preparing the questions I would ask students, I was more likely to be confident with the demonstration and have a more engaging experience for the class. I also noted this trend with my CT's lessons and demonstrations. Whenever he practiced demonstrations and wrote down questions to ask the class ahead of time, he was more likely to have a successful demonstration.

Figure 14

Spring Observation Summary Page - 4/21

Instructional Delivery (1): • Communicates targets/directions/procedures • Lesson(s) sequenced/scaffolded appropriately • Checks for understanding and differentiation used to meet the needs of all learners
• WHY will it create hydrogen gas? • Good connection to zephyrs (blimps) - Why were they using hydrogen? Boom - a student basically filled it in for you - the US put an embargo on He to prevent Germany from having the blimps, so they resorted to using hydrogen. • I like to have the balloon up toward the ceiling more so the flames roll out - also leave black char marks on the ceiling which I'm sure admin hates, but Chem students think is really cool. • I like to think of them as a "partial picture" as opposed to the models not being true - science is evolving - reinforce this • Cookie dough model didn't have protons and neutrons - positive matter with negative particles inside. • Instead of telling them where neutrons/protons go, ask them. • CFU - where do you put the first electrons you fill in?

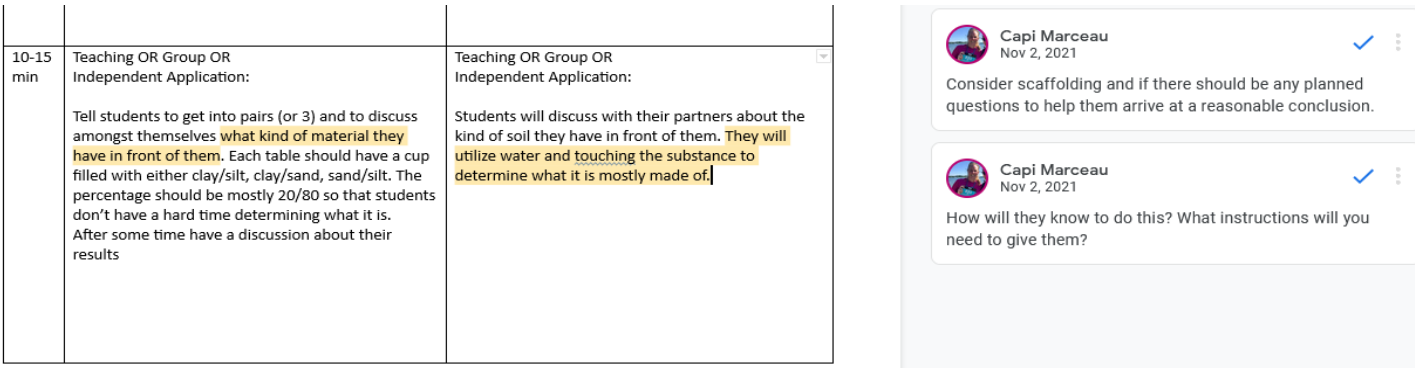
Feedback from my supervisor (in blue) about my instructional delivery from my valence electron lesson she observed, taken from the Spring Observation Summary Page – 4/21

Along the topic of demonstrations comes another important theme which is hands-on activities. Prior to this project, I was already aware of the importance of having students engage

with hands-on activities in the science classroom. This can be seen in my lesson plans from early on in the school year such as figure 15 from my first written lesson plan for an observation. At the time I had planned very little instruction or structure to these activities. One of my journal entries reflects this lack of structure leading to students getting off task, “I did not have a good lineup of questions for students to answer while investigating their samples. Some of them quickly got off task and it was difficult to get them engaged”. Students were more likely to play around and explore the activity than they were to learn some of the key concepts for that lesson. In the example you can see my supervisor’s notes which reflect this lack of structure. As I continued on in my school year I see progression to more structured activities in my lesson planning. My journal reflects that these activities had abundantly more success in getting students to learn the major concepts while engaged in the hands-on activity. Figure 16 is an example of a hands-on activity I had used later in the school year. Note that I ask students to explain how their activity relates back to the core concepts being taught in the lesson. I utilize “why” questions that again promote inquiry-based learning and allow students to attain that “light bulb” moment through their own accord. My journal reflects lessons like this having a wide range of success.

Figure 15

Sand Silt Clay Lesson Plan



10-15 min	Teaching OR Group OR Independent Application: Tell students to get into pairs (or 3) and to discuss amongst themselves what kind of material they have in front of them. Each table should have a cup filled with either clay/silt, clay/sand, sand/silt. The percentage should be mostly 20/80 so that students don’t have a hard time determining what it is. After some time have a discussion about their results	Teaching OR Group OR Independent Application: Students will discuss with their partners about the kind of soil they have in front of them. They will utilize water and touching the substance to determine what it is mostly made of.

Screenshot taken from my Sand Silt Clay lesson plan which shows my planning and my supervisors feedback about it.

Figure 16

Energy Lesson Plan #3

5 mins	**Group Application:** Evaluate: Walk around the room and have each group demonstrate their Rube Goldberg machine. Ask the group where potential and kinetic energy is being used, why they chose their design, and what measurements they would need to take if they wished to calculate the potential and kinetic energy.	**Group Application:** Evaluate: Students will have their Rube Goldberg machines evaluated by the teacher. They will ensure that they are ready to answer where potential and kinetic energy is being used, why they chose their design, and what measurements they would need to take if they wished to calculate the potential and kinetic energy.

Part of my lesson plan taken from Energy Lesson Plan #3 in which I have prepared a series of questions that students must answer about the Rube Goldberg Machine.

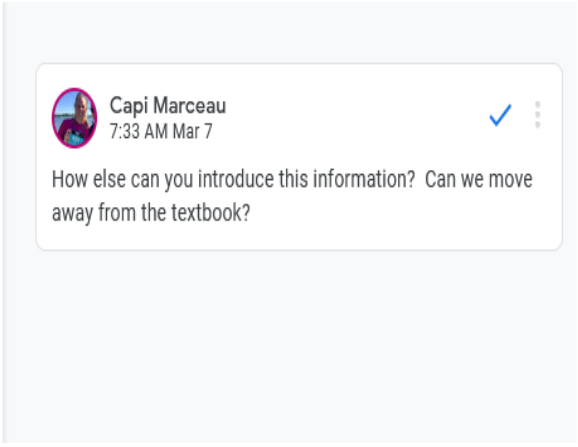
Along with the theme of hands-on activities I noticed a new theme emerge from my journal reflection data. As the school year progressed into material that I was not as familiar with, I started to turn more towards using the textbook. Although this at first was a smooth transition, it eventually became more of a bad crutch. Figure 17 is an example of when my supervisor started to notice this trend of using the textbook instead of other forms of teaching. My journal reflections during this time show that students were less engaged in the material and were more likely to run into behavioral problems, “Abby and Allie were very vocal about not wanting to use their textbook today, and their attitudes are starting permeate with the rest of the class”. Indeed, it felt like class time was more of a grinding experience than it was an exciting and inquisitive learning experience. My data therefore reflects the importance of incorporating more hands-on activities and demonstrations, as typically these activities created a more

engaging atmosphere in the classroom. Although a textbook is a useful tool to help learn a concept, it should not be heavily relied upon in the science classroom.

Figure 17

Thermal Energy Lesson Plan #1

15 mins	**Teaching/Independent Application:** Explain: Have the class take out their notebooks and textbooks and turn to page 138. Have volunteers read parts of page 138 and 139, stopping to write down the vocab word temperature and thermal energy. Now have a volunteer read the first paragraph on Heat, again stopping to write down the definition of the vocab word heat. Have your students highlight in their notebook the definitions of heat and temperature. Have the class write down at least one sentence example using the word temperature correctly, and another sentence using heat correctly. Ask a couple volunteers to share their examples, and ensure that most of the class	**Teaching/Independent Application:** Explain: Students will take out their textbooks and notebooks and turn to page 138. They will then volunteer to read aloud the sections in the book and write down the key vocab words as they come along. After writing down the definition of the vocab word heat, students will then write two sentence examples clearly showing the difference between the words heat and temperature. Students will then share their examples with the class so that everyone has a much better understanding of the difference between these two vocab words.



Screenshot taken from my Thermal Energy Lesson Plan #1 which shows my lesson relying on a textbook and my supervisors feedback about that.

The final theme I noticed in regards to effective teaching practices specific to the science classroom was the use of technology. One of the first lessons my supervisor observed incorporated the use of Chromebooks to access a website to conduct a soil survey as shown in figure 18. My journal reflection from that lesson talks about how successful that activity was as students were not only engaged with using the technology but it was also a personalized experience as students needed to look up the soil composition of the area around their home. Although my data is rather unclear as to why, there was a long gap between that lesson plan and the next time I utilized technology such as Chromebooks in the classroom. Going through my lesson plans over the course of the school year I noticed that using videos and certain scientific tools were integrated throughout the lessons, but the use of Chromebooks had diminished almost completely. That is, up until a journal entry where I talk about how a student asked why she

needed to bring her Chromebook to class if she was not going to use it "Lenny was unprepared again for class by not bringing her Chromebook. She replied that there was no point in doing so if we never use it. She has a point; I need to incorporate it more". From that point forward, the use of Chromebooks were integrated much more often into the curriculum. This showed very positive results. My journal reflections state that students were more engaged when the use of Chromebooks were more often integrated into a lesson series, "Everyone was engaged with the simulation, stayed on task, and it was really easy to walk around and assist". The use of online simulations allowed for me to teach concepts that are hard to replicate in the classroom. Indeed, my journal notes a steady increase in student engagement with the increased use of Chromebooks in the classroom. My data shows, however, that the use of Chromebooks does require me to watch out for certain things that can hinder the success of an activity. Figure 19 illustrates some of those concerns from my supervisor's feedback from an observation incorporating an online simulation. Some of these concerns are general ones mentioned earlier in this analysis such as the importance of modeling and better prepared demonstrations. There are also the other concerns though, such as where my location is in the classroom and technical issues. That all being said, my data reflects that the increased use of technology in the classroom leads to myriad of benefits for my students and myself.

Figure 18

Sand Silt Clay Lesson Plan

Teaching OR Group OR Independent Application: Briefly go over the importance of soil, and the kind that is best for growing crops. Discuss with students what they think their own backyard soil would be. Have them get their chromebooks out, access Web Soil Survey (WSS), and then pass out a worksheet for each student. Go over a practice problem with the worksheet involving a soil survey of Perrydale highschool. After that practice problem, have students choose either their backyards or a local park they enjoy and finish the worksheet looking up that area's information.	Teaching OR Group OR Independent Application: Students will work on using the Web Soil Survey program and filling out their worksheet.

Part of my lesson from the Sand Silt Clay lesson plan where I have students utilize Chromebooks to access an online soil survey.

Figure 19

Winter Observation Summary Page – 3/2

Instructional Delivery (1): • Communicates targets/directions/procedures • Lesson(s) sequenced/scaffolded appropriately • Checks for understanding and differentiation used to meet the needs of all learners	*Instructional Delivery (2):* • Integration of technology and/or digital tools • Safe and respectful learning environment
• There is a tendency to do a lot of powerpoints, I like that you physically write out some of the notes on the doc camera - it helps with pacing. • Activated prior knowledge - net force from the day before. • Used gradual release with the simulation - worked through the first question as a class. Go slower! Then walk around to make sure everyone is seeing what you want! (hint they are not) • If you can work from a laptop you can teach from the back of the room where you can see their computers.	• Start class with student led demonstration • Make sure to clarify that the balls have different masses and emphasize that prior to the demo. Rolling a shotput and nerf ball also works and is more obvious for observers. • Instead of asking who is not there yet, just walk the room. (you go there eventually) • Make sure to model and show what the different potential relationships could be, if you talk linear you should have something to compare it to… • Reinforce that the student who suggested the acceleration "goes up" is correct but ask the follow up question "can we be more specific about how much it goes up?" if they say "by 5" then go to another example of where it doubles and see it it also increases by "5" if not why not, how are they similar, what patterns do you see? • They probably don't know what "the factor" means

Feedback from my supervisor (in blue) in regards to my instructional delivery from a lesson she had observed, taken from the Winter Observation Summary Page -3/2.

Summary

The data I have collected and analyzed for this action research project is invaluable to reflecting on bettering myself as an educator. Through the lens of the three research questions I was able to ascertain a great deal of information about what good and bad practice can look like. This allows me to reflect on my successes and failures in the classroom and to learn and grow from them. The journals, lesson plans, and feedback from my supervisor and CT will play a large role in how I continue to work on and improve my teaching.

It is truly interesting how certain themes came up that I was not expecting, such as the importance of demonstrations and how they are conducted in the classroom. These sorts of unique trends make this type of data analysis all the more important, as it allows me to reflect on certain aspects of my teaching I did not think I needed to reflect on. I am excited to continue to use this data and try to analyze it through different lenses in the future. For example, how successful were my lessons that relied heavily upon teaching vocab? Did my lessons incorporate proper lab safety? These kinds of questions are also valuable information for improving my teaching. It is imperative, therefore, that I continue to record this type of data with my teaching both now and in the future so that I can analyze my growth as a teacher. In the following chapter, I will analyze my data and themes that I found to come to a conclusion about my research questions as well as an overall reflection of my teaching.

Chapter 5

Conclusion

Overview

The goal of this action research project was to help me research some of the ways in which I can effectively teach better. This was dictated by three main research questions: 1) How can I effectively differentiate in the classroom? 2) What are some effective teaching practices I can use in the classroom? 3) What are some effective teaching practices specifically for teaching science? To find the answers to these questions, I reviewed the research on expert texts and literature around these concepts. I also used my own data I collected from my time spent at my placement school in relation to my lesson plans, feedback from my CT and supervisor, as well as my reflective journals.

Results

For the first research question, my review of research literature tells me that as the years have gone by the classroom has become a more diverse environment. It is this diversity that helps drive the need for me to differentiate my teaching. What my data has shown me is that when it comes to lesson planning, I need to address the specific needs of my students with each individual lesson plan. What I have found is that it is ineffective to make a generalized plan, even if it involves good practices. Each lesson needs to specifically address how I will meet the needs of my diverse learning audience in order to be effective. Along with that, I have noticed that my lessons are far more engaging to students when I incorporate their various backgrounds and cultures. This kind of culturally responsive teaching has been shown to be effective in both research and my own data. Specifically, my data suggests that students are far more engaged and get much more out of the lesson when I make the material relevant to them from a cultural perspective.

Another key aspect of differentiation that my data showed me was how important it was to allow students the opportunity to be creative with their responses or products of understanding. Students were more passionate and spent more time making better quality products when they were able to be creative and individualistic with their responses. What this shows is that again my data supports the theory of culturally responsive teaching as an effective strategy for differentiation. Allowing more opportunity for students to turn in work where they can create what they want allows them to share a piece of their culture and background with me. This also helps me understand what their interests, passions, and skills are so that I can plan better assessments that fit theirs needs in the future. Using assessments and what I learned from my students' work will help me to adapt my lessons to address the specific needs of my students, which is in line with what my research says about culturally responsive teaching.

For my next research question dedicated to effective teaching practices, my data was able to come up with a few themes that seemed to connect to each other. The biggest theme that stood out to me was the importance of scaffolding. I note from my data that scaffolding is vital for not just the lesson series but each individual lesson as well. What this means is that it is important that my lessons are structured so that they lead students to eventually work on their own with the material without needing as much of my guidance or support. This should also be done over the course of one lesson. My data suggests that careful planning throughout the lesson, clarifying instruction, assessments, and modeling are all ways to help successfully scaffold the lesson for students. This also agrees with the research I reviewed talking about how scaffolding can come in a variety of different methods. Modeling and checking for understanding were two key themes that my data suggests are vital to scaffolding and therefore effective teaching practices. Modeling allowed for students to understand the expectations and how to do the work on their own.

Checking for understanding allowed for me to see how students were handling the material and if additional support or teaching was needed. It also allowed me to work on classroom management. My data suggests that when I did not walk around the room there was more opportunity for students to get off task whereas if I did walk around the room not only was the classroom better managed, but I was able to check for my student's understanding better.

For my third research question, I looked over my data that helped show some of the effective teaching practices that were specific to teaching science. My review of research on this topic suggested that inquiry-based learning, incorporating technology, and promoting hands-on activities were all effective practices. My data completely supported these concepts. A good example of this was my promotion of asking questions such as "how" and "why" throughout my lessons. Doing this allowed for more curiosity in the classroom, all around leading to students being more engaged with the content. My data also supported the theory that incorporating technology into the science classroom led to more engagement and created a more personalized experience for students. Lastly, the data I collected in regards to hands on activities showed just how crucial they are to a science lesson. When my lesson plans were geared mostly towards the textbook and taking notes, there was a significant decrease in student engagement and participation in the lesson. When I incorporated more demonstrations and hands-on activities my data shows a significant increase in not only student engagement and academic success, but it also created a more positive atmosphere for learning which is exactly in line with what the research suggests about these activities.

Limitations

Although a majority of the data and research I collected during this Action Research Project was a success, there were some key limitations to my project. For starters, I could not pull data specifically from my students work. This is because of the Institutional Review Board's (IRB) rules and requirements. Because of this, whenever I mention how students did in my data, I am only referring to how I think they did based on my journal reflections. These journal reflections are personal writings that come with emotion and biases. This is much different than data I would have collected such as student scores and assignment quality. There is always a danger with using biased data, as it can potentially taint the results. That being said, in this situation I also had feedback and commentary from both my CT and supervisor that helped keep the journal biases in check.

Another limitation of my project was how the data was presented or collected. It was not until a little before halfway through the school year that I knew what my focused research questions would be. This means the data I had collected prior to that point was not geared to help me answer these questions. Although I still found use and relevance from my data collected early on, it would have been much more ideal if I had it properly planned out from the beginning of my school year. Along with that, there was much of my data collected that was not entirely useful for specifically answering my research questions. This is because much of my data came from feedback from my CT and supervisor, who were trying to help me with improving my teaching all around, not just specifically focusing on my research questions. This means there was a good amount of data that unfortunately was not relevant to this project. If I was to do this project again, I would ensure that I had a firm grasp on my research questions before beginning my data collection.

Implementation

My research and findings from this project will have a considerable impact on my future teaching practices. The goal of this project was to find ways to be a more effective instructor, and I firmly believe that what I learned from this project will do exactly that. For starters, I am now much more confident in my ability and understanding of what is needed to effectively differentiate in the classroom. I will avoid creating blanket lesson plans that do not directly address the specific needs of certain learners. Instead, every lesson I write will be directly curated to address those students' needs. This includes adapting old lesson plans so that they more accurately fit not only the students' learning needs but also their cultural backgrounds as well. This is just one of the few ways I can promote culturally responsive teaching. I will also promote more group work opportunities as well as allow more individualistic ways for students to turn in their assignments which will help create a more inclusive learning environment.

In regards to effective teaching practices in the classroom, there are quite a few things I learned that will be implemented in my future classrooms. Although before this project I was aware of scaffolding, I was not as aware of how its different facets and key aspects play a large part in student understanding and independence. Modeling is one such aspect that at the start of this project I was doing an underwhelming performance on. Because of this project, I will be much more cognizant of how I am modeling an assignment or activity for students. I will also be more aware of how I am checking for students' understanding. This means more informal assessments, questioning, and walking around the room to ensure students are not only understanding the concepts but are also on task and paying attention. It is also key to note how scaffolding can be achieved both during a lesson as well as over a series of lessons. It is important, therefore, that I remember to remind students about the learning target for that day's

lesson as well as remind them (and myself) of the standard and goal we are trying to reach for that unit series.

For my future teaching experience in the science classroom, there are several ideas that will be implemented more effectively because of this project. I have already shown my success in making sure not to answer students' questions but rather respond with a question that will hopefully lead them to figuring out the answer. With that being said, I was given crucial feedback on how I can work on gearing those questions to direct students to think about the core concept they are learning and what this means in real world situations. Although I am familiar with inquiry-based learning, this project helped me discover there are still aspects of it that I need to work on. This is also true for hands-on activities. This project helped me realize just how important demonstrations are in the science classroom and how they can have a large impact on not just student understanding but also engaging students' curiosity. Moving forward I will be sure to include them much more frequently into my lessons, especially if I can substitute a large chunk of textbook reading with a demonstration instead. As for technology, my research and data clearly agree that incorporation of technology is a crucial element to effectively teaching science. It promotes differentiation, inquiry, a positive learning environment, individualism, and easier access to content for both students and myself alike. Based on this first year of teaching, I have much more to learn about integrating technology and what is out there that I can use. I will be sure to do more research and attend more professional learning sessions dedicated to technology use in the classroom.

Conclusion

The goal of this action research project was to learn how I can become a more effective teacher. This was to be accomplished by reviewing my philosophy of teaching, reviewing

research, and compiling my own data that would then be analyzed and reviewed. I learned quite a lot about not only good teaching practices, but also myself and where I am as an aspiring teacher. Before this project I had never put into words what my philosophy of teaching was. It was an insightful experience reviewing who I want to be as a teacher and what teaching is defined as from my perspective. From there, I conducted an extensive review of research and literature dedicated to differentiation, effective teaching practices, and teaching practices specific to the science classroom. This review helped educate me on a multitude of concepts and theories that I can use or should avoid in the classroom. Finally, reviewing my own data was an eye-opening experience when compared to my teaching philosophy and literature review. It was interesting to see in what ways my teaching was aligned with my philosophy and research, but also what areas I am in need of improvement on. For example, addressing student's specific learning needs in each lesson plan, modeling, and incorporating more questions that engage students in higher order thinking skills are all areas that I will need to continue to work on.

This action research project has been a truly insightful and eye-opening experience for me. I have learned what my values are, what research considers as good teaching practice, and what I actually do that is either effective or ineffective as an educator. Because of this, I have a much better understanding as to where I am as a teacher and what I need to continue to work on or watch out for. I am excited to use this project to help guide my future practice and help me become an effective teacher. I look forward to my future in the classroom, and will no doubt conduct another action research project to evaluate my progress. Much as students are constantly learning, so am I.

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Appendix

Lesson plans should be submitted to your mentor teacher and supervisor prior to teaching them. You should receive feedback and approval to teach these.

Lesson Plan Teacher Candidate: Daniel Lampe Date of Lesson: 11/3/21

<table>
<tr><td colspan="3">Lesson Title/Description: Soil Lab</td></tr>
<tr><td>Lesson # 1 of 1</td><td colspan="2">Time Allotted for this Lesson: 50 minutes</td></tr>
<tr><td>Standards: 2-PS1-1.Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.</td><td>Central Focus: Students will become more familiar with the different rock and soil types on earth.</td><td>Learning Targets: Students will be able to identify the difference between sand. Silt, and clay. They will also be able to search where these can be found in their local area.</td></tr>
<tr><td colspan="3">Pre-Requisite Knowledge and/or Skills:

Students should have a rough understanding of the importance of soil and its general properties.

How I know the students have this:

Beginning of class will be some questions and based on student response will tell me their pre=requisite knowledge.</td></tr>
<tr><td colspan="3">Academic language that will be used in lesson:

Sand, Silt, Clay, Soil

Strategies and opportunities for supporting academic language:

Mentioning words several times over the course of the lab. Utilizing hands on activities so students feel the difference.</td></tr>
<tr><td colspan="3">Connections to students’ “Funds of Knowledge”/assets, prior knowledge, and or/interdisciplinary connections that will be made during the lesson:</td></tr>
</table>

How have you addressed the needs of diverse learners ? (Ex: IEPs, 504s, linguistic & cultural diversity, students without prerequisite knowledge, etc.)

I will ensure that all students are understanding of the basic concepts of this lab before beginning it. I will ensure that vocabulary is repeated multiple times for those with different linguistic backgrounds. A part of this lab lets students choose something local to them, allowing them to share a little about themselves.

What technology supports or integration are included in this lesson?

Chromebook, web browser

Materials/Equipment/Supplies/Technology/Preparation:

Soil samples of clay, silt, sand. Water. Chromebooks

	Procedure: TEACHER DOES… ***Include "look fors" and other ways you'll observe and check with students to be sure they are engaged in the learning.***	**Procedure: STUDENTS DO…** ***Include evidence of student engagement that you'll include / watch for to monitor student learning***
Time 10-15min	Motivation/Hook: Mr. Ferguson initiates conversation about soil with the usual questions of the day.	Motivation/Hook: Take notes and ask questions.

10 mins	Teaching andIndependent Application: Begin by having a discussion about the 3 soil types. This includes going over what they look like, particle size, and their properties when interacting with water. Show the students a physical example of each one.	Teaching OR Group OR Independent Application: Students will take notes and participate in discussion.
10-15min	Teaching OR Group OR Independent Application: Tell students to get into pairs (or 3) and to discuss amongst themselves what kind of material they have in front of them. Each table should have a cup filled with either clay/silt, clay/sand, sand/silt. The percentage should be mostly 20/80 so that students don't have a hard time determining what it is. After some time have a discussion about their results	Teaching OR Group OR Independent Application: Students will discuss with their partners about the kind of soil they have in front of them. They will utilize water and touching the substance to determine what it is mostly made of.

10-15min	Teaching OR Group OR Independent Application: Briefly go over the importance of soil, and the kind that is best for growing crops. Discuss with students what they think their own backyard soil would be. Have them get their chromebooks out, access Web Soil Survey (WSS), and then pass out a worksheet for each student. Go over a practice problem with the worksheet involving a soil survey of Perrydale highschool. After that practice problem, have students choose either their backyards or a local park they enjoy and finish the worksheet looking up that area's information.	Teaching OR Group OR Independent Application: Students will work on using the Web Soil Survey program and filling out their worksheet.
	Closure: Talk about what students found about their backyard/park and what that means in terms of if they wanted to grow crops.	Closure: Reflect on what they learned in class.