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The Role of Science in Elementary Education

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The Role of Science in Elementary Education and the Challenges of Integration

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Abstract

The role of Science in education has evolved over the years. Although it is currently considered an important subject, there is a gap in knowledge involving the level at which Science is incorporated in elementary education and how teachers view the subject. Since the introduction of the Next Generation Science Standards, there has been a shift towards creating more equitable learning opportunities that include inquiry based and three-dimensional instruction (Britton, Iveland, Schneider, Tyler, & Valcarcel, 2016). Recent studies show that many teachers struggle to incorporate science standards and concepts and lack confidence in cohesively integrating science into their lessons (Nadelson & Smith, 2017). A study assessing the needs of teachers who were struggling to integrate science found that professional development was the most common recommendation teachers provided (Bressler, Shernoff, & Sinha, 2017).

This study explored the presence of science in elementary classrooms and sought to understand obstacles teachers face in incorporating science as a main subject. The research was conducted through a series of interviews with elementary teachers from three separate schools throughout the Bay Area. These interviews focused on teachers' history, their current classes, and their overall experiences and opinions regarding science. This study also provides examples in which science is used to create agency and equity while providing real world opportunities for involvement and growth.

Findings show that science is a popular subject amongst students and promotes inquisitive behavior and collaboration. However, due to a lack of time, resources, and prioritization, science instruction is limited in most classrooms. While teachers recognize its

significance and enjoy teaching and engaging students with the subject, it remains an inconsistently taught subject (especially after the recent pandemic). It was clear that resources and a lack of support were at the core of the issues preventing science from being a core subject.

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Chapter 1: Introduction

It all started with Space Club. While student teaching in the fourth grade, I witnessed the passion of a group of students, helmed by a tenacious ten-year-old, who met weekly during lunch time to present findings, videos, and engage in discussions about all things Space. Having been learning online for close to a year due to the COVID-19 Pandemic, these students came up with a unique solution to cope with remoteness and yearning for collaboration. Through a shared interest in space exploration, these students planned meetings in their own time and extended an invitation to anyone interested in participating. The Space Club not only reignited my own interest in space, but they also caused me to wonder-why isn't this kind of enthusiasm for Science being encouraged on a more regular basis in elementary schools?

The presence of Science in education, specifically in the United States, has been inconsistent since the establishment of the public education system. However, the consistent integration of Science creates equitable learning opportunities for students of all ages. The National Assessment of Educational Progress (NAEP) published a study in 2019 which found that 27% of fourth graders tested at the basic achievement level, and the proficient level fell to just 36% of students (NAEP Report Card: Science, 2019). Fourth grade is the first year that elementary students are required to take Science specific assessments, and these results show the lapse in long term Science retainment nationally.

The effects of the COVID-19 Pandemic have inevitably impacted school routines, including curriculum integration plans; however, Science provides students and teachers with opportunities for hands-on learning and collaboration with peers, which students lacked while learning remotely during the 2020-2021 school year.

Statement of Purpose

The aim of this study was to examine the presence of Science in elementary school classes and to identify the factors that prevent Science from being integrated as a core subject by teachers. The central research questions were: (1) What are the barriers teachers face when incorporating or integrating Science as a core subject in elementary classrooms? And (2) what are teachers perspectives about teaching Science in elementary grades?

Previous studies focused on the integration of Science, Technology, Engineering, and Mathematics (STEM) subjects in elementary schools. However, research has found that there continues to be a lack of consistency in time allocated for STEM subjects. One study conducted on Kindergarten and 1st teachers in 2010 found that only 20% of teachers reported teaching Science daily as opposed to 90% who reported teaching mathematics and reading daily (Bassok et al., 2016). A different study indicates that the time and resources designated for Science instruction are unevenly distributed amongst districts and schools depending on their socioeconomic status (Stefanski, 2019). A study from 2019 cites a lack of training and support as the main issue for teachers aiming to integrate Science content (Hammack, 2019).

These studies are beneficial in examining the presence of Science in elementary classrooms, but there remains a gap in understanding the issues teachers have in integrating Science consistently. This research project sought to further investigate these challenges while focusing on the experiences and recommendations provided by teachers actively integrating Science into their classes.

Overview of Research Design

This research project revolves around the experiences of four different participants: two 4th grade teachers and two 5th grade teachers. These participants taught at three different schools; two out of three schools were classified as dual immersion. The third school's students primarily spoke English as a second language and the teacher who participated in this study was bilingual and supported them in that capacity. All schools supported diverse demographics of students; however, the majority of the students at each school were Hispanic/Latino and considered to be economically disadvantaged.

Three out of four of the participants were teachers that I worked with as a student teacher or were former peers in my credential program. However, one of the participants was a new acquaintance introduced by one of the three other participants. Half of these teachers had been teaching for 10 or more years, and the other half had been teaching one to two years.

Significance of the Study

Science is not prioritized in elementary classrooms because it can be challenging to integrate, and many teachers lack the time and support necessary to do so successfully (Hammack, 2019). This was evident throughout the research process as there were consistently high expectations for the volume of work and subject matter teachers are expected to integrate into their curriculums. Similarly, certain subjects are prioritized more than others, specifically Reading, Writing, and Math, all of which have state assessments throughout elementary grades. In contrast, Science does not have any formative assessments until students are in 4th or 5th grade, which may directly relate to its lacking presence throughout lower elementary grades.

This study sought to bring greater clarity to the challenges, and successes, teachers have had integrating Science, directly from their perspectives and experiences. This study provides a unique perspective on the topic of Science instruction and integration because data was collected following the upheaval caused by the COVID-19 Pandemic. This event caused many shifts within schools, specifically in subject prioritization, teaching strategies, and the needs of students following this traumatic period.

Following the turmoil created by the COVID-19 Pandemic, teachers and schools did a remarkable job providing as normal of a school environment for their students as possible, both remote and in person. However, the prioritization of Reading and Writing became even more stressed, leaving subjects like Science to fill in short time gaps as needed; however, according to the teachers involved in this study, Science is largely missing from daily or weekly instruction. The inclusion of Science in elementary classrooms is integral for providing opportunities for inquiry, collaboration, and engagement for students. There are many opportunities for teachers to incorporate Science in a way that is attainable and enriching for students and teachers alike. It is worth noting that not all teachers have the flexibility to dictate or modify their curriculums; however, there are many ways in which Science can be introduced through cross subject integration and other strategies.

The role of Science in education has continually shifted throughout history. The importance of Science instruction is currently determined on a state, district, and school level, with different teaching standards in place to help guide teachers through required teaching material. This study focused on the current ways Science is integrated and sought to provide

concrete resources for successful implementation and prompt change in the form of effective teaching practices.

This research is directly related to providing equitable learning opportunities for students through understanding how we can support teachers and make adjustments to curriculum, if and when possible. By increasing our understanding of the difficulties teachers are facing with subject integration and adaptation, this study will impact students positively as a result.

Chapter 2: Literature Review

This literature review examines the establishment of existing frameworks surrounding Scientific integration in elementary education, the challenges that teachers face in incorporating Science in their classes, and the necessity of including Science as a main subject to provide an equitable learning experience for youths. While studying the impacts of Science throughout the United States education system, it was evident that Science has been viewed as a subject that is not consistently prioritized (Powell, 2007). With the semi-recent introduction of the Next Generation Science Standards (NGSS), STEM have taken precedent in K-12 education (Britton, Iveland, Schneider, Tyler, & Valcarcel, 2016). However, Science is often not incorporated into elementary grades until 4th or 5th grade and negates the goal of sustained learning and building upon past knowledge for further subject retention (Hanuscin & Zangori, 2016). This is not necessarily due to opposition to scientific instruction in elementary education but is rather a byproduct of a lack of training, resources, and time constraints (Hammack, 2019). Using a constructivist and 21st Century lens, this literature review aims to delve into these topics further and discuss the equitable necessity of including scientific content in elementary education.

This literature review begins by scrutinizing the role of Science in the United States school system, starting with the impact of the Space Race, how Science instruction has evolved since then, and its current status within elementary education. This review then analyzes the integration of Science and any hurdles that teachers face in incorporating it as a main subject through a constructivist and 21st Century framework. This literature review concludes by exploring the role of equity in scientific instruction while providing some examples of

community and inquiry-based projects and methods that were positively used to generate constructive hope and agency for students through sustainable learning practices and inquiry-based projects. Additionally, this review aims to clarify the existing gap in knowledge for further understanding.

Historical Background

Science has been present throughout history as an important and somewhat controversial topic of study and interest. As defined by the Science Council, "Science is the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence" (Science Council, 2009). The development of STEM education has evolved since its formal introduction to the education system in the 1990s and aims to provide a cohesive learning experience that brings together multi subject pedagogy (Hom, 2014).

Despite the existence of Scientific instruction in schools, Science did not become a prevalent part of United States schools until the mid 1950s. In the early 1900s, the United States went through a period of significant change. Two World Wars occurred within a mere 20 years of each other, in which American scientists played an important role in the world, with the invention of the first nuclear weapons. With the ruling of *Brown vs. Board of Education,* segregation was outlawed in American schools, irrevocably changing the U.S. (Powell, 2007). However, no other event made as profound of an impact on Science in the American education system as the launch of the first satellite into space by the Soviet Union in 1957. This achievement shocked the world and started the period of time referred to as the *Space Race* in which major countries around the world attempted to catch up to these Scientific

advancements and successfully get the first astronaut into space (Dean, 2007). This event was an alarming realization to many that the United States was not as powerful or Scientifically competitive as others assumed. Sputnik acted as a "focusing event" for the American people and led to many major shifts in focus within the U.S. education system (Powell, 2007).

The U.S. government reacted immediately, creating The National Aeronautics and Space Administration (NASA) in 1958 with the goal to develop civilian aerospace research (Hechinger Report, 2011*).* The U.S. Government passed the National Defense Education Act in 1958, allocating more than a billion dollars to new Science curricula (Powell, 2007)**.** The National Defense Education Act of 1958 (NDEA) was then written into law in order to increase federal funding for students and make higher education more equitable (Hechinger Report, 2007). In an effort to rejuvenate curriculums, several famed scientists, including David Hawkins (assistant to Robert Oppenheimer, one of the creators of the nuclear bomb), were given the job of creating Science and STEM related curriculums (Powell, 2007)**.** It was the first time that the federal government made a major investment in curriculum development for K-12 grades and not just college level courses. The National Science Foundation funded the integration of Physics, Biology, Chemistry, Mathematics, and even social Sciences into the education system by the 1960s (Smith & Nadelson, 2017).

Following the successful launch of American astronauts into space and onto the Moon, Scientific advancements continued, but support for Science in education stagnated. In 1982, President Reagan's administration decreased the budget for the National Science Foundation by 70% which eliminated all support for elementary, middle, and high school initiatives and programs (Hechinger Report, 2007). As a byproduct, this also cut all teacher training and

curriculum support for Science. In 1983, a report titled *A Nation at Risk* was published in which the authors wrote, "The educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a nation and as a people" (Bell, 1983, p 5). This report was written in an attempt to re-engage with the American people to make necessary beneficial reforms in the public school system and remain at all competitive on a global scale, particularly in STEM subjects (Park, 2004). In an effort to reignite some of the fervor that the Space Race generated, the National Commission on Mathematics and Science Teaching for the 21st Century was created in 1999 by U.S. Secretary of Education, led by John Glenn, in an effort to improve Math and Science standards in education (Hechinger Report, 2007). An additional report published in 2000, *Before It's Too Late*, urged the need for bonuses and higher salaries as an attractant for Science teachers (Hechinger Report, 2007).

One of the most significant policies that has affected Science in the last twenty years is *No Child Left Behind* (NCLB), which was signed by President Bush in 2001. This policy shifted the focus in schools (particularly elementary schools) from Science and other subjects to increase national scores on Math and Reading standardized testing (Britton, Iveland, Schneider, Tyler, & Valcarcel, 2016). This policy is now seen as being too dependent on standardized testing and inequitable to certain areas that lack resources and funding. NCLB has been restructured as the *Every Student Succeeds Act* (ESSA) which was signed into law by President Obama in 2015 (U.S. Department of Education, 2015).

In 2007, The U.S. National Academies published the report "Rising above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future," which warned that in order for the U.S. to remain competitive as a global leader, it was imperative that Math and

Science were prioritized more in education (Hom, 2014). The Obama administration sought to improve STEM education and in 2009, created the initiative *Educate to Innovate*. This initiative was part of a national effort to improve STEM literacy, improve the quality of teaching (specifically Math and Science), and create more equitable opportunities for minorities and women (Hom, 2014). In an effort to bolster STEM education, the Obama administration contributed $3.1 billion in federal programs that would foster interest, attract STEM teachers, and increase overall understanding of the standards and frameworks (Hom, 2014).

The Next Generation Science Standards

In 2010, a draft of the Next Generation Science Standards (NGSS) was published, titled "Getting the Science Right" (Smith & Nadelson, 2017). This introduced a new set of standards and frameworks that were collaboratively created by a team of scientists and experts to develop relevant, diverse, and immersive Science lessons/units (Wysession, 2013). These standards embraced an inquiry-based perspective and encouraged the use of three dimensional and hands-on experiences as a way of teaching and learning Science. The framework was centered on three main dimensions: scientific and engineering practices, crosscutting concepts, and disciplinary core ideas in Science and Engineering (Hanuscin, Zangori, 2016). These standards aimed to support a more consistent STEM based framework for education from kindergarten through high school and provide connections to the Common Core State Standards (CCSS) for teachers (NGSS, 2011).

The creation of the NGSS in 2013 provided a unique opportunity for teachers to make big changes for long term learning practices. Science based lessons were in need of relevant connections and experiences that would engage students past the initial lesson and through an

entire unit (Smith & Nadelson, 2017). With the new standards, it was clear there was also a need for renewed instruction and engagement in the critical subjects—Earth and Space Sciences in elementary education—which in the past had been introduced in middle and high school rather than elementary school (Wysession, 2013).

During the incorporation of the NGSS, shifts in traditional Science lessons were crucial in order to provide inquiry and three-dimensional based instruction. In response, districts and schools were responsible for creating frameworks and curriculum that would create more equitable learning and teaching environments. Some of the shifts that were necessary for NGSS implementation included shifting to inquiry-based instruction, real-world examples and lessons, three-dimensional scientific content, and integrated scientific disciplines and English Language Arts (ELA) based lessons (Britton, Iveland, Schneider, Tyler, & Valcarcel, 2016).

Challenges, Theoretical Frameworks, and Incorporating the NGSS

The integration of STEM subjects in all grades is a matter of equity and is key to generating lifelong learning practices in young students. According to Bressler (2017), "innovation in STEM fields drives not only economic growth, but also the quality of life" (p 2). Science and STEM lessons foster curiosity, flexibility, group work with peers, and the opportunity to unite cross cutting subject concepts (Hom, 2014). Science lessons promote innovation inside and beyond the classroom, providing individuals with the tools to apply their scientific understanding in all aspects of their lives (Slykhuis, Martin-Hansen, Thomas, & Barbato, 2015). However, Science can be a difficult and intimidating subject to teach, especially for elementary school teachers. Researchers have found that teachers are mostly supportive of NGSS and are interested in Science integration but are constrained by a lack of training,

resources, and support for implementation in the classroom (Hammack, 2019). Without proper preparation, these standards can be overwhelming and confusing, especially since the NGSS are standards, not a curriculum which teachers can follow (Hammack, 2019).

Researchers have focused on the hurdles and hardships that prevent teachers from integrating Science as a core subject in elementary education. There are consistent themes that teachers voice which prevent them from integrating Science and there is a need for more information about which resources or methods of support were missing and would be useful in the integration process. With the introduction of the new standards and increased presence of Earth and Space Sciences also comes the theme of human interactions and human impact on the environment (Wysession, 2013). There is an increased need for these topics in elementary education in order create and elaborate on connections between standards and students' understanding (Wysession, 2013). This researcher points out that many of those connections, including the connections between Engineering, Technology, Earth and Space Sciences are inevitably connected not only within school subjects but with community experiences and current events (Wysession, 2013). However, these topics present certain challenges for teachers, as they break with the traditional Science topics taught in elementary education to add to established curriculums (Wysession, 2013).

Research has shown that experience-oriented scientific inquiry is more effective than solely teaching readings and lectures; however, this requires teachers to create stimulating curricula based on the NGSS (Hammack, 2019). The NGSS stresses the importance of experience-oriented scientific inquiry rather than lectures and readings and tries to provide a straightforward set of standards to combat the many contradictions that have existed regarding

the best way to incorporate and teach Science (Nadelson & Smith, 2017). Teachers argue that a lack of support and dedicated preparation time is a major reason for lack of confidence and interest in integrating Science into their classes (Nadelson & Smith, 2017).

With the introduction of the NGSS, there is an increased need for adaptation and training for teachers and teaching programs. Similar to the need for improved training, there is also the need for a more hands on practical approach that gives teachers a straightforward way to connect their prior knowledge with the new standards (Hanuscin & Zangori, 2016). In one study, researchers found that some of the NGSS were easily adopted and utilized throughout lessons but that teaching and incorporating all of them was a challenge (Nadelson & Smith, 2017). These findings were helpful to consider because they help clarify the need for specific resources and individual training required for teachers, making it more of an efficient and beneficial experience for all teachers. Researchers found that there was a significant increase in dedicated time to Science after a one-year transition period for participating teachers, and that the transition period was necessary for teachers to feel confident incorporating the standards and Science lessons regularly in their classes (Britton, Iveland, Schneider, Tyler, & Valcarcel, 2016).

Constructivism and the 21st Century Skills

Constructivism is a philosophical worldview that argues that knowledge is learned by actively engaging with subject matter and building upon prior knowledge to increase the likelihood of long-term subject retainment and development (Voon, Wong, Looi, & Chen, 2020). This is a critical framework to consider with the topic of integrating Science because knowledge is gained through active learning and experiences, and the NGSS are based on active learning.

These standards allow students to develop their own understanding about how they learn and how they can accumulate knowledge that can be used across all topics and aspects of life (Voon, Wong, Looi, & Chen, 2020).

Constructivism can be further broken down into two subcategories: individual based learning (called cognitive constructivism) and sociocultural constructivism, which focuses on the experiences made with others and knowledge acquired with others (Harlen, 2015). All parts of constructivism focus on the need for inquiry (seeking information to answer questions) based instruction to develop understanding and to make sense of phenomena and information (Harlen, 2015). This framework provides students and teachers with the opportunities to learn through both individual and collaborative experiences; by providing students with the necessary scaffolding (the introduction of ideas at necessary moments to broaden prior knowledge), teachers can foster independence and growth within their students in Science lessons (Harlen, 2015).

The 21st Century Skills are integral for successful Science instruction in elementary education. The 21st Century Skills are an integrated approach that aims to support student success while also preparing students for future careers and education (21st Century Skills, 2016). This framework is meant to help build the foundation in which students can be successful, especially in the future. These skills are broken into three main categories: learning skills, literacy skills, and life skills (21st Century Skills, 2016). Learning skills include: critical thinking, creativity, collaboration, and communication. The second, literacy skills, includes information, media, and technology. And lastly the category life skills include flexibility,

leadership, initiative, productivity, and social skills (21st Century Skills, 2016). These skills and goals for learning align with the goals of the NGSS, Science instruction, and Constructivism.

Learning and Teaching Practices

Research has shown that sustainable and equitable learning practices make Science more relatable and memorable in the long term for both teachers and students (Lee & Okhee, 2020). There is a specific need for the adoption of "practical knowledge" of the NGSS that can be utilized in the classroom, especially for teachers that did not have Science instruction as a part of their teacher preparation courses (Hanuscin & Zangori, 2016). By building practical knowledge of the NGSS, teachers are able to readily use real world examples and teaching strategies that not only expand the knowledge of their students but also their own long-term retention of this subject matter (Hanuscin & Zangori, 2016). With the introduction of the NGSS in 2013, there was an increased need for adaptation and training for teachers and teaching programs. With this training, there is also the need for a more hands on practical approach that gives teachers a straightforward way to connect their prior knowledge with the new standards (Hanuscin& Zangori, 2016).

By incorporating Science as a prioritized subject, there are more opportunities to involve students in inquiry-based learning which leads to long term subject retention and involvement within their schools and communities (Ratinen & Ilkka, 2021). This also provides the ability to introduce subject matter and lessons that involve relevant phenomena; teachers and schools can make Science accessible and compelling to students while also making Science more equitable to all students (Lee, 2020).

Equity and Social Justice

Although the aim of the NGSS is to provide more equitable learning opportunities for students, these standards do not automatically create this environment. Equity is not just an overarching ideal; it is made up of thoughtful decisions and ideas that make an experience or situation equitable. Each school and teacher has their own set of challenges and resources that are unique (Sakar, 2018). Elementary school teachers are already teaching multiple subjects with high expectations surrounding Literacy and Mathematics. Simply asking teachers to add more into an already full curriculum does not address the impact on teachers and their potential for burnout. Although some districts and schools provide the necessary support for STEM instruction, there are not enough consistent or affordable training opportunities for teachers; each district has access to specific curricula and resources, and meeting all standards is challenging on a regular basis (Sakar, 2018).

The lack of Science instruction is tied directly to inequity within the school system. Schools in communities with a majority of socioeconomically disadvantaged populations may lack funding and resources to adequately meet the needs of their students while incorporating subject matter (Stefanski, 2019). It is important to note that integration of a topic is not enough to be equitable and meet the needs of all students, especially when considering there are other factors that are often out of the teachers' control that impact the success of students (Stefanski, 2019). Integration is often used to meet general requirements, but teachers are not able to adequately commit time in their schedule, especially when there is high pressure surrounding assessments, time management, and the needs of a whole class of students (Stefanski, 2019). A study was conducted prior to the Covid 19 Pandemic with two first-grade

teachers, each with over ten years of teaching experience, in one high income school and a low-income school both located within the same urban area/district. Researchers found that at the lower income school, there were expectations to teach Science during dedicated time for Literacy and a lack of consideration for its effect (Stefanski, 2019). This study also exposed more inequities than teachers thought existed, especially in different students' ability to master the topics (Stefanski, 2019). The researcher's observations revealed that reading Science texts was not an adequate substitution for true scientific understanding, which involves engaging in scientific thinking, talking, and hands-on activities (especially important for first graders and younger students) (Stefanski, 2019). The researchers found there is still need for in depth analysis of factors that may limit overall growth in urban schools as well as "context specific" support for teachers (Stefanski, 2019).

This case was interesting in how it showed the developmental skills that 1st graders have or should be developing and how Science and Literacy can positively impact their learning progress (Stefanski, 2019). The conversational way in which the teachers discussed Science with their students seemed to be an effective way to have the 1st graders encounter scientific terminology and think about the different terms they came across (Stefanski, 2019).

There is a need for increased awareness about teaching practices beyond a United States context, or specific state perspective. By introducing a global perspective that encourages an understanding of the relationship between current events, social, cultural, environmental, economic, and political factors, teachers can create an equitable perspective for their students to embrace. This global context is especially important in elementary grades because young students can bring this awareness with them as they move throughout grades

(Ratinen, 2021). Many schools and districts serve diverse students with extended families located in other regions throughout the world; providing these connections deepens the empathy within a classroom community and makes subject matter exciting on a personal level (Ratinen, 2021).

Community and Project Based Learning

In the past, there has been a lack of teaching that emphasizes adaptation and mitigation regarding climate change, which is crucial to engaging young students not only in school but in their communities and beyond. This strategy exists in other countries and educational systems and has created great change, even at a federal level, which has positively impacted both youth and adults (Ratinen, 2021).

There are many experience-based projects and experiences that students of all ages can take part in. The Global Educational Program (GLOBE) for elementary and high school levels in Costa Rica, encourages students to engage in scientific inquiry and investigation with students about environmental issues within their communities (Rojas, 2015). This organization's purpose is "to support students, teachers, and scientists in a collaborative inquiry-based research of the environment and the land system close to NASA's Earth System Science Projects (ESSPs), NOAA (National Oceanic and Atmospheric Administration) and NSF (National Science Foundation) in the research and study of the dynamics of the Earth's environment" (Rojas, 2015). This project gave students the opportunity to work with their peers, teachers, and scientists in a collaborative way that made a positive impact on their communities and futures. The majority of participants found it to be more enriching than a traditional Science classroom setting and

came away notably more motivated, and engaged in Science than before, more than their peers that did not participate (Rojas, 2015).

This project incorporates concepts from Constructivism and 21st Century Skills to build upon young learners' interest and knowledge in Science and their communities, while also creating future opportunities for growth and careers in the process. Science is not a sterile subject; it can be very personal and provide opportunities for deep inquiry, which is part of why it is so important to integrate this topic in all grades so that students can build their own understandings and interest. This study was also inspiring in the way that its intention is not only to support students but to foster a collaborative relationship between students, teachers, and scientists (Rojas, 2015).

Engaging youth in community-based learning projects and experiences provides them with a unique opportunity to use their voices and build a foundation for further scientific inquiry. In order to make Science and the NGSS more equitable and successful within elementary education, there is a need to feature "meaningful phenomena" (Lee, 2020).

In a recent study, researchers focused on the impact that relevant phenomena can have in making Science accessible and compelling to students. The researcher's approach was to make the phenomena relatable to experiences young students are having at home, in their communities, at school, etc. (Lee, 2020). The researcher wrote, "As students recognize the relevance of Science and engineering to their lives or future careers, they are compelled to use their knowledge to solve problems in their communities and participate in citizen Science" (Lee, 2020). The participants in this study were 5th grade students in an urban school district made up of diverse student groups or, as the author specifies, "students from both dominant and

nondominant groups in terms of race, ethnicity, culture, language, and social class" (Lee, 2020). Students were able to engage with the subject matter on a deeper level once it was given relevant meaning and built upon their previous knowledge and created long term subject retention (Lee, 2020).

Youth engagement in Science has been studied in recent years. In a study conducted in Finland, researchers describe the current environmental challenges occurring due to climate change and the need for adaptation and mitigation (Ratinen, 2021). The author focuses their research on the effect of these changes through youth perspectives. They argue that youth are making significant progress and change globally (e.g. Greta Thunberg, Youth Climate Strikes) and that their impact should be celebrated and embraced within the education world (Ratinen, 2021). The author points out that there is a general lack of teaching about adaptation and mitigation on a global scale, which is crucial to engaging young students not only in school but in their communities and beyond (Ratinen, 2021). The author also notes that Finland has Geography and Science as core subjects which incorporate climate change as a focus (Ratinen, 2021). This helps students, and teach, come up with coping strategies and educational adaptations that benefit students and foster constructive hope while gaining relevant knowledge regarding climate change (Ratinen, 2021).

The author's emphasis on adaptation and mitigation is a good way to incorporate the topic of environmentalism and climate change in elementary school without it being focused solely on the negative impact associated with climate change. Through Science instruction, they incorporate social justice, current events, mental health, and policies as well (Ratinen, 2021). The researcher writes, "In climate change education, it is important to maintain a perspective

of hope, as hopelessness leads to pessimistic attitudes towards the future and, ultimately, this does not help in mitigating climate change" (Ratinen, 2021, p 3). This empathetic teaching strategy could be implemented in the United States and could be incorporated into elementary education to create a safe and healthy learning environment.

Within Northern California, there have been recent initiatives and projects aimed at youth involvement and community-based Science education. A recent project involved the Y-plan (a civic learning and engagement initiative) and the Resilient by Design Bay Area Challenge which collaborated to create an "equity-driven framework" for young people to engage in city planning with a focus on resilience (McKoy, 2020). This project brought together community members, public officials, scientists, and students to examine and plan for adaptations that the Bay Area will need to incorporate in the coming years to combat and adapt to climate change (McKoy, 2020). The researchers and project coordinators hoped to teach professional tools and practices while also encouraging students and young people to get engaged in their communities (McKoy, 2020). These researchers worked with 830 elementary and high school students, in 32 classrooms, and over 100 professionals and civic leaders (McKoy, 2020). The students were primarily low-income young people of color that attended public school while the professional adults varied (city planners, teachers, scientists, climate specialists, etc.) (McKoy, 2020). The projects the students helped with involved ecological restoration, cultural appreciation, and youth engagement projects (McKoy, 2020). This article was insightful and encouraging in how it showed the variety of ways that students and youth can get involved in their communities. It showed that elementary aged students have the ability and interest in these topics to participate in advanced projects and are motivated to make a positive impact in

their communities. The authors noted, “These young people proposed sophisticated design and policy interventions far beyond their years, spoke confidently with adults at public forums, and crafted elaborate models to represent their ideas and visions for the future” (McKoy, 2020 p.6). This kind of experience contributes to youths’ feelings of constructive hope and fosters independence and inquiry.

Conclusion

It is clear from this review of literature that a focus on Science and Math education fluctuates with different world events and levels of national security (Powell, 2007). The scientific gains and developments since the time of Sputnik are undeniable. However, it is important to note that the Space Race was a relatively recent event that affected generations of students and scientists in unprecedented ways. This time period is still emulated by generations and the impact of being able to witness the Space Race and the first generation of astronauts spurred the enthusiasm for Science-based learning (Dean, 2007). We now live in a time where we are inundated with space-oriented discovery and achievements with regular space launches, successful experiments on Mars, and even the first civilian entries into space. How do we harness a similar phenomenon to the Space Race to re-engage with younger generations scientifically? This is a key factor in the gap of knowledge for ongoing advancements for Science-based learning in elementary education.

In the last two decades, there has been a significant push to incorporate Science more in the elementary classroom, especially through the use of cross cutting subjects and inquiry-based lessons (Harlen, 2015). Throughout this review, the main factors negatively impacting teachers are consistent: the interest and intent for teachers to integrate Science is present but

they are coping with a lack of understanding; there is minimal time for collaboration or planning; and there are general barriers within the school system (Hammack, 2019). Time for collaboration and planning as well as teacher professional development were the most common recommendations from teachers (Bressler, Shernoff, & Sinha, 2017). And still, many teachers lack the confidence or resources to integrate Science in the classroom as a core subject (Hammack, 2019).

There continues to be a lack of information as to how Science is prioritized in the curriculum and classroom compared to the expectations created by the NGSS. With the absence of assessments for lower elementary grades for Science-based understanding, it is hard to grasp the presence of Science in elementary classrooms. The purpose of this study is to highlight the importance of Science when it is not featured as a priority in the curriculum while also looking at strategies to properly equip teachers and students through scientific inquiry and integration. By incorporating constructivism and the 21st Century Skills, there are many ways teachers can encourage inquiry-based, long term subject retention throughout elementary school and into upper grades. Early encouragement of Science learning is key to fostering curiosity and success for young learners.

This research aims to further examine the ways in which Science is being integrated in elementary education, the perspectives of teachers, and the possibilities that exist for incorporating Science as a core subject in elementary education. This study will provide some resources, examples, and insights into the experiences of teachers teaching Science in elementary classrooms.

Chapter 3: Methods

Description and Rationale for Research Approach

For this study, the main worldview that influenced the research and qualitative data approach was the constructivist philosophical worldview. This worldview supports the idea that everyone has a unique perspective formed by their experiences and the research itself relies heavily on the participants and their opinions of the subject matter (Creswell, 2018). I chose this worldview because my research focused on the opinions and reflections of elementary school teachers and the role that Science plays in their curriculums. This study used a qualitative method approach in which the majority of information was gathered through individual interviews with teachers. This study also incorporates the use of the 21st Century Skills as a theoretical framework to assess the multi-dimensional learning and teaching strategies that teachers are using while incorporating Science into their classes.

The role of Science in education has evolved and changed over the years. Although it is currently considered a priority subject, there is a gap in knowledge involving the level at which Science is incorporated in elementary education, and how teachers view the topic within their own classes. Research shows that while the Next Generation Science Standards (NGSS) are a fixture in elementary curriculum, there are challenges that prevent teachers from implementing these standards consistently (Hammack, 2019). Teachers specifically voice that there is a lack of training, resources, and support that prevent them from teaching Science consistently (Hammack, 2019). Since the introduction of the Next Generation Science Standards, there have been more consistent efforts to create equitable learning experiences based around inquiry and three-dimensional scientific instruction (Britton, Iveland, Schneider, Tyler, & Valcarcel, 2016).

This study aims to explore the gap in knowledge surrounding the challenges in implementing the NGSS and Science-specific pedagogy in elementary education through this mixed method approach.

In order to establish a framework for this research, I focused on first building a foundation of the school and participants' background information including teaching history, school demographics, and any general views that had already been communicated regarding Science as a core subject. I participated as a student teacher with one of the participating teachers the prior year and noted any experiences or Science -specific information or lessons that were significant during my time at this school. I also noted any prior facts or reflections regarding the other teacher participants that agreed to be interviewed. This prior knowledge was beneficial for coding, and note taking throughout the interview process (Creswell, 2018). In an effort to promote reflection and discourse from the participants, I incorporated more open-ended interview questions (Creswell, 2018). This was key to this research because I was interviewing teachers specifically to get their unique take on Science in elementary education. Every participant had a different opinion or set of experiences that has shaped their views of this topic (Creswell, 2018). This required me to be mindful of my own experiences and views regarding Science and to reflect on how this formed over time, in order to remain objective throughout this process. I sought to minimize my experiences in order to respect and empathize with each participant's perspectives and the many possible factors that affect their views (e.g., diverse backgrounds, resources, needs for English Language Learners, special needs students, training, support) (Creswell, 2018).

This study used a qualitative approach to gather data, where the majority of the data was collected from interviews with participants. The triangulation of the accumulated background data, researcher observation notes, and interview results, which provided more substantial information for this study.

Research Questions

The aim of this study was to examine the presence of Science in elementary classrooms and to identify the factors that prevent Science from being integrated as a core subject. Using a mixed method approach, I utilized individual interviews with teachers to determine the factors that impede the incorporation of Science. The central research question for this study was: what are the barriers teachers face in consistently integrating Science as a core subject in elementary classrooms? The sub-question that provides the framework for researching this main question are: (1) What are teachers' perspectives about teaching Science in elementary grades?

Research Design

Research Site and Entry into the Field

This study was conducted with elementary school teachers from three different schools in Northern California's Bay Area. These teachers were selected because I had pre-existing relationships with several of these teachers, from student teaching, as peers from the researcher's teacher credential program, as well as a new acquaintance introduced by one of the active participants. All of the teachers at the time of this research were invited to participate in this qualitative study with individual interviews. In order to provide confidentiality for the participants, pseudonyms were used for all contributors and for the school sites, which

will be referred to as North View Elementary School, Pacific Elementary School, and Forest Elementary School throughout the following sections.

The 1st participant, Alex, taught at North View Elementary School which serves a predominantly minority student population of 93%, with the majority of students classified as English Language Learners throughout their time at this school. There are around 180 students enrolled at North View Elementary School with at least one teacher per grade with an onsite teaching coach available to the participant. The 2nd and 3rd participants, Melanie and Rebecca, teach at Pacific Elementary School, which is classified as a dual immersion school serving around 280 students, with a minority population of 96%. These teachers also have an onsite teaching coach who helps support the teachers with their Science instruction. The last participant, Jessica, teaches at Forest Elementary School which is also a dual immersion school with a student population of around 280 and a minority enrollment of 87%.

Prior to this research, all three schools were required to meet online during the Covid-19 Pandemic from March 2020 through November 2020. At the time of this research, the students had returned to in person classes with the full cohort. The Covid-19 Pandemic influenced the presence of Science in elementary education and will be a factor to consider when interviewing these teachers.

Participants and Sampling Procedure

Teachers teaching grades ranging from Kindergarten through 5th grade were asked to take part in this study. The participants taught 4th and 5th grades and ranged in years of experience and age. All teachers' names have been removed and replaced with pseudonyms. The purpose of recruiting these elementary school teachers for this research was to gain insight

from professionals that had taught a range of grades and students. The goal was to engage with participants that were currently teaching different grades so that the information covered a spectrum of students and ages. Teachers were recruited for this study directly by myself via email. Prior to completing the survey, the participants were asked to review the Letter of Introduction (Appendix B) which clarified my intent and request for participation in the survey. Each interview participant was given an informed consent form (Appendix C) requesting their consent as well as their acknowledgement of the ability to withdraw from the study if needed. These forms also specified the ways in which their identities would be protected and gave specifics about the time and effort that would be required by the participants.

Methods for Data Collection

Prior to the beginning of the interview process, I spoke directly with each participant who was given a description of the study and a requested timeline for survey submission and gained their written consent. The interviews were conducted individually over Zoom or the telephone, lasting between 45 minutes to an hour. The interview questions (Appendix E) were designed to allow for open conversation and reflection (Creswell, 2018). The basis of the interview questions was to establish the participants' history of teaching and their understanding of how Science is integrated in their classes. The questions focused primarily on their experiences teaching Science while also asking how they noticed their students reacting to Science-based lessons.

Data Analysis

The data for this qualitative study was collected from several individual interviews conducted with a select group of teachers (Creswell, 2018). The interviews were conducted

over Zoom or the telephone (depending on the participant's availability and preference) and were recorded so that both video and audio were saved. The interviews were later transcribed and coded. Throughout each interview, I had specific notes with any prior knowledge or relevant information open with interview questions available with corresponding notes for each participant. Anytime a noticeable reaction occurred, I made a small note to refer to the saved footage at the end of the interview. If a participant had an issue with an interview question or needed to take a break, this was also noted. Following each interview, I immediately wrote down any noticeable thoughts or reactions that occurred throughout the process and wrote analytic memos for each interview (Creswell, 2018). I made sure to note any similar reactions or responses from participants, as well as any outliers that stood out from the group.

Study data for this research was concept coded prior to the distribution of the survey to the participants in an attempt to identify any potential themes or patterns that may occur throughout the data collection process (Creswell, 2018). After the completion of the interviews, the cumulative qualitative data was assessed and open coded for patterns and noticeable themes (both positive and negative). The transcribed interviews were categorized by similarity in responses and coded with key words and significant responses or reflections (Creswell, 2018). In order to triangulate the interview data, analytic memos were also used to organize the data fully and to look for any gaps in understanding that would potentially require a follow up with a participant for clarification. All data collected was stored on digital spreadsheets and Microsoft Word documents in order to analyze and compare the response; all data was then coded through a more focused lens.

Validity

While working on this study, I was not teaching in my own classroom but had completed a portion of my student teaching with one of the teacher participants and attended my teacher credential and graduate program in this school's region. These experiences may have influenced my research because I was personally interested and invested in the topics that are covered in classes and will be seeking a teaching position in this district in the near future. I have a personal interest in seeing how Science is regarded by teachers and hope to positively influence some of the conversations surrounding Science in elementary education. I am aware of these biases and made a consistent effort to address these validity threats with the use of multiple strategies. Another element to note, is that my student teaching primarily took place virtually over Zoom and I did not get the chance to observe much in person learning. This is worth remembering in case this impacts my prior knowledge regarding this school and its teaching practices.

One of the ways that I addressed these validity threats is through the triangulation of background information, interview data, and researcher notes/analytic memos for a qualitative methods approach to acquire as much complete data as possible from the participants (Maxwell, 2017). As the researcher, I made every effort to provide a safe and private environment for each interview by using strategies that would support each participant as needed (Creswell, 2018). In order to provide data that could be compared and analyzed for trends, I made sure that the questions remained consistent throughout each interview, there were no mishaps with the recording of each interview, and that all were transcribed and coded properly. After coding and transcriptions were complete, I followed up with the interview participants in order to clarify any outstanding statement or questions for respondent

validation (Maxwell, 2017). While transcribing and analyzing data, I made sure to leave the responses intact and did not alter any answers, regardless of any personal or emotional responses that I felt.

Chapter 4: Findings

The purpose of this project was to study the presence of Science instruction in elementary classrooms and to examine the current ways that teachers are integrating Science into their curriculum. This study also sought to uncover the factors that make it challenging for teachers to incorporate Science into their school days and investigate the processes that they have adopted to effectively integrate and frame Science as a prioritized subject. After analyzing and reflecting on the qualitative data gathered through interviews with each of the four participating teachers, it was clear that all participants recognized the importance of Science integration as well as the positive impact on young students. However, although Science is clearly popular and beneficial to all students, the participants voiced similar challenges that often make it difficult to incorporate Science at the expected level.

The findings in this chapter centered around five overarching themes. The first theme examines the role of the Science standards and curricula, as well as the equalizing nature of Science for all students in the elementary classroom. The second theme discusses the participants' observations regarding their students and how Science impacted their inquiry, independence, and collaboration across subjects. The third theme explores the impacts of the COVID-19 Pandemic in the classroom. The fourth theme discusses the presence of climate change and teaching with sensitivity. And the final theme focuses on the participants' reflections.

As previously stated, the participants in this study teach at three different schools throughout the Bay Area and are referred to as Alex (5th grade teacher at North View

Elementary), Melanie and Rebecca (5th and 4th grade teachers at Pacific Elementary) and Jessica (4th grade teacher at Forest Elementary school).

Science Standards, Curricula, and English Language Learners

Science Standards and Curricula

All of the participants involved in this study are currently teachers in California (specifically in the Bay Area); they each spoke about the inclusion of the CCSS as well as the NGSS in their curriculum. Two of the participants, based out of the same school, also use the Full Option Science System (FOSS; developed by University of California- Berkeley's Lawrence Hall of Science), which focuses on robust three-dimensional learning and engineering principles, starting in Kindergarten.

The frameworks set by the NGSS and the CCCS provide a road map for the specific topics and units that are covered in each grade. The participants spoke at length about the ways in which they decide how, and when, to incorporate the Science standards and balance their other subjects and requirements. They noted various forms of support that had either been made available to them or that they had adopted within their schools. All participants listed their teacher or grade partners as crucial parts of their support team while teaching and planning out their lessons. Three out of the four participants cited the impact of having on-site coaches that helped support the needs of both the teachers and their students. The fourth participant noted that she did not have access to a coach but worked closely with their partner teacher, principal, and other teachers who had experience teaching upper elementary grades.

Each educator had different methods of incorporating the standards and units into their classes and schedules. Alex explained her process:

> We meet with our coach, and look at the current lessons and unit we are teaching. Right now, we're working on ecosystems so we, with the coach, look at the NGSS standards, and the California state standards. And that's how we look at what we need to plan ahead for and then create a unit based on that.

Not only do the teaching strategies vary from teacher to teacher; each school and district has their own policies and curricula expectations for Science. Pacific Elementary School, where Melanie and Rebecca teach, has adopted the Full Option Science System curriculum (FOSS), which expands upon the NGSS and CCCS in the classroom. FOSS is meant to engage students and foster independence and inquiry throughout the course of elementary education and beyond. Rebecca explained the ways in which FOSS is used to assess her students' comprehension, and the recent shifts she has recognized:

> We use the FOSS coding system to identify a students' competence. 1 (notions), 2 (recognition), 3 (conceptual), 4 (strategic). In the past my students were mostly 2 or 3, this year quite a bit more 1 and 2. Several factors could contribute to this: a novice teacher teaching 3rd grade, coming in from a pandemic, and also the transformation from English only to Dual immersion. Science is taught in English and students do not begin literacy in English until 2nd grade at my site. I have Science specific blocks in my schedule but I also use Language Arts time for reading about Science and writing about Science when I can.

Melanie, a first year teacher at her school, expanded on her efforts to integrate Science while adhering to FOSS and how it has impacted her classes:

> We have a very robust curriculum and it's a lot of prep, to make the Science hands-on and to make sure all the materials are set up, and the cleanup and, as a newer classroom teacher, it's the challenge of having the routines in place. The teachers at (Pacific Elementary) together are very collaborative and they chose to be a Science focused school. We have a full time on site Science coach, who's taught for a very long time, and she works for the Science Department of the school district.

Similarly, Jessica plans units and lessons based on the NGSS and CCCS, but does not have access to a teaching coach and instead works closely with her peers to develop relevant and stimulating Science lessons. As a fourth grade teacher, she makes an effort to emphasize the connections between the California history and social studies units with relevant Science content. She speaks about planning around the NGSS with her grade partner and planning out the Science units before the school year even starts, while also remaining flexible to the need for changes as they come up. She says:

> With our Science units, we build upon them and figure out what we need to do now, or which is the most appropriate curriculum or unit to teach at the present moment. We'll take one aspect of learning about rocks and then make a connection by going into our social studies unit and learn about the gold rush and what it meant to pan for gold, and how to distinguish between different types of rocks. Then we decide if we need to pivot, especially because of the needs of our own students and our own classrooms. We have the unit plans, and the pacing guides for them but, if we need to pivot based on classroom needs, we'll do that.

Jessica's reference to remaining flexible was echoed throughout the interviews by all participants. While the goal is to plan ahead and prep as much as possible prior to the units and lessons, a school day does not typically follow a precise schedule and requires the teachers to adapt the lessons as needed.

Science as the Great Equalizer

A consistent theme that came up throughout the interviews was how the participants felt there was pressure to focus primarily on students' reading levels, especially for the English Language Learner (ELL) students. All participants voiced a similar need to incorporate Science when they could throughout other subjects in an effort to try to meet all requirements, particularly regarding reading level expectations following the COVID-19 pandemic.

As discussed earlier, the participants in this study teach at three different schools- two out of three schools are classified as dual immersion; however, the third school's students primarily speak English as a second language and the participating teacher is bilingual and supports them in that capacity. As a result, the topic of English Language Learners and their ability to comprehend the standards and materials proved to be imperative in finding out more about how teachers felt about Science being a prioritized subject.

Melanie had an interesting perspective regarding this increased push for increased Reading and Writing levels as a new teacher at her school. She talked about how there were notably low reading levels in her grade and how her school used cross subject topics to build literacy and understanding rather than focusing on assessments. For her, the goal was more focused on finding a balance for her students and supporting them in long term learning

practices. She spoke about how integrating Science bolstered her students' ability to succeed in all subjects:

> If I lean on my Science curriculum, they have the language arts integrated into it. We have the state Science test in fifth grade but my school doesn't put a lot of pressure on the testing because the majority are English Language Learners and even if they are learning and improving overall the test scores aren't necessarily going to reflect it. So the administration, and the district, acknowledge that we have to take the test but it's not going to accurately reflect the learning. And because of that there isn't such a push to teach towards test results. It's more focused on trying to help the students meet them at their current level, and helping them to learn and grow.

This perspective is important to note, not only for a Science-based study, but for new teachers and longtime teachers that teach in schools with high ELL enrollment. New teachers, like Melanie, often feel immense pressure to meet all requirements and report high student assessment scores while also trying to manage their classes and settle into the role of teaching.

Similarly, Jessica spoke about the benefits of having a dual immersion program and how it can help take pressure off of ELL or newcomer students who may be struggling to keep up with content due to language barriers. She spoke about the ability for her students' to code switch and how it made for a more inclusive setting for ELL students:

> Even though our Science is taught primarily in English, especially with my ELL students, I can flip flop. I have a newcomer student, and he really still struggles with understanding concepts in English. So I often asked his question in Spanish, and nobody questioned anything about it, because it was so natural, and then the conversation just kind of

> continued in English. It's very natural for them to code switch and figure out what they need to understand to be able to comprehend, and then to repeat, or answer questions.

Jessica's recognition of the added stress and pressure of not being able to understand a language in a classroom setting is integral to making sure that students feel they are in a safe environment to learn about any subject. Science, similar to Reading and Social Studies, is a subject that all students are somewhat aware of and by giving the student the ability to collaborate and take part in the lesson, Jessica provided an invaluable opportunity for the newcomer to take part in the lesson.

Rebecca voiced an observation that is important and relative for teachers that have students that speak multiple languages and come from multicultural communities. She said:

> I teach Dual Immersion one way 50/50 sequential. I have two cohorts of students that I teach 50% of the time. I have many students that are multilingual learners. All but two students have a language other than English as their home language.

This reflection was important to note as the languages that students speak may not be the languages covered in dual immersion, which can be challenging to support especially while trying to incorporate multiple subjects into classes. However, Science provides the opportunity for collaboration with peers and independent work which can boost ELL students' confidence while allowing them to have an outlet that is not quite as rigid as many other subjects are.

When speaking with Melanie about how Science influences her students, she spoke about how it impacts all of her students positively and is potentially less stress-inducing than subjects such as Reading can be for ELL students as well as her students with special learning needs.

> I think that the Science curriculum is the great equalizer for all of my students. When we're doing these groups it's not necessarily the highest testing students who are going to get the answer, because they're experimenting with it, and they have to be open and creative with the process. I have a newcomer student who recently moved from Mexico, and spoke no English and he's often able to do the experiment and understand and make something of it. Even though I teach primarily in English, I'm able to access the entire curriculum in Spanish if I need to in order to offer extra support to my students.

Jessica and her team noticed not only the shared interest from her students regarding Science but also how teaching Science in English supported their dual immersion learning process. She said:

> Currently we're keeping Science as a solely English taught subject and they've had Science all year long. We decided as a team that it's more manageable for the students to keep it solely in English with translating and figuring things out in a different language. The kids really love learning about Science and we've managed to incorporate it into our schedule four days a week.

The experiences that each participant spoke about really solidified the importance of Science inclusion in the classroom. It is not only a subject but also a tool that teachers can use to support their diverse classrooms and bring equitable learning opportunities to their students.

Students: Inquiry, Independence, and Collaboration

A popular theme throughout this research was how elementary age students enjoy Science and that teachers recognize the impact that Science instruction has on their ability to question phenomena, explore them in depth and, in the process, foster independence and

collaboration. The interview data showed how the ongoing challenges with incorporating Science into the curriculum contrasted the students' and teachers' interest in the subject. During the interviews, each educator responded to the question, "Do your students enjoy learning about Science?" with an unequivocal "yes." These teachers explained that students enjoy learning primarily because of the hands-on and collaborative nature of Science, which was a recurring theme throughout the interviews. Similarly, all teacher participants shared that they enjoyed teaching Science and worked hard to feature it as much as possible but were impacted by the many other requirements and expectations for teachers.

When speaking with Alex about her students' interest in Science, she noted that it was not solely the subject that was so appealing and motivating for students but also the opportunities that it presented. Alex said:

> I think they all pretty much enjoy anything that's hands on and working together is a big part of it. Being able to annotate and observe and come up with questions, and work together gives them a sense of independence.

Rebecca noticed a similar reaction amongst her students, saying: "My students love Science, it's definitely a favorite subject for many of them, particularly the hands-on part of the investigation. Science is unique because it serves as an entry point for any learner to engage in challenging content."

When asked if she felt that her students came to the fifth grade prepared for the subject material, Melanie was very positive about the levels of comprehension she noticed right from the start. She noted that this was most likely due to the fact that many of these students have been at a Science-oriented school since starting their elementary education. She spoke about it

further saying that it was also evident during remote learning, when it was obvious that Science remained attractive to her students:

> They've been getting Science in a robust manner since kindergarten, and they have this engineering class which they really enjoy. They're well prepared by the time they get to me, even with Zoom, which was notable because that was my last lesson of the day. But I think that most of the students would choose to come back on because it was engaging and it piqued their interest even if they were tired.

COVID-19's Impact on Science in the Classroom

A major theme that was inevitably connected to elementary curricula is the impact of the COVID-19 Pandemic on students. At the time that this research was conducted, the COVID-19 Pandemic had been ongoing for almost two years. Since the beginning of the COVID-19 Pandemic, teachers have faced many stressors, including the need to reintegrate students into a school routine. This has proved difficult as many students have fallen behind in interpersonal skills as well as a significant number of students who spent the last at least six months of their education completely online. Teachers face pressure to gain ground to combat the growing achievement gap, which stresses the importance of Reading and Math more than other subjects, putting additional focus and requirements on a tight schedule. It is also worth noting that COVID-19's effect stretched further than just classroom subject matter and impacted teachers and students of all ages, including social and emotional gaps and trauma that continue to exist due to this unprecedented time.

All research participants touched upon the theme of COVID-19 and its continuing impact on their classes. The need to re-establish routines and classroom etiquette was a shared

sentiment by all participants. While discussing the impacts caused by COVID-19 on Rebecca's class, she spoke about the social, emotional, and developmental impacts the pandemic had on her students and the need to focus on building back routines that would not have taken so much effort in the past. She said: "This year, I have had to do a lot more of the foundational work this year with my students because of the loss of learning that took place during the pandemic and distance learning."

Melanie reflected on the impact that COVID-19 has had not just on her and her students in the classroom but also in the larger school community- within their families and changes in their home lives. She noted that**,** "I'm serving a very specific population, where the kids come in and they're experiencing trauma. It's just a lot to support this community in the classroom at this time, in particular."

An additional issue that these participants voiced was that remote learning and mandated safety precautions meant that experiments and lessons required additional materials which were not always provided by the schools. Melanie spoke about the difficulties she had regarding the lack of physical resources and materials that most Science lessons required pre-pandemic. She found ways to get creative and provide equitable learning opportunities for her students even while they were learning remotely due to the pandemic. She shared:

> During COVID-19 and distance learning, I was teaching Science routinely, and it was going well, but the only way to teach it was by demonstrating it because I couldn't get the materials easily out to the students. A couple times, I said, 'Go get some soil from outside, wherever you can find soil, and then, shake it up.' And then, we would talk about the different layers found within soil.

Alex spoke about having a similar experience to Melanie, providing interesting insights regarding the preparation and effort required to do successful lessons in a socially distanced environment:

> They were still able to do it, it just meant that I had to buy almost double the supplies to make sure because at that point, we weren't sure if the students' supplies would be transmittable if COVID were on them. So we ended up making sure that every student had their own materials. Last year, we did some mystery powders to look at how matter changes. And instead of having two or three kids share, each person had their own little tray, and I had to cut those little trays up and just pour everything myself. So everything took a lot longer but we were able to do it.

Alex also spoke about how she incorporates Science into her reading time when she can because English Language Arts has become the primary focus for improvement and development in her classes. She discussed some of the challenges that this creates for her in her classes: "Reading at grade level right now is the main priority. And so we're just kind of taking a step back from focusing so much on other subjects."

Alex's admission was consistently voiced by the participants throughout the interviews. The COVID-19 Pandemic altered the focus and rhythm that teachers had worked so hard to establish pre-pandemic and are consistently working hard to regain their footing after such an unprecedented event.

Teaching about Climate Change with Sensitivity and Community-Based Projects

A large part of the conversations with participants throughout this study was about the impact of Climate Change and how community-based learning is being integrated into Science

lessons. While students were learning remotely, they were exposed to a lot more news related content throughout the day than they would normally have been in the classroom. A significant event that affected all of these participants and their students were the wildfires in the fall of 2020 that severely impacted the majority of Northern California. These conversations focused on whether these teachers taught about climate change in their classes and if so how they remain sensitive to prevent anxiety while expanding students' awareness.

Melanie's Science lessons focused a lot on climate change, mitigation, and how the Bay Area (and world) are directly impacted. She provided information about the opportunities and resources that have been made available to her within her district as well as any that she sought out to incorporate the topic of climate change while promoting climate justice and awareness.

> I'm a part of a professional development inquiry group and am getting a stipend to develop and implement climate justice lessons that are actionable. Last summer, I went to the climate generation conference, which was on Zoom, but it was great; there were thousands of teachers and interested people from around the country that attended and a lot were teachers and we got to collaborate and share ideas. And together with my Science Coach, I'm competing for a grant for our climate unit that we're developing right now.

She also notes that she has made an effort to include these topics more in her class as she feels that FOSS and the other standards lack sufficient subject matter surrounding climate change. For example, during a unit about the atmosphere, she found that the curriculum did not include information about what is impacting the atmosphere; she broadened the subject matter

accordingly. She also spoke about having the opportunity to work with a local Science institution to develop programs and facilitate immersive experiences for her students. She spoke about the kind of lessons they are currently focusing on:

> The goal is to develop a community based project, which is going to be a biome and is all about sustaining life on Earth. We are asking ourselves as scientists, how can we protect Earth and how can we create our own sort of biome.

She went on to speak about the importance of teaching this subject with sensitivity and empathy:

> We have to teach it with sensitivity: we want the kids to be aware, but not to induce panic. In our conferences, the question of how we can teach this in a way that is more of a call to action is often brought up. So as teachers, we focus on acknowledging that yes, climate change is happening but through the lens of what we are doing to make adaptations and through mitigation. And then based on our location, it always brings us back to climate justice. Because the areas where these students live are going to be most impacted by climate change and rising sea levels. So we're always talking about the call to action, the justice aspect about it, and the equity factor. We want to teach it in a way that the students feel powerful and capable and not just bogged down by all of it.

Alex also incorporates climate change and justice into her Science lessons. At the time of the interview, she and her class were beginning to dive further into this topic in their Earth Sciences units. She said:

> We've talked about climate change, but not at length. We will learn about it more in upcoming units but I would say I don't feel confident that we've done a lesson where everybody understands it completely. They are able to discuss different natural disasters and how it affects different spheres and of course, with the fires that we have they are very knowledgeable about them. Or at least aware. I think as far as the units that we discuss with our coaches, we try to bring it to the real world and I think climate change is going to come up more now going forward.

Rebecca shared that she had a series of projects that focused on climate change and community based education:

> Students learn about how humans negatively impacted an ecosystem and how some activists helped save a local Lake Ecosystem. We have always gone to the local waste management facility for a field trip to learn about the 4R's- reduce, reuse, repair, and recycle. Then students come back and do a community service project at school where they each spend a week in the cafeteria teaching students how to correctly sort their trash.

Jessica spoke about how she and her team do not currently cover the topic of climate change in her class but that she was motivated to integrate the topic more.

Educator Reflections- What Can Be Done Differently?

The last major theme found in the interviews was the importance of the participants' reflections about how they felt about Science and suggestions for how it can be integrated more successfully. There were several topics that the participants all brought up in their interviews. They shared that resources and mentors were an integral part of the support that

was available to them at their schools. Science based conferences and training are technically provided to the participants but are challenging to attend, and are often at inconvenient times, which can be an additional burden.

Each school clearly differed in what they offered to their teachers as well as their curriculum requirements and expectations. The curriculum that Melanie and Rebecca use, FOSS, provides ongoing teacher development programs as well as opportunities to work closely with local Science institutions. However, the other two participants felt that they were already trying to keep things going smoothly for their students and it would be a struggle for them to take on more work, even in the form of personal development.

When asked what they wished was different or more readily available for them to integrate Science more effectively in the classroom, each teacher had a unique and thoughtful response. Alex shared:

> Well, I wish that we had more opportunities to do more experiments. And I think it might just be a matter of me trying to fit those kinds of things in. I would say that's my biggest wish, and I hope that my partner and I can fit in more hands-on experiences. I just feel like that's where kids really get into things, not just from listening to a lesson.

She also spoke about some of the ongoing challenges she noticed when trying to incorporate Science into her classes.

> I find it challenging when it's not only Science that you're doing, but you're also teaching reading strategies at the same time. So you really have to plan for your instructional minutes to count. Because I have to teach reading strategies, and they need time to also practice them. And so we practice reading strategies using the Science materials but, I

always find it challenging that you're not taking the Science to its fullest level, because you're really also doing reading strategies.

Jessica had a different focus for what she hoped to be more present in her lessons and classroom, specifically noting the lack of time and resources that are often listed as requirements for each lesson. She would prefer more straightforward lessons that require less of the classroom time and preparation required by the teachers.

Melanie acknowledged the unique situation that she and Rebecca have at their Science-oriented public school. But she confided that she worried that Science is not being taught consistently in other schools, especially when she speaks with her peers: “When I talked to other teachers and other schools, not very much Science is being done, and it's an afterthought.”

Rebecca shared that she hoped to be able to contribute to Science education, and expand upon her passion for the subject. She hopes to have more time to plan and develop her own Science curricula: “My dream would be to write my own project based units and use my Science textbook and trade books to teach all of my relevant language arts standards instead of having to use a separate language arts curriculum.”

Conclusion

This study found that there were consistent challenges that teachers face in integrating Science while also highlighting some inspirational Science curricula and teaching strategies. The main challenges that the participants voiced were; a lack of time in general for Science instruction, resources, and the impacts of COVID-19 which shifted the focus in their classrooms.

The lack of Science in elementary education was recognized by all of the teacher participants. Each participant mentioned they noticed from conversations with others or through personal observations that there was often a lack of prioritization of Science in elementary schools, which motivated them to feature it more in their own classes. Rebecca spoke about this, saying:

> Although Science is a priority at my site, I do not think that is the case across the district. We rotate Science kits in our district and I can tell when the materials are not being used. Also the district has basically cut the entire Science Department team down to a few people who are also responsible for Math. There is no accountability for Science.

Each participant shared honest and thoughtful feedback throughout this interview process. They each had a unique voice and background which provided valuable insight into the challenges teachers face in Science integration. Although COVID-19 has made teachers have to take a step back and build back important routines, each participant noted the enthusiasm their students showed when given the opportunity to engage in Science lessons. The teachers shared some of the creative ways they introduced the topic of climate change into their curriculums to combat stress and establish social justice and hope in the classroom. And the teacher who had not taught about climate change shared that they felt inspired to do so more in the future. The teacher participants made it clear that their students truly enjoy engaging in Science lessons and find that it provides equitable learning opportunities for all students.

Chapter 5: Discussion

This qualitative study sought to determine the ways in which Science is integrated into elementary education by gaining insight directly gathered from teachers. Several consistent challenges presented themselves throughout this process which provided invaluable insight that can be used to make Science integration more effective and manageable. Through this research, I was able to identify elements that can support teachers in lesson planning, teaching strategies, and improve teachers' experiences integrating Science into their classes.

There proved to be a consistent trend that carried over from the research and literature review concerning how teachers are unable to incorporate Science consistently due to their other requirements and responsibilities. These challenges have been exacerbated by the COVID-19 Pandemic, meaning that teachers must spend more time re-building routines and establishing healthy classroom behavior amongst their students. A similarity found between the research and literature review was that teacher support for Science varies from school to school, as do opportunities for personal development and training (Sakar, 2018). Another consistency was that students enjoy Science and do well in settings that foster collaboration and inquiry (McKoy, 2020). It was also evident that throughout the United States' education history, Science instruction fluctuates in importance with shifting world events (Hom, 2014).

This study found that each school differs in their ability to offer Science-based curricula. Certain schools have chosen to embrace the inquiry and independence that Science gives their students and balance their classes around the subject, but some are simply unable to do so due to limited time and resources. The impact of COVID-19 has affected the state of Science in the classroom, and teachers are trying their best to meet the expectations set by the academic

achievement gaps and behavioral shifts that have developed in the last two years. All teachers agree that Science is an important topic especially in elementary education, but some still struggle under the weight of all the different requirements and expectations set on teachers to incorporate it as much as they would like.

The role of a constructivist teaching approach with scientific instruction was clearly evident in both the research and literature review, showing that students engage and retain information when they are given the opportunity to construct their own learning both independently and collaboratively. This research found that Science lessons provided students with the opportunity for collaboration with peers, development of their problem-solving skills, and provide an equitable learning opportunity for all students. Science instruction also provided opportunities for teachers to discuss real world events and occurrences with their students while in a setting that provided a safe environment.

Implications for Literature

After concluding this research, I found somewhat surprising results that were inconsistent with the data gathered initially in the literature review. While doing research for the literature review, the data was mostly supporting the hypothesis that Science is not prioritized, and that teachers feel unable to incorporate it due to other constraints or a lack of training. However, this study showed that three out of four participants have Science integrated rigorously in the curriculum and have designated time for Science lessons four to five times a week. This was significant and showed how schools that prioritize students' long-term Science-based learning and inquiry have more consistent lessons throughout their schedules.

This research showed that although all participants integrated Science, they were not all able to do it at the same level and each had a different amount of support and curriculum specific to their schools, districts, and funding. Each participant gave insight into how they integrate Science into their classes and for the most part followed similar strategies for incorporating it amongst the other prioritized subjects. However, there remains a gap in knowledge regarding the site-specific limitations that exist and may contribute to ongoing challenges. This is relevant to this study because all schools are located within the same region but vary greatly in their designated curriculum, on-site support, and flexibility for incorporating Science into their classes regularly.

This research provided helpful insights into the different curricula the participants used, the general expectations surrounding their lessons following remote learning, as well as how they felt about Science at the time of the interviews. The interviews also showed the kind of training and personal development the participants took part in or had access to, which varied from school to school. It is worth noting that although the majority of these teachers reported regular Science lessons, they also reported that they knew this was not necessarily the norm.

Implications for Practice and Policy

These findings show how some teachers have effectively integrated Science and built long term Science-based learning practices for their students which benefits them in all subjects and future grades. Furthermore, findings are helpful in identifying the ways in which Science curricula is taught inconsistently across elementary school sites and may help inform their educational policies. Additional policy implications related to this study's findings are that policies aimed at standardizing the integration of Science content should address/include

teacher support and resources needed for integrating Science as a core subject. By incorporating some of the methodology and strategies noted by the participating teachers, other teachers can provide more equitable learning opportunities for all students. Additionally, by integrating lessons and projects that examine the role of communities and climate change, teachers have the opportunity to instill social justice in their Science curricula.

Limitations of the Study and Directions for Future Research

There are several limitations for this study. This research was conducted over a short amount of time (one semester) and if given more time, it would have been interesting to interview more teachers from lower elementary grades and from more schools throughout the Bay Area.

The participants in this study provide a limited perspective because they are teachers from 4th and 5th grade only. This study only focused on teacher participants; in the future, it would be interesting to include administration, principals, and teaching coaches. Getting a full range of participants could prove challenging, as was the case in this study. Although many teachers were reached out to as potential participants in a mixed method study, there were few willing participants, and the study shifted to a qualitative interview study focused on a small pool of teachers.

As mentioned earlier, the schools in this study vary in student and teacher diversity, socio economic demographics, and districts (funding, resources, curricula). The topic of curriculum, subject inclusion, and teaching strategies is a personal topic and this research sought to provide undiluted and honest reactions from the participants.

A remaining gap in literature for this study is the specific expectations schools and districts have in place surrounding Science integration in elementary schools and why these expectations can differ greatly. There are many ways that this research can be developed. One suggestion is to conduct a large-scale study involving more teachers and other participants to get a wider range. Also, there is a need to dig deeper into the systemic policies that are currently in place (on a large and local scale). And lastly, by observing (in person) the differences in teaching styles and methods in the schools that successfully integrate Science as well as the schools that struggle to do so.

Conclusion

What started out as a seemingly small observation during student teaching bloomed into a passion project that proved to be a very personal subject not just for myself but also for the participants. The intellectual purpose of this research was to explore if Science is being integrated into elementary education whereas the practical purpose was to determine how teachers felt about teaching the subject and prioritizing it in their classrooms. These goals are interconnected because teachers are expected to incorporate all required subjects and standards into their lessons and Science is not consistently taught in elementary classes. Teachers may feel that incorporating Science into their classes is a burden and figuring out how they are trying to incorporate it and why they may be feeling hesitant is the only logical place to start identifying what needs to be changed or supported.

The most important thing that I learned while conducting this research is that young students love Science. This was confirmed by all participants and reminded me of why this

research was relevant time and time again. It was also clear that students' interest in Science often had a contagious spirit and spread not only to their peers but also to their teachers.

This research provides hope for the future of Science in education; not only is Science surprisingly adaptable, it provides students with the opportunities to be inquisitive and develop their social emotional skills through peer and independent work. The instructional units and projects that teacher participants spoke about were inspiring and provided some resources and possibilities for other teachers to adopt in their own classrooms. Science is a subject that should be available for all students to learn about in depth- age should not be a limitation in determining whether this subject matter should be incorporated into classrooms, especially when it is apparent that elementary students are passionate about this expansive subject.

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APPENDIX A

CONSENT FORM TO BE A RESEARCH PARTICIPANT

1. I understand that I am being asked to participate as a participant in a research study designed to examine the role of science in elementary education. This research is part of Emily Moran's Master's Thesis research project at Dominican University of California, California. This research project is being supervised by Dr. Katie Lewis, Assistant Professor, Department of Education, Dominican University of California.

2. I understand that my participation in this research will involve taking part in two 30-minute interviews, which will include a career history, general curriculum questions, and opinion on the state of science in elementary education.

3. I understand that my participation in this study is completely voluntary, and I am free to withdraw my participation at any time.

4. I have been made aware that all interviews will be recorded. All personal references and identifying information will be eliminated when these recordings are transcribed, and all participants will be identified by numerical code only; the master list for these codes will be kept by Emily Moran in a password-protected file, separate from the transcripts. Coded transcripts will be seen only by the researcher and her faculty advisors. One year after the completion of the research, all written and recorded materials will be destroyed.

5. I am aware that all study participants will be furnished with a written summary of the relevant findings and conclusions of this project. Such results will not be available until May 1, 2022.

6. I understand that I will be discussing topics of a personal nature and that I may refuse to answer any question that causes me distress or seems an invasion of my privacy. I may elect to stop the interview at any time.

7. I understand that my participation involves no physical risk, but may involve some personal discomfort, given the nature of the topic being addressed in the interview. If I experience any problems or serious distress due to my participation, Emily Moran will provide contact information for mental health services.

8. I understand that if I have any further questions about the study, I may contact Ms. Moran at emily.moran@students.dominican.edu or her research supervisor, Dr. Lewis, at katherine.lewis@dominican.edu. If I have further questions or comments about participation in this study, I may contact the Dominican University of California Institutional Review Board for the Protection of Human Participants (IRBPHP), which is concerned with the protection of volunteers in research projects. I may reach the IRBPHP Office by calling (415) 482-3547 and leaving a voicemail message, by FAX at (415) 257-0165, or by writing to the IRBPHP, Office of the Associate Vice President for Academic Affairs, Dominican University of California, 50 Acacia Avenue, San Rafael, CA 94901.

9. All procedures related to this research project have been satisfactorily explained to me prior to my voluntary election to participate.

I HAVE READ AND UNDERSTAND ALL OF THE ABOVE EXPLANATION REGARDING THIS STUDY. I VOLUNTARILY GIVE MY CONSENT TO PARTICIPATE. A COPY OF THIS FORM HAS BEEN GIVEN TO ME FOR MY FUTURE REFERENCE.

_____ _____

APPENDIX B

LETTER OF INTRODUCTION TO PARTICIPANTS IN STUDY RESEARCH

Dear Study Participant,

My name is Emily Moran and I am a Graduate Student in Dominican University of California's Master of Science in Education program. I am conducting a study as a part of my graduate requirements for a Master's Degree, and this work is being supervised by Dr. Katherine Lewis, Assistant Professor of Education at Dominican University of California. I am seeking voluntary participation in my study, which examines the integration of science in elementary education curriculum, specifically from teachers' points of view.

Participation in this study involves participating in one forty-five minutes to an hour interview with the researcher. The interviews will focus on the state of Science in elementary education. Please note that any participation is completely voluntary, and you are able to withdraw from participating at any time. Pseudonyms will be used to protect the identities of participants electing to participate in the interviews.

If you choose to be a participant in this interview, please complete and submit the following consent form.

If you have any questions or concerns regarding this process or study, please contact the researcher directly at the email address below. If you have any further questions about the study, you may contact the research supervisor, Dr. Lewis, at katherine.lewis@dominican.edu. If you still have unanswered questions, please contact the Dominican University of California Institutional Review Board for the Protection of Human Participants (IRBPHP), which is concerned with the protection of volunteers in research projects. You may reach the IRBPHP Office by calling (415) 482-3547 and leaving a voicemail message, by FAX at (415) 257-0165, or by writing to the IRBPHP, Office of the Associate Vice President for Academic Affairs, Dominican University of California, 50 Acacia Avenue, San Rafael, CA 94901.

If you would like to receive results from this study, a summary will be presented in April 2022 at Dominican University of California's Scholarly and Creative Works Conference.

Thank you in advance for your participation.

Sincerely
Emily E. Moran
Emily.Moran@students.dominican.edu