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IMPLEMENTING INQUIRY: A CASE STUDY OF SECONDARY SCIENCE TEACHERS' PERCEPTIONS OF CURRICULUM CHANGE

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IMPLEMENTING INQUIRY: A CASE STUDY OF SECONDARY SCIENCE TEACHERS' PERCEPTIONS OF CURRICULUM CHANGE

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ABSTRACT

IMPLEMENTING INQUIRY: A CASE STUDY OF SECONDARY SCIENCE TEACHERS' PERCEPTIONS OF CURRICULUM CHANGE

Pamela A. Gordon

With the constant strive for higher standards in education, New York State has joined with other states in the nation to develop a new strategy to teach science and 21st-century learning skills to ensure that our children are ready to compete in the global economy. This study sought to determine the current knowledge and perceptions of in-service teachers in New York State regarding the shift in standards from the 1996-based standards to the recently adopted New York State Science Learning Standards (NYSSLS) and their implementation in the classroom. The study aims to help identify the shifts in classroom practices resulting from the new standards and determine possible barriers to implementing the NYSSLS in New York State. Participants in the study were in-service teachers and administrators in New York State.

DEDICATION

I dedicate this accomplishment to my late father, who always pushed me to be my best and taught me that nothing was impossible if you set your mind to it and worked hard enough. To my mother, “the woman” who has been my rock through everything, my number one motivator, and to whom I owe the world because I would not be the person I am without her constant support and encouragement. To my husband, who sacrificed sleepless nights and relentless hours taking care of the little things to allow me the time to pursue my dreams and work on this dissertation. Finally, to my children Joseph, Zachary, and Mackenzie, who fill me with wonder and immense joy every day. Watching you grow and learn will always be my life's most rewarding and joyous experience. Always stay curious, and don’t forget to pursue your dreams.

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Chapter 1

Introduction

Within education, there has been a shift in policy and a call for more rigorous standards to ensure students are ready to compete in the global economy (Jerald, 2008). With this new shift, it was not long before science became a part of the change to develop students' 21st-century science skills and increase their academic success. This shift calls for a change in pedagogy, which requires teachers to switch from teacher-centered learning to student-centered learning. This shift coincided with advancements in teaching methodology and best practices for learning and instruction. Inquiry-based learning has come to the forefront of education as a prominent learning strategy through the use of problem-based or project-based teaching approaches, which shows repeated positive relationships between its use and increased student achievement and student motivation toward learning (Bara & Xhomara, 2020; Arce, Bodner, & Hutchinson, 2014; Brush & Saye, 2000; Che Isa & Azid, 2021; English & Kitsantas, 2013; Lee & Blachard, 2019).

Research has found that throughout their educational experience, students must be exposed to and engage with meaningful learning experiences and collaborative dialogue better to understand the scientific process (Jerald, 2008). These experiences and discussions must allow ideas and more complex topics to be investigated from many perspectives and viewpoints (NYSED, 2018). The new standards call for a shift to research-based best practices that focus on student-centered learning through inquiry. This is a significant shift in teaching methodology from the previous standards, which focused strictly on specific content area knowledge (Pruitt, 2017). To implement the new standards that call for an increase in inquiry-based methodology in the classroom, an

understanding of teacher perception of and reaction to the change in the standards is instrumental.

This qualitative case study examined science teachers' and administrators' perceptions of mandated curriculum changes under the implementation of the New York State Science Learning Standards (NYSSLS).

History of Science Reform

There is a long history of change in the field of education, science education in particular. The attempts to change science education in the United States began as early as the 1800s under the Jacksonian Democracy; as a result of an increase in funding, the American Association for Advancement of Sciences (AAAS) was founded in 1848 and became an organized body with a commitment to advancing science and relations (AAAS, 2018). The idea of advancing education is not specific to science alone. There have been various methods and attempts to increase student achievement, including legislation. In 2001, Congress approved The No Child Left Behind Act (NCLB). It mandated high-stakes testing of students to hold schools accountable for student achievement and issued penalties for schools not making adequate yearly progress (H.R. Rep. No. 107-63, 2001).

In November of 2007, the Council of Chief State School Officers (CCSSC), the National Governors Association (NGA), and Achieve, Inc released "Benchmarking for Success: Ensuring U.S. Students Receive a World-Class Education" (Jerald, 2008). This document suggested that the United States upgrade its standards to an internationally benched set of English Language Arts and Math standards to compete in the global economy (Jerald, 2008).

Development for a new framework for science education was not far behind and began development as a draft framework for the NGSS. Since the NGSS development, New York State began adapting the standards in 2015 (NYSED, 2015). The New York State Board of Regents developed and adopted the new standards in December 2016, released a statewide strategic plan for science education, and set out for the new standards to become effective July 1, 2017 (NYSED, 2016). These new standards replaced those developed in 1996, which lacked the 21st-century skills students need to succeed in the current global economy (Kay, 2011). New York State has developed and begun implementing a timeline to help transition between the different sets of standards over five years (NYSED, 2022). This five-year plan lays out implementation beginning in July of 2017 and ending with full implementation of the NYSSLS and the end of the current standards beginning in the 2021-2022 school year (NYSED, 2019).

In the winter of 2019, a viral pandemic reached New York State. This unprecedented pandemic forced the closing of schools to in-person learning and caused a shift to learning remotely over a digital platform (Francom, 2021). This caused the original timeline of the implementation of the NYSSLS to be revised and pushed back. Total implementation and administration of the new assessments were scheduled to be completed and in place by September 2024 and are now projected to be implemented and in place by June 2026 (NYSED, 2022).

History shows a continuous effort to increase student achievement through legislation and the implementation of new standards. Through reform, teachers are often asked to change methodologies, content taught, and pedagogy to help conform to the lastest shift in education. Historically, science standards focused on specific content and

memorization of facts. The NYSSLS, like the NGSS, focuses on a deeper understanding of the phenomena and the interactions that occur (Pruitt, 2017). This study examined the implementation of the NYSSLS and teachers perception of the change.

Purpose of the Study

This study examines in-service science teachers' and administrators' perceptions of implementing the NYSSLS and their experiences implementing the new standards in their classrooms. The NYSSLS and its implementation in schools call for a shift from traditional teacher-centered teaching models to an experience-centered model driven by experienced phenomena and inquiry. This new set of standards sets the framework for a shift in how the material is presented to the students and in the way that material is learned and explored. A comprehensive plan for implementing the new standards with fidelity can begin by examining in-service science teachers' and administrators' vision, perceptions, experiences, educational beliefs, and voices. This study explored the current implementation practices, potential barriers, and the resources needed to implement the new NYSSLS properly.

Theoretical Framework

The theoretical framework for this study is based on Andy Hargraves' and Michael Fullan's (2012) Professional Capital Theory and Peter Senge's Five Disciplines of Learning Organizations (2006) to investigate perceptions of mandated science curriculum change. Teacher perceptions of change are influenced by the investment in professional capital by the organization (Hargreaves & Fullan, 2012) and the learning organization's ability to expand its capacity to adapt to generate new learning (Senge, 2006).

Fullan, Hargreaves, & Ricon-Gallardo (2015) view professional capital as the collective capacity of the profession and its responsibility for continuous improvement and the success of all students. For change to be successful, policies and corresponding strategies must focus investments on purposeful group learning and collaborative development, leveraging the group to change the group (Fullan, Rincon-Gallardo, & Hargreaves, 2015). The professional capital view of teaching assumes that good teaching is technically sophisticated and challenging, requires high levels of education and long periods of training, perfected through continuous improvement, involves wise judgment informed by evidence and experience, shares collective accomplishment and responsibility, and maximizes, mediates and moderates instruction (Hargreaves & Fullan, Professional Capital: Transforming Teaching in Every School, 2012). Hargreaves & Fullan (2012) express their theory of professional capital (PC) is the culmination of human capital (HC), social capital (SC), and decisional capital (DC). These three types of capital combine to form professional capital to amplify and produce effective teaching and learning for the entire profession (Hargreaves & Fullan, 2012).

While Fullan and Hargreaves (2012) focus on the professional capital of the organization, Senge (2006) shifts the focus to the individual to enable the learning organization. According to Peter Senge (2006), it is in a person's nature to learn, and their love of learning enables the learning organization to exist. Learning organizations tap into this love of learning, commitment to learning, and the capacity to learn at all levels to ensure organizational success. Senge defines a learning organization as “organizations that can truly “learn,” that can continually enhance their capacity to realize their highest aspirations” (Senge, 200g, p. 6). Senge defined five disciplines converging to innovate

learning organizations: Systems Thinking, Personal Mastery, Mental Models, Building Shard Vision, and Team Learning. These five disciplines are each developed separately but will be critical to the other dimensions' success. Learning organizations enable groups to achieve more than the individual through integration and support of Senge's Five Disciplines; my study will investigate the implementation process and potential barriers through the lens of the five disciplines.

Although two separate theories, Professional Capital and the Five Disciplines of learning organizations, can be utilized together to help guide change. The researcher integrated both frameworks and constructed a merged framework to examine organizational change. Building professional capital within Senge's five disciplines establishes an efficient framework for a sustainable and robust learning organization amidst an evolving instructional shift in curriculum and pedagogy. This study aims to find the barriers to implementing the NYSSLS in the learning organization through the merged theory uniting Fullan, Hargreaves & Senge.

Significance of the Study

With the push for new standards and a shift in teacher pedagogy, the NYSSLS represents the most significant shift in science education in New York State since the development of the 1996 learning standards. The development and implementation of the National Science Education Standards 1996 across the country sparked states like New York to reassess or develop standards following the new methodology and approaches. The new focus on implementing science standards and learning methods based on the NGSS has again caused New York State to reevaluate the standards and develop the new NYSSLS.

New York State is currently going through phase one of the NYSSLS implementation that brings awareness of the new standards to the state's various schools. Bridging off the NGSS, New York State adapted the NYSSLS for its purposes, keeping most of the standards from the NGSS but breaking them down into different domains. Historically, educational reform and innovation are not without resistance (Terhart, 2013). Although there has been extensive research on educational change and teacher reaction (Snyder, 2017; Hargreaves, 2006; Hargreaves, 1998), there is a significant lack of research on teacher reaction to change in the context of science education (Baghoussi & El Ouchdi, 2019; Hargreaves, 2006; Snyder, 2017; Terhart, 2013). Adopting the NYSSLS required a shift in content knowledge and teacher pedagogy. This transition drastically differs from the former learning standards for Math, Science, and Technology adopted by New York State in 1996. These new standards require new pedagogy and a shift from previous training in the science content. This intensive shift in the science education model fosters the opportunity to focus research on curriculum change in science education. While the implementation of the NYSSLS is still ongoing and success is still largely undetermined, it is imperative to determine the current perceptions of the new standards and their implementation amongst in-service teachers and administrators in New York State. This study investigated teacher and administrator perceptions of implementation and barriers to the NYSSLS through the lens of the professional capital theory. This study determined the existing knowledge and perceptions of in-service teachers in New York State regarding the NYSSLS, identified the shifts in classroom practices resulting from the new standards, and determined possible barriers to implementing the NYSSLS in New York State.

Connection to Vincentian Mission

The Vincentian Mission strives to provide excellence in education for all people, especially those who lack physical, social, or economic advantages (St. John's University, 2022). This study aims to identify potential barriers to promoting the proper implementation of the NYSSLS and increase global connections for advancing education in the field of science. This study will help identify possible institutional structures that hinder improving science instruction, implementation, and progress.

Research Design and Research Questions

This study used a qualitative case study approach to explore the implementation of and the current perceptions of in-service teachers and administrators in New York State regarding the NYSSLS. This case study approach will allow exploration of the lived experience of in-service teachers and administrators in a New York school district. The sample consisted of 12 in-service teachers and two administrators. Data collection methods included teacher focus groups, individual teacher interviews, individual administrator interviews, and documents from New York State; professional development and district-provided resources were utilized to develop a deeper conceptualization of the research topic.

1. What was the process of implementing the NYSSLS? How did key stakeholders, educators, and administrators respond to this process?
2. How do in-service educators in a particular school district perceive the NYSSLS?
3. What are in-service teachers' perceptions regarding the impact of the NYSSLS reform on their professional practices in science education?

This study used purposeful sampling to select New York School District participants. The participants for this study included 15 Science teachers and two administrators from a New York School District that is implementing or preparing to implement the mandated curriculum changes outlined in the NYSSLS. Individuals were recruited through an email seeking volunteers for the study, including a Microsoft form that interested parties filled out to participate. After selecting volunteers, they were placed into two focus groups. Individual teacher-participant interviews were selected from the focus groups, and two administrator interviews were conducted. An analysis of documents included science department meeting agendas, the NYSSLS standards framework, and teacher classroom observations.

Definition of Key Terms

Common Core State Standards (CCSS) – Common Core State Standards are a set of high-quality academic standards in mathematics and English language arts created to ensure that all students graduate from high school with the skills and knowledge necessary to succeed in college, career, and life, regardless of where they live (CCSS, 2022).

Next Generation Science Standards (NGSS) – The Next Generation Science Standards are standards for K-12 Schools that set expectations for what students should know and be able to do through dimensions that include crosscutting concepts, disciplinary core ideas, and science and engineering practices. (NGSS, 2022).

Dimensions – Represent the three significant elements of science and engineering that, when properly integrated, provide students with a context for the content of science, how science knowledge is acquired and understood, and how concepts that have meaning

across the disciplines connect the sciences. Engineering is a set of systematic practices applied to derive solutions to human problems (NYSED, 2018).

Crosscutting Concept (CCC) – According to the NGSS, *Crosscutting Concepts* are concepts that hold true across the natural and engineered world. Students can use them to make connections across seemingly disparate disciplines or situations, connect new learning to prior experiences, and more deeply engage with material across other dimensions. The NGSS requires that students explicitly use their understanding of the CCCs to make sense of phenomena or solve problems (NGSS, 2018).

Disciplinary Core Idea (DCI) - *Disciplinary Core ideas* represent the fundamental ideas for understanding a science discipline. The core ideas all have broad importance within or across science or engineering disciplines, provide a vital tool for understanding or investigating complex ideas and solving problems, relate to societal or personal concerns, and can be taught over multiple grade levels at progressive levels of depth and complexity (NGSS, 2018).

Science and Engineering Practices – practices that are emphasized to construct each performance expectation. There are eight science and engineering practices in the NGSS and NYSSLS. The practices are what students DO to make sense of phenomena. They are both a set of skills and knowledge to be internalized. The SEPs reflect scientists' and engineers' primary methods to investigate the world and design and build systems (NRC, 2018).

New York State Education Department (NYSED) – The governing body of education in New York State, run through the University of the State of New York (New York State Education Department (NYSED), 2019).

New York State P-12 Science Learning Standards (NYSSLS) – New York State Science Learning Standards are a new Framework for teaching science in grades P-12 in New York State based on the NGSS. (NYSED, 2016).

National Research Council (NRC) - is an organization committed to improving public policy and decision-making and promoting the acquisition of scientific knowledge (NRC, 2012).

Inquiry-Based Learning (IBL)- Inquiry-Based Learning is a style of learning and teaching in which the teacher's a facilitator, and students engage in the content by exploring phenomena, asking questions, and solving problems (NRC, 2012)

Problem-Based Learning (PBL) – Problem-Based Learning is a style of learning and teaching in which the teacher presents the students with a predefined problem, and the students are then empowered to research, apply their knowledge, and collaborate to solve the problem (English, 2013).

Project-Based Learning (ProjBL) – Project Based Learning is a learning style in which students work on a project over an extended period, exposing them to a real-world problem or complex question and helping them to research to solve the problem. Once the student or students have come up with a possible solution, they present it (English, 2013).

STANYS - is an acronym for the Science Teachers Association of New York State. This organization's mission is to promote excellence in science education and collaboration to provide opportunities for all students to participate in and learn science in New York State.

Chapter 2 Literature Review

Introduction

This chapter reviews the existing literature and presents the research findings. The research presented in this chapter was obtained through peer-reviewed journals, books on educational theory and teaching, web resources, and national and state educational policy. This section begins with a discussion of the theoretical framework for the study. The findings from the literature have been structured into the following: 1) History of changes in science education; 2) Research on effective teaching practices in education and science education; 3) Research-based best practices; 4) research on teacher professional development and change. This section closes with a discussion of the gaps in the existing literature, which this study addresses.

Theoretical Framework

In response to the ever-evolving society and economic market, a new set of p-12 learning standards was developed to help students prepare to compete in this rapidly changing job market by advancing their 21st-century science skills, abstract reasoning, collaboration skills, ability to learn from peers and technology and to develop their flexibility as learners (NYSED, 2018). This shift requires teachers to change their daily teaching to help address and prepare students with necessary 21st-century learning skills. The theoretical framework for this study is based on Andy Hargraves' and Michael Fullan's (2012) Professional Capital Theory and Peter Senge's Five Disciplines of Learning Organizations (2006) to investigate perceptions of mandated science curriculum change. Teacher perceptions of change are influenced by the investment in professional

capital by the organization (Hargreaves & Fullan, 2012) and the learning organization's ability to expand its capacity to adapt to generate new learning (Senge, 2006).

Professional Capital Framework

Fullan, Hargreaves, & Ricon-Gallardo (2015) view professional capital as the collective capacity of the profession and its responsibility for continuous improvement and the success of all students. For change to be successful, policies and corresponding strategies must focus investments on purposeful group learning and collaborative development, leveraging the group to change the group (Fullan, Rincon-Gallardo, & Hargreaves, 2015). The professional capital view of teaching assumes that good teaching is technically sophisticated and challenging, requires high levels of education and long periods of training, perfected through continuous improvement, involves wise judgment informed by evidence and experience, shares collective accomplishment and responsibility, and maximizes, mediates and moderates instruction (Hargreaves & Fullan, 2012). Hargreaves & Fullan (2012) express their theory of professional capital in a formula (figure 1) where PC is professional capital, HC is human capital, SC is social capital, and DC is decisional capital. These three types of capital amplify each other and produce effective teaching and learning for the entire profession (Hargreaves & Fullan, 2012).

Figure 1

Hargreaves & Fullan's Professional Capital Formula

Note: Reprinted from A. Hargreaves and M. Fullan (2012). Professional capital: Transforming teaching in every school (p.88), 2012, Teachers College Press New York, NY. Copyright 2012 by Teachers College Press.

Human capital refers to people's skills and economically valuable knowledge that can be developed through training and education (Hargreaves & Fullan, 2012). This view of education recognizes the value of investing in a person's skills and education to realize an economic return later. Human capital in teaching requires in-depth knowledge of your content and how to teach it, having developed the requisite knowledge and skills to teach and understand children and how they learn, and possessing the passion and emotional capabilities to empathize and relate to various stakeholders in the organization to serve all students and increase the individual capabilities as you continue in the profession (Hargreaves & Fullan, 2012). Social capital exists in the relations among people. It builds on the power of the group by enabling teachers to collaborate and learn from each other by building networks of trust, learning, collaboration, and communication (Hargreaves & Fullan, 2012). The higher the quality of these interactions and relationships, the more capital they yield and the more significant the results. Hargreaves and Fullan argue that the greater the social capital in the school's culture, the more chance of successful

change. Teachers need colleagues to help them fuel and direct their efforts, to pick them up when they are down or have made a mistake, to offer constructive feedback, and to help push change forward. Decisional capital is the ability to make wise judgments when insufficient data guides a person. Decisional capital is developed and acquired through structured and unstructured practice, reflection, and experiences. It is enhanced by recalling and drawing on the experiences and insights of colleagues in forming judgments and decisions over many different occurrences (Hargreaves & Fullan, 2012).

Hargreaves and Fullan (2012) maintain that professional capital is the cornerstone concept that highlights and defines what is necessary to create high performance and quality in all professional practices during times of change and is vital for the future of society and the teaching profession.

Current use of the Professional capital theory in the literature

The following studies validate Fullan and Hargreaves's (2006) theory of professional capital. Melesse & Belay (2022) examined the link between engagement in diverse professional learning activities, job satisfaction, and teacher professional capital development. For the study, the researchers used a quantitative correlational design using a sample size of 302 teachers, 188 male, and 114 female, from primary schools in Banja Woreda, Ethiopia. Participant experience ranged from 1 year to 31 years, and 240 held diplomas, while 62 were first-degree holders. Melesse & Belay utilized the survey inventory developed by Hargreaves and Fullan (2012) and validated by Sintayehu (2021). The scale included three dimensions: human capital, social capital, and decisional capital, using a 5-point Likert scale ranging from 1 strongly disagree to 5 strongly agree. Teacher engagement in professional development was also investigated using a scale developed

by Sintayehu (2021) broken down into two dimensions: teacher engagement in individual professional learning activities and teacher engagement in collaborative professional learning activities. This survey also utilized a 5-point Likert scale ranging from 1 never to 5 always. The last area investigated was teacher job satisfaction using a scale developed by OECD (2020) and validated by Sintayehu (2021) using a 5-point Likert scale that ranged from 1 strongly disagree to 5 strongly agree. Melesse & Belay found that individual professional learning activities had a significantly stronger positive effect on teachers' professional capital development than job satisfaction. The results indicate that teachers who perceived a higher level of engagement during individual professional learning opportunities and higher job satisfaction showed increased perceived growth of professional capital (Melesse & Belay, 2022). Melesse & Belay also found that teacher job satisfaction is positively and directly related to professional capital development. Increased perceived professional capital positively influences teacher engagement in individual professional learning activities such as reading professional literature, regularly studying lesson materials and textbooks, developing teaching materials, and utilizing student feedback to improve teaching in the classroom (Melesse & Belay, 2022).

Similarly, Coker (2021) utilized Hargreaves and Fullan's (2012) theoretical framework of professional capital. Coker (2021) conducted a study to explore the impact of increased connectivity and access to the Internet using the experiences of professionals from three sectors, education, health, and business, concerning professional learning and their use of technology. Coker conducted semi-structured narrative individual interviews with a loose schedule focusing on interest rather than specific questions. Interviews were conducted face-to-face or over the phone with thirty-two professionals from three

different professions. The interviews were audio recorded and later transcribed and sent to the interviewee to review for accuracy and to remove any identifying information. Interviews were analyzed using an inductive-deductive framework and coded by a single researcher. The themes that emerged from the interviews were challenges (time, distance, cost), attitude to professional learning, Professional networks, professional dialogue, technology use, attitudes, and confidence. Coker (2019) found that professionals in rural areas have less access to their peers, which can negatively impact their decisional capital due to the knowledge being less accessible. Human capital also suffers in rural areas due to a lack of technological capabilities that affect access to support or individual development. Social capital was also hindered in rural areas of Scotland due to the nature of building relationships and trust, which can be impeded over distances without proper access to technological interventions. Networks for professionals and conferences that value rural voice highlighted what technological intervention is capable of, but the challenges of the rural area's access to peers remain a detriment. Coker (2019) found that distance and lack of technology were barriers that did not enable the flow of professional capital. Properly harnessing technology may provide equity and access to new knowledge and create opportunities for increased professional dialogue and capital.

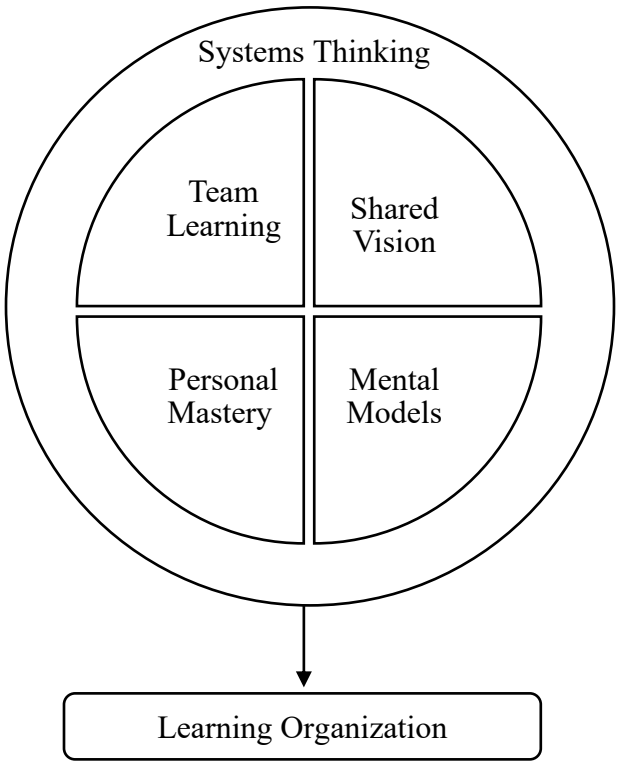
There is longstanding research on change and teacher perception of change. By identifying the organizations' ability to learn, we can identify possible barriers within the organization (Senge, 2006). This study will address the need for research on science teachers' perception of mandated curricular changes and what barriers exist in its implementation to identify potential barriers and recommend possible solutions.

Five Disciplines of Learning Organizations

According to Peter Senge (2006), it is in a person's nature to learn, and their love of learning enables the learning organization to exist. Learning organizations tap into this love of learning, commitment to learning, and the capacity to learn at all levels to ensure organizational success. Senge defines a learning organization as “organizations that can truly “learn,” that can continually enhance their capacity to realize their highest aspirations” (Senge, 200g, p. 6). Senge defined five disciplines converging to innovate learning organizations: Systems Thinking, Mental Models, Personal Mastery, Building Shard Vision, and Team Learning. These five disciplines are each developed separately but will be critical to the other dimensions' success.

Figure 2

Senge's Five Disciplines of Learning Organizations



Note: Adapted from Mildawani, T (2021) Implementation of Senge's Fifth Discipline: Strategy to Anticipate Change, The International Journal of Social Science and Humanities Invention 8(5), 6460-6463

Each dimension provides a path to genuine learning that can extend the capacity to create for the organization's future. Systems thinking "integrates the disciplines and fuses them into a cohesive body of theory and practice," making the learning organization and its aspects understandable (Senge, 2006, p. 12). Systems thinking enables a view of the more extensive system instead of just the most visible parts to enable a shared understanding of complex problems within the organization (Senge, Hamilton, & Kania, 2019). Personal Mastery is the commitment to an individual's lifelong learning. With personal mastery as a dimension, individuals continually clarify and deepen their unique vision, develop patience, focus their energies, and objectively see reality (Senge, 2006).

Mental Models explain how we see the world through generalizations, deeply ingrained assumptions, pictures, or images that influence our understanding and actions (Senge, 2006). When mental models are utilized as a discipline, our current view of the world breaks down. It encourages them to engage in learning conversations to balance advocacy and inquiry with our thinking and open our thoughts to others' influence. Building a Shared Vision fosters genuine commitment rather than compliance by revealing a shared vision and picture of the organization's future instead of dictating the vision. When organizations build a genuine vision shared by all stakeholders, the individuals want to excel and learn (Senge, 2006). Team Learning utilizes dialogue to suspend the team members' assumptions and expand the team's capacity to think together to attain insight not reachable as an individual (Senge, 2006). Team Learning enables individuals to grow more rapidly than they could have alone. Teams, not individuals, are the fundamental learning unit in modern organizations that lead to innovations and progress (Senge, 2006).

The success of a learning organization lies in its interconnectedness to the five disciplines and how they work together to amplify each and lead to innovation and the creation of desired results. The learning organization utilizes the five disciplines (systems thinking, mental models, personal mastery, team learning, and shared vision) to allow and support individuals in their pursuit to develop their capacity to create the desired results continually. Senge (2006) perpetuates that successfully implementing the five disciplines will enable the learning organization to effectively use systems thinking intertwined with the four other disciplines to create a shared understanding to base critical decisions and foster innovation. Implementing new curricular changes can be limited by the

organization's ability to learn and foster growth. This study will explore the organizations' ability to learn and adapt to change as defined by Senge's (2006) five principles.

Current use of Learning Organization theory in the literature

Organizations are constantly evolving and changing while trying to maintain success. There are many frameworks and approaches to develop and influence a successful organization, but the theories have no validity without being backed by research.

Silva (2018) investigated the extent to which research organizations use the Five Disciplines model and how they adapted these disciplines into the organization's culture. The study was conducted in two phases using an exploratory sequential design. The study utilized surveys and interviews to gather qualitative and quantitative data (Silva, 2018). The first phase (pilot phase) collected data through an online survey, two phone interviews, and a scientifically validated questionnaire (DLOQ) developed by Marsick and Watkins to assess organizational learning culture. Phase two collected data on educational culture. A review of the overall DLOQ scores indicated participant organizations had strong leadership but lacked on-the-job learning opportunities, education, and growth. The study recommended performing a learning organization assessment, building a shared vision, promoting a learning culture, and integrating systems thinking as the following steps to ensure proper utilization of the five disciplines.

Similarly, Mufeed (2018) investigated the following factors at the University of Kashmir: the perception of the teaching staff regarding organizational learning practices in the selected institution to compare the perception of male and female teaching staff towards organizational learning, to analyze the perception of organizational learning

across ages and to draw a conclusion to help suggest measures for enhancing organizational learning in the selected institution. Mufeed used a questionnaire distributed to 100 staff members across five of the university's schools. The study found that the staff had a favorable attitude toward organizational learning, with the highest mean score in team learning (3.32) followed by shared vision (3.27), systems thinking (3.25), mental models (3.22), and the lowest area score was personal mastery (3.19). The male staff showed higher satisfaction as compared to females. The perception of organizational learning by age showed an increased perception of learning organizations as age increased. The 50 and above group showed the highest perception, and the 30 – 40-year-old group showed the lowest. The study found a positive correlation among organizational learning practices (Mufeed, 2018).

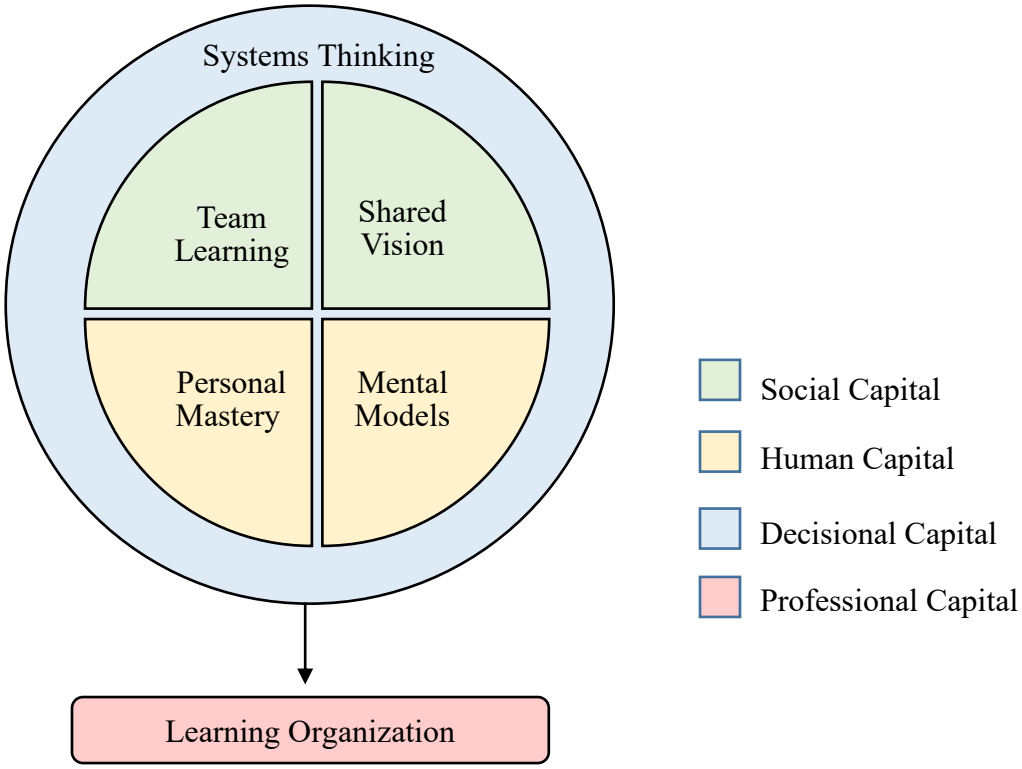
There continues to be longstanding research on organizational change and teacher perception of change. This study will address the need for research on science teachers' perception of mandated curricular changes and what barriers exist in its implementation to identify potential barriers and recommend solutions to overcome them.

Merging Theoretical Frameworks

Although two separate theories, Hargreaves and Fullan's Professional capital theory and Senge's Five Disciplines can be utilized together to help guide change. The researcher integrated the frameworks and constructed the Systems and Capital Model (Figure 3) as a merged framework to help guide change within organizations.

Figure 3

Systems and Capital Model



Using the new construct of the merged framework, new connections can be seen and utilized: (a) Team Leaning and Shared Vision are social constructs that align to harness the power of the group to create and innovate change; (b) Personal Mastery and Mental Models are individual human capital investments that further enhance change; (c) Systems thinking exhibits decisional capital in overseeing human and social capital to ensure a working system of change (d) Learning organizations that are working in tandem with all five disciplines and developing the three different types of capital are generating professional capital to increase the capabilities of the learning organization during change. Building professional capital within Senge's five disciplines establishes

an efficient framework for a sustainable and robust learning organization amidst an evolving instructional shift in curriculum and pedagogy.

Literature Review

The NYSSLS results from the combined efforts of various educational organizations, teachers, stakeholders, and educational professionals over eight years to change how science is taught in New York State. Under the guidance of the NGSS standards, New York State began its expedition to develop a statewide strategic plan for science education and to consider a new set of K-12 science learning standards. This new set of standards requires a shift in how the material is presented and learned in the science classroom, which aligns with how professionals work in the field.

History of Changes in Science Education

NYSSLS Change in Pedagogy in the Science Classroom

The shift to the NYSSLS officially began in January 2015 after the New York State Board of Regents approved a plan to develop a new draft set of standards (NYSED, 2015). The new standards were based on the A Framework for K-12 Science Education: Practices, Crosscutting Concepts, Core Ideas, and NGSS standards. According to the New York State Strategic Plan for Science, "the shift to a new set of standards is an initiative to create a statewide learning community to enhance science education and improve student achievement of the NYSSLS leading to career and college readiness and a scientifically literate population capable of addressing the needs of society, participating in a global economy, and sustaining the physical and living environment" (NYSED, 2015).

In shifting the standards, the state is changing the emphasis of science learning from lecture-based learning to active learning that integrates the most current teaching practices, including hands-on research practices that resemble current scientific exploration research practices (NYSED, 2018). Shifting the focus to three-dimensional learning through experience with scientific phenomena is no small task. It requires a change in how the material is presented to the students and how it is learned.

Central to this change in standards and methods, research shows that educators have multiple responses to change amongst teachers and staff that schools encounter when shifting from one framework to another (Terhart, 2013). Each shift in pedagogy and standards is typically met with resistance to change that must be overcome to drive the change needed for the transition to be successful (Fullan, 2001).

History of Common Core State Standards

In the United States, each state was responsible for writing standards for the schools in their jurisdiction; there were no common state standards to benchmark what students should know by the time they reached each grade level. The No Child Left Behind Act of 2001 was put into place to help "ensure that all children have a fair, equal, and significant opportunity to obtain a high-quality education and reach, at a minimum, proficiency on challenging State academic achievement standards and state academic assessments" (U.S. Department of Education, 2004). It is argued that this legislature paved the way for developing the common core standards in needing a common benchmark to assess student achievement across the country. While individual state standards have been around since the early 1990s, each state had its level of proficiency

regarding the grade level and its standards; this made it difficult to determine what proficiency meant across grade levels across the United States.

The official quest for a national set of standards began in November 2007 at the Council of Chief State School Officers (CCSSO) annual forum in Columbus, Ohio (NGSS, 2018). Following this forum, the Council of Chief State School Officers, the National Governors Association, and Achieve, Inc released "Benchmarking for Success: Ensuring U.S. Students Receive a World-Class Education" in 2008 (Jerald, 2008). This article suggested that the United States upgrade its standards to an internationally benched set of English Language Arts and Math standards from Kindergarten to 12th grade to ensure that students have the necessary skills and knowledge to compete in the global economy (Jerald, 2008).

In 2009, in response to higher interest from states to develop these standards, NGA and CCSSO convened educational policy advisors and chief school officers to begin discussing and committing to the development of a national set of standards for Mathematics and English Language Arts eventually becoming the final release of the Common Core State Standards in 2010. Once this set of standards was released, each state reviewed them to fit their models and replace their current English Language Arts and Mathematics standards.

While states were busy developing common standards for English and Math, a new set for science was not far behind. Development for a new framework for science education was being developed by an 18-member committee of experts appointed by the NRC (NRC, 2018). This group of scientific professionals took 18 months to develop a draft framework released in the fall of 2011 to gain feedback from various stakeholders,

including NSTA, AAAS, and CSSS, among other groups. The framework was also put through the peer-review process to be reviewed before completing the final version put forward in 2013 to be adopted by the states (NRC, 2018). The final document put forward by the groups was the NGSS adopted by twenty states. Similarly, twenty-four states adopted or developed a framework based on the NGSS (NSTA, 2014).

History of Science Education in New York State

The change in science education began in the 1800s under the Jacksonian Democracy and increased funding support for public education. This increase in funding allowed the founding of the AAAS in 1848. This highlighted the formation of a scientific community across the United States (AAAS, 2018). Science education began to boom in the 1940s when legislation was passed that increased education funding in the United States (New York State Archives Partnership Trust, 2009). This legislation eventually led to a restructuring of the AAAS from a simple emphasis on promoting communication to an organized body with a commitment to advancing science and relations (AAAS, 2018)

In response to the final document, the NGSS, New York State approved the Statewide Strategic Plan for Science and began adapting the standards in 2015 (NYSED, 2015). Science teachers in New York State began to prepare a draft of the new K-12 NYSSLS based on a survey that NYSED sent out to stakeholders in science education across the state. Once the draft standards were completed, they were released along with a survey for stakeholders to rate the new standards, which was collected in February 2016 (NYSED, 2016). The New York State Board of Regents adopted the new standards in December 2016, released a statewide strategic plan for science education, and set out for the new standards to become effective July 1, 2017 (NYSED, 2016).

The NYSSLS highlights three necessary dimensions to provide students with a high-quality science education. Dimension one includes science and engineering practices scientists use to investigate the world. Dimension two includes disciplinary core ideas built upon as the students progress through their K – 12 years. The final dimension, dimension three, focuses on the cross-cutting concepts that apply across various science disciplines and enable students to make sense of the phenomena around them (NYSED, 2018). These new standards replaced those developed in 1996 and lacked the 21st-century skills students need to succeed in the current global economy (Kay K., 2011). New York State is currently in its guiding years regarding these standards. It has developed and begun to implement a timeline to help transition between the different sets of standards over five years (NYSED, 2022). This five-year plan lays out implementation beginning in July of 2017 and ending with full implementation of the NYSSLS and the end of the current standards beginning in the 2021-2022 school year (NYSED, 2019).

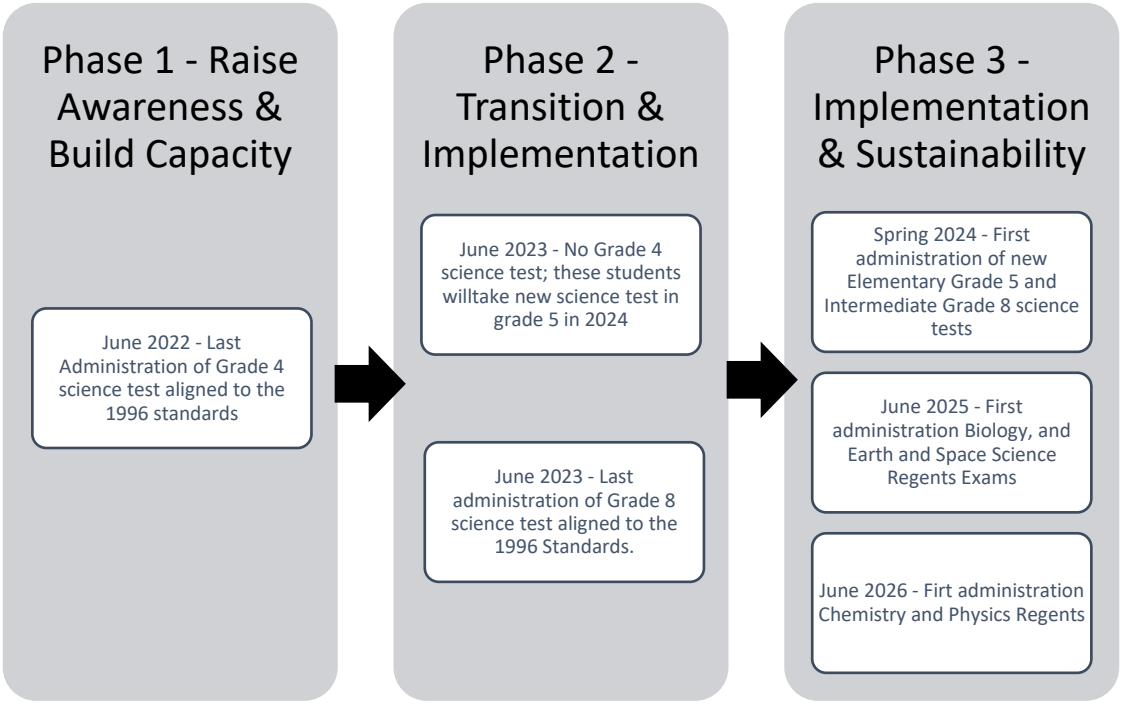
The NYSED NYSSLS Implementation Roadmap outlines this plan in the following phases: Phase I of New York States' implementation begins with raising awareness and building capacity for the new standards from July 2017 to August 2019. The next phase, phase II, focuses on transition and implementation from the old standards to the new standards from September 2019 to August 2021. Finally, phase III continues with implementation and shifts the focus to the sustainability of the standards from September 2021 to August 2024, ending with full implementation of the NYSSLS (NYSED, 2018)

In the winter of 2019, a viral pandemic reached New York State. This unprecedented pandemic forced the closing of schools to in-person learning and caused a

shift to learning remotely over a digital platform (Francom, 2021). This caused the original timeline of the implementation of the NYSSLS to be revised and pushed back (figure 4). Total implementation and administration of the new assessments are scheduled to be completed and are now projected to be implemented and in place by June 2026 (NYSED, 2022).

Figure 4

New York State P-12 Science Standards Development, Adoption, and Implementation



Note: Adapted from "Science Timeline for Development, Adoption, Implementation" by NYSED, *Next Generation Learning Standards Roadmap and Implementation Timeline*, 2022.

NYSSLS/NGSS Framework

The NYSSLS are based on the NGSS standards and New York State stakeholder feedback. The significant change shifting from the 1996 learning standards for Math,

Science, and Technology to the NYSSLS is the change from standards with performance indicators that outlined what needed to be taught and changing them to performance expectations outlining what the students should be able to do at the end of instruction in a particular grade level band. The New York State Board of Regents voted on and approved this new set of standards to begin implementation by the 2017 school year. The board of regents recommended that the standards be rolled out in three different phases: Phase I focuses on the initial transition of the NYSSLS; the main goal is to raise awareness and build capacity. Then, phase II focuses on the transition and implementation from the past standards to the NYSSYS. Finally, phase III focuses on school implementation and sustainability of the standards (NYSED, 2016).

The NYSSLS are based on the NGSS and the Framework for K–12 Science Education developed by the National Research Council (NYSED, 2016). This framework is a series of performance expectations that determine what students should be able to complete due to their understanding of science. The NYSSLS framework focuses on three dimensions: science and engineering practices, crosscutting concepts, and disciplinary core ideas that students need to gain a high-quality education. These three dimensions give students a view into how science is observed, conducted, and understood in the field. The dimensions also focus on how concepts are interconnected between disciplines and woven into everyday life to solve real-life problems (NYSED, 2016).

The first dimension, science and engineering practices, focuses on the primary practices that scientists employ in the field as they explore and build new theories and the procedures engineers use to solve real-world problems (NYSED, 2016). Eight science and engineering practices laid out by the NYSSLS are intended to increase students'

ability to develop an understanding and deepen their skills in science and engineering (NYSED, 2016). These eight standards are: asking questions and defining problems, developing and using models, planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, constructing explanations and designing solutions, engaging in argument from evidence, obtaining, evaluating, and communicating information (NYSED, 2016).

Understanding the Structure of the Framework

As with the NGSS, the NYSSLS is a significant shift in science education, expectations, integration, and how the content is taught. One major shift in these standards is that they are meant to be student performance expectations, not a curriculum set that must be taught, unlike the 1996 learning standards previously used in New York State (NYSED, 2018). These performance expectations outline what students are expected to understand and do after they study the particular band of science presented. The bands each have three dimensions integrated into the standards similar to the NGSS. The dimensions outlined provide students with vital exposure to how science knowledge is acquired and understood, a context for the specific scientific content being studied, and a look at how concepts have a universal meaning across different content areas (NYSED, 2018).

NYSSLS are broken down by grade bands, giving individual bands to preschool – 5th grade and joint bands in middle and high school. Each grade band has a set of performance expectations with clarification statements to guide further what students should do after learning the specified band. Each band is also defined by three major

areas: the science and engineering practices, disciplinary core ideas, and crosscutting concepts in each set of expectation bands, as shown in Figure 5.

Figure 5

Sample band from NYSSLS MS: Space Systems

MS. Space Systems		
MS-ESS1-1. Develop and use a model of the Earth-Sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the Sun and moon, and seasons. [Clarification Statement: Examples of models could include physical, graphical, or conceptual models.]		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. -Develop and use a model to describe phenomena. (MS-ESS1- 1),(MS-ESS1-2)	**ESS1.A: The Universe and Its Stars** -Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS-ESS1-1)	**Patterns** Patterns can be used to identify cause-and-effect relationships. (MS-ESS1-1) **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-ESS1-1),(MS-ESS1-2)

Note: Adapted from "New York State P-12 Science Learning Standards" by NYSED, NYS P-12 Science Learning Standards (MS), 2016.

21st Century Science Skills STEAM/STEM

For our students to be successful and able to compete in the current economy, they must possess specific skills needed in the 21st-century economy. We are currently preparing our students for jobs that do not exist yet but can be obtained by possessing certain skills. The Partnership for 21st-century Learning developed a framework of necessary skills that students need to succeed with input from teachers, experts, and business leaders to narrow down what skills are vital in the ever-evolving economy (Battlle for Kids, 2019). They broke this down into four major areas: Content knowledge

and 21st-century themes, learning and innovation skills, information, media and technology skills, and life and career skills.

Each group comprises different skills necessary to ensure mastery of 21st-century skills and adequately prepare students for the global economy. The first grouping focuses on the critical subject areas and the 21st-century themes. It identifies fundamental subject areas that students need, including reading or language arts, English, World Languages, Arts, Mathematics, Economics, Science, Geography, History, and Government and Civics (Battlle for Kids, 2019). They also emphasize school moving beyond the simple scope of the subject and include interdisciplinary themes such as global awareness, economic, financial, business, entrepreneurial, civic, health, and environmental literacy. The second grouping stresses learning and innovation skills through the four C's: critical thinking, communication, collaboration, and creativity. The third grouping focuses on the need for informational, media, and technology skills, breaking it down into informational, media, and literacy (Battlle for Kids, 2019).

To prepare our students for the 21st century and ensure they have the necessary skills to compete in the global economy, new standards like NGSS have been adopted to elevate science education for all students. Students are now expected to develop an integrated understanding of science as a body of knowledge and apply that knowledge in a practical context. This transformation of science education will not occur without challenges. One of the biggest obstacles is the shift in instructional practice that had previously separated content from process under the previous standards to the inquiry-based approach that requires students to apply crosscutting concepts that unify science and engineering. Inquiry-based learning is the cornerstone of the design of NGSS, and

successful implementation of the new standards requires extensive professional development for the teachers in this instructional practice. Therefore, the quality of the professional development and the application of inquiry-based learning in the classroom will determine how effectively the NGSS is adopted within the school.

Inquiry-Based Learning in Science Education

In science education and other areas of education, Inquiry-based learning has been moved to the forefront of research-based learning strategies to enhance student achievement. Inquiry-based learning is emphasized as an essential method of learning in the acquisition of science skills and processes (Dole, Bloom, & Kowalske, 2015; Panjaitan, 2020; Arce, Bodner, & Hutchinson, 2014; Ogweno, Kathuri, & Nkurumwa, 2021). The American Association for the Advancement of Science and the National science education standards called for increased inquiry in the classroom and focused on using hands-on investigation as the primary student-centered learning method for acquiring the necessary skills (National Research Council, 2012). Inquiry is seen as a best practice due to its nature of teaching by "doing," which models how science is performed in the real world (National Research Council, 2012).

This type of teaching focuses on increasing the ’student's science process skills and creativity (Panjaitan, 2020). Inquiry education comes with various definitions and has been broken down further into more focused practices, Problem-Based Learning, and Project Based Learning (Dobber, Zwart, Tanis, & Van Oers, 2017). In either process, students work closely with the steps of scientific investigation to define a problem, experiment to find a solution or gain more information about the problem. They discover successes and non-successes, plan out further experiments to confirm or dispute their

findings, develop conclusions based on the results, and report those findings to be tested and reviewed (Panjaitan, 2020).

Problem-Based Learning

Studies suggest that Problem-based learning (PBL) is an instructional strategy that focuses on immersing students in problem-solving situations to potentially improve higher-order thinking skills, motivation, attitude, comprehension, and application of knowledge with the teacher as the facilitator and not the lecturer (Lee & Blachard, 2019; Ertmer & Simons, 2006; McConnel, Parker, & Eberhardt, 2018; Savery, 1996; Jerzembek & Murphy, 2013). PBL was developed in the 1950s to help increase medical 'students' skills in clinical reasoning and problem-solving skills (Barrows, 1983; Neufield & Barrows, 1974). This practice was used to increase student capacity to absorb the information around them, understand, retain, and use it in their current work to solve the problem. This approach focuses on six core principles: a learner-centered approach, small group work, teachers as facilitators, authentic, real-world problems to help stimulate learning, the development of problem-solving skills, and self-directed learning (Barrows, 1996).

Various approaches and problem-based learning methods are used in education (Ertmer & Simons, 2006; Savery, 1996; Dole, Bloom, & Kowalske, 2015). In a quasi-experimental research study conducted by Bara & Xhomara (2020), the researchers utilized a constructivist approach to learning where students utilize an active approach to develop their understanding. The researchers used a matching-only design to place students in the control or experimental groups. The study utilized 417 university students who completed a survey based on the relevance of the science education questionnaire

(Camilla and Svein, 2004). The study found a medium positive correlation between problem-based learning and academic achievements (Bara & Xhomara, 2020). This conclusion was also supported by Lee & Blanchard (2018), who used a quantitative study approach to investigate the teachers' perceived ability to implement PBL and their perceived success for their students. The study found that teachers with PBL experience had a higher comfort level with PBL teaching and had greater expectations of academic success and collaboration from their students than those unfamiliar with PBL.

According to English & Kitsants (2013), the main objective of PBL is to focus on the learners as constructors of their knowledge. This construction of knowledge must be in the content being taught, and where they would then apply the knowledge, they will develop creative and critical thinking strategies (Savery, 1996). This will ensure students are monitoring their understanding and are actively involved in their learning. The study done by Ogweno et al. (2021) utilized a quasi-experimental design that followed nonequivalent control groups in Kenyan Secondary Schools to determine the effects of PBL on student academic achievement. The study utilized twelve secondary schools in Kenya, six following the Problem-Based Learning Model and six following the lecture teaching method. At the end of the study, the pre and post-tests for each group were analyzed, and the findings showed that the students taught under the PBL method had higher learning outcomes than their counterparts in the lecture teaching method. This study shows that it is beneficial to immerse the learner in the problem at hand and give more profound meaning and motivation to the learning while collaborating with their peers to solve the issue. PBL's strength lies in its ability to increase ’students' ability to attain higher levels of competency and transferrable skills through meaningful practice

(Ertmer & Simons, 2006; Ogweno, Kathuri, & Nkurumwa, 2021). PBL aims to deepen their understanding of the subject matter being investigated while building ’students' higher-order thinking skills to help prepare them for future challenges (Ogweno, Kathuri, & Nkurumwa, 2021).

Challenges of Problem-Based Learning

PBL is not without difficulties; Studies demonstrate that developing a practical PBL problem requires significant changes for teachers, students, administration, and the learning environment, which is heavily research-intensive and time-consuming (Camacho, Rybels, Coppens, & Pineda, 2020; Ertmer & Simons, 2006; Nurlaily, Soegiyanto, & Usodo, 2019). PBL problems must be well structured and allow for multiple solutions but narrow enough to enable the students to see the problem being given (An, 2013; Lee & Blachard, 2019). The switch to student-centered teaching is not easily implemented in the classroom as it forces teachers to take on a guiding role and attend to various aspects of the learning environment simultaneously (Brush & Saye, 2000). This can be difficult for teachers who do not have enough support or guidance in PBL (Ertmer & Simons, 2006; Goodnough & Hung, 2008). Ertmer and Simmons outline further implementation challenges: "creating a culture of collaboration and interdependence, adjusting to changing roles, and scaffolding student learning and performance.” (Ertmer & Simons, 2006).

Nurlaily et al. (2019) used a qualitative descriptive study using purposive random sampling through in-person individual interviews. They found that two significant areas face challenges in implementing PBL: the planning and implementation stages. The significant issues found in the planning stage were the construction of the lessons that

took a long time to create, making teachers reluctant to use the PBL method because it was time-consuming and complicated (Nurlaily, Soegiyanto, & Usodo, 2019). Teachers were also concerned about the learning objectives not being achieved using a PBL approach. The second area of concern highlighted by Nurlaily et al. (2019) was in the implementation of PBL; students were not accustomed to this type of learning and did not know how to identify and understand the problem due to their limited exposure to a PBL environment.

Camacho and Rybels et al. also explored PBL implementation literature. They discussed three of the most common difficulties in PBL implementation: challenges in the organization's culture, changes in the teacher value system, and changes in the instructional organization and structure (Camacho, Rybels, Coppens, & Pineda, 2020). Similarly, Bouhuijs found that PBL affects three levels: the teacher, the program, and the organization. Teachers, Students, and the organization need adequate preparation and training on the why and how of PBL for PBL to be successfully implemented (Bouhuijs, 2011).

Project-Based Learning

Project Based Learning (ProjBL) is similar to Problem-based learning. Still, it differs in that it is an instructional strategy that focuses on the completion of projects or complex tasks that challenge students to solve questions or problems by designing, problem-solving, decision-making, and investigating the project over an extended period to develop a real-world product or presentation (Dole, Bloom, & Kowalske, 2015; English & Kitsantas, 2013; Lazic, Knezevic, & Maricic, 2021; Martinez, 2022; Bell, 2010). Project-based learning is student-centered, focusing on real-world tasks that

simulate a professional situation. The students utilize self-directed learning according to specific parameters or project frames (Isa & Azid, 2021). Project-based learning differs from problem-based learning because students use a case-specific understanding to develop a suitable product or presentation. Project-based learning yields higher scores and motivates students more than traditional lecture-based education (Lazic, Knezevic, & Maricic, 2021; Puangspunsi, 2021; Bell, 2010; Martinez, 2022).

Lazic et al. investigated the influence of project-based learning on student achievement in elementary math in Serbia. The study used an experimental group comprising three third-grade elementary classes in one school and a control group, each containing three 3rd grade elementary classes in a different school. The students were all given a pre-test at the beginning and a post-test at the end of the study. Students scored uniform results in the pre-test, but when analyzing the post-test scores, students in the project-based learning group were significantly higher than those in the control group. This finding supports using project-based learning to increase student achievement as a best practice in teaching (Lazic, Knezevic, & Maricic, 2021).

Similarly, Martinez (2022) engaged in a mixed methods research design to examine 'teachers' knowledge and confidence in designing a project-based learning curriculum. The study included 16 in-service teachers participating in a master program class on curriculum and instruction. The participants were secondary school teachers from five different districts and varied in their content area specialties. Participants were given two pre-post surveys, one to measure confidence in PBL design and one to measure knowledge of PBL principles. Each participant had an end-of-course interview and submitted an integrated cross-curricular PBL unit completed during their time in the

course. The study found a strong positive relationship between confidence in designing a PBL unit and 'teachers' knowledge of PBL. Martinez also found that for change in the classroom to be meaningful, there needs to be sustained collaborative practices for teachers to develop and implement their skills.

Teacher education in Project-Based Learning is an excellent indicator of increased student achievement. Student perception of their learning also affects student achievement (Puangspunsi, 2021). Puangpunsi used a mixed methods approach to examine 'students' perceptions of using PBL in 21st-century skills and how it influenced English Language Learning. They used 104 participants enrolled in a university English course. Students were given two questionnaires, one using a 1 – 5 Likert scale and one using a system of 12 checkboxes. Students were also investigated further by semi-structured interviews. Puangspunsi found that 'students' positive perception of PBL led to higher confidence, increased motivation, and an authentic opportunity to use language skills in real-life scenarios. They also found that implementing PBl simulates productive learning behaviors aligned with the necessary 21st-century skills (Puangspunsi, 2021).

Challenges of Project-Based Learning

Creating project-based learning, similar to problem-based learning, is time-consuming for educators. While there are clear advantages to using project-based learning to motivate and increase student academic achievement, project-based learning is not without its set of implementation challenges (Vasiliene-Vasiliauskiene, Vasilis-Vasiliauskas, Meidute-Kavaliauskiene, & Sabaityte, 2020; Baghoussi & El Ouchdi, 2019; Viro, Lehtonen, Joutsenlahti, & Tahvanainen, 2020) a study by Viro et al., teacher perception of project-based learning was examined by surveying Finnish classroom

teachers. The study used two surveys to identify perceptions and barriers to project-based learning implementation in math and science courses. The researchers found that the critical characteristics of PBL were the development of teamwork skills and the connection between theory and practice. The findings also found that educators lack the necessary resources and support to implement project-based learning with fidelity (Viro, Lehtonen, Joutsenlahti, & Tahvanainen, 2020). The research also outlined critical school supports such as time to plan and implement project-based learning, ready-made project instructions, idea tips, advice from experienced teachers, and training for project-based learning issues would enhance the success of project-based learning (Viro, Lehtonen, Joutsenlahti, & Tahvanainen, 2020).

Similarly, Baghoussi & El Ouchdi (2019) found that when studying in a third-year secondary school, the absence of detailed guidelines for each project fulfillment and the lack of Project Based learning training for teachers hinder the use of project-based learning in the classroom. Baghoussi & El Ouchdi (2019) also found that other influences that impede the use of project-based learning include obstacles like crowded classes, the length of the program, and the baccalaureate exam requirements. They found that teachers opted to utilize project-based learning as a culminating final project rather than a central instructional pedagogy; researchers view this as a potential starting point for a gradual shift in pedagogy (Baghoussi & El Ouchdi, 2019).

Vasiliene-Vasiliauskiene et al. (2020) also found that the positive results of increased academic achievement could only be realized with appropriate teacher training, strategies for teacher collaboration, methods for shifting pedagogy from teacher-centered to student-centered instruction, and tools for scaffolding student learning through the

project-based learning method (Vasiliene-Vasiliauskiene, Vasilis-Vasiliauskas, Meidute-Kavaliauskiene, & Sabaityte, 2020). They further outline that project-based learning is a time-consuming collaborative process, and time needs to be allocated for teachers to successfully develop and implement the strategy successfully.

Summary

Inquiry-based learning through problem-based or project-based approaches shows repeated positive relationships between the use of methodology and increased student achievement and student motivation toward learning (Bara & Xhomara, 2020; Arce, Bodner, & Hutchinson, 2014; Brush & Saye, 2000; Isa & Azid, 2021; English & Kitsantas, 2013; Lee & Blachard, 2019) As educational pedagogy shifts new advancements in teaching methodology, and best practices begin to emerge and move to the forefront of education. This research-based best practice is sound in theory and backed by research and technique. However, it often lacks the necessary support in the current educational system to enact the change they were designed to accomplish (Bouhuijs, 2011; An, 2013; Ertmer & Simons, 2006).

Research on Teacher Professional Development and Change

Ongoing professional development for teachers is a standard institutional practice that can influence an organization and its teachers (Ke, Yin, & Huang, 2019; NYSED, 2016; Gupta & Lee, 2020; Main & Pendergast, 2016). Many professional organizations and state teacher licensing requirements also require professional development hours. New York State teachers must complete 100 hours of continued teaching and leader education (CTLE) every five years to maintain their teaching certificates (NYSED, 2021). The main goal of teacher professional development is to increase teacher

knowledge and capacity and help develop teachers as professionals to improve student academic achievement (Gupta & Lee, 2020; Ke, Yin, & Huang, 2019; Ke, Yin, & Huang, 2019).

China has come to the forefront of research among the countries requiring school-based, job-embedded professional development due to its scores on the Programme for International Student Assessment (PISA) tests. Ke et al.(2019) used a questionnaire survey with stratified random sampling using four districts with differing economic development levels. Within those four districts, schools were selected randomly according to student performances, financial capacities, and location variations. Once the schools were established, the 7th and 8th-grade teachers were invited to respond to the survey. 1506 teachers, 470 male and 1036 female teachers with an average experience of 18.68 years from 53 schools participated in the study. The study found that teachers who participated in school-based professional development enhanced their sense of self-efficacy and adopted desirable teaching strategies in the classroom. Ke, Yin, and Huang also found that the frequency of professional development did not significantly affect teacher efficacy and strategies. They discovered that collaborative lesson planning and teacher collegiality significantly affected teacher self-efficacy and teaching strategies. The study also highlighted the role of teacher-collegial relationships as teacher collegiality had the highest positive effects on teacher efficacy and adoption of desirable teaching strategies (Ke, Yin, & Huang, 2019).

Gupta and Lee (2020) used a mixed methods design to determine ’participants’ perceptions, experiences, methods of instruction, and student achievement. The study occurred at a Title 1 school with a total enrollment of 780 students; 98% were African

American, and 95% received free or reduced lunch. The researchers used teacher questionnaires, classroom observations, teacher grades in the course, and student achievement scores related to reading. They found that teachers have varying levels of content understanding, background knowledge, and training expectations, and it is critical to assess these factors to tailor professional development toward the 'group's exact needs. 'Teachers' ratings indicated that the professional development material was mastered well and supported the 'teachers' scores of mostly 'A's and 'B's in the course. Gupta and Lee also found that teachers utilized and implemented the targeted skills and strategies consistently in the classroom, but the workshop covered many other techniques that were not seen. When investigating student reading achievement, the study had mixed results; there was a slight gain in the grade level equivalents, and most students did show progress on the benchmark scores. Still, they did not keep pace with the progress of the norm group throughout the year and did not perform well on the STAR assessments compared to the norm group (Gupta & Lee, 2020).

Similarly, Main and Pendergast (2016) investigated the effectiveness of professional development around major reform using many participants in Queensland, Australia. A mixed methods approach was used where SPSS analyzed the quantitative data, and Leximancer was used to analyze qualitative data in extended responses. Main and Pendergast utilized two surveys; the first focused on the Targeted Professional Development Scale (TPDS) using a five-point Likert scale. The second survey also incorporated TPDS but focused on 'participants' perceptions of program effectiveness, increased understanding, and process and content effectiveness. The program was delivered to 258 public secondary schools; each was multifaceted and conceptually built

around the Educational Change Model (Pendergast et al., 2005). The study included five core features endorsed in the literature critical components for effective teacher professional development: Content Focus, Active Learning, Coherence, Duration, and Collective Participation (Desimone, 2009). The study found that participants viewed professional development as relevant and worthwhile. Participants could choose and utilize the most impactful and relevant components of their daily practice. This study emphasized the need for collective participation and highlighted the need for collaborative planning time and ongoing support while utilizing the strategies to develop as teachers. While the majority of the results from the study found positive correlations, the study did bring up the need for training and support before starting any actions, and some participants felt that even though the professional development was beneficial, it also came too late in the process.

Professional development in education can be a valuable part of a 'school's culture and climate. Through the research, it is shown that professional development that is relevant and tailored to the needs of the group can help to support and inspire change through collaboration and help to increase teacher self-efficacy.

Professional Development in Science Education

Implementing inquiry-based science education is challenging for educators (Almuntasheri, Gillies, & Wright, 2016; NYSED, 2016; Havice, Havice, Waugaman, & Walker, 2018). Research has emphasized the effectiveness of inquiry-based education and its positive effect on student learning. Despite this abundant research, enacting inquiry in the science classroom is still problematic (Almuntasheri, Gillies, & Wright, 2016).

Alumtasheri, Gillies, and Wright (2018) investigated the effectiveness of a guided inquiry professional development program with the current teacher-directed model in improving 'students' understanding and explanation of science. The researchers focused on density content and split the teachers into guided inquiry and teacher-directed groups. The guided inquiry group participated in professional development activities where they explored inquiry activities that strengthened the 'students' conceptual understanding of density. The teacher-guided group taught their lesson based on the prescribed Saudi Arabian science curriculum. The participants were six male teachers from 6 schools split randomly between the two conditions, all with at least ten years of teaching experience. The student participants were 118 male students from similar backgrounds and enrolled in the designated 'teacher's classes; 107 students completed both the pre and post-test; there were 55 in the guided inquiry group and 52 in the teacher-directed group. Alumtasheri, Gillies, and Wright found that students exposed to a guided inquiry approach showed an increased conceptual understanding of density than their peers and scored higher on the multiple-choice and short-answer portion of the test. The researchers argue that these findings support the need for teacher professional development in inquiry-based practice to help foster appropriate support strategies for students during learning (Almuntasheri, Gillies, & Wright, 2016).

Yang, Liu, and Gardella (2018) investigated a similar study that examined teacher professional development on 'teachers' content knowledge, inquiry teaching practices, and 'students' understanding of interdisciplinary science concepts. The study utilized an Interdisciplinary Science and Engineering partnership 5-year professional development program. Yan, Liu, and Gardella (2018) collected data from teacher surveys, teacher

professional development records, teacher pedagogical content knowledge (PCK) tests, and student surveys. Teachers were chosen on a volunteer basis and were administered PCK tests every summer. Their students were administered an interdisciplinary content test at the beginning and end of the year. Teachers could choose from three types of summer professional development opportunities: Interdisciplinary research, science curriculum study, and a college course in physics and engineering. Teachers were all required to submit an interdisciplinary science inquiry (ISI) plan that closely modeled the science content they were teaching. They then conducted the research under the STEM faculty at the university. Teachers also were a part of professional learning communities (PLC) that focused on facilitating teacher implementation of interdisciplinary science inquiry in the classroom. The PLC followed a similar sequence in each session, starting with an introduction to the interdisciplinary science inquiry framework focusing on the nature of science. Then, workshops focused on specific strategies to implement interdisciplinary science inquiry in various science content areas and concluded with teacher reflection and sharing of experience integrating interdisciplinary science inquiry in the classroom. The study found that teachers who participated in interdisciplinary science inquiry (ISI) research and professional learning communities scored higher on the pedagogical content knowledge tests. They also found that students whose teachers had more than 150 hours of professional development scored significantly better on the interdisciplinary science test than their peers (Yang, Liu, & Gardella Jr., 2018).

Integrative STEM education requires teachers of all experience levels to undergo training and increase their learning and concept implementation success in the classroom (Havice, Havice, Waugaman, & Walker, 2018). Havice et al. investigated the

effectiveness of an integrative STEM education institute in 7 school districts in South Carolina. The institute was designed for teachers in grades K – 5 to empower teachers and administrators with the tools and confidence to implement integrative STEM in their classrooms and schools. The institute utilized content coaches to assist schools in developing integrative STEM curriculums that utilized and solved real-world school-based problems. The team used two pre- and post-survey surveys to investigate the immediate outcomes and effectiveness of the professional development instruction and the self-efficacy gained by teachers in STEM pedagogy. The second survey examined the long-term effects of the STEM institute through alum participation and the ability to continue integrating the strategies taught in the professional development institution. Havice et al. found that after the institute, all participants reported higher levels of expertise and proficiency than before. There was a statistically significant difference in the pre and post-scores, indicating learning objectives were met during the institute, coinciding with positive teacher perception of the professional development institute. The long-term outcomes also came with positive perceptions that 73% of alums could use the integrative STEM strategies in their classroom, and 62% collaborated with colleagues to help introduce the STEM activities in their schools. Harvice et al. highlights the benefit for teachers at all experience levels to participate in integrative STEM training and enable teachers to implement strategies to support foundational science concepts by exploring the scientific principles.

Bancroft and Nyirenda (2020) reviewed the literature on K-12 science teacher professional development strategies from 2001-2017. They screened the studies, looking for primary, peer-reviewed research articles that focused on the design of professional

development programs for K-12 science teachers. They selected 36 studies that met the requirements set out by the research and found three main themes in the analysis: professional development program context, professional development program research design and methods, and professional development program outcomes. The studies reviewed showed common professional methodology in providing long-term inquiry-based, content-focused experiences aligned to the 'teachers' necessary standards. Studies that utilized a content-centered inquiry-based approach to professional development also reported increased student achievement and engagement through classroom observations and student assessments. Bancroft and Nyirenda also found that teacher self-efficacy and successful implementation increased when given adequate time to practice, develop skills, and collaborate with colleagues to create content-based, student-focused inquiry lessons during professional development programs.

Summary

While implementation of inquiry-based science education remains a challenge for many educators, research has shown that appropriate content-specific training, time allocation for collaboration within departments, and continued support and guidance in developing student materials can lead to higher student outcomes and greater teacher self-efficacy. There is a need for professional development when designing, implementing, and facilitating interdisciplinary science inquiry instruction.

Professional Development Challenges

While continued professional development is integral to teacher education programs and certification agencies and is considered best practice across many states and countries, professional development has challenges. The purpose of high-quality

professional development is to help teachers improve their professional practice and continue to support the life-long learning journey (Tyagi & Kumar Misra, 2021; Eroglu & Donmus Kaya, 2021; Booth, Coldwell, Muller, Perry, & Zuccollo, 2021).

With the growing focus on quality teacher educators, Tyagi and Kumar Misra (2021) conducted a study using a stratified cluster random sampling method. The study used teacher educators teaching Bachelor of Education and master of education classes affiliated with Chaudhry Charan Singh University. The seven aided schools and 14 self-finance teacher education colleges are spread in all seven Meerut and Saharanpur Mandal districts. Researcher-developed surveys collected the data; the first was the teachers' continuous professional development initiatives scale, a three-point rating scale using often, sometimes, and never. This survey included two items in 5 dimensions (collaborative, reflective, constructive, digital, and financial initiatives). The second instrument was also researcher-developed and titled the teacher continuous professional development challenges scale. This scale used a five-point Likert scale ranging from strongly agree to strongly disagree and included 28 items focusing on infrastructural, institutional time managerial, psychological, unavailability of opportunities, and financial type of challenges—the final sample size of teachers that filled out both surveys were ultimately 113 educators.

Tyagi and Kumar Misra found that 50.44% of teachers regularly help junior colleagues with professional development. Discussing classroom experiences was the highest-rated reflection-based professional development initiative, with 57%. The study referenced a lack of opportunity and financial challenges, highlighting the extra expense for professional development not reimbursed by the institution and not easily accessible

nearby. The study also highlighted some of the institutional difficulties of continuous professional development, including lack of time or allowance of leave to participate in professional development activities, lack of time in the day to conduct research and collaborate with colleagues, reluctance to arrange professional development opportunities as well as a lack of access to new literature and methods. Tyagi and Kumar Misra also highlighted time management challenges, including scheduling conflicts between work schedules and professional development opportunities, lack of time at home due to family responsibilities, and insufficient time to engage in professional development activities. Psychological challenges include teachers' perception that professional development is unnecessary and they are already settled in their position. The survey also indicated the need for scheduled professional development within the workday. Despite the small sample size, Tyagi and Kumar Misra briefly look at the challenges highlighted regarding professional development in India.

Similarly, in Turkey, Eroglu and Donmus Kaya (2021) utilized a qualitative approach, and the phenomenology method was used to investigate barriers to professional development among teachers. The study consisted of 12 teachers from different subjects who work in four high schools in Elazig, Turkey. The voluntary study included four female teachers and eight male teachers ranging from 2 years of experience to 27 years of experience. The participants held either a ’bachelor’s degree or a ’master’s degree. The study utilized phenomenological interviews as the primary method of data collection. The interview included a section for teacher demographics and a second section including four semi-structured questions about professional development barriers. The interviews were recorded and transcribed individually and then manually coded using the descriptive

analysis method. Of the original 18 teachers, only 12 participants completed the structured interviews, each ranging from 15 to 20 minutes. Eroglu and Donmus Kaya found four distinct areas regarding barriers related to in-service training programs, school functioning, individual barriers, and others. Barriers related to in-service training programs identified negative attitudes of teachers towards training courses and inconvenient course timing as the two most prominent barriers to in-service training. When looking at the barriers related to functioning at school, the data revealed a flawed teacher performance evaluation system in which teachers who work hard and teachers who do not earn the same wage. Lack of time and a high workload were also identified as barriers. When investigating individual barriers, participants highlighted financial problems due to poor teacher salaries. Other barriers identified included a lack of professional development opportunities or limited school-provided opportunities. Overall, Eroglu and Donmus Kaya found that in-service training programs lack the necessary support for teachers to utilize professional development effectively.

Booth, Coldwell, Muller, Perry, & Zuccollo (2021) employed a mixed methods scoping study to explore mid-career teachers in England. The primary method of data collection was the use of surveys and interviews. Data from the TALIS 2018 survey was also analyzed and used in the study. Mid-career teachers who participated in the TALIS survey reported a reduced need for professional development compared to their early-stage peers. They also reported an increase in barriers and that professional development engaged in is less effective. Focus group participants (62%) expressed that professional development is often outside working hours, leading to conflicts with family and other commitments. Participants indicated the second most prevalent barrier was the cost of

professional development and the lack of incentives to attend. Like Eroglu and Donmus Kaya, Booth, Coldwell, Muller, Perry, and Zuccollo found that nearly a third of participants indicated that provided professional development was not in line with their learning needs and, therefore, ineffective. Large group or whole school professional development was also not perceived as effective as it lacked content specificity.

Summary

While professional development intends to foster growth and collaboration to increase teacher pedagogy and expertise, barriers still exist within its development. Ineffective implementation and planning often lead to negative teacher perception of professional development and a lack of motivation to attend or seek out individual professional development opportunities. Lack of funding or positive institutional emphasis on the importance of professional development can hinder teacher participation in necessary professional development activities.

Conclusion and Gap in the Research

The literature review showed that as educational pedagogy shifts, new advancements in teaching methodology and best practices change in education. Inquiry-based learning through problem-based or project-based approaches has become a prominent strategy in education and shows repeated positive relationships between its use and increased student achievement and student motivation toward learning (Bara & Xhomara, 2020; Arce, Bodner, & Hutchinson, 2014; Brush & Saye, 2000; Che Isa & Azid, 2021; English & Kitsantas, 2013; Lee & Blachard, 2019). With innovation also comes challenges; even though these research-based best practices are sound in theory and backed by research, they often lack the necessary support in the current educational

system to enact the change they were designed to accomplish (Bouhuijs, 2011; An, 2013; Ertmer & Simons, 2006). Research shows that professional development that is tailored to the needs of the group and relevant to the content being taught can help to support and inspire change through collaboration and help to increase teacher self-efficacy (Main & Pendergast, 2016; Gupta & Lee, 2020; Ke, Yin, & Huang, 2019). While teacher professional development can be a vital asset to individual teachers, the research shows that professional development is not always viewed as beneficial or necessary, which can lead to negative teacher perception and a lack of interest in future professional development opportunities (Tyagi & Kumar Misra, 2021; Eroglu & Donmus Kaya, 2021; Booth, Coldwell, Muller, Perry, & Zuccollo, 2021)

Existing research on curriculum change and teacher perception has mainly focused on elementary and higher education, focusing on Mathematic and English curricula and student achievement (Baghoussi & El Ouchdi, 2019; Viro, Lehtonen, Joutsenlahti & Tahvanainen, 2020; Vasiliene-Vasiliauskiene, Vasilis-Vasiliauskas, Meidute-Kavaliauskiene, & Sabaityte, 2020). To provide adequate professional development support and instructional support plans to help assist teachers during the transition and to help develop a more successful long-term change, teacher perception of the mandated curriculum change must be understood. There is a significant lack of research on teacher perception of curriculum change in the content of science education.

This study will add to the existing body of research by examining science teachers' perceptions of the implementation of NYSSLS and how the curriculum changes affect their instructional practice and professional learning. In contrast to earlier studies that treated inquiry-based teaching practices, teacher training and support, and teachers'

receptiveness to change as distinct components in the context of transitioning to the NGSS-defined vision of science education, this research reevaluates these elements by adopting a unified conceptual framework rooted in the Five Disciplines (Senge, 2006) and Professional Capital (Hargreaves & Fullan, 2012). This new approach transcends the conventional repository of analysis and examines the change among these crucial factors to shed light on the intricate connections and dependencies between inquiry-based teaching, teacher development, and the willingness of educators to embrace change. This holistic perspective offers a more comprehensive understanding of the dynamics driving the successful implementation of NGSS-guided science education, ultimately contributing to more effective and sustainable improvements in classroom practices and student outcomes.

Chapter 3 Methodology

Introduction

This chapter outlines the methods and procedures used for data collection and analysis for this study. This study is a qualitative case study. This chapter details the study's case study approach, the methods used, and the procedures followed for data collection, coding, and analysis. (Stake, 1995). This case study examined secondary science teachers' perceptions toward mandated curriculum changes, specifically the implementation of the NYSSLS in a New York Public School District. Data collection methods include teacher-participant focus groups, individual teacher-participant interviews, individual administrator-participant interviews, and a content analysis of documents related to implementing the curriculum changes mandated by the NYSSLS. Documents from New York State, professional development, and district-provided resources were utilized to develop a deeper conceptualization of the research topic.

Research Design

This study employed a case study methodology. This case study included focus groups, interviews, and a review of artifacts. A case study approach is useful when studying the complexity and particularity of a single case to help gain an in-depth understanding of the case by collecting and analyzing multiple data sources (Stake, 1995; Creswell, 2017). A case study approach allowed a greater understanding of current implementation measures and potential barriers in a bounded system. This case study site was chosen based on socio-economic statistics, demographics, and location within New York State. Site selection is widely used in qualitative research when researchers

intentionally select individuals and sites to learn or understand a central phenomenon (Creswell, 2017).

During the case study, I conducted research for three months in the Ivy Vines School District. Employing the case study framework allowed me to capture the participants' lived experiences through multiple methods, including focus groups, individual interviews, and document collection, to see the experiences and potential barriers to NYSSLS implementation.

Research Questions

1. What was the process of implementing the NYSSLS? How did key stakeholders, educators, and administrators respond to this process?
2. How do in-service educators in a particular school district perceive the NYSSLS?
3. What are in-service teachers' perceptions regarding the impact of the NYSSLS reform on their professional practices in science education?

Methods and Procedures

Setting

The researcher selected the setting: the Ivy Vines School District in New York State. As shown in Table 1, the Ivy Vines School District in 2020-2021 had a total student population of 3,634 students, with 1,817 being males and 1,817 being females. The Ivy Vines School District comprises 55% White, 29% Hispanic or Latino, 9% Black or African American, 4% Asian, 2% Multiracial, and 0% American Indian or Alaska Native (NYSED Data Site, 2022). The student population includes 42% who are economically disadvantaged, 19% who are classified as students with disabilities, 5% as English

Language Learners (ELL), and 2% who are homeless Native (NYSED Data Site, 2022). The community in which the school district is located has a median household income of $104,940 and a per capita household income of $40,253 (United States Census Bureau, 2022). The district's overall graduation rate is 91%, with an average per pupil expenditure of 25,312 Native (NYSED Data Site, 2022).

Table 1

2020 – 2021 Enrollment Data the Ivy Vines School District (NYSED Data Site)

Ethnicity	Number of Students	Percentage
American Indian or Alaska Native	1	0%
Black or African-American	324	9%
Hispanic or Latino	1,049	29%
Asian	137	4%
White	2,055	55%
Multiracial	68	2%
Total	3,634	100%
English Language Learners	198	5%
Students with Disabilities	681	19%
Economically Disadvantaged	1,527	42%
Homeless	63	2%
Foster Care	7	0%

Participants

The participants for this study included 12 science teachers and two administrators from a New York School District that is implementing or preparing to implement the mandated curriculum changes outlined in the NYSSLS. This study used purposeful sampling to select New York School District participants. Purposeful sampling aims to understand the central phenomena by selecting "information-rich" participants (Creswell, 2017). Participants were chosen based on their extensive experience teaching science under the previous standards. This trait is considered

“information rich” due to the participants' years of experience and insight (Creswell, 2017). Each participant had taught for over ten years, giving them a unique perspective during the change process. Administrators were chosen to participate in the study due to their perspective of the change process from an administration perspective. This case study included two focus groups split by topic taught. One group comprised grades 6-8 science teachers who taught the life sciences, and one group of grade 6 – 8 science teachers who taught the physical sciences. This case study included individual teacher-participant interviews based on courses taught after the participants were chosen. The administrator interviews comprised the grades 6-8 science department chairperson and the director of STEAM. Individuals were recruited through an email seeking volunteers for the study, including a Microsoft form that interested parties filled out to participate. The first round of recruitment was sufficient to gather enough participants to conduct the study. After selecting volunteers, they were placed into two focus groups considering the content taught and years of experience.

Table 2

Participant Description

Participant	Years of Experience	Tenure Status	Subjects Taught
Focus Group 1			
Cara	21 Years	Tenured	Physical Science, Regents
Catherine	22 Years	Tenured	Physical Science
Jodie	14 Years	Tenured	Physical Science
Daniel	23 Years	Tenured	Physical Science
Vivian	20 Years	Tenured	Physical Science, Regents
Christina	12 Years	Tenured	Life Science
Focus Group 2			
Paul	25 Years	Tenured	Physical Science
Arline	19 Years	Tenured	Life Science
Erwin	23 Years	Tenured	Life Science, Physical Science
Trisha	21 Years	Tenured	Life Science
Mia	23 Years	Tenured	Life Science
Kimberly	12 Years	Untenured	Physical Science
Administrator			
Velma	2 Years		Administrator
Jodie	6 Years		Administrator

Data Collection Procedures

Focus Groups

This study consisted of two teacher-participant focus groups of six participants per group, one of predominantly life science teachers and one of the physical science teachers. By utilizing focus groups, we can gain essential insights from minimally understood topics (Berg & Lune, 2011). Focus groups were the first method of research collection to gain a general understanding of the group's lived experiences and to better select teacher participants for individual interviews. The researcher utilized a semi-structured interview protocol to conduct the focus groups (Appendix F) to help guide the conversation toward the perception of the implementation of the NYSSLS. Focus groups

were utilized to collect a shared understanding from several individuals and to get specific views from individuals (Creswell, 2017). This focus group allowed the participants to share their background knowledge, experiences and needs related to the NYSSLS and their implementation in the classroom. Potential challenges, barriers, and suggestions for implementing NYSSLS were also shared and discussed. Each focus group session was recorded using a password-protected audio recording device, reviewed, transcribed, and coded to identify possible themes and similar concepts. The researcher also recorded field notes and nonverbal communication to gain a complete understanding of the group dynamic. Focus group protocols were used and were adapted (Appendix F) with permission from Papandrea (2020). Transcriptions of the focus group session were presented and verified for accuracy by each participant in the focus group. It is essential to utilize similar protocols to capture the essence of implementation barriers and further deepen my study to uncover implementation practices and obstacles in the selected sample.

Individual Interviews

This study consisted of six individual interviews. The participants were selected from the two teacher focus groups, one building-level administrator interview with the science department chairperson, and one district-level administrator interview with the director of STEAM to gain an in-depth understanding of science teachers' and administrators' perceptions of mandated curriculum change. One-to-one interviews were utilized in line with the methodology outlined by Creswell (2017). Individual interviews with teachers were conducted for approximately 40 minutes following a semi-structured interview protocol (Appendix I) that was audio-recorded and transcribed using a

password-protected device and transcribed. Individual interviews with administrators were conducted for approximately 30 minutes following a semi-structured interview protocol (Appendix H) that was audio recorded and transcribed (Creswell, 2017). Utilizing individual interviews, the researcher asked guiding open-ended questions to gather information about the implementation, perception, and potential barriers to the NYSSLS. Three individual teacher-participant interviews were chosen from each focus group to understand science teachers' perceptions of mandated curriculum change. The participant was asked to share personal experiences, perceptions, and challenges experienced or perceived concerning implementing the NYSSLS. Using data collected from the individual interviews, the researcher transcribed, coded, and identified similar themes among participants. Individual Interview protocols used were adapted with permission from Papandrea (2020). After transcription, participant interview transcripts were presented to the participants for member checking to ensure that the transcript accurately represented the session. The protocols captured a deep understanding of the implementation process. They asked the necessary questions directly to the point, including participant views, perceptions, and individual challenges that have been faced due to current implementation challenges. The directness and simplicity of these protocols were essential for my study and helped me gain a necessary understanding of the process present in this sample.

Teacher Classroom Observations

This study consisted of five teacher-classroom observations, with participants selected from the individual interviews. Classroom observations were conducted for approximately 40 minutes, and field notes were recorded as a non-participant observer.

Observations were taken of the room layout, the teacher's chosen activity, and whole classroom instruction to describe the teacher's classroom practice in detail. Student interaction and participation were not observed. Hand-written field notes were presented to the participant after the observation to verify that the notes taken accurately represented what occurred in the classroom. Observations allow data to be monitored and recorded as it occurs in a setting and to help study actual vs. perceived behaviors (Creswell, 2017). The observation protocol was necessary for my study to understand teacher perception of practice versus existing classroom practices.

Document Content Analysis

The researcher also analyzed the content related to implementing mandated curriculum changes due to implementing the NYSSLS adopted in 2016. A document content analysis provided background and context to this study (Creswell, 2017). The protocol for reviewing the documents is included in Appendix J. Reviewing the documents helped the researcher understand what is required to implement the NYSSLS, required Investigations, and state-provided materials. Documents were collected and analyzed in line with Creswell (2017) and O'Leary (2014). Relevant texts were gathered, copied, annotated, accessed for authenticity, and explored for content, background information, and questions that arose (O'Leary, 2014). Documents gathered included science department meeting agendas, the NYSSLS document, the four required Intermediate Level Science (ILS) Investigations from NYS, Sample ILS Assessment questions, teacher observation field notes, and NYS memos regarding the new standards and the implementation process.

Data Analysis Approach

This study utilizes qualitative focus group interviews, individual teacher interviews, individual administrator interviews, classroom observation field notes, and document content analysis as multiple data collection methods. Protocols in appendix F – appendix J were utilized to ensure the reliability of the data collected for this case study. Evidence was used to identify and support common themes, enhancing this study's accuracy (Creswell, 2009). To increase reliability, the researcher used participant verification. Participants were asked to review and verify the transcribed interviews for accuracy and issues.

Managing and Organizing the Data

According to Creswell (2017), data organization is critical in qualitative research due to the large volume of information collected during the study. The interview and focus group sessions were audio recorded, and the audio recordings were stored on a password-protected cell phone. Recordings were then transferred to a password-protected computer for transcription. Transcripts, audio recordings, teacher observations, and documents were then organized into named files for easy access to the data. Files were then uploaded to the Dedoose software for coding, which was password-protected and utilized to store and code the data. This enabled the researcher to code the data for common themes and gain insight. According to Saldaña (2016, p. 4), a code is a short phrase or word that assigns a symbolic, summative, essence-capturing, salient, and or evocative attribute for visual or language-based data. Coding is often seen as the critical link between the data collected and the explanation of their meaning (Saldaña, 2016).

Coding

The data was coded according to the model set forth by Saldaña (2016) and includes all data collected from the focus groups, individual interviews, classroom teacher observations, and document analysis. The data used three rounds of coding. The first round was coded utilizing attribute coding to log essential demographic characteristics of the participants and critical information from the data (Saldaña, 2016). According to Saldaña (2016), attribute coding is used for studies with multiple participants and provides essential information and context for interpretation and analysis. After the initial coding round, the data underwent code landscaping to identify subcodes in the dataset further. The second coding round consisted of pattern coding to further group and identify emergent themes within the data sets (Saldaña, 2016). After the second coding cycle, code weaving was utilized "to interpret how the individual components of the study weave together" Saldaña (2016, p. 276).

Theme Development and Re-Coding

During the second and third rounds of coding, themes began to take shape and develop. Codes were regrouped based on their similarities and distinctive patterns to illuminate a deeper reflection of human experience (Saldana, 2016). Re-coding enabled the researcher to refine themes even further to develop specific sub-categories that embody the lived experience of these particular participants. Once these themes have been revealed, refined, and broken down into sub-themes, a theory developed regarding teacher perceptions and implementation of the NYSSLS to help guide policy and future implementation.

Trustworthiness

The data analysis portion of this research study utilized triangulation from multiple data sources to ensure reliability and substantiate claims (Creswell, 2017; Stake, 1995). The data from two focus group sessions, teacher participant interviews, two administration participant interviews, teacher classroom observations, a content analysis of the NYSSLS, department meetings, and NYS assessments were utilized to enhance understanding and support the findings and conclusions in this study.

This study utilized member checking to ensure credibility and to maintain that all accounts are accurate by asking members to review the transcripts to ensure accuracy in transcription and ensure the account is complete and is a fair representation of the account (Creswell, 2017). After completing the focus groups and individual interviews, all recordings were transcribed and presented to the participants to verify and sign that the transcribed text accurately represented their interview or focus group session. Member checking was utilized to establish the account's validity and allow members to add additional information (Amankwaa, 2016).

Research Ethics

Approval for the study was received from the university's Institutional Review Board (IRB). After IRB approval, a meeting was scheduled with the superintendent of schools to request permission to conduct the study in the district. The superintendent reviewed the study’s goal, protocols, and letters of consent and verbally granted permission to conduct the study in the district. Approval was verified in writing through email (see Appendix A). Recruitment emails were then sent out to all science teachers in the district. Those chosen for the study were asked to carefully review and sign a consent

form for each component they volunteered to participate in (see Appendix B through Appendix D) before data was collected to ensure consent was a focus of the study. Once the consents were reviewed and signed, they received a copy that was dual signed by the researcher. Each consent form outlined the following information: the purpose of the research study, a description of the data collection component and procedures, a statement of the benefits of this research study, the confidentiality of participants, the right to withdraw from the study at any time, the right to refuse to answer any question they preferred not to answer, and a contact person to ask questions or report concerns to regarding the study.

Each focus group session and individual interview was audio recorded with permission from each participant. Sessions began with an overview of the purpose of the study and a statement that if anyone would like to withdraw participation from the study, they can let me know at any time. Confidentiality was reviewed, and participants were reminded that their names would not be included in the results. Pseudonyms for all participants and the institution were used to keep confidentiality. Once the recordings were complete, the audio and transcriptions were stored securely via a password-protected device. Files were then uploaded to the password-protected Dedoose software.

Researcher Role

It is through the role of the researcher that context is created, and rich data is collected from the participants regarding their lived experiences (Chenail, 2011). As a current science teacher who has participated in developing and implementing the NYSSLS at the middle school level, my experiences in implementation have driven the desire to focus on this case. Although my interest in this study stems from my

experiences, it is necessary to remain neutral and not provide bias or ask purposefully leading questions based on desired outcomes or individual perceptions I may carry with me (Creswell, 2017). As the researcher, the thoughts, feelings, and perceptions of the participants were analyzed to identify potential barriers to implementation and indicate possible solutions to enhance implementation efforts in education in the future.

During my research, I used several strategies to address and recognize potential bias stemming from my position and experience as a researcher. When repurposing the focus group and individual interview questions from the protocols used by Papandrea, 2022, it was essential to ensure the questions were not leading and there was no wording bias to prompt or lead the participants in their responses (Creswell, 2017). Questions were also written in an open-ended format to prevent yes or no responses and to elicit a truthful and detailed response (Creswell, 2017). During the focus group sessions and individual interviews, I refrained from adding information and revealing my viewpoints to the participants. For example, I did not share my views on implementing the NYSSLS or their use in the classroom. Sharing my opinion may have swayed participants' opinions towards a specific viewpoint, and they may not have shared how they viewed the standards. Also, I did not mention my experiences implementing the NYSSLS and the challenges I faced, as it may have swayed the participants from giving an honest answer on their perceptions. It is necessary to limit bias, prevent the inaccurate representation of interpretations, and ensure credibility.

Chapter 4 Data Analysis

Introduction

This qualitative case study aimed to determine secondary science teachers' perceptions towards mandated curriculum changes with implementing the NYSSLS. Data collection methods included two focus groups of teacher participants, six individual interviews of teacher participants, one individual interview of a building-level administrator-participant, one individual district-level administrator, and classroom observations. A content analysis of New York State's rollout of the P-12 Science Learning Standards and department documents relating to implementation were also reviewed. This chapter analyzes themes that emerged within the collected data according to the context of the research questions.

Three overarching themes emerged from the data analysis collected from the study. The first central theme was teaching science content and methodology. Three sub-themes emerged in the first overarching theme: science content and implementation, reading ability vs. assessments, and the impact on student learning. The second overarching theme was communication. Two sub-themes emerged within the second overarching theme, including the NYSSLS rollout and the disconnect between the district and the department. The third overarching was resources and collaboration. Three sub-themes emerged within the third overarching theme: professional development received, time, and resources necessary for implementation (Table 3). This chapter describes each central theme concerning the study's research questions.

Table 3

Central Themes and Sub-themes

Overarching Theme	Sub-theme 1	Sub-theme 2	Sub-theme 3
Impact of Statewide Decisions on Learning	Impact of Learning Standards on Teaching Science Content	Impact of Assessment Reading Level on Assessment Performance	Impact on Student Learning and Motivation
Impact of Resources and District Support on Teachers Ability to Implement the Standards	Rollout of the New Standards and Assessments	Communication between the District and the Department	Teacher Collaboration and Resources Necessary for Implementation (Time, PD)

Findings

Theme 1 Impact of Statewide Decisions on Learning

The first theme to emerge during the data analysis process was the impact of statewide decisions on learning. Each participant was asked to share their views on the implementation and influence of the NYSSLS on their teaching methodology in the classroom. Within this theme of science and teaching methodologies, the following three themes emerged: science content and implementation, reading ability vs. assessments, and impact on student learning. These three sub-themes collectively describe science teachers' perceptions towards the NYSSLS and the influence the implementation of the new standards has had on their teaching and Methodology in the science classroom.

Impact of Learning Standards on Teaching Science Content

The first sub-theme regarding the impact of statewide decisions on learning from the collected data was the struggle to incorporate specific science content while implementing the new standards. Participants were asked about their views of the NYSSLS and how their instructional practices have changed due to implementing the latest standards in their classrooms. Most participants viewed the inquiry-based approach as beneficial. However, the implementation of the standards has been difficult. The teachers also expressed concern about the standards not being specific enough, leaving them frustrated with how they will achieve them in their classrooms.

There was a consensus among experienced science teachers that the purpose of the change in standards was viewed as beneficial. Still, concern was also raised with the lack of concrete performance indicators in the standards and content necessary for understanding what was missing from the new standards. Mia, an experienced science teacher of 23 years, expressed her approval of the shift in science content and benefits to the students learning by stating, “I think the new learning standards are benefiting the students. I think the standards incorporate phenomena and more inquiry-based activities and labs.” She emphasized this benefit and the shift to student-centered learning by stating, “I think this definitely impacts their learning, and students have more of a lead rather than just teacher lead lectures.” She was echoed by Arline, an experienced science teacher of 19 years, who agreed with the positive impact on student learning and added, “I do think it makes the kids try to think a little bit more and more deeply about the content. It’s not just content-based, it’s not just memorization of content, and it’s more of an application of content.” Arline emphasized her support for the standards by

elaborating, “I think that the standards have some validity to them. I think that if we can accomplish those standards and make our students successful, it will be a good thing.” Positive praise of the new standards continued with Vivian, an experienced science teacher of 20 years, as she expressed her positive view of the change in standards by stating, “Overall, I think it’s a positive change, and I think it’s going to lead to better student learning and better student thinking.” Paul, an experienced science teacher of 25 years, agreed and supported the new standards. He emphasized his optimistic view of incorporating the different dimensions by stating, “I like the idea of the science engineering practices because I think it adds another dimension to the instruction. I also like the cross-cutting concepts where you’re teaching them certain skills like looking for patterns, looking for cause and effect.” Vivian agreed and went on to elaborate on the change she sees in teaching the content at a deeper level instead of just teaching the surface level and stated, “As far as the standards themselves, I think it gives more depth to the learning as opposed to a mile wide and an inch-deep curriculum. I like the idea that we’re delving deeper.”

While most of the views of the new shift in standards were positive, concerns were expressed about the specificity of the standards. Jodie, an experienced physical science teacher of 14 years, expressed her overall view and concern with the lack of specifics in the new standards, stating, “There were not a tremendous amount of specifics, but it looked like more of a general guideline of what needed to be taught at each grade band.” Daniel, an experienced physical science teacher of 23 years, agreed and raised concern that the standards lacked specificity by adding, “It wasn’t as specific as I had hoped it would be.” Cara, an experienced physical science teacher of 21 years,

agreed that there were not a lot of specific standards that needed to be taught and expressed her concern and frustration about the lack of content present in the standards compared to the old standards and stated:

> There are things that are not in the standards that I feel really should be. I feel like there are some basics that are left out, so when we created our curriculum, we put things in that weren't in the standards just because we felt that there wasn't a way to teach without them. For example, the 8th-grade standards do not include density, but how do you teach about weather or plate tectonics or all of these different concepts without knowing about density?

The lack of specificity in the standards creates frustration among teachers working to implement the new standards. Trisha, an experienced science teacher of 21 years, agreed with Cara and expressed her frustration with the lack of content specificity contained in the standards and the way the standards flow by stating:

> I find that there is a lot of information being cut out of science-pertinent information, especially at the 7th-grade level. I think that we are trying to teach for the test, and that is not the way science should be taught. Students should be taught a curriculum based on their grade level and based on how science should flow.

Arline agreed and shared her experiences changing her teaching and implementing the new standards and expressed her opinion that necessary information is being cut out of the standards by adding, "Changing what I used to do from my old standards to now, and there are some things that I feel like why are we getting rid of that information when I feel like it's so important." Trisha agreed and added her frustrations,

“I find them to be very vague and not enough. A lot of information is being taken away from our students in terms of what they should learn, so I’m not happy with them.” Arline reiterated her views of the missing information being essential and challenging to implement by adding, “Some of the decisions the state has made about what’s important to cover in the curriculum, I find that has been a challenge.” Most experienced science teachers view the standards as a positive shift in teaching and learning science content. However, they expressed frustration with the lack of specificity and missing content in the new standards and struggled with how to implement them in the classroom. Compared to the previous standards, a content analysis of the NYSSLS showed that the new standards expect the students to have a significant idea of the topic but do not detail the specific content. The Introduction to the NYSSLS 2018 states, “The New York State P-12 Science Learning Standards are a series of performance expectations that define what students should understand and be able to do as a result of their study of science.” They are further broken down into science and engineering practices, disciplinary core ideas, and crosscutting concepts relevant to each standard. Connections to the New York State Next Generation Learning Standards for ELA/Literacy and Mathematics are included. The Introduction to the NYSSLS 2018 also states, "The performance expectations do not dictate curriculum; rather, they are coherently developed to allow flexibility in the instruction of the performance expectations.”

Figure 6

NYSSLS Human Body Systems Standard Example

MS. Structure, Function, and Information Processing		
MS-LS1-3. Construct an explanation supported by evidence for how the body is composed of interacting systems consisting of cells, tissues, and organs working together to maintain homeostasis. [Clarification Statement: Emphasis should be on the function and interactions of the major body systems (e.g., circulatory, respiratory, nervous, musculoskeletal).] [Assessment Boundary: Assessment is focused on the interactions between systems, not on the functions of individual systems.]		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories. • Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-LS1-3)	**LS1.A: Structure and Function** • In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3)	**Systems and System Models** • Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. (MS-LS1-3) --- **Connections to Nature of Science** Science is a Human Endeavor • Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (MS-LS1-3)

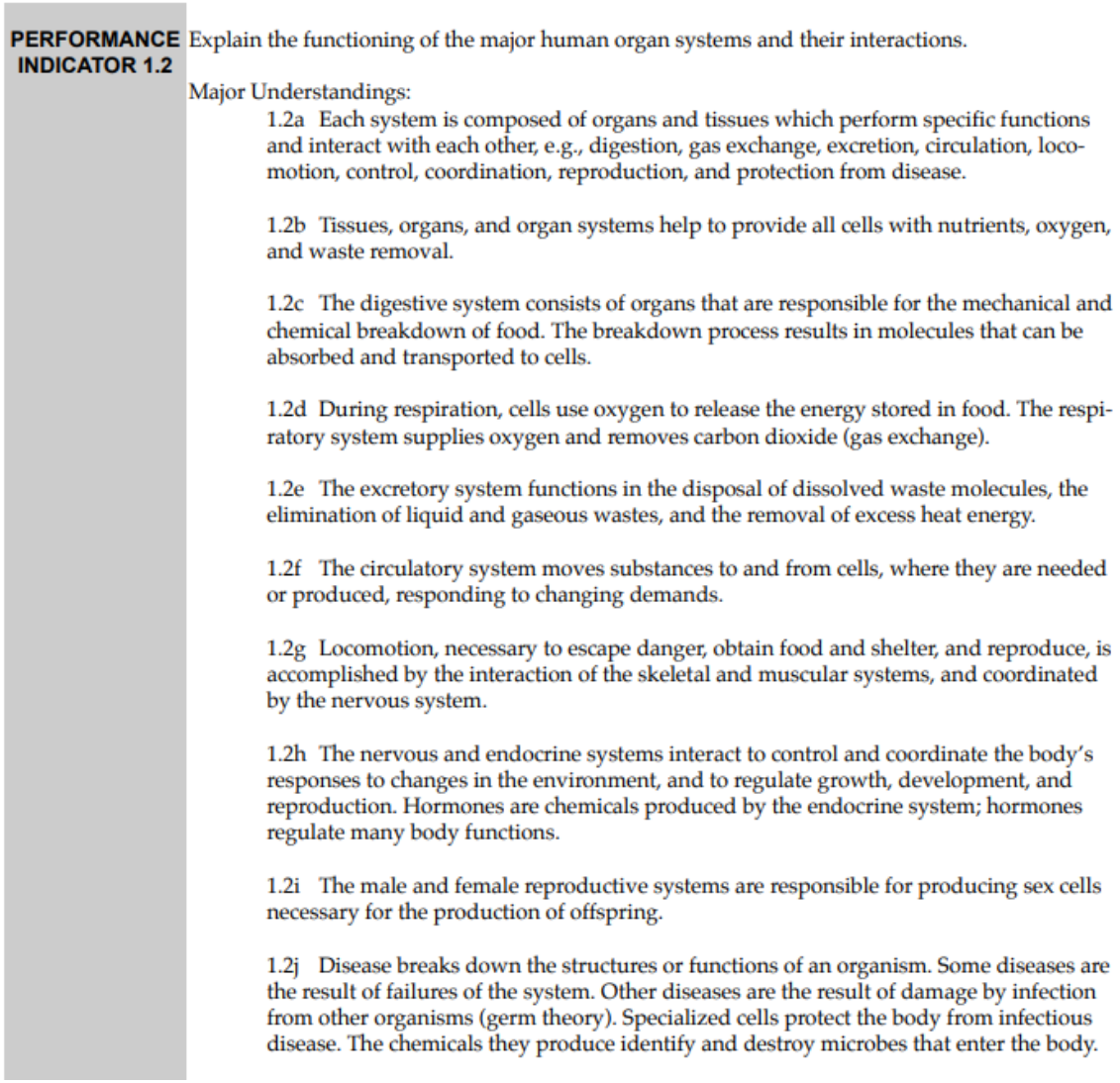
Note: Adapted from "New York State P-12 Science Learning Standards" by NYSED, NYS P-12 Science Learning Standards (MS), 2016.

Compared to the previous science standards (the 1996 Intermediate Level Science Standards), the content analysis revealed a shift in how the standards are written, what is being assessed, and the focus of the standard itself. Middle school science standards include the human body and the systems that interact within it. Human body systems were chosen to compare the focus of the old standards versus the new ones.

When comparing the standards for human body systems, the new standard that includes human body systems is included in the band for structure, function, and information processing. It is broken down in the “MS. Structure, Function, and Information Processing” band, and the standard reads “MS-LS1-3. Construct an explanation supported by evidence for how the body is composed of interacting systems consisting of cells, tissues, and organs working together to maintain homeostasis.” It includes a clarification statement, “Clarification Statement: Emphasis should be on the function and interactions of the major body systems (e.g., circulatory, respiratory, nervous, musculoskeletal).” It clarifies what will be assessed: ”Assessment Boundary: Assessment is focused on the interactions between systems, not on the functions of individual systems.” It includes science and engineering practices, disciplinary core ideas, and cross-cutting concepts shown in Figure 6. Compared to the previous standards on the human body, the old standards are grouped by content area, with standard four being all life science standards, then broken down further by area. For example, in Figure 7, Human body systems are explained under performance indicator 1.2 and detail the significant understandings students are expected to know after the topic.

Figure 7

1996 ILS Standard Example



PERFORMANCE INDICATOR 1.2 Explain the functioning of the major human organ systems and their interactions.

Major Understandings:

1.2a Each system is composed of organs and tissues which perform specific functions and interact with each other, e.g., digestion, gas exchange, excretion, circulation, locomotion, control, coordination, reproduction, and protection from disease.

1.2b Tissues, organs, and organ systems help to provide all cells with nutrients, oxygen, and waste removal.

1.2c The digestive system consists of organs that are responsible for the mechanical and chemical breakdown of food. The breakdown process results in molecules that can be absorbed and transported to cells.

1.2d During respiration, cells use oxygen to release the energy stored in food. The respiratory system supplies oxygen and removes carbon dioxide (gas exchange).

1.2e The excretory system functions in the disposal of dissolved waste molecules, the elimination of liquid and gaseous wastes, and the removal of excess heat energy.

1.2f The circulatory system moves substances to and from cells, where they are needed or produced, responding to changing demands.

1.2g Locomotion, necessary to escape danger, obtain food and shelter, and reproduce, is accomplished by the interaction of the skeletal and muscular systems, and coordinated by the nervous system.

1.2h The nervous and endocrine systems interact to control and coordinate the body's responses to changes in the environment, and to regulate growth, development, and reproduction. Hormones are chemicals produced by the endocrine system; hormones regulate many body functions.

1.2i The male and female reproductive systems are responsible for producing sex cells necessary for the production of offspring.

1.2j Disease breaks down the structures or functions of an organism. Some diseases are the result of failures of the system. Other diseases are the result of damage by infection from other organisms (germ theory). Specialized cells protect the body from infectious disease. The chemicals they produce identify and destroy microbes that enter the body.

Note: From "Learning Standards for Math, Science and Technology, 1996" by NYSED, Intermediate Science, 1996.

The content analysis of both standards shows a difference in learning and teaching expectations for teachers and students. The new standards lack the detailed performance indicators present in the old standards. The new standards outline what students are expected to do but lack specifics on what exact details they are responsible for knowing.

While performing the content analysis of the department meeting agendas, the collected data focused on shifting the current questioning in science courses to a more application-based approach. For example, an agenda from September 2022 said, “Focus this year should be on questioning – less content, more application of concepts/ideas.” The meeting agendas also focused on utilizing consistent vocabulary across grade-level courses, incorporating phenomena in lessons, and providing links to access phenomena.

Jodie, an administrator of 2 years, shared a positive aspect of the lack of specificity in the new standards but also voiced concern about the continuity of the standards across different classrooms due to the implementation of the new standards. Jodie explained, “The standards themselves, I think, are good. I wish there were a little more guidance as far as the information contained in the standards.” She felt the standards lacked detail and did not include specific information like the old standards. She viewed this as both a positive and a negative and explained further by raising the question:

> What specifically is included under each of the standards? Some of them are vague, which is a positive that it leaves a little more freedom in the classroom, but on the other side, there’s some discrepancy sometimes from classroom to classroom.

While Administrators viewed the lack of specificity as a positive change, allowing teachers to be creative and express academic freedom to meet the new standards, there were concerns about classroom consistency within each grade level with the lack of specificity in the new standards.

While most teachers saw the new standards as a positive, Erwin, an experienced science teacher of 23 years, agreed with the lack of specificity but disagreed with the way standards are written and their lack of relation to his current view of teaching and expressed his frustration with them by adding, “I like the idea of them, but I don’t feel that it exists in any reality with these kids, the way they actually think and process things and see the world around them.” He explains this perspective shift further by stating, “In my experience, the trends come, and they go. The pendulum swings one way to the next, and in my 23 years, I've seen it swing back twice this way, and it always swings away.” The constant changing of methodology, standards, and fads in education has left some teachers frustrated and resistant to change when practices that they are familiar with have led to student success in the past. Velma, an administrator, acknowledged this resistance to change and offered an explanation, adding, “Teachers that have been doing a good job and are successful in how they've been doing things are going to be hesitant to change because now you don't know if you're going to be successful in this new way.”

A review of teacher classroom observation reports showed that teachers already use inquiry-based activities to deliver content to their students. Inquiry-based activities focus on student discovery through carefully curated activities. Erwin, an experienced science teacher of 23 years, used a student-centered frog dissection to implement the standard MS-LS1-3. (Construct an explanation supported by evidence for how the body is composed of interacting systems consisting of cells, tissues, and organs working together to maintain homeostasis.) Vivian, an experienced physical science teacher of 20 years, facilitated student creation of a scale representation of our solar system to implement the NYSSLS “MS-ESS1-3 – Analyze and interpret data to determine scale

properties of objects in the solar system." Teachers in this district are utilizing student-based learning strategies through inquiry-based learning to implement the NYSSLS.

The analysis of the collected data, including focus groups, individual interviews, teacher-classroom observations, and document content analysis, revealed that most science teachers perceived the changes outlined in the NYSSLS to be a positive change; however, they also perceived the lack of specificity in the standards negatively impacted their ability to cover the science content effectively. Administrators perceived the lack of specificity as positive but were concerned with classroom consistency.

Impact of Assessment Reading Level on Student Performance

The second sub-theme regarding methodology and science teaching from the collected data was the impact of the assessment's reading level on student performance. Participants across both focus groups and individual interviews were asked about their views on the assessments created for the NYSSLS. Most participants viewed the assessments developed and released thus far by New York State as far above the students' reading ability, impacting their assessment performance regardless of their scientific knowledge and understanding.

Findings revealed that years of experience impacted teachers' perspectives of reading ability and its impact on student performance. There was a consensus among the experienced science teachers that the Investigations developed by New York State to assess student ability regarding the new standards are at a higher reading level than the student level. Mia expressed her concern about the state-mandated lab Investigation assessments released by the State in October of 2022, saying, "The Investigations are

new for us; looking at it initially, we felt that the reading level was a little high and difficult.”.

Arline echoed her concerns and emphasized the concern about the level of the investigation assessments being higher than grade level by saying:

> I think that some of them are a little difficult for the grade level. I think they’re written at a level that’s higher than what some of our students can handle. I’m seeing that the new standards are asking students to apply their knowledge. They need higher reading comprehension levels. They need to make comparisons and inferences. So, those are some challenges that I’m noticing, and it is impacting the way I teach.

The main concern is that even if the students know the knowledge being asked, the question level is too high for them to understand and answer.

Kimberly, a less experienced science teacher, added to the concerns about reading levels by adding that “ the science that they have to do, the vocabulary is beyond their reading level.” Vivian agreed and expressed her concern about the high reading level of the assessments by stating, "I think at this point they seem a little, especially the Investigations, higher level than we have been used to, and I worry that the students will be able to meet the challenges." Vivian elaborated on her concerns by stating, "It's even more in-depth than the earth science curriculum for the 8th grade, so it's a higher level than the Regents.". Here, Vivian refers to the Regents exams that New York State requires for high school graduation. Cara echoed the concern about the level being higher than the student's ability: “I don't know if the Regents level kids could have handled that investigation and the weather that we teach the 8th grade and the weather that we teach

the regents level kids. This was a regents-level activity." The focus groups and individual interviews echoed concerns that the advanced students with higher levels of achievement would struggle with the state investigation assessments due to the assessment's higher-than-typical reading level. Jodie, the science chairperson, reflected on the Investigations that she oversaw at the elementary school level and added:

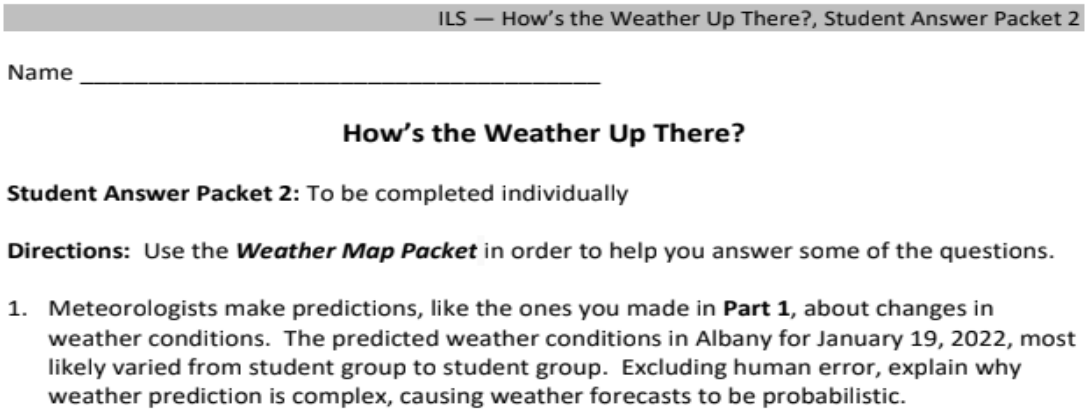
> The Investigation itself wasn't terrible, but the questioning and the language. Again, if you're looking at 3rd, 4th, and 5th graders, what you are asking them to do to make the connection? And that's the idea, right? You're not just learning this. You're making connections to something else. That's what they're looking for.

Administrators and teachers are concerned about the reading level being much higher than the student's ability and how that will impact their assessment.

During the content analysis, the Investigations released from the state were analyzed for their reading level using the Flesch-Kincaid Grade Level Test. "The Flesch-Kincaid grade level readability formula analyzes and rates text based on a U.S. grade school educational level. The formula uses the average number of words per sentence and the average number of syllables per word to generate a result. A grade level score of 8.0 means that an eighth-grader can understand the text." (Social Security Administration, 2015). Questions from each assessment were analyzed and yielded the following results. The investigation titled "How's the Weather up there?" question 1 in student answer packet 2 (Figure 8) showed a Flesch-Kincaid Grade level of 12.2, indicating that a student in the twelfth grade can read and understand the text.

Figure 8

ILS Investigation Example Question



ILS — How's the Weather Up There?, Student Answer Packet 2

Name _____

How's the Weather Up There?

Student Answer Packet 2: To be completed individually

Directions: Use the ***Weather Map Packet*** in order to help you answer some of the questions.

1. Meteorologists make predictions, like the ones you made in **Part 1**, about changes in weather conditions. The predicted weather conditions in Albany for January 19, 2022, most likely varied from student group to student group. Excluding human error, explain why weather prediction is complex, causing weather forecasts to be probabilistic.

Note: From "How's the Weather Up There?" by NYSED, ILS Investigation, Student Answer Packet 2, 2022.

The investigation titled "It's Alive" question 1a in the student answer packet 2 showed a Flesch-Kincaid Grade level of 10.7, indicating that a student in the eleventh grade can read and understand the text. The investigation titled "All Mixed Up" question 2 in student answer packet 2 showed a Flesch-Kincaid Grade level of 12, indicating that a student in the twelfth grade can read and understand the text. The investigation titled "Cool It!" question 3 in student answer packet 2 showed a Flesch-Kincaid Grade level of 12, indicating that a student in the twelfth grade can read and understand the text. Findings show that the Investigations for the intermediate level, grades 6-8, are written on a higher grade level, making it difficult to read and understand.

Concerns developed not only on the reading level being too high for students to understand but also questioning what skills the Investigation was assessing, the student's reading level, or the content knowledge they intended to apply to the problems. Cara reiterated her concerns and uncertainty about the upcoming 8th-grade written science assessment by stating:

> My concern is, if this is the writing on these Investigations, what will the new testing look like? Because if you're using higher level vocabulary and the kids are not going to know what you mean and they don't have the fortitude to push through it, they're just going to give up and write anything. That's not really a measure of my educating them in science if they don't know what probabilistic means. It was very confusing: a lot of packets and a lot of papers, and it makes me crazy that they printed them not in color.

When implementing the standards, the intent is for the students to acquire knowledge and be able to convey that knowledge to solve a problem or explain a phenomenon. If the tool intended to assess student knowledge is above their understanding and much too complicated, is that an accurate measure of their learning? Concerns about what the assessments are measuring came into question. Teachers are frustrated with the level of the assessments not being attainable for most of their students. Jodie reiterated Cara's concern by elaborating:

> You're not assessing the science content; you're not accessing their learning in science; you're not assessing us as teachers even if you want to put it that way because you're they're not getting through that language piece that confusion of the multiple papers which seems like a little thing to grown adults but it's a big thing for students to deal with in the midst of a state assessment.

All experienced science teachers expressed concern with the reading level of the NYSSLS Investigation assessments and students' ability to understand what is being asked of them to have a fair opportunity to demonstrate their acquired knowledge of the topics covered. Teachers also expressed frustration with the assessment's high reading

level and concerns that the assessment was not assessing their content knowledge and acquired skills if the students could not understand what was being asked. During an observation of Arline's class, students could not answer the questions and had difficulty navigating the interface. Arline conducted a lesson on the endocrine system, assisted by an online platform to help students lead their learning and progress at their own pace through the material. The lesson was modeled using the first question as an example, and the teacher led the class through the example. They were then released to complete the activity with a partner. The students were unable to answer the initial questions on the activity. The teacher had to reteach the material and guide small groups after instruction had already been given. This redundancy in instruction could indicate the level of questioning was higher than the student's comprehension.

The analysis of the collected data, including focus groups, individual interviews, teacher-classroom observations, and document content analysis, revealed that most secondary science teachers and administrators perceived the assessments developed and released thus far by New York State to be above the student's current reading ability and questioned the purpose of the assessment and the validity of the information it was assessing.

Impact on Student Learning and Motivation

The third sub-theme from the data was the impact of the new learning standards on student learning and motivation. Participants across both focus groups and individual interviews were asked about their views on how the NYSSLS has impacted student learning. Most participants viewed student learning under the new standards as emerging and developing over time. They believe that the standards can be beneficial to student

learning and motivation. However, time is needed for the students to develop their science skills and get accustomed to learning in this way before learning and motivation can be truly assessed.

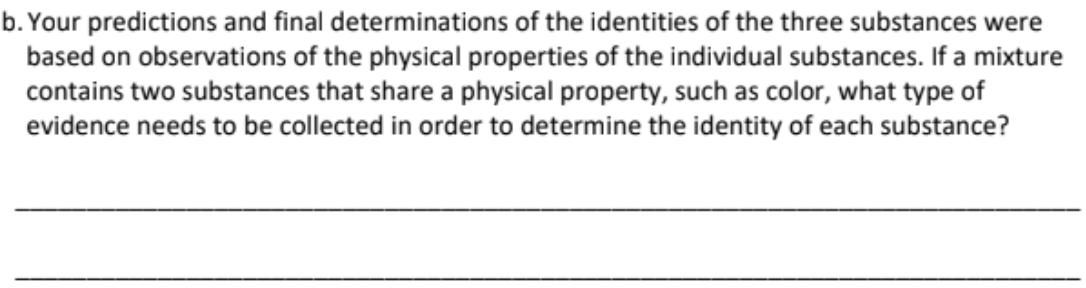
Findings revealed that teachers perceived that with the implementation of the new standards, there was deeper student learning, less automatic recall, and decreased student motivation. Experienced life science teachers agree students can access deeper learning through inquiry and collaboration. However, students are expected to learn quicker than desired, which negatively impacts student fluency in basic facts and overall motivation.

Mia views the change in standards and student expectations as a positive experience. She shared her view of the new standard's effect on student learning by stating, “I definitely think that the standards incorporate phenomena and more inquiry-based activities and labs.” She expressed her views that students can take more ownership of their learning with this new approach. “I think this definitely impacts their learning, and students have more of a lead rather than just teacher lead lectures. Arline agreed that the shift in the new standards utilized was positive and added, “I think that if we can get our students to do these Investigations successfully, it will be an amazing thing. I think that they will become amazing scientists and science learners.” Trisha added that the teaching methods favored teachers and students and stated, “In terms of how I'm teaching, I do like some of the ways in which the standards want us to teach. A lot of investigation, a lot of phenomena being introduced, I think that's important for the students.” Daniel agreed but shared his concerns about student learning and ability to access the information by saying, “If we're doing this investigative phenomenon type learning, will they be able to pull the information that they need in order to answer these

higher level questions?" The question style has shifted from straightforward data analysis to a focus on data interpretation and application of concepts. In the past investigation, students were asked to conduct a density experiment at one of the stations. They were then asked if their calculations agreed with their conclusion and had to explain. The new question focus shifts to more of an application of properties to determine the data. In a sample question shown in Figure 9 from the investigation All Mixed Up, students must apply their knowledge of matter to help identify the substances in the diagram and then explain how their behavior determines the identity of the substances instead of simply identifying the particles.

Figure 9

Sample Question from ILS – All Mixed Up, Student Answer Packet 2


b. Your predictions and final determinations of the identities of the three substances were based on observations of the physical properties of the individual substances. If a mixture contains two substances that share a physical property, such as color, what type of evidence needs to be collected in order to determine the identity of each substance?

_____

_____

Note: From "All Mixed Up" by NYSED, ILS Investigation, Student Answer Packet 2, 2022.

Vivian agreed that the students were engaging in more inquiry-based activities but found that students were struggling to accept the challenge. There appears to be a lack of motivation to complete the activities and develop the skills necessary to change their thinking scientifically. She added her similar classroom experiences with a lack of student motivation by stating:

> Since we started switching to the more inquiry-based approach for the 8th grade, I find the students are struggling. They are not rising to the occasion, and the effort put in by the students and their grit to be able to finish assignments is severely lacking. I think although it's a good change overall, it's just not kind of making it to the students yet. I like the idea that we're delving deeper, but I think it's going to take some getting used to, and I think the students are going to need to get used to that at an earlier level than in 8th grade.

Kimberly agreed that student motivation was lacking and negatively impacting student learning. Students are expected to behave like scientists and learn through inquiry on their own, facilitated by the teacher and their intrinsic motivation. When students don't complete their responsibilities, it brings the lesson down and impedes learning due to a lack of knowledge or preparation. Kimberly stated:

> I feel like I agree with that because the kids are expected to do a lot on their own, and they don't do it. They're now lost. You're trying to move on, and it's like those days where you do take that extra day and say, let's go over it. Then that throws you so far behind, but it was so worth it because they actually got it, but you don't have the availability to do that all the time.

Arline agreed with the lack of motivation and the concern over how to get the students where they need to be to be ready to learn in the way the standards promote by adding: "There is going to be a lot of hand-holding. I think, especially in the beginning, there may be more teacher-guided demos with it as opposed to letting them go and do it on their own." She elaborated on how to try and bridge that gap to enable student success

by utilizing the gradual release of responsibility model, stating, “Then we can slowly give some things to them and some to us, and then eventually hopefully we’ll get a group that has some science background that definitely can actually do this, I think it’s gonna be challenging.” Erwin echoed Arline's concerns by adding his own recent classroom experiences and frustrations with student motivation and learning by offering a possible explanation that students lack necessary science skills due to their lack of exposure to hands-on activities during the COVID-19 pandemic by stating, “Anything hands-on they had a hard time with the last year or two; they missed out on basic science skills.” He continued to express that student ability has slowly increased as they have been exposed to more hands-on activities. However, they still struggle by stating, “As the years progress, they have become more able to do it, but just being aware that they have a hard time doing anything hands-on and not being fully guided is probably the biggest thing.”

Jodie agreed that the new standards require a shift in how learning is presented and how the students learn the material. She added her views by stating, “I do think it makes the kids try to think a little bit more and more deeply about the content. It's not just content-based, it's not just memorization of content, and it's more of an application of content.” Cara agreed and elaborated that the shift in student learning has enabled students to collaborate during laboratory activities and apply their knowledge successfully to solve the problem. Still, students also struggled with basic facts and information recall. She elaborated on what she had seen in her classroom assessments and lab activities by stating:

> I've noticed since the shift of trying to get the kids to think deeper, I have seen an improvement in the constructed response to the deeper thinking questions, but

> what I'm also seeing is that the simple I remember what this word is, they're getting those questions wrong.

Arline agreed that the students are being asked to make deeper connections and to apply their knowledge, and that means instruction needs to change to incorporate the new question styles. She said, “I'm seeing that the new standards are asking students to apply their knowledge. They need higher reading comprehension levels. They need to make comparisons and inferences. Those are some challenges that I’m noticing, and it’s impacting the way I teach.”

Mia agreed and added her experiences and concerns about the special education population, saying:

> I'm a little concerned about the special education students. I feel like making those deeper connections is hard for them to begin with, and now we're asking them to do it even more on their own with even less extra support of memorizing those basics first and then making those connections.

Jodie agreed and added her concerns about bridging the gap and getting students to the point where they are ready and able to achieve the standards by stating, “How do we get the students to that place where they can think more deeply about it and come up with these because it is a total shift in what they have done before.” Vivian agreed, adding, “I find that the students have a very difficult time thinking on their own.” She voiced her concerns about students' lack of motivation, offering up a potential reason for that lack of motivation and perseverance in learning, questioning if the COVID-19 pandemic and the switch to virtual learning with little student accountability lead to a

decrease in student motivation and ability to persevere by stating, “Grit is the right word. They don't have that, and whether that is a COVID thing or a teenager thing, they're just going to look at it and be like, yeah, whatever, and give up.”

Most experienced science teachers expressed concern regarding the depth of student learning and a lack of basic fact recall. There is also a perceived decrease in student motivation in the science classroom that appears to be due to the lack of accountability during the COVID-19 pandemic and due to altering their instructional practices to help prepare the students to access deeper learning through student-led inquiry instruction. Teachers believe this is due to a lack of student exposure to lab activities and rigor during the COVID-19 pandemic, a lack of exposure to the new methods of student-led inquiry instruction, and a lack of required more profound thinking skills. Schools were closed during the first year of the COVID-19 pandemic, and all instruction was moved to virtual learning. During this time at the Ivy Vines School district, students did not have access to hands-on lab equipment, grading policies were still being developed, and no student received a failing grade. Students returned to the building during the second year through a complete in-person, hybrid, or entirely virtual model. The in-person model had students attend school daily and stay in one classroom with desks six feet apart. The hybrid model had students attend their four main subjects (math, science, English, and social studies) in person every other day in one classroom with desks six feet apart and were virtual and attended their specials on the other day. The entirely virtual model students logged in through google meet from their location. None of the models allowed for hands-on lab activities or the sharing of materials due to

the unknown spread of the virus. Student learning during this time was inconsistent, lacked accountability, and, at times, rigor.

The administrator, Jodie, viewed student learning as developing as students are further exposed to it, stating, “I like the questions because I think it does make the students think, and it's not something they can just look up. They have to learn how to use their brains again and not just Google everything.” Velma agreed that student learning is emerging as we move toward the new standards and students are exposed to them, stating, “I think the new standards will help students learn. I don't think we're there yet. I think the goal is to encourage students to think and figure things out.” She elaborated that this was a change from past practice in that learning was discovered by the students and not just lectured and expected to be memorized. She stated, “In the past, students were just told what they needed to know, then they were asked to memorize it.”

After a content analysis of the department meeting agendas, there was an emphasis on incorporating student data chats and providing resources to phenomena to help increase student motivation and learning. For example, an agenda from November 2022 emphasized student data chats to help improve student learning read, “Use data to guide data chats for whole-class/individual goal setting. Consider pulling the top 5-10 questions students struggled with and having them complete this so they can reflect and assist in the data chat.” The same agenda also gave helpful links to find motivating phenomena to incorporate into lesson planning.

The analysis of the collected data, including focus groups, individual interviews, teacher classroom observations, and content analysis, revealed that most experienced life science and physical science teachers perceived a negative impact on student motivation

and learning in the science classroom. The view of administrators revealed that even though student motivation and learning are viewed as poor, they perceive an increase as standards are further implanted.

Theme 2 Impact of Resources and District Support on Teacher's Implementation Ability

The second theme to emerge during the data analysis process was the impact of the district support and resources on the teacher's ability to implement the new standards. Each participant was asked to share their views on the implementation of the NYSSLS and how they impacted their instructional practices, professional life, and what challenges they faced. Within this theme of communication, the following themes emerged: the New York State Rollout of the NYSSLS, the communication between the district and the department, and teacher collaboration. These three sub-themes collectively describe science teachers' perceptions of the NYSSLS and the influence the implementation of the new framework has had.

Rollout of the New Standards and Assessments

The first sub-theme regarding the impact of resources and district support on teacher's ability to implement the standards from the collected data was the Science Learning Standards and the new assessment rollout by New York State. The participants were asked to share their views on implementing the NYSSLS, how they impacted their professional instructional practices, and what challenges they faced as a result of implementing the new standards. Most participants expressed concern and frustration with how the state rolled out the new standards and assessments. Participants in both focus groups and administration highlighted the lack of resources provided by the state,

sample questions, lab Investigations, supply needs, etc., and the lack of time to implement the Investigations once the state released them as a hindrance to implementing the new standards with efficacy.

Most experienced science teachers expressed frustration and concern with the rollout of the new standards and assessments by the state. They expressed dissatisfaction with the release of necessary materials to guide the implementation of the new standards. Arline started the conversation by voicing her opinion of the rollout, stating, “I think the frustrating part is the lack of resources from New York State.” She explained the frustration with not having resources such as sample questions to develop resources for her students. She elaborated, “I think that we're looking for more information on how the questions are going to look on the exams. We need those resources, and they've really delayed releasing them.” Trisha agreed, adding, “I feel like there's just a miscommunication between implementing these standards and really having these kids understand what we're teaching.”

Arline elaborated on Trisha's statement, adding, “I think that we need more support from the state and just an idea of what our students are going to have to do when they're assessed, but I think that this direction of learning is a good one” Paul agreed and added, “The implementation has been poor on the state’s part. They're not really giving us the professional development that we need to kind of understand what the state is looking for with these standards.” Vivian shared her views of the rollout of the new standards being problematic and lacking resources by stating, “I think the idea of them is good. I think the rollout has been problematic. I think there's not enough support for the teachers, particularly in the area of curriculum.” Cara agreed and shared her frustration

with the lack of resources provided by the school district and the state. She has the burden of creating new resources to implement the standards without a basis for how the new assessments will look. She said, “We're constantly working, trying to change things, and I'm finding it very difficult to find resources. I feel like there's very little put out from the state other than these standards as far as resources that could help us.” Vivian shared Cara’s concerns and added, “Finding the curriculum, finding the phenomena, and shifting that towards student learning has been a real challenge.” Jodie agreed with the lack of resources and information, particularly regarding the assessment of these standards, adding:

> I think what has been lacking and, whether it's from the state or from BOCES or both because I don't think the district even has access to it yet, is that there is very little information on how this is going to change in the assessment piece.

Frustrated with the lack of information and ability to plan for new requirements, Jodie added: “I think there's a tremendous lack of planning from the state.” She elaborated by sharing her frustration with the state release of the new required Investigations in October 2022 and requiring them to be completed by students the same year by stating, “Releasing these Investigations in October of the year that they're saying they should be implemented is unfair to the districts from the supply point of view.” This lack of planning on the state's part puts districts in a bind with scheduling, budget, supplies, and the ability to implement these Investigations effectively. Jodie elaborated, “It's completely unfair to the teachers, and we need to squeeze these in, and it will affect everybody's experience. The state released them at the end of October to implement this year without any guidance.”

Cara agreed with the lack of planning and argued that the rollout of the standards and the Investigations should have been better planned, saying, “The Investigations should have been rolled out slowly.” The lack of time given by the state to implement the Investigations before the written assessment is frustrating to teachers. Cara continued, “The fact that the 7th graders next year are taking this test, and I'm going to have to find time to do three of the four Investigations in 8th grade is ridiculous.” Cara highlighted that the amount of time needed to complete the new Investigations without gaining additional time to complete the curriculum is a struggle for teachers. She expressed frustration with the quick implementation, stating, “They should have rolled them out a few years ago. If each investigation will take a week, where am I finding three weeks of room in my curriculum?”

Jodie agreed and explained further the lack of communication and inconsistency from the state regarding the Investigations, stating, “We’re just finding out how they are going to assess these new standards, which seems to be where the big gap is right now.” She expressed frustration with the inconsistent communication regarding the NYS-required Investigations and how they will be administered. “I have two papers from New York State that say different things about how these Investigations will be administered. One says you can assign them for homework, and the other says they are not supposed to leave the building.” Most experienced science teachers expressed concern regarding the rollout of the new standards, Investigations, and assessments by New York State. Findings agreed on the lack of time to prepare and implement the new standards and align them with the new assessments. There was also an agreement on the lack of time to

acquire and plan the resources to implement the recent intermediate-level science Investigations.

The administration echoed the teacher's concerns with the new standards and Investigations rollout. Jodie shared her frustration with the lack of specificity from the state regarding the Investigation and the limited time to gather supplies, stating, “We are supplied with little guidance on how to do this. Here's a stack of things you have to do, here's all the equipment you need, and it's completely on the district to supply all of those materials.” Velma amplified the concerns about the lack of provided information to implement the necessary Investigations in the timeframe required by the state by stating, “I think we should have had way more notification that that was going to happen. We knew they were happening, but we didn't know how that was going to affect us.” New York State had provided notice that there would be Investigations, but what they looked like, what equipment they required, and how much time was needed to perform each one was not released with adequate time to implement effectively. The lab material list was released in May 2022, the Investigations were released in October 2022, and all four lengthy Investigations are expected to be administered before the 8th-grade assessment in June 2024. Velma added, “Just because you give us these standards and you give us a timeline doesn't mean we know the end result. We should have been warned about what's expected, not just give us these standards.” New York State released the list of required materials for the middle school Investigations in May 2022 (Figure 10).

Figure 10

New York State Required Investigations for the Elementary- and Intermediate-Level Science Tests Memo

Intermediate-level Science

- Lab Equipment
  - Microscope (optimally 1 for every 2 students)
  - 120 mL (4 oz) container with lid (1 for every 2 students)
  - Petri dishes with lids (1 set of 3 for every 2 students)
  - Protective eyewear (1 per student)
  - Magnets
  - Celsius thermometer (1 for every 2 students)
  - 100 mL graduated cylinder (1 for every 2 students)
  - Hot plate (1 for teacher use)
  - 500 mL Beakers (1 set of 2 for every 2 students)
  - Tweezer or forceps or wooden splints (class set)
  - Eye dropper or pipette (class set)
  - Filter funnel (1 for every 2 students)
  - Microscope Slides (5 of each slide)
    - Elodea; Onion; Cheek (squamous epithelial); Paramecium; Euglena; Yeast; Human Nervous Tissue (multipolar neuron); Hair; Thread; Sand

- Materials for Students
  - Paper towels
  - Masking tape
  - Substances: water, iron fillings, black sand, salt, aquarium gravel, sugar, white/light colored sand, lentils, and mineral oil
  - Styrofoam cup with lid
  - Filter paper (1 for every 2 students)
  - Cups
  - Stainless steel metal washers (mass of one washer should be approximately 20 grams and uniform in size)
  - 2-liter soda bottle
  - Calculator (1 per student)

Note: From "New York State Required Investigations for the Elementary- and Intermediate-level"

Velma echoed Jodie's frustrations with the lack of time and resources needed to effectively implement these Investigations on the state's provided timeline by adding: "There's a difference between knowing something is coming and actually seeing what is expected." Planning can be challenging without understanding all aspects of what is required. Velma expressed her frustration with the time allotted before implementation.

She shared a possible solution: "I would have liked to have been given these Investigations this year but have them start not next school year but the year after, giving districts time to work out the budget, the space, the location, and the how." Velma argued that districts need time to work out the logistics of the change to implement it effectively. She continued to express the need for additional time. She expressed that giving time to see how the Investigations and assessments are constructed can help teachers better prepare to support the students by stating, "Change our instructional methods to better prepare our students for the test before you just throw it on us at the same time."

The analysis of the collected data, including interviews and content analysis, revealed that secondary science teachers and administrators perceive the rollout of the NYSSLS, Intermediate Level Science Investigations, and standardized assessments as impeding their ability to adequately plan out and implement the curriculum and Investigations, which negatively impacts student preparation for the new standard assessments.

Communication between the District and the Department

The communication between the district and the department was the second sub-theme regarding the impact of the district's support and resources on the teacher's ability to implement the new standards from the collected data. The participants were asked to share their views on implementing the NYSSLS and what support they received from the department, the district, and the administration to help them implement the new standards. They were also asked what challenges they faced due to implementing the new standards. Most participants expressed concern and frustration with a lack of resources provided by the district, a lack of time allotted to create resources, and a lack of focus on

science professional development to help them implement the required change in standards.

Some experienced science teachers expressed frustration and concern with the lack of resources provided to help support this shift in standards. Paul expressed his concern with the lack of resources provided by the district to support the transition to the new standards, stating, “Zero, the district hasn't given us anything really.” Arline added that there seems to be an attempt to focus on the change and the department's needs, but insufficient time is allotted to be beneficial. She stated, “At our department meetings, they try to focus on it, but in reality, it's not enough time like we really need professional development.” Paul disagreed and felt that time at department meetings was focused on data and testing instead of creating and finding new resources to support the change in curriculum. He said, “It seems like they're more focused at our department meetings on data and testing than instruction. We're looking at data from old tests that aren't really covering this stuff the way it's supposed to be covered.” Arlene agreed and added her concern that her district is "very English and Math driven" and often focuses on the assessment data from these two cores subjects and questions the mismatch between the district's policy and resource investment. She stated, "if you [the district] want to make this a priority, we have to put money and time into it', however, so far she has not seen that financial and human resource investment from the district. Paul shared that the district's focus may be misguided, and teachers need increased support to implement the new standards effectively. He said, “I think the focus of the district is kind of a little off. They're not really giving us the professional development that we need to understand what the state is looking for with these standards.” Jodie, an administrator, added that

there is very little in terms of the next step in professional development for science, stating, “I have to say that there is very little, so whether it's the school or the district, its only ELA and Math based no one pays attention to science.”

A content analysis of department meeting agendas showed that there has been a constant inquiry into the department's needs. Every monthly agenda features a needs section asking the following questions: “What do you need curriculum-wise? Anyone have any wants as far as staff development or PD, conferences, etc.?” This shows that department meetings try to identify and meet the department's needs; however, it does not indicate that these needs have been addressed or simply identified. The department meeting agendas for October, November, December, January, and February all mention testing dates and data chats.

Jodie shared the teacher's frustrations about the time and new equipment that is needed to properly implement and prepare for these new Investigations by adding an administrative perspective, stating, “From a realistic everyday point of view, I’ve gone to the director of math and science; the budget for this year was done by the time this stuff came out at the end of October.” School budgets are done well in advance; adding new items can be difficult if the budget is already allocated. She added, “I don't have a few $1000 to buy these materials to do them this year. The budgets are already done. Like we've all said, we're just trying to figure it out as we go.”

Most participants voiced their need for support regarding curricular resources and time to develop a new curriculum when implementing the new standards. Vivian introduced her understanding of the implementation issues surrounding the standards by stating, “There’s not enough support for the teachers, particularly in the area of

curriculum. I think we need to focus more on finding curriculum and actually getting that working for our students." Cara agreed that very little curriculum support was available. She emphasized the need for time and funding to support the new implementation and develop the curriculum to implement the new standards with fidelity. She stated, "Unfortunately, we were not given any time or funding or anything else to recreate our curriculum, so it was something we kind of just had to figure out on our own time." Mia spoke about needing a textbook that aligns with the new standards. She emphasized that teachers are left to find and create a curriculum to align and implement these new standards independently. This process is time-consuming. She stated, "It's been difficult because we don't have a set textbook for our curriculum and the new standards. A lot of our resources are pretty much all the resources we have created, so that definitely takes a lot of time." Cara expressed her frustration with the demands of the new standards and changing the curriculum without having additional time by stating, "I feel like the demands on the teachers have been increasing exponentially, and every time I turn around, it's now you have to do this, now you have to do that, and there's just not enough time during the day to do all those professional responsibilities and create a new curriculum." Velma, the administrator, shared the teacher's frustration with the lack of time available to allow teachers to develop this new curriculum, stating:

> The best thing you can do is sit at a table with everybody and work together, but there's no time for that. I don't have the money to say I can support you in so many different ways, like we just don't have it, and I'm not even sure money would take care of everything. I think it's really just the time.

Cara agreed there is a lack of time to create the necessary materials to shift to the new standards. She stated,

> Unfortunately, I guess a lot of things boil back to money, but you have districts that have a ton of money that can buy all these things, and here you go, I'll pay you to write a curriculum, and they give their teachers time and money and ours doesn't so you know we're left scrambling.

Arline spoke to the lack of adequate resources available. The Ivy Vines School district was able to pilot a program designed to meet the new standards before the state release of the new assessments. She spoke about the program's expense and that it did not meet all the needs to implement the new standards effectively. She added that when there are conferences or professional development opportunities available, the whole department is often unable to attend together; instead, one representative can attend and bring back the information to share with the department, which is not enough. She stated:

> We piloted a program, and then we found one we liked. We realized that it's extremely expensive because it's all consumable. The district has to keep buying into it, and they have to purchase it for five years. We also weren't 100% happy with any one program so we started creating our own. Sometimes, we are allowed to go to workshops or conferences, but not the whole department, one person for each content area, and it's not enough.

The administrator, Jodie, added that there is a lack of resources available overall, not just in this particular district. She stated, "I was looking into professional development, and I have to say that there is very little. It is only ELA and math-based; no one pays attention to science." Arline added, "I wish that we had more access to

resources. It's still in the early phases, though there's not a lot out there. I think it's just how to overcome. I'm constantly looking for things." Most participants viewed time and curricular resources as the most critical resources needed to implement the standards effectively. The lack of these two resources is a barrier to implementing the NYSSLS.

Teachers expressed dissatisfaction with the amount of paid time allotted to develop new materials and resources to support the implementation of the new standards in the classroom. Cara expressed her frustration with the lack of resources. She shared her recent experience working with colleagues over the summer on their own time to create a curriculum to begin the implementation process without district support, stating, "We basically rewrote our curriculum over the summer because we were told well the standards changed, and good luck." Jodie, an administrator, offered a possible explanation for the lack of material resources provided by the district, explaining that what the teachers were developing was better than what was available for purchase at the time and stated

> the teachers in the department made changes within the curriculum. They spent their own time over the summer writing packets and booklets for the students that aligned with the standards because, at the time, what the teachers were able to prepare was far better than what any textbook company had available.

Vivian agreed with the lack of available material resources, stating," There is very little." Cara frustratedly pointed out that there is a lack of paid curriculum writing opportunities available that the district is willing to pay for. She stated, "Curriculum writing doesn't seem to be a thing anymore, at least here, and we're just being told that that's just part of your regular job." Christina, a special education science teacher, added

that lack of time to create materials for the general education students also impacts the special education students due to lack of time to modify assignments that are being created as the year progresses with the added responsibilities, stating “it's hard to find the time to collaborate too because you everyone has so many responsibilities in the day to day.” Cara agreed that there is an increase in teacher responsibilities aside from the curriculum that takes time away. She stated, “I feel like the demands on the teachers have been increasing exponentially,” adding,” There's just not enough time anymore during the day to do all those professional responsibilities and create a new curriculum.” Cara also highlighted the issue of lab equipment that is needed to implement the new standards and a lack of district funding to help provide materials needed to enhance the student experience, stating, “We created all these new lab activities and hands-on activities we maybe ordered a few things and the rest of the stuff we found, or we bought, or we asked people to bring in baby food jars, and you know we kind of did it all on our own.”

The analysis of the collected data, including interviews and content analysis, revealed that secondary science teachers perceive a disconnect between the support they have received from the district and the support necessary to implement the NYSSLS properly.

Teacher Collaboration

The third sub-theme regarding the impact of resources and district support on the teacher's ability to implement the standards from the collected data was the need for teacher collaboration. The participants were asked to share their views on implementing the NYSSLS and their challenges when implementing the new standards. Most participants expressed concern about the lack of time to collaborate with colleagues.

Participants in both focus groups and the administration highlighted the need for teacher collaboration to implement the NYSSLS properly.

Most teachers and administrators viewed collaboration as essential to the implementation process. Arline spoke to the benefit of her grade level having a common prep time to plan and collaborate during the school day to help support the new changes. However, not all grade levels have this opportunity, which is necessary. She stated:

> The one nice thing about our 7th-grade department is that we all have the same, for the most part, the same off periods. We have a few periods off where we can look at the curriculum and make some changes, but that's not the case with everybody in the science department. I know our 8th-grade teachers don't have common prep periods, making it very difficult to collaborate with colleagues.

Mia agreed that the common planning time is essential to help develop more inquiry-based activities with colleagues to help implement the new standards and increase student learning. She stated, “We have common planning times that help us. We are working on developing labs and activities that are more inquiry-based and student-focused that address the new standards.”

Cara agreed that collaboration is essential and elaborated that there is no time during the school day to collaborate to begin creating material to implement the new standards. The materials created to implement the new standards were created collaboratively during the summer to try and get ahead of the new changes. She stated:

> With the 8th grade curriculum, we decided that we were going to rewrite the curriculum to meet the new standards. We sat around my pool all summer, me and two of my colleagues, and we came up with labs. We made a packet, and one of

my favorite things, lab summary pages, we made for after doing the lab. It's a couple of pointed questions to ensure the kids got what they needed from the activity. We spent a whole summer sitting around the pool, making our new curriculum so we could work together.

Velma, an administrator, added her views that in the Ivy Vines District, the teachers and administrators need time. They need time to collaborate, sit down and work things through, develop a curriculum, and adjust. Unfortunately, it is not easy to provide the time needed. She stated:

> Time, I wish I had more time. I wish I had time to just sit with teachers and talk about what they're worried about and just time to work it through. There's a solution to all of this, and we will do fine, and we'll find a way, and we'll make it work, and our kids are going to do great, like I know that. It's just finding the time to help everybody get there. Teachers want the support not necessarily from me but from each other and the time to actually work it through.

Most participants viewed time for collaboration amongst teachers as an essential part of implementing the new standards. The lack of time to collaborate during the school day hinders implementation and forces teachers to collaborate outside their work day.

During a content analysis of the science department meetings, there was a slight emphasis on grade-level meetings to increase collaboration. The September 2022 meeting agenda slightly focused on collaboration, indicating “Grade level meetings - standards, test questions, etc.”. The March agenda highlighted PLC associates and the overview of introducing protocols for student engagement broken down into grade-level meetings “PLC Associates and protocols.” The April 2023 agenda indicated grade-level

collaboration with PLC associates to review a lesson, “PLC Associates - April 18th: Bring lesson plan”.

The analysis of the collected data, including interviews and content analysis, revealed that secondary science teachers perceive teacher collaboration as necessary to implement the NYSSLS properly.

Conclusion

After analyzing the data, two main themes emerged: statewide decisions' impact on learning and the impact of resources and district support on teachers’ ability to implement the standards. Findings for theme one revealed that teachers perceive the changes in standards positively. However, teachers and administrators expressed frustration with the lack of specificity in the standards, the lack of student motivation towards learning utilizing these new standards, and the challenging reading level of the Investigation assessments. Findings for theme two revealed that teachers expressed frustration with the state's rollout of the new standards, a disconnect between the support they have received from the district and the support needed, and the desire for collaboration as a necessary tool to implement the NYSSLS.

Chapter 5 Discussion

Introduction

This qualitative case study aimed to determine in-service science teachers' perceptions towards mandated curriculum changes while implementing the NYSSLS in a suburban New York School District. The data collected and analyzed in this study included individual interviews, focus group interviews, and a content analysis of department meeting agendas, the NYSSLS, the 1996 Learning Standards for Math, Science, and Technology, and the assessments associated with each set of standards.

Three research questions guided this research. The first question investigated the NYSSLS implementation process and focused on how key stakeholders, educators, and administrators responded to this process. The second question investigated how in-service educators in a particular school district perceived the NYSSLS. The final research question examined in-service teachers' perceptions regarding the impact of the NYSSLS reform on their professional practices in science education. The data analysis revealed two main findings across the stakeholders: teachers and administrators. The first finding was that implementing the NYSSLS increased stakeholder frustration due to the lack of specificity of the standards and the shift in assessing students' understanding of questions above the student's reading levels. The second finding was that teachers have become frustrated and discouraged with the rollout of the mandated curricular changes in the science classroom due to a lack of communication between New York State, the district administrators, and teachers, increasing the stakeholder's desire for time to collaborate with colleagues to create resources to aid implementation.

Discussion of the Findings

This chapter will connect the findings to the existing literature and the following research questions: 1) What was the process of implementing the NYSSLS? How did key stakeholders, educators, and administrators respond to this process? 2) How do in-service educators in a particular school district perceive the NYSSLS? 3) What are in-service teachers' perceptions regarding the impact of the NYSSLS reform on their professional practices in science education?

Discussion of Research Question #1

The first research question in this study investigated the implementation process of mandated curriculum changes and stakeholder response to the process. The data analysis found that implementing the NYSSLS increased stakeholder frustration. Participants, both educators, and administrators, highlighted several areas of the implementation process as negatively impacting their ability to implement the new standards effectively. Resistance to change must be overcome with each shift in pedagogy and standards for the transition to be successful (Fullan, 2001). Stakeholders indicated the lack of resources provided by the state as the most frustrating aspect of the implementation process. Many teachers and administrators perceived a lack of necessary resources aligned with the new standards. They also indicated a lack of communication from the state regarding the new standard assessments that negatively impacted their ability to implement the standards and adequately prepare their students for success. Teachers, Students, and the organization need adequate preparation and training on the why and how of implementing an inquiry approach for the method to be successfully implemented (Bouhuijs, 2011).

Educators and administrative personnel collectively expressed dissatisfaction regarding how the State of New York introduced the educational standards and assessment protocols. Administrators and teachers were displeased that New York State did not release the required lab investigation information until the school year of the first administration of the required Investigations. Administrators focused on the fact that the required Investigations were released after most budgets were complete, required ample supplies, and were required to be implemented the same year, leaving little time to find funding and implement them successfully. Teachers focused on the fact that New York State has not provided resources, such as documents or sample assessment questions. Research on implementing new curricular changes shows that change can be limited by the organization's ability to learn and foster growth. The organization's ability to learn and foster growth is hindered if the materials and requirements are not provided and are unclear (Senge, 2006).

The teachers also perceived a disconnect between the support they received from the district and the support necessary to implement the NYSSLS properly. There is an overall lack of professional development in implementing the new standards effectively. Research shows that professional development that is tailored to the change being sought and relevant to the content being taught can help to support and increase teacher self-efficacy and inspire change through collaboration (Main & Pendergast, 2016; Gupta & Lee, 2020; Ke, Yin, & Huang, 2019). Teachers and administration emphasized the importance of teacher collaboration and common planning time in the implementation process.

Discussion of Research Question #2

The second research question in this study investigated how in-service educators perceive the NYSSLS. The findings showed that teachers view the changes outlined in the new standards as beneficial, and teachers feel that the new standards support inquiry in the classroom. Research supports using an inquiry-based approach as a best practice in teaching to increase student achievement (Lazic, Knezevic, & Maricic, 2021). Teachers did express concern with how they were supposed to implement the new standards in their classrooms and what a successful implementation model looked like. The teachers also expressed concern about the standards not being specific enough, leaving them frustrated with how they will achieve them in their classrooms. Current research found that implementing inquiry-based practices in the classroom faces two specific challenges: planning inquiry-based lessons is complicated and time-consuming, and teachers are reluctant to implement the strategy for fear of the learning objectives not being met by the students (Nurlaily, Soegiyanto, & Usodo, 2019). Administrators perceived the lack of specificity as positive but were concerned about classroom consistency.

The teachers and administrators perceived the released required investigation to be above the student's current reading ability. They question the purpose of the assessment and the validity of the information it is meant to assess. Teachers perceive a negative impact on student motivation and learning in the science classroom due to the shift to the new standards and possible result of the COVID-19 pandemic. Studies show that with the initial implementation of inquiry instruction, students did not know how to identify and understand the problem and were not accustomed to this type of learning due to their limited exposure to an inquiry environment (Nurlaily, Soegiyanto, & Usodo,

2019). Teachers perceive an increase in achievement as students are exposed to more critical thinking at a younger age. The view of administrators revealed that even though student motivation and learning are viewed as poor, they also perceive an increase in student motivation and learning as standards are further developed. The research supports the gradual increase in student motivation and learning. Puangspunsi found that students with a positive perception of inquiry instruction had higher confidence levels, leading to increased motivation (Puangspunsi, 2021). This indicates that as students become more familiar and confident with inquiry-based learning, their motivation will increase, as perceived by teachers and administrators in this study.

Discussion of Research Question #3

The third research question in this study investigated to what extent teachers' perceptions of the NYSSLS reform impacted their professional practices. Teachers are frustrated with the lack of specificity in the standards and question how they will cover specific standards without teaching perceived necessary base information for student understanding. Research shows that there is often a lack of the necessary support in the current educational system for supporting new practices to enact the change the innovation was intended to accomplish (Bouhuijs, 2011; An, 2013; Ertmer & Simons, 2006). Teachers agreed that New York State needs to provide more resources promptly for the planning and implementation of the standards. They must provide more time to gather resources and implement the required Investigations adequately. Teachers expressed frustration with a lack of sample questions to develop new practice questions and align their instruction to prepare students for the new assessments.

Teachers emphasized the importance of providing common planning time and teacher collaboration to create inquiry-based lessons and assessments and support each other while developing and implementing the NYSSLS. This idea is supported by the research that for teachers to successfully develop and implement inquiry-based learning effectively, time needs to be allocated as development is a time-consuming and collaborative process (Vasiliene-Vasiliauskiene, Vasilis-Vasiliauskas, Meidute-Kavaliauskiene, & Sabaityte, 2020). The research further supports that purposeful group learning and collaborative development are necessary to foster successful change efforts (Fullan, Rincon-Gallardo, & Hargreaves, 2015).

Relationship of Findings to Theoretical Framework

Organizational change can be a challenge. The implementation of the NYSSLS presented a shift in the current learning organization and the development of professional capital in the Ivy Vines School district. While the goal of standards reform is uniform change, that change can be limited by the organization's capability to learn and foster growth during implementation (Senge, 2006). When the organization's ability to learn and foster growth is hindered during the implementation process, it disallows the development of professional capital and impedes the success of the learning organization. The professional capital view assumes that good teaching is challenging, requires high education and prolonged training, and is continuously improved through wise judgment, evidence, and experience to maximize instruction (Hargreaves & Fullan, 2012). Hargreaves & Fullan (2012) express their theory of professional capital, where human capital, social capital, and decisional capital amplify each other and produce professional capital, which results in effective teaching and learning for the entire profession

(Hargreaves & Fullan, 2012). Similarly, Senge's learning organization model utilizes the five disciplines (systems thinking, mental models, personal mastery, team learning, and shared vision) to allow and support individuals in their pursuit to develop their capacity to create and implement continuously desired results. Senge (2006) perpetuates that successfully implementing the five disciplines will enable the learning organization to use systems thinking to enact change effectively. Hargreaves and Fullan's Professional capital theory and Senge's Five Disciplines can help guide the change process when utilized together.

The development of social capital through team learning and shared vision was minimally present through teacher-sought collaboration and communication despite the lack of communication from NYS and the availability of collaborative time provided by the district. The development of social capital was hindered by the lack of communication from the state and the lack of time allotted for teacher collaboration by the district, increasing teacher frustration. The development of human capital through personal mastery and mental models was hindered by the lack of resources provided by NYS. Teachers and administrators expressed frustration with the uncertainty of the required lab Investigation requirements, the challenging reading level of the required Investigation, and how the standards would be assessed due to the lack of examples provided. Individuals expressed frustration with the lack of professional development provided to support the change and the availability of professional development opportunities from the state. The development of systems thinking was derailed by the lack of communication from the state to put the necessary systems in place to support the transition to the NYSSLS. Systems thinking builds upon the proper development of

human capital and social capital. Suppose those domains are not functional due to deficits in the organization. In that case, the learning organization cannot effectively build professional capital and sustain the change until all areas are adequately developed.

Relationship of Findings to Related Research

Impact of Statewide Decisions on Learning

The first major finding from this study was that in-service science teachers viewed the mandated curricular changes in the science classroom as beneficial and necessary; however, teachers expressed frustration with the lack of specificity in the standards and uncertainty with how to implement the standards. Teachers and administrators expressed frustration with the level of the assessments released thus far by New York State and the student's motivation towards learning using this new methodology to implement the standards. This finding supported current research on inquiry-based learning and emphasized student discovery as an essential method of learning in the acquisition of science skills and processes (Dole, Bloom, & Kowalske, 2015; Panjaitan, 2020; Arce, Bodner, & Hutchinson, 2014; Ogweno, Kathuri, & Nkurumwa, 2021). While teacher perception of the standards was mainly positive, many teachers expressed frustration with how to implement the standards and how the standards were going to be assessed. The major methodology shift from the previous standards to the NYSSLS is that under the previous standards, what needed to be taught was clearly outlined through performance expectations. The new standards focus on what the students should be able to do. While this shift in methodology was perceived as beneficial as it gave teachers more freedom to meet the standards, it also left teachers frustrated with the lack of specificity about what to teach and what was being assessed.

Teachers were reluctant to utilize new methodologies to implement the new standards due to concerns that the standards would not be met and students would be missing vital science information. Previous research has also shown that teachers have been reluctant to implement an inquiry approach due to concerns about students reaching learning objectives and the lack of student experience with this methodology for them to be successful (Nurlaily, Soegiyanto, & Usodo, 2019).

Previous studies show that as students are exposed to inquiry-based learning activities, they increase their motivation and acquisition of 21st-century skills (Puangspunsi, 2021). The findings in this study mirror the previous studies where student learning and motivation increase as exposure to the learning method increases (Almuntasheri, Gillies, & Wright, 2016). Teachers in this study expressed that students are still unfamiliar with the method, which negatively impacts their motivation and learning. This finding is supported by the current research literature that limited exposure to an inquiry environment negatively impacted students' ability to identify and understand the problems given to them (Nurlaily, Soegiyanto, & Usodo, 2019). Teachers also expressed that they still need training to implement inquiry-based learning effectively to provide appropriate support for students during learning (Almuntasheri, Gillies, & Wright, 2016). This study supports the existing literature that a shift in learning methodology and standards often lacks the needed support in the current educational systems to effectively enact the change they were designed to accomplish (Bouhuijs, 2011; An, 2013; Ertmer & Simons, 2006).

Communication

The second major finding perceived from this study was inadequate communication between New York State, the district, and the teachers, resulting in increased frustration for districts and teachers implementing the new standards. Teachers and administrators expressed frustration with the lack of timely resources provided by the state to implement the standards. They expressed concerns about not having access to the new required Investigation activities, a lack of sample questions from the new assessments, and inefficient time to collect the materials needed and organize how the required Investigations would be implemented. This discovery confirmed existing research in which a lack of resources prevented the flow of professional capital, severely limiting the learning organization from successfully implementing the new science standards (Coker, 2019). Teachers need curriculum support to effectively implement new standards, such as time to prepare and plan, access to high-quality resources, expert teachers, and specific training (Viro, Lehtonen, Joutsenlahti, & Tahvanainen, 2020).

There was a perceived disconnect between the professional development at the building and district levels that the teachers were receiving and the professional development the teachers needed to implement the NYSSLS. Professional development opportunities that the department administrator conducted were viewed as beneficial and targeted toward implementing the NYSSLS but were not viewed as enough. Teachers expressed their desire for more focused professional development sessions to help them with the implementation challenges. Teachers perceived the district-level and building-level professional development sessions negatively and viewed them as math or English Language Arts focused, making them ineffective in supporting the needs of the science

teachers implementing the NYSSLS. This lack of time and effective professional development caused teachers to seek collaboration outside of their typical school day to meet the demand to implement the standards. Previous research has found that professional development that is relevant and tailored to the specific needs of the teachers can help to support and inspire change (Pendergast et al., 2005). This study supports the existing literature that ineffective communication between New York State, administration and teachers has caused teachers to become frustrated with the implementation of the NYSSLS and dedicate their own time outside of regular work hours to collaborate with colleagues due to a lack of available resources, lack of effective professional development, and lack of allotted time by the district.

Need for Resources and Collaboration

The third major finding from this study was the lack of resources provided negatively impacted teachers' perception of implementation and increased teachers' desire for professional development opportunities to collaborate with their colleagues to implement the new mandated curricular changes. A lack of resources and allocated time forced teachers to rely on each other through collaboration for support to implement the new standards. This finding supported previous research emphasizing the need for training and support before starting any implementation processes (Main & Pendergast, 2016). Teachers and administrators discussed the importance of having the opportunity to collaborate with colleagues to create resources to implement the NYSSLS. They emphasized their desire to be allotted more time to collaborate. This discovery is supported by previous research that collaborative lesson planning and teacher collegiality significantly affected teacher self-efficacy and teaching strategies. Research shows that

collegiality positively affects teacher efficacy and the adoption of desirable teaching strategies (Ke, Yin, & Huang, 2019).

The lack of professional development fueled teachers' desire for high-quality professional development to implement the new standards effectively. The lack of provided professional development and available professional development from the state caused frustration amongst in-service science teachers. As a result, teachers focused on collaboration with colleagues to develop, create, and implement new inquiry-based lessons to implement the standards. This discovery supports previous research that there is a need for training and support before implementation, and this training often comes too late in the process (Main & Pendergast, 2016). This study supports the existing literature that teachers need time and high-quality professional development before implementing the new standards to enact change effectively.

Limitations of the Study

This study included four major limitations. The first limitation of this study was the small sample size. Due to the inherent characteristics of qualitative case study research, the limited sample size could limit the external validity of the findings. According to Creswell (2012), the external validity of qualitative research is an inability to generalize the findings to other persons, settings, treatment variables, and measures. The findings cannot be generalized since case study research aims to study what makes a group or circumstance unique. However, case studies generalize to other situations and circumstances and build on theoretical assumptions. When additional research through case studies elicits similar results, they can be used to support the hypothesis and included in creating the theory (Yin, 2012).

The second limitation is that the sample was chosen through purposeful sampling. All participants work as administrators or teachers in the district where the researcher is employed. Since the researcher was the facilitator of the individual interviews, focus groups and classroom teacher observations may have influenced the participant's responses. However, the researcher was not in a supervisory position to the participants and could not be disciplined or penalized for their participation or non-participation in the study.

The third limitation of this study was an uneven distribution of teacher experience. The teachers who volunteered to participate in the study had similar years of teaching experience. Most participants have been teaching for 20 - 25 years in the field. Their shared views and shared experience may have influenced their views of curriculum change and reform and may differ from teachers with more or less experience with teaching and curricular change.

Lastly, the fourth limitation was the short time frame of the study, approximately six months during the 2022-2023 school year, and the ever-changing political environment and new educational reform initiatives being implemented. The findings of this study may be limited to this one particular snapshot in time.

Recommendations for Future Practice

Central to this change in methodology and standards, research shows that there are responses to change amongst stakeholders that schools encounter when shifting from one framework to another (Terhart, 2013). Each shift is typically met with resistance to change that must be overcome for the transition to be successful (Fullan, 2001). This study describes in-service science teachers' perceptions of the implementation of the

NYSSLS. Three themes were revealed regarding teachers' perception toward mandated curricular changes: Science teaching and methodology, communication, and resources and collaboration. The study supports the following recommendations for implementing mandated curricular change:

Recommendations for the State Education Department

Participants, both teachers and administrators, expressed their frustration with the rollout of the NYSSLS and the lack of resources provided by the state to support this transition. It is recommended that the state provide timely and detailed information regarding new standards and assessments. Documents that should be provided, including example documents, sample assessment questions for teachers, and required laboratory Investigations, should be provided with time to properly support the implementation before making implementation mandatory. Studies show that there is a need for specific training before the implementation process can begin (Main & Pendergast, 2016). Professional development should be developed to uniformly disseminate information and support stakeholders to implement the standards with fidelity. Through the research, it is shown that professional development that is relevant and tailored to the needs of the group can help to support and inspire change through collaboration (Pendergast, et al., 2005).

Recommendations for the School District Leaders

It is recommended that the district create a comprehensive content-specific professional development plan that includes all stakeholders in the planning process to implement new mandated curricular changes. Research shows that teacher collegiality positively affects teacher efficacy and the adoption of desirable teaching strategies (Ke,

Yin, & Huang, 2019). Allocate time for curriculum development ahead of mandatory implementation that includes all stakeholders to ensure teacher buy-in to support the change. Provide staff with opportunities to seek outside professional development as a team to expand their understanding of the change and provide an opportunity to collaborate. Research supports the need for inquiry-based professional development to foster appropriate strategies to support student learning (Almuntasheri, Gillies, & Wright, 2016).

Recommendations for School-Building Leaders

To support teachers during mandated curricular change, it is recommended that the building provide teachers with common planning time in their typical school day based on their grade level and the subjects being taught. This allows teachers to collaborate daily to support the mandated changes and increase teacher buy-in. According to the research, it is beneficial to provide teachers with additional time to explore, collaborate, and create new resources to help with the implementation process (Bancroft & Nyirenda, 2020). Lastly, it is recommended that professional development opportunities be targeted to the needs of the staff and that staff be included in the professional development planning process. Research has found that in-service training programs often lack the necessary support for teachers to utilize the training effectively, and large-scale training often lacks the specificity necessary to be effective (Eroglu & Donmus Kaya, 2021; Booth, Coldwell, Muller, Perry, & Zuccollo, 2021).

Recommendations for Teachers

Recommendations for teachers include continuous collaboration with content and grade-level colleagues to develop, review, and create a curriculum that aligns with the

new standards (Vasiliene-Vasiliauskiene, Vasilis-Vasiliauskas, Meidute-Kavaliauskiene, & Sabaityte, 2020). Seek professional development opportunities outside of the classroom to attend as a grade level/content team or, at the very least, turn key to the grade level/content team after the training. Continue to create and utilize inquiry-based learning opportunities in the classroom to familiarize students with an inquiry approach to science and to teach the necessary 21st-century science skills. Research supports teachers utilizing strategies to support the foundational science concepts to increase student learning (Havice, Havice, Waugaman, & Walker, 2018).

Recommendation for Future Research

There are several recommendations for future research. First, since the study was a single case study focused on one district's perception of implementation, the study could be replicated to include a larger sample. A multi-case study could be used to gain further insight into implementing the NYSSLS amongst different districts and add to the current body of research to increase the external validity of the findings.

Similarly, this study was limited to teacher perception of the NYSSLS; research could include participants from different content areas to investigate how mandated curricular change affects different content areas. New York State is implementing the Next Generation Learning Standards for math and English language arts, with full implementation and assessments expected in June 2026 (NYSED, 2023). Combining this research with previous research on mandated curricular change could help develop theory and inform educational policy.

Additionally, the framework could be utilized to conduct a mixed methods study by utilizing a survey to reach a more significant sample of participants across New York

State, increase the range of teacher experience and perception, and help determine the influence implementation has across different educational settings. This can then be compared to the findings to determine transferability and increase the external validity of this study.

Conclusion

The findings from this study reveal in-service science teachers' perceptions of the impact of the mandated curricular changes in science education through the implementation of the NYSSLS. Teacher perceptions were analyzed, and the findings revealed a need for increased communication between science teachers, districts, and the state education department. As the recommendations for future practice suggest, the findings showcased the need to create a learning organization based on the development of professional capital through increased collaboration, communication, and targeted content-specific professional development. The continuous shift in standards, methodology, and best practices has caused teachers to become frustrated and discouraged. As a result, science teachers see a shift in standards and learning methodology that lacks the support in the current educational system necessary to implement the standards effectively. The ineffective communication between the New York State Education Department, administration, and teachers has caused teachers to become frustrated with the implementation and dedicate their own time to collaborate with colleagues due to a lack of available resources, a lack of effective professional development, and a lack of allotted time by the district. The lack of resources negatively impacted teachers' perception of implementation and increased their desire for professional development opportunities to collaborate with their colleagues to implement

the new mandated curricular changes. The current research literature on science teacher perceptions of mandated curricular changes is limited. The existing gap in the change process primarily focuses on student achievement as the result of a program. The studies on teacher perception investigate perception at the elementary and higher education levels and mainly focus on English Language Arts and Math. The research does not look specifically at secondary science teacher perceptions. Including secondary science teachers' perceptions of mandated curriculum changes addresses the gap in the existing research literature.

APPENDIX A LETTER OF CONSENT (SUPERINTENDENT)

[redacted] Superintendent of Schools
[redacted] School District
[redacted] NY [redacted]

Dear Dr. [redacted]

I am a Doctoral student at St. John's University in Queens, New York. I am writing to request your support in conducting a research study that I believe will have an impact on science education. The current body of research indicates that teachers' perceptions towards mandated curriculum changes have an impact on the success of implementing the change process. A gap in the research exists when examining mandated curriculum changes in the field of science.

I will be investigating secondary science teachers' perceptions towards mandated curriculum changes under the New York State P-12 Science Learning Standards. I am requesting permission to conduct focus groups and individual interviews of secondary science teachers and administrators during the 2022-2023 academic school year. If permission is granted, you will be provided with a copy of the invitation to participate in the research study, which will be sent electronically to the secondary science teachers in your school district. During the collection of the qualitative data during the focus groups and individual interviews, teachers and school district will be given a pseudonym to maintain confidentiality.

Thank you for your time and consideration of this request. If you would like to grant permission, please email the approval to [redacted] If you have any questions, please do not hesitate to contact me at [redacted] Or my faculty sponsor, [redacted], at [redacted] The results of this study will inform educational leadership of the relationship between teachers' perceptions towards mandated curriculum changes and the success of implementing the change process.

Respectfully,

Pamela A. Gordon

From:
Date: Wed, Jan 11, 2023, at 2:57 PM
Subject: Doctorate Study
To: <pamela.mcgirr16@my.stjohns.edu>
Cc: admin

Good afternoon,

It was a pleasure meeting with you. Your request to conduct a research study in West Babylon has been approved. Please let me know if you need any additional information.

[redacted]
Superintendent of Schools
[redacted]
Office: [redacted]
Fax: [redacted]
Twitter: [redacted]
Facebook: [redacted]

APPENDIX B LETTER OF INFORMED CONSENT (FOCUS GROUP)

Invitation and Consent to Participate in a Research Study (Focus Group)

Dear Participant:

You are being invited to take part in a research study to learn more about secondary science teachers' perception towards mandated curriculum changes under the New York State P-12 Science Learning Standards. I will conduct this study as part of my St. John's University doctoral dissertation. My faculty sponsor is Dr. DiMartino, Department of Administration and Instructional Leadership. If you agree to be in this study, you will be asked to do the following:

- A focus group lasting from 30 – 60 minutes. Audio recordings of the focus groups will be made so that the data can be transcribed and analyzed. You may review the audio recordings and request that all or any portion of the recordings be destroyed, that includes your participation. Pseudonyms will be used during transcription for all proper names in order to maintain confidentiality and anonymity.

Although you will receive no direct benefits, this research may help the investigator understand perceptions towards the implementation of the New York State Science Learning Standards and help to better inform implementation changes by educational leadership.

All consent forms will be kept separate from the transcription data to ensure that the names and identities of all participants will not be known or linked to any information provided. Participation in this study is voluntary. You may refuse to participate or withdraw at any time without penalty. For interviews, you have the right to skip or not answer any questions you prefer not to answer. All responses and feedback will be confidential and anonymous throughout the entire research study.

If you have any questions or concerns, please contact me at [redacted] or call [redacted] or my faculty sponsor, Dr. Catherine DiMartino, at 718-990-2585.

Thank you for your time and participation in this study.
Respectfully,

Pamela A. Gordon

Yes, I agree to participate in the study described above.

_____	_____
Participant's Signature	Date
_____	_____
Researcher's Signature	Dat

APPENDIX C LETTER OF INFORMED CONSENT (INTERVIEWS)

Invitation and Consent to Participate in a Research Study (Interviews)

Dear Participant:

You are being invited to take part in a research study to learn more about secondary science teachers' perception towards mandated curriculum changes under the New York State P-12 Science Learning Standards. I will conduct this study as part of my St. John's University doctoral dissertation. My faculty sponsor is [redacted] Department of Administration and Instructional Leadership. If you agree to be in this study, you will be asked to do the following:

- An individual interview lasting from 30 – 60 minutes. Audio recordings of the interview will be made so that the data can be transcribed and analyzed. You may review the audio recordings and request that all or any portion of the recordings be destroyed, that includes your participation. Pseudonyms will be used during transcription for all proper names in order to maintain confidentiality and anonymity.

Although you will receive no direct benefits, this research may help the investigator understand perceptions towards the implementation of the New York State Science Learning Standards and help to better inform implementation changes by educational leadership.

All consent forms will be kept separate from the transcription data to ensure that the names and identities of all participants will not be known or linked to any information provided. Participation in this study is voluntary. You may refuse to participate or withdraw at any time without penalty. For interviews, you have the right to skip or not answer any questions you prefer not to answer. All responses and feedback will be confidential and anonymous throughout the entire research study.

If you have any questions or concerns, please contact me at [redacted] or call [redacted] or my faculty sponsor, [redacted] at [redacted].

Thank you for your time and participation in this study.
Respectfully,

Pamela A. Gordon

Yes, I agree to participate in the study described above.

_____ _____
Participant's Signature Date

_____ _____
Researcher's Signature Date

APPENDIX D LETTER OF INFORMED CONSENT (OBSERVATIONS)

Invitation and Consent to Participate in a Research Study (Observations)

Dear Participant:

You are being invited to take part in a research study to learn more about secondary science teachers' perception towards mandated curriculum changes under the New York State P-12 Science Learning Standards. I will conduct this study as part of my St. John's University doctoral dissertation. My faculty sponsor is [redacted] Department of Administration and Instructional Leadership. If you agree to be in this study, you will be asked to do the following:

- A classroom observation lasting from 30 – 40 minutes. Notes of the observations will be taken. Pseudonyms will be used for all proper names in order to maintain confidentiality and anonymity.

Although you will receive no direct benefits, this research may help the investigator understand perceptions towards the implementation of the New York State Science Learning Standards and help to better inform implementation changes by educational leadership.

All consent forms will be kept separate from the data to ensure that the names and identities of all participants will not be known or linked to any information provided. Participation in this study is voluntary. You may refuse to participate or withdraw at any time without penalty. All responses and feedback will be confidential and anonymous throughout the entire research study.

If you have any questions or concerns, please contact me at [redacted] or call [redacted] or my faculty sponsor, Dr. Catherine DiMartino, at 718-990-2585.

Thank you for your time and participation in this study.
Respectfully,

Pamela A. Gordon

Yes, I agree to participate in the study described above.

_____ _____
Participant's Signature Date

_____ _____
Researcher's Signature Date

APPENDIX E PROTOCOL ADAPTATION PERMISSION

ST. JOHN'S UNIVERSITY

Re: Doctoral Dissertation Protocol Request

Hi Pamela,

You have my permission to use and modify the protocols used in my study for the purpose of your case study, looking at the perceptions and implementation of the new science standards. Good luck with your study, and please let me know if you have any questions along the way.

Have a great day,

Ricky V. Papandrea Jr., Ed.D.

APPENDIX F TEACHER FOCUS GROUP PROTOCOLS

Opening:

Thank you for taking the time to participate in this focus group concerning science teachers' perceptions towards mandated curriculum changes under the New York State P-12 Science Learning Standards. Your participation in this focus group supports my research study on how teachers' perceptions impact the change process. The goal of this focus group is to discuss how the implementation of the New York State P-12 Science Learning Standards has impacted your perceptions of implementing change in the science classroom. Before we begin, is there anyone who does not want to participate in the focus group? If any of you decide at any point during the focus group that you would no longer like to participate, please let me know.

Overview:

During the focus group, I am going to ask a few questions. After each question is asked, I will ask that each participant share their ideas in discussion with myself and the other group members. The entire focus group session will be captured in an audio recording in order to allow for an accurate account of what takes place. The only people who will know what is said are those of us in this room during the focus group session. The discussion and transcripts from the focus group are completely confidential. When the results of the focus group are shared, none of your names will be included. Does anyone have any questions before we begin?

Focus Group Questions:

1. What do you know about the New York State P-12 Science Learning Standards?
2. How do you feel about the changes to science instruction in the New York State P-12 Science Learning Standards?
    a. Instructional changes?
    b. Content changes?
    c. New pressures?
    d. Shifts?
3. How did your instructional day change with the implementation of the New York State P-12 Science Learning Standards?
4. What type of support have you received from the department in implementing the New York State P-12 Science Learning Standards?
    a. How has the Science Department been involved in the implementation?
    b. What type of professional development has been provided?
    c. What type of resources have been provided?
5. What type of support have you received from your administrative team?
    a. Department Supervisor?
    b. Principal?
    c. District Office?
6. Are there additional supports you would want to receive from your administrative team?
7. How do you feel about new required Investigations? (Middle Level only)
8. What else should I know about these changes? What could have been done differently? The same?

Closing:

Thank you for taking the time to share your thoughts about the implementation of a mandated curriculum in the science classroom under the New York State P-12 Science Learning Standards. Your feedback will no doubt help support my research study as well as our ability to support science teachers in implementing mandated curriculum changes.

APPENDIX G TEACHER INTERVIEW PROTOCOLS

Opening:

Thank you for taking the time to participate in this interview on science teachers' perceptions towards mandated curriculum changes under the New York State P-12 Science Learning Standards. Your participation in this interview supports my research study on how teachers' perceptions impact the change process. The goal of this interview is to discuss how the implementation of the New York State P-12 Science Learning Standards has impacted your perceptions of implementing change in the science classroom. If you decide at any point during the interview that you would no longer like to participate, please let me know.

Overview:

During the interview, I am going to ask a few questions. The entire interview session will be captured in an audio recording in order to allow for an accurate account of what takes place. The only people who will know what is said are those of us in this room during the interview. The discussion and transcript from the interview are completely confidential. When the results of the interview are shared, your names will not be included. Do you have any questions before we begin?

Interview Questions:

1. What grade level do you teach?

a. How long have you been teaching?

b. How long have you been teaching this grade level?

2. What are your views of the new standards outlined in the New York State P-12 Science Learning Standards?

3. What are your views of the new assessments created for the New York State P-12 Science Learning Standards?

4. Can you give me an example or examples of significant changes in your professional life as it relates to the New York State P-12 Science Learning Standards?

    a. What impact, if any, has the New York State P-12 Science Learning Standards had on your teaching methods in the classroom?

5. How has the implementation of the New York State P-12 Science Learning Standards impacted your instructional practices?

    a. How have New York State P-12 Science Learning Standards impacted students' learning in the classroom?

6. Have you done anything to help facilitate a successful implementation of the New York State P-12 Science Learning Standards?

    a. What professional development opportunities have you sought out? Was it helpful?

    b. Have you collaborated with your colleagues? How? Why?

7. Have you encountered any difficulties or challenges during the implementation of the New York State P-12 Science Learning Standards?

    a. What difficulties or challenges?

    b. What do you need to overcome or make the challenges easier?

    c. How have you overcome some of the challenges in implementing the New York State P-12 Science Learning Standards?

8. Are there any specific student populations that the new standards might be challenging for?

9. What are your views on the relationship between administration and teachers?

    a. Do you feel there is trust and respect? Is the relationship a partnership? How? Why or Why not?

Closing:

Thank you for taking the time to share your thoughts about the implementation of a mandated curriculum in the science classroom under the New York State P-12 Science Learning Standards. Your feedback will no doubt help support my research study as well as our ability to support science teachers in implementing mandated curriculum changes.

APPENDIX H ADMINISTRATOR INTERVIEW PROTOCOLS

Opening:
Thank you for taking the time to participate in this interview concerning the science administrator's perceptions towards mandated curriculum changes under the New York State P-12 Science Learning Standards. Your participation in this interview supports my research study on how teachers' and administrators' perceptions impact the change process. The goal of this interview is to discuss how the implementation of the New York State P-12 Science Learning Standards has impacted your perceptions of implementing change in the science classroom. If you decide at any point during the interview that you would no longer like to participate, please let me know.

Overview:
During the interview, I am going to ask a few questions. The entire interview session will be captured in an audio recording in order to allow for an accurate account of what takes place. The only people who will know what is said are those of us in this room during the interview. The discussion and transcripts from the interview are completely confidential. When the results of the interview are shared, your names will not be included. Do you have any questions before we begin?

Interview Questions:
1. How long have you been the administrator overseeing the Science Department?
a. Were you a science teacher, and if so, how long?
2. What are your views of the new standards outlined in the New York State P-12 Science Learning Standards?
3. What are your views of the new required Investigations created for the New York State P-12 Science Learning Standards?
4. Can you give me an example or examples of significant changes in the teachers' professional life as it relates to the New York State P-12 Science Learning Standards?
5. How has the implementation of the New York State P-12 Science Learning Standards impacted the instructional practices in the department you supervise?
    a. What is the most important change you have made in the curriculum?
    b. Do you think New York State P-12 Science Learning Standards has helped improve students' learning? Why or why not?
6. What are some examples of things you have done to help the teachers with the implementation of the New York State P-12 Science Learning Standards change process?
7. What are some examples of challenges you had to face in implementing the New York State P-12 Science Learning Standards change process?
    a. What supports do you need to provide teachers to overcome or make the challenges easier?
8. How has your job changed?
    a. Recommendations for State? b. What would you do the same/differently?
8. Are there any specific student populations that the new standards might be challenging for?
9. What are your views on the relationship between teachers and administration?
    a. Do you feel there is trust and respect? Is the relationship a partnership? How? Why or Why not?

Closing:
Thank you for taking the time to share your thoughts about the implementation of a mandated curriculum in the science classroom under the New York State P-12 Science Learning Standards. Your feedback will no doubt help support my research study as well as our ability to support science teachers in implementing mandated curriculum changes.

APPENDIX I TEACHER OBSERVATION PROTOCOLS

Observation Protocol:

Observer: _____ **Date: _____**

Time: _____ **Length of Observation: _____**

Setting (Sketch of room set-up):

Teaching Methods Used:

Description of Activity:

Reflective Notes:

APPENDIX J DOCUMENT ANALYSIS PROTOCOL

Document Analysis Protocol - adapted from O'Leary (2014).

1. Gather relevant texts.
    a. New York State P-12 Science Learning Standards
    b. Statewide Strategic Plan for Science and Science Learning Standards

    NYSSLS Required Investigations Released (October 2022)
    c. Structures and Properties of Matter: All Mixed Up (PE: MS-PS1-8)
    d. Energy: Cool It! (PE: MS-PS3-4)
    e. Weather and Climate: Air Mass Matters (MS-ESS2-5)
    f. Structure Function and Information Processing: It's Alive? (MS-LS1-1)
    g. Department Meeting Agendas ()
    h. Professional Development Documents (Dec 2022)

2. Develop an organization and management scheme.
    a. Upload to Dedoose to store and manage all data

3. Make copies of the originals for annotation.
4. Asses the authenticity of documents.
5. Explore the document's agenda and biases.
6. Explore background information
7. Ask questions about document
    a. Who produced it?
    b. Why?
    c. When?
    d. Type of data?
8. Explore content
    a. Data Analysis through multiple rounds of coding
    i. Attribute coding – Code Landscaping
    ii. Pattern coding
    iii. Code Weaving

APPENDIX K IRB APPROVAL

Federal Wide Assurance: FWA00009066

Feb 27, 2023, 3:40:31 PM EST

PI: Pamela McGirr
CO-PI: Catherine DiMartino
The School of Education, Ed Admin & Instruc Leadership

Re: Expedited Review - Initial - **IRB-FY2023-207** *IMPLEMENTING INQUIRY: A CASE STUDY OF SECONDARY SCIENCE TEACHERS' PERCEPTIONS OF CURRICULUM CHANGE*

Dear Pamela McGirr:

The St John's University Institutional Review Board has rendered the decision below for *IMPLEMENTING INQUIRY: A CASE STUDY OF SECONDARY SCIENCE TEACHERS' PERCEPTIONS OF CURRICULUM CHANGE*. The approval is effective from February 27, 2023, through February 26, 2024.

Decision: Approved

PLEASE NOTE: If you have collected any data prior to this approval date, the data must be discarded.

Selected Category:

Sincerely,

Raymond DiGiuseppe, PhD, ABPP
Chair, Institutional Review Board
Professor of Psychology

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