DIGITAL TECHNOLOGY AND TEACHER PREPARATION: THE INSTRUCTIONAL ROLE OF SOCIAL MEDIA AMONG PRE-SERVICE TEACHERS

By

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Abstract

As social media use becomes more prevalent among teachers, it becomes vital to understand how teachers are using social media and what effects it has, if any, on teaching practices in the classroom. This study sought to explore the relationship between pre-service teachers' use of social media and their perceptions of inquiry-based science education, an important teaching best practice.

This study is unique in that it explores pre-service teachers' use of three social media platforms—Twitter, Facebook, and Pinterest—and how pre-service teachers plan to apply them to classroom education. Previous studies focused on only one social media platform, usually Twitter or Facebook. This study surveyed 113 pre-service teachers in their 3rd or 4th year of school at one of two teacher colleges. The survey employed multiple choice, open-ended, and Likert-type questions to assess pre-service teachers' use of social media as well as their attitudes surrounding inquiry-based instruction. In order to better explain and analyze survey results, fourteen survey participants were interviewed with follow-up questions to elaborate on both social media use and inquiry attitudes.

Findings indicated that the pre-service teachers used social media, and overwhelmingly Pinterest, to find lesson plans and classroom organizational ideas. Cited reasons for this practice included convenience, variety of lesson planning, and easily searchable databases. The study found statistical significance in that teachers who aspire to teach lower grade levels will turn to social media to find lesson plans more frequently than those who aspire to teach higher grade levels. The study found social media use had no statistically significant effect on the level of inquiry-based teaching that the participants aimed to achieve in their future classrooms.

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Chapter 1: Introduction

Background of the Problem

During the past decade, the widespread use of social media has altered the way people communicate and gather information. Multiple factors contribute to this change in human interaction, including expanding familiarity with digital devices and the availability of sophisticated applications. As people become increasingly reliant on rapid communication, they come to demand technological advances as a means to achieve progress (Landsbergen, 2011). Educators are actively exploring social media's potential to enhance their profession. For instance, teachers collaborate and expand their knowledge via social media, since it is an expedient way to share collect information. While there is a significant body of educational literature on social media, minimal research examines it in terms of education and communication style. In light of the growing influence social media plays in the field of education, this dissertation examines the professional use of social media among pre-service teachers who plan to teach elementary or middle-level grades and its relationship to their pedagogy and professional collaboration.

As accessibility to and variety in social media continue to increase, educators can use it to augment professional activities in myriad ways. Professional development is one such application. An increasing number of pre-service teachers join virtual professional communities to correspond with other educators, expand their professional development options, and seek out professional ideas such as lesson plans and classroom management techniques (Vockley & Lang, 2009). They find social media an efficient way to stay current on policy changes and educational news (Phillips, Baird, & Fogg, 2011). The top social media resources for educators include Twitter, Facebook, and Pinterest. One report specifically recommended Twitter to educators:

> Educators really can't afford not to be on Twitter. Our educational landscape is changing very rapidly. Our students are using this technology every day, and as educators we must continually be growing and finding new ways to learn and to reach our students. Is Twitter perfect? By no means. But used correctly, Twitter can become a catalyst in transforming your classroom, your school and your teaching. So be bold, step outside the box, and start tweeting today. (NEA, 2012)

This dissertation investigated how pre-service teachers use social media to communicate with other educators and its relationship to professional activities, a fundamental aspect of teaching. The study also sought to determine if these teachers use some social media resources differently than other resources. Much of a pre-service teacher's preparation is structured around educational philosophy, lesson design, and classroom management. Effective, experienced teachers use a variety of resources to supplement ideas and techniques to be used in the classroom, as do pre-service teachers. Social media has made the task of accessing new concepts, fresh ideas, and best practice models easy, but not always the most efficient. No longer tied to cumbersome print sources (which often limit a pre-service teacher's scope of information as well as the time available to explore it), teachers with Internet access can use social media to explore an endless variety of current ideas and novel practices. For instance, a teacher accustomed to presenting a science lesson by direct instruction from the textbook may, through social media, discover an intriguing selection of lesson-plans that include inquiry-based activities. By implementing some of these lessons, he/she may increase student engagement and learning. This study explored how pre-service teachers use social media and to what extent they planned to implement the ideas they found in their future professional classrooms.

Statement of the Problem

Through gaining awareness of professional resources available via social media, pre-service teachers may be more likely to employ professional ideas in their future classrooms, including inquiry-based instruction, and may feel validated in doing so through digital contact with other teachers. Deeper understanding of pre-service teachers' social media usage and communication styles provide added insight into teacher education programs, as well as into the reasons why social media use has increased in the population in general.

Purpose of this Study

The intent of this mixed methods study is to explore pre-service teachers' use of social media and their perceptions of inquiry-based science education, an important teaching practice. Quantitative analysis addresses patterns associated with answers from a survey. Pre-service teachers from two universities filled out the surveys while attending the class, *Teaching Science in the Elementary Classroom*. The questions were a mixture of multiple-choice, Likert-style and open-ended type questions. Information from these results were explored further in a qualitative phase. Interviews from a subset of survey participants were used to amplify the results by exploring aspects of pre-service teachers' relationship between social media and perceptions of inquiry-based methods. The reason for the follow-up qualitative research was to understand and better explain the quantitative results.

Research Questions

This dissertation focused on pre-service teachers' use and implementation of social media as an educational tool. The study addressed the following questions:

1. How do elementary and middle-school pre-service teachers use different forms of social media in practice? Is there a difference by grade level?
    a. How frequently do they access social media as a professional tool for educational use?
    b. How do they use it for communicating with other pre-service teachers?
    c. How do they use it as a tool to find teaching ideas and strategies?
2. How do pre-service teachers perceive the relationship between their social media usage and inquiry-based classroom practices? Is there a difference by grade level?
3. What is the relationship between pre-service teachers' use of social media and plans for inquiry science instruction?

Definitions of Terms

The following definitions provide consistent understanding of terms used throughout the study:

Facebook: A social networking site where users can create a personal profile, add other users as friends, and exchange messages. It can also generate automatic notifications when friends update their profiles or post new material (Boyd & Ellison, 2010).

Pinterest: A social photo sharing website that allows users to create and manage theme-based image collections for events, interests, hobbies, and more. Users can browse other pin boards for inspiration, re-pin images to their own collections, and/or "like" photos (Desai, 2012).

Social Media: A group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, allowing the creation and exchange of user-generated content (Kaplan & Haenlein, 2010).

Social Network Sites (SNS): Web-based services that allow individuals to 1) construct a public or semi-public profile within a bounded system, 2) articulate a list of other users with whom they share a connection, and 3) view and traverse their list of connections and those made by others within the system. The nature and nomenclature of these connections may vary from site to site (Boyd & Ellison, 2010).

Twitter: An online social network that allows users to post short messages that can be read by any other Twitter user. It allows users around the world to stay connected to their friends, family members, and coworkers through their computers and mobile phones. Users declare the people they are interested in following (Huberman, Romero, & Wu, 2008).

Conclusion

This study explored how social media is employed by elementary level pre-service teachers and its relationship to their pedagogy. While these teachers have various levels of proficiency using social media in their personal lives, little is known about its use—actual and potential—for educational purposes. These purposes include but are not limited to teacher preparation, lesson planning, perspectives on inquiry instructional methods, and communication regarding educational topics.

This research follows a classic mixed-methods model: it utilizes a survey to explore the professional use of social media among Midwestern pre-service teachers, as well as semi-structured interviews of selected survey participants. The survey, which focuses primarily on applications such as Twitter, Facebook, and Pinterest, measures pre-service teachers' use of social media and perceptions of instructional design. It asks how pre-service teachers use social media to interact professionally and develop instructional methods. The results will contribute to a greater understanding of the application of social media to pre-service education.

Chapter 2: Review of the Literature

At first glance, social media and education may appear to be mutually exclusive domains. However, the potential of social media for educational purposes—teacher preparation, lesson design, and communication of ideas among practitioners—is just now being explored. This study enhances understanding in the field by examining how pre-service teachers use social media for communication and as a professional tool.

Headlines such as "Twitter, a necessity for educators in 2012" and "Twitter won't change your life, but it might make your job more fun and a little easier" have become commonplace in newspapers as well as at educational conferences, where publishers present guides on how teachers can use social networking to communicate ideas with others (NEA, 2012). They tout social media as an efficient and interesting forum for collegial discussion of short and concise thoughts (Scheffer, 2012). Teachers are busy and social media presents a way for them to use limited time productively. Some educators even believe that social media might soon replace traditional teacher professional development because of its highly motivational nature and ease of use (Vockley & Lang, 2009).

This chapter provides an overview of social media today and traces its recent increase. It explores how educators use social media to plan and enhance professional activities, such as through the implementation of inquiry-based lessons. Public media presents a confusing and often negative view of social media in relation to education, obscuring its real and meaningful uses in teaching. Hence, this study also includes a review of theories that provide insight into the widespread popularity of social media, and why educators are choosing to use it alongside traditional methods of professional development and collaboration. It covers the idea of technology literacy and how this relates to previous research.

The Emergence of Social Media

Media that is "social" exists in a format in which users can interact and exchange information with each other. Users can communicate with other people or connect with businesses and organizations. Social media is "a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0 and that allow the creation and exchange of user-generated content" (Kaplan & Haenlein, 2010, p. 61). Throughout this dissertation, the term social media will be used to reference those tools that facilitate social interaction via the Internet through applications such as Pinterest, Facebook, and classroom blogs. Pre-service and in-service teachers can use these resources to find ideas, communicate with colleagues, and inform themselves about current issues and research.

Social media's place in education is a direct result of the increasing use of digital media in society at large. In 2010, reports showed that 40% of sixth-graders used a social network (Reich, 2010). Experts expect this number only to increase over time as more students become digital natives, using computers even from the time they were toddlers (Wankel, 2009). Adult educators are joining as well, with 60% having joined a social network as of 2010 (Pilgrim & Bledsoe, 2011). The resulting impact of social media is evident in the classroom: both teachers and students use social media in their search for information and collaboration, as well as in the realm of personal communication.

The evolution of social media has shaped the ways in which students communicate with each other and their educators. Young adults spend almost as much time on social networking websites as they do watching television (Vockley, 2007). Through extensive use of social media, students develop a facility for its applications as well as the desire for more complex and interesting uses. By engaging students in activities through the use of social media, teachers can take advantage of a highly motivating force, one that if used effectively, can enhance student learning.

Social media and education. A group of educators at a conference in New York proposed the following scenario:

> Instead of enduring long hours in a professional development workshop, where everyone learns the same thing at the same time, teachers participate in individualized professional development in real time via social media. It can immediately and at the convenience of the teacher, address the demand for ideas regarding lesson planning, classroom management issues, or student motivation, in particular students with special needs from high-achievers to students with disabilities. (Scheffer, 2012)

Beyond professional applications, pre-service teachers are discovering ways social media can expand their own learning and preparation. One valuable application is communicating with other educators. By using social media, educators find professional "communities" that are based on interest and expertise, as opposed to those involving only colleagues in the immediate vicinity (Vockley & Lang, 2009). Social media in this form is especially advantageous for teachers in small schools or for special groups of teachers, such as new teachers, who might otherwise be isolated due to distance between building locations (Vockley & Lang, 2009). Emerging social media technologies are continuing to shape how teachers engage in development and interact with colleagues (Vockley & Lang, 2009). Consequently, this intersection of education and social media needs exploration.

As the selection of social media has become more diverse, so has teachers' use of it. According to Forte, Humphreys, and Park (2012), of all the forms of social media used by teachers, Twitter is one of the most popular for professional use. It offers "a forum for teachers to not only talk about their professional practice and share practical information and news, but also find like-minded educators and give a voice to their ideological commitments" (Forte et al., 2012). Teachers use Twitter to communicate easily with other educators at a distance. They share ideas and expand each other's pedagogy. Traditionally, a closed classroom door isolates a teacher, who is also limited by the time available to collaborate with colleagues. Social media presents an alternative solution to both of those situations. In addition to concrete ideas, tweeting (i.e., posting on Twitter) offers teachers camaraderie, confidence, and the impetus to creativity.

Whereas most social media retains a textual component, there is growing interest in other forms of digital communication, such as image-based communication. Pinterest is a popular image-based form of social media. Pinterest has quickly gained popularity due to its ease of use (Desai, 2012).

For several years, Facebook has remained popular with pre-service teachers because many of them might have used Facebook as undergraduate students themselves (Suwannatthachote & Tantrarungroj, 2012). Suwannatthachote and Tantrarungroi (2012) found that all 205 pre-service teachers in their study had used Facebook before enrolling in a teacher preparation course and were comfortable using it as a collaborative tool in their professional environment. Facebook can be used in many different ways, but they are most often used to give or receive feedback from others or as a way to make information available to a large number of followers simultaneously (Phillips et al., 2011). As Facebook continues to grow in popularity, its use for educational purposes will likely change and expand, as well.

Social media's effect on pedagogy. Social media aids pre-service teachers by extending their opportunities to explore and share ideas about both content and delivery. Social media offers more avenues for pre-service teachers to gain confidence in meeting new challenges (Valazza, 2011), by helping them broaden their knowledge of subject matter and perfect their delivery and classroom management skills, which may have an affect on student learning. A distinct advantage to augmenting pre-service education using electronic media is that it allows greater flexibility for pre-service teachers, as well as the opportunity to target specific areas of individual interest and need. Pre-service teachers also benefit from expanded interaction with other professionals.

In order to meet the needs of schools, it was necessary to prepare the educators responsible for teaching a growing, mobile population. Furthermore, because the rate of cultural change has accelerated in the last two generations, it has been necessary for teachers to continue to learn beyond their initial education and certification. States started requiring a successive model for teacher education so that practitioners could prepare their students for life in an increasingly global society (Wood, 2005).

Today models for professional development vary, but the goal remains the same—the ongoing growth and learning of teachers. In-service and pre-service teachers participate in professional growth models to "develop, implement, and share practices, knowledge, and values that address the needs of all students" (Schlager & Fusco, 2003). Teachers increasingly rely on digital media for information about their own professional development (Vockley & Lang, 2009). Furthermore, in many of the current models, pre-service teachers use technology to communicate with each other to enhance their practice. They collaborate, share and refine ideas, and provide support and feedback to each other. In this way, they enrich their lessons and learn to teach more effectively.

Technology is, in this context, somewhat of a double-edged sword, making learning more readily accessible while limiting access to that learning based on available technology. As more technology becomes available for teacher preparation, training and time to learn how to use these tools are essential. "Teachers have more resources available through technology than ever before, but have not received sufficient training in the effective use of technology to enhance learning" (Culp, Honey, & Mandinach, 2005). It is a Catch-22: without sufficient time and instruction about how to use the technology at their fingertips, there is little net gain for new teachers already challenged by a heavy schedule. While e-learning and other online instructional methods provide alternatives, new teachers need additional time to become familiar with each new technology and to discover how they can implement it to meet their future classroom and professional development needs.

Teachers and technology literacy. Competency and comfort with technology depend on a person's prior experience. A pre-service teacher's disposition toward technology is influenced by his or her specific successes and failures, and the quality of opportunities to employ technology in both the personal and professional realms. The technology one grows up with, the devices one becomes familiar with through education and entertainment, the type of technological instruction and support available, and one's access to technology contribute to a person's computer comfort level and expertise (Wankel, 2009). In relation to any given digital technology, most people progress through stages of computer literacy before attaining a level of computer fluency. The level of skill ultimately attained relates to, among other factors, the learner's motivation, access to support, and experience with technology.

Computer literacy refers to a basic level of computer skills. In the initial stages of this level, an individual begins to master the use of digital technology and typically needs support.

"Computer literacy" implies a fundamental familiarity with the world of technology and facility with its tools, including personal computers, cellphones, and iPods (Basili, 2008), and involves knowledge and use of email, word processing, and Internet searches (National Research Council, 1999). However, to incorporate a new component—a device or application—into his/her repertoire, a computer-literate person needs assistance. Through instruction and practice, computer-literate individuals begin to employ their newly acquired knowledge and skills independently and creatively.

The more advanced level, computer fluency, involves a higher and more complex level of technological creativity analogous to fluency in a foreign language. In language fluency, the learner moves beyond constructing basic sentences and dependency on a bilingual dictionary to authentic communication and meaningful personal use of the language. Computer fluency likewise permits the user to express thoughts and communicate with others (Papert & Harel, 1991). A person fluent in informational technology has a deeper and more flexible understanding of technology and can apply it in everyday life (National Research Council, 1999). Components of computer fluency include the ability to find, evaluate, and ethically use digital information to solve problems. Computer fluency involves specific knowledge, skills, and dispositions such as differentiating between digital information and print information, possessing the expertise to use specialized tools for finding digital information, and developing the dispositions needed to function well in the digital information environment (National Research Council, 1999). A computer-fluent teacher uses technology easily and confidently to navigate a variety of sites to gather information. A computer-fluent teacher likewise employs digital information and associated hardware with greater frequency and efficacy than a computer-literate teacher, thereby enhancing learning experiences for his or her students.

How teachers use social media. Social media can enrich the professional environment by providing teachers with the ability to create new ideas, present fun activities, and make the lessons lively (e.g., Forte et al., 2012; Reich, 2010; Roscorla, 2012; Shaltry et al., 2013; Suwannatthachote & Tantrarungroj, 2012; Visser et al., 2014; Vockley & Lang, 2009; Wankel, 2009). Such examples of social media frameworks include Pinterest, which allows photo sharing by its unique mechanism of pinning, and Facebook and Twitter, both of which serve as tools for sharing text, comments, photos, and group chats. Teachers can use these instruments to interact with students and other teachers directly, allowing them to exchange information and frequently communicate on matters of education. Accordingly, the purpose of this paper is to contribute to the existing research literature to discuss how pre-service teachers are using social media as an educational tool and describe the several ways it can be used to enhance education (e.g., Forte et al., 2012; Suwannatthachote & Tantrarungroj, 2012; Visser et al., 2014; Wankel, 2009).

To access a given social media tool one has to create a personal account, which allows a user to post, comment, and tag other users within the platform. For Facebook and Twitter, this process has simple steps that include providing a username, email, and a date of birth. Pinterest, on the other hand, only requires connecting the app with either Facebook or Twitter. Once a user has a functioning account, he or she acquires exclusive rights to post, share, create and participate in groups, comment, and follow other users (Hamel, 2015). Teachers and students can use these features to communicate with each other at any time, even outside regular school hours.

Facebook and Twitter are the other essential tools for teacher communication. Facebook, for example, allows teachers to post their ideas and thoughts to their friends and groups in the form of text, photos, or links. Their friends would view the published materials, and members can also initiate one-on-one or group online chats to transmit the intended information (Suwannatthachote & Tantrarungroj, 2012). Twitter, on the other hand, employs the use of text and links that allows teachers to tweet and retweet topics of interest to their followers. This mechanism allows the teachers and their participants to have interactions that serve as communication forums between them (Carpenter & Krutka, 2014).

Social media provides unlimited educational resources to both educators and students. In education, it can help teachers get access to collaborative lesson plans and professional ideas that enhance the classroom or improve their communication and interactive skills (Phillips et al., 2011. For instance, the lesson planning boards available on Pinterest provide detailed information on how to organize classroom sessions, and since similar topics are grouped together, users can use keyword searches to research specific topics more easily (Hamel, 2015). Many educators share their skills with each other on Pinterest, and a teacher could use that opportunity to search for his or her subjects and apply the information to improve their professional activities. Teachers can use pinned educational bookmarks to shape their lesson plans, as they provide links to more information about a range of concepts (Rayburn, 2014). Moreover, Pinterest presents extra tips for class organization, lesson plans, and ways of making learning interesting (Mekeel, 2014). Other than the methods mentioned above, Pinterest can be a source of inspiration in many respects; they include getting ideas for class decorations, getting ideas for new projects, exchanging lesson plans, getting links to vital teaching resources, and finding tutorials ("37 ways," n.d.).

Teachers can also use Facebook and Twitter to access lesson plans and professional ideas. For instance, they can send friend requests to other renowned educators on Facebook or browse pages for related content, and use the resulting information to manipulate their professional programs. Moreover, they can interact with other teachers and exchange ideas in one-on-one chats or group chats. Twitter, on the other hand, gives teachers the ability to browse, follow, and view content from users who share essential educational materials. The forums on the website also provide valuable information that aids in professional development and the acquisition of particular needs that are part of classroom organization (Visser, Evering, & Barrett, 2014).

Apart from providing educational resources, social media plays a part in making sure that individuals stay current on politics and dynamic education environments. Firstly, the use of social media allows the exchange of relevant information within a society, which helps ensure that people are up-to-date with current events. One of the platforms that assists teachers in staying updated is the Common Core State Standards, which allows authorities and educators to share information and educational materials on Pinterest (Roscorla, 2012). Another way is the use of Diigo, a powerful tool that integrates with Twitter to store and revisit tweets, which then can be shared with other groups to create a community of informed individuals (Still, 2013).

The literature about the use of social media as an educational tool emphasizes that it provides additional information, making it an important approach for teachers in integrating information technology into the education sector (Shaltry, Henriksen, Wu, & Dickson, 2013). It has the power to build a community that uses technology to accomplish classroom tasks, making learning attractive and making it easier to accomplish tasks. Further, social media allows educators to control the classroom environment by sourcing new ideas or creating blogs that are used to harness comments from users and ideas from colleagues (Davidson, 2013).

Overall, the recent popularity of social media has prompted the growth of the communication sector, including the education sector. As the above literature dictates, embracing social media in education is the way forward to make classroom environments stimulating and learning fun. If students experience learning as fun and stimulating, then there is the possibility of making them understand what their teachers present to them. Therefore, pre-service teachers should consider embracing social media as an educational tool.

Inquiry-Based Learning

What is inquiry? There is a diversity of scholarly meaning concerning the nature of inquiry (Furtak, Seidel, Iverson, & Briggs, 2012, p. 300) and particularly what is meant by "inquiry-based" instruction as related to what teachers do. Additionally, how scholars understand inquiry is not always aligned with how practitioners understand and practice it (Minner, Levey, & Century, 2010). However, there are commonalities widely agreed upon within inquiry-based scholarship. Inquiry refers to the diverse ways in which scientists study the natural world, and to how students understand that knowledge (National Research Council, 1999). Minner et al. (2010) would add that inquiry additionally refers to a pedagogical approach employed by teachers. Likewise, inquiry-based learning refers to active, "hands-on" learning in which the student's progress is based on the process and his or her analytical skills, rather than on how much knowledge is acquired (Bruner, 1961). In 2000, the National Research Council identified core components of inquiry from the learner's perspective in which learners: 1) are engaged by scientifically oriented questions, 2) give priority to evidence, which allows them to develop and evaluate explanations that address scientifically oriented questions, 3) formulate explanations from evidence to address scientifically oriented questions, 4) evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding, and 5) communicate and justify their proposed explanations (NRC, 2000).

Is inquiry effective? Many meta-analysis comparing student outcomes in a traditional lecture setting to an inquiry-based class assert that inquiry produces more science learning, yet critics still argue that it is important to identify the features of inquiry learning that make it effective, rather than encourage teachers to take a mere background role while "students engage in self-guided, hands-on activities of dubious value" (Furtak et al., 2012, p. 301). Studying the usefulness of inquiry is further complicated by the fact that activities conducted by both students and teachers that are called 'inquiry' in the literature involve different cognitive processes (Furtak et al., 2012, p. 302). For this reason, it is important for researchers to describe classroom lessons rather than simply label them as 'inquiry' activities.

In a three-year study conducted by Marx (2004) examining 8000 students, those who learned science using inquiry-based methods improved their test scores, especially students who had been chronically low achievers. This study is ongoing, and as inquiry-based teaching increases in all the classrooms being observed, test scores continue to improve each year. Overall, this type of hands-on learning has been shown to increase students' scientific understanding (Marx, 2004).

In a five-year study conducted by Minner et al., (2010) thirty years of literature spanning from 1984 to 2002 were examined to determine the impact of inquiry-based instruction on K-12 science learning. The results of the study indicated that, while there was no statistically significant association between the amount of inquiry-based instruction students received and the learning of science concepts, the active thinking necessitated by the investigation cycle that inquiry demands (generating questions, designing experiments, collecting data, drawing conclusions, and communicating findings) *does* produce a measurable and compelling positive impact on students' understanding of science content (Minner et al., 2010, p. 493).

In 2012, Furtak et al. published a meta-analysis of inquiry-based science teaching literature and divided their results into a two-part descriptive framework based on (a) the cognitive processes students engage in and (b) the extent to which activities are guided by teachers. Their results indicate an overall positive effect of inquiry-based teaching practices on student learning and particularly in *epistemic* inquiry—inquiry-based on students knowing how science knowledge is generated and students conducting their own investigations. Another effective cognitive process was a combination of *epistemic, social* (the process of communicating science ideas), and *procedural* (methods of discovery). The *conceptual* cognitive process consisting of facts, theories, and science principles that treats science as a body of knowledge was not shown to be effective. The study additionally suggested that it is important for teachers to guide student activities in the context of inquiry learning.

Inquiry is an attractive approach for many teachers. According to Lipman (1989), one reason for this popularity is that "[t]he product of inquiry is meaning, and it is meaning for which we are all voracious, perhaps students most of all. An education that produces meaning will be satisfying for its own sake, and not merely for the sake of extrinsic benefits" (p. 11). Lipman explains that we are all searching for an understanding of the world around us. If educators keep this in mind and provide students an authentic opportunity to learn through inquiry, their students will be more motivated to learn.

Different ways of using science inquiry. To implement inquiry-based science education adequately, it is crucial that pre-service teachers fully comprehend the basic concept of inquiry and the difficulties and advantages of utilizing it. They also need to have had previous experience utilizing inquiry in their own lives, so they can utilize it in their lessons more easily (Lee & Shea, 2016). However, previous studies report that around 90% of pre-service teachers do not have any experience utilizing inquiry-based techniques. As a result, many of them hold or acquire certain misconceptions regarding the use of inquiry for teaching science (Windschitl, 2004). For instance, they may start believing that conducting science experiments firsthand is inquiry-based learning as it involves following step-by-step instructions, which misrepresents the nature and goals of inquiry. It is therefore important to outline what both learners and teachers can do to promote inquiry-based learning.

Inquiry-based learning can be approached from both learners' and teachers' perspectives. As indicated by NGSS (Next Generation Science Standards; 2012), educators ought to have the capacity to utilize different instruction and learning systems to empower learners by enhancing the concepts of science and logical studies through examinations. Similarly, learners ought to have the capacity to outline and lead logical examinations, and to obtain scientific understanding and knowledge with the help of inquiry-based learning (Shively & Yerrick, 2014). Keeping in mind the end goal to differentiate inquiry-based teaching and learning processes from the inquiry practiced by researchers or in a general sense, NGSS accentuate five vital components of an inquiry-based learning class: engagement of learners in scientifically-oriented queries, learners justifying and communicating their explanations, learners connecting scientific knowledge with those explanations, formulation of explanations from scientific evidence, and lastly, giving priority to scientific proofs when responding to queries (Bybee, Minstrell, & van Zee, 2000).

Within science classrooms, learning activities that incorporate each of these five components demonstrate inquiry-based teaching. There are various methods of pursuing inquiry-based learning within an educational environment. For example, educators can structure examinations so learners get to move forward toward the results that are expected of them (centered on teacher), or utilize free-running investigations of phenomena that are not yet explained (centered on student) (Richardson & Liang, 2008). Both of these inquiries are open-ended and very organized, and each has its part in the classroom. The educators' specific educational objectives often influence which type of inquiry is used (Plevyak, 2007).

In recent years, science instructors have been trying new strategies to educate their learners along these lines. These strategies are collectively referred to as the methods of inquiry-based learning. The old way to educate learners about scientific inquiry focused more on repetition or imitation of previously conducted experiments, with the help of laboratory guidelines set by standard rules (Plevyak, 2007). While those strategies helped create numerous extraordinary researchers, their insight mainly resulted from their own problem-solving and critical thinking skills, which were enhanced only as a side effect of the examinations and the experiments (Bybee et al., 2000). Providing students with a motivating learning environment, and compelling them to use inquiry, might help develop and enhance their processing skills and logical critical thinking capacities associated with the subject of science.

A significant part of the work in inquiry learning activities involved working in sets or teams to solve an issue or complete a project (Richardson & Liang, 2008). In cooperative and collaborative learning activities, learners work together in small groups to solve a scientific problem based on their collaborative understanding and knowledge (Varma, Volkmann, & Hanuscin, 2009). Such group activities are advantageous for behavioral and social learners, as they help with improving students' self-concepts, socially interacting with one another, accomplishing the task on time, and developing positive emotions towards other class fellows (Shively & Yerrick, 2014). Nonetheless, learning which is effectively collaborative can be perplexing to actualize. Previous studies have distinguished at least three potential obstacles to group-based activities: creating standards and structures inside the teams that permit people to cooperate, creating projects that assist helpful work, and creating discipline-suitable systems for discourse that assist with the rich learning of study material (Bybee et al., 2000).

On the off-chance that learners take part in hands-on examinations within these collaborative teams, the classroom where the activities take place must be science-oriented. Teams require space to cooperate, extra space (e.g. spacious tables) to place their ongoing experiments, and access to all kinds of scientific materials. Most middle-schools and some primary schools have a science room where this is conceivable. Outside of such rooms, teachers may need to move seats and tables around and utilize trays or small boxes for ongoing work and materials (Chabalengula, Mumba, & Mbewe, 2012). In grade schools, many materials utilized for experimentation are by and large normal and reasonably priced, such as soil, seeds, paper clips, and strings. Some supplies and equipment may be costlier: binocular magnifying lenses, stop clocks, prisms, measuring instruments, and batteries. In a few subjects, such as space science or earth science, experimentation with real questions isn't conceivable so activities might require models, outlines, or other media (Richardson & Liang, 2008). Whatever the materials, it is vital that they are available to the learners as they need them, and that learners take full responsibility for using the tools carefully and correctly (Varma et al., 2009).

In developing inquiry skills, it is vital that learners get the chance to utilize their skills and discuss this utilization with other peers. In numerous science lessons, learners are unable to observe the experiments in front of them firsthand, or choose how to lead an examination, or experience collecting useful information to solve the problem at hand. Instead, most of these tasks are done by the teacher on the students' behalf, or the students learn certain procedures from the books provided to them (Bybee et al., 2000; Richardson & Liang, 2008). These books usually come with full instructions, allowing less room for the students to make their own assumptions or inquire about why or how a certain phenomenon is taking place. Many students of science thus lack the aptitudes or skills associated with conducting or planning an investigation or experiment (Chabalengula et al., 2012). Therefore, students find it difficult to develop or enhance their skills in drawing conclusions, interpreting data, or basing claims on evidence. These experiences and skills are considered to be the most important factors within inquiry-based learning and teaching, so developing them in students requires special attention by teachers (Windschitl, 2004).

Making a plan to accomplish a task is a complex skill which requires both experience and the ability to thoroughly consider and predict the outcomes of that task. However, most young students find effective planning particularly difficult (Varma et al., 2009). Distinctively, students mostly think in the back of their minds about whatever that they are doing when conducting an experiment or accomplishing a task (Lee & Shea, 2016) without consciously identifying and ordering the steps of the task. In order to develop planning skills within these children, the teachers can utilize inquiry-based teaching by asking them specifically what they will do to complete the task (Richardson & Liang, 2008).

If the examination is descriptive rather than experimental, elementary students need to talk about what might be imperative for observation, how they are going to observe it, and how the data collection process will be conducted (Shively & Yerrick, 2014). When the students reach middle-school, they will need these planning skills in order to solve scientific problems (Chabalengula et al., 2012). Younger children typically develop these skills faster than older children. Hence, developing these skills during elementary school is essential to enhance and support children's planning and problem-solving skills (Bybee et al., 2000). Fortunately, even if these skills are not explicitly taught in the classroom, students can develop them at home or in other contexts.

Another very important method that teachers can use for successful implementation of inquiry-based teaching is creating records of students' science work (Chabalengula et al., 2012). This may include posters, charts, graphs, flowcharts, drawings, and texts. Keeping these records is considered a fundamental way of working experimentally and using a scientific approach. Making these records guides students towards clarifying their assumptions about a certain phenomenon, and helps them comprehend how far they have come and how much they have already learned (Chabalengula et al., 2012). It also helps them remember details from the previous lessons. Instructors can likewise use these records to ascertain students' assumptions, survey their improvement, and try to understand how their students think. For instance, the records may show that a student did not understand what was actually taught, or comprehended it from a different perspective: right but in a wrong way.

These records appear in a variety of formats. Most learners try to maintain a journal of everything they have learned during the lesson; they write down everything that the teacher says for later reading. Students likewise write down scientific content when they make reports for homework or deliver in-class presentations, which may include diagrams, flowcharts, and other writings (Chabalengula et al., 2012). Naturally, each recording method has its own writing style: presentations and written reports require completely different techniques (Lee & Shea, 2016). Activities conducted during a science class therefore give the learners the chance to work on their learning, speaking, and writing skills, but it is imperative to focus on scientific inquiry rather than writing or reading skills.

An important consideration for teachers as they facilitate inquiry learning is how heavy or light a hand they need to take in the instruction. Critics of a widespread adoption of inquiry-based classroom practices argue that minimally guided lessons do not help students learn, however these critics tend to equate inquiry with the largely discredited student-led strategy called 'discovery learning' and inquiry is commonly understood to rely on instructional guidance throughout the process (Furtak et al., 2012, p. 323; Minner et al., 2010, p. 476). In their meta-analysis, Furtak et al. (2012) found, though non-conclusively, that structured inquiry approaches that rely on teacher guidance produced more substantial learning gains as compared to either student-led discovery learning or traditional, didactic lessons (Furtak et al., 2012, p. 323). It is therefore important to ensure that teachers adopt teaching practices that are truly inquiry-based and that they avoid both "cookbook" experimentation that is but traditional didactic instruction in disguise *and* unstructured, student-directed discovery learning when possible.

Because social media is playing an increasingly important professional role in educational practices, it is important to consider the potential use of social media in enhancing the inquiry-based teaching skills of pre-service teachers (Shively & Yerrick, 2014). Teachers can join different educational communities on Twitter or Facebook, where they can exchange ideas and knowledge with other group members (Binns & Popp, 2013). Social media forums can be a great help in expanding pre-service teachers' horizons and skills, including skills related to inquiry-based learning (Lee & Shea, 2016). In particular, teachers can join social media groups that explicitly focus on inquiry-based teaching, and thereby gain experience with inquiry through their interactions online (Binns & Popp, 2013; Lee & Shea, 2016). This might be especially important in finding lesson plans or connecting with more experienced teachers who can help newer professionals become more comfortable in conducting true inquiry and walking the line between giving students too much leeway (discovery learning) and too little influence over the lesson (traditional). Hence, social media networking has the potential to play a vital role in developing and expanding the inquiry-based teaching skills of pre-service teachers.

Inquiry models. Inquiry activities can vary greatly and have been categorized in different ways. They were first categorized by Schwab (1962). Later, Herron identified five levels of openness for inquiry in science activities (1971). Rezba, Auldridge, and Rhea (1999), as reported in Bell, Smetana, and Binns (2005), presented a four-level model of inquiry instruction based on the previous work of Schwab (1962) and Herron (1971). Finally, Kim and Kellough (1994) categorized inquiry into three different levels.

Schwab (1962). Schwab's 1962 article identified the need for an updated method of teaching science because while the field of science itself had radically changed, its teaching had not. He noted that his contemporary science courses followed a nineteenth-century, literalist understanding of the nature of science: a process of observation to seek and find inalterable truths. However, these methods poorly matched the dynamic field of twentieth-century scientific inquiry. Methods of rapid data collection and analysis had changed science from a process of observing the natural world into a wholly different sort of field. Schwab's (1962) contemporary science removed its subject matter from normal contexts to facilitate experimentation, revised conclusions in the face of new evidence, and pluralized the character of the field such that distinct bodies of knowledge emerge that, while different from one another, represent neither 'true' nor 'false' information but rather different "cuts" through the subject matter.

Schwab (1962) argued that teaching science in a way that facilitates understanding of the properties of dynamic science is imperative, both to prepare future scientists and to help citizens recognize the processes of dynamic science. Schwab stated,

> the literalist curriculum conveys the impression that the conclusions of science are inalterable truths. This conviction then encounters flat contradiction five to ten years later. The students remembered science falls into desuetude and is replaced by different formulations. Unprepared for such a change, unapprised of its significance, the former student, now a voting member of the polity, is again confused and retreats from his confusion to a relativism which makes no effort to distinguish expertise from the trappings of authority. (1962, p. 377)

Thus, teaching science as a process of inquiry not only equips students to succeed in the classroom or to enter science fields as adults, but it also imparts an experiential knowledge of the process of inquiry to all students who partake. Whether or not they work in a scientific field as adults, they will understand that the conclusions of science are subject to change in light of further data. This will change their discourse in discussing science and voting on issues that are informed by scientists. Teaching inquiry also has the potential to make students open to changing their opinions in light of new evidence, which is a valuable skill in life as well as in science.

The article further discussed a revised science pedagogy as a process of inquiry, in which "problems are posed to which the student does not already know the 'right' solution," and "goals are set which call for development by the student of plans of attack and patterns of experiment" (p. 377). It is important for students to learn, not how to come to right answers, but how to employ methods that are more likely to produce correct answers. Schwab (1962) posits four combinations of materials and methods to facilitate such inquiry-based learning:

1. *Climactic Narrative with Downward Movement of Discussion*. In this method, the rhetoric of conclusions is replaced by a narrative of the course of an inquiry, leading to the climactic conclusion where current theory emerges. Following the narrative's end, downward discussion begins and moves backward through the story's timeline. The teacher asks questions that explore the grounds of the theory. This form serves to exhibit the course and reasoning of an inquiry process, but is limited because its attention to current theory avoids controversy and changes, and presents inquiry as a somewhat linear process.
2. *Climactic Narrative with Upward Movement of Discussion*. This method shifts from emphasizing the climactic current theory toward scrutinizing the inquiry process. "Upward movement of discussion exhibits inquiry as a process of problem-detecting, formulating, and solving rather than as a history and justification of a current theory" (p. 378). In this method "all conclusions, including those of the climax theory, are treated as tentative (though effective) new formulations" (p. 378). This method helps students avoid thinking of inquiry as a linear process leading toward the final-feeling climax of current theory.
3. *Multilinear Exposition or Narrative*. In this process, the narrative is adjusted "to include exposition of alternatives, difficulties, and doubts attendant on the inquiry" (p. 378). This encourages students to discuss an array of arguments and argue in favor of one or the other with each other. "Their varying emphases, reasons, oversights, and misjudgments can then be brought to light and examined" (p. 378). This method leaves room to discuss controversy within the scientific community and the possibility that conclusions may be overturned by a competing idea. This fits

with Schwab's (1962) earlier stated idea that students unprepared for the tentative nature of conclusions will become suspicious of expert opinion and that inquiry learning will help them avoid feelings of uncertainty when scientific conclusions they had learned are overturned later with evidence.

4. *Original Papers as Materials for Secondary Inquiry*. This method utilizes original research papers as the foundation of inquiry. "They contain models of phases of inquiry: the formulation of a problem; determination of the relevance of data; evaluation of alternative principles and solutions, etc." (p. 379). This method forms the pinnacle of Schwab's four step method for understanding inquiry and provides direct models of actual inquiry (1962). It allows students to read and understand an actual inquiry process. However, reading actual scientific research papers as a primary form of inquiry instruction might be too boring to be feasible for most students.

Herron (1971). Herron (1971) discussed the widespread adoption inquiry-based curricula like those Schwab called for in his 1962 article. He noted that while middle-school science curricula had changed rapidly to incorporate inquiry, the evaluation of these curricula lagged conspicuously behind the widespread adoption of the materials. He cited two reasons for the discrepancy. First, the materials themselves were often unclear. Second, there was "a general lack of a sound conception of the nature of scientific inquiry on which to base evaluative efforts" (p. 171).

Herron (1971) divided his study into three parts. The first develops a conceptual framework for analyzing accounts of scientific inquiry and uses this framework to describe other accounts of inquiry; the second determines the clarity and coherence of new inquiry-based materials covering three science subjects; and the third "concerns the degree to which teachers of science have a grasp of notions of scientific inquiry" (p. 172). It is in the third part that Herron (1971) identified five levels of openness for inquiry in science learning activities. Using the transcripts of fifty recorded interviews with teachers actively using the new curricular materials, Herron (1971) examined "their views of scientific inquiry and their perceptions of the courses they [taught]" (p. 205). Accordingly, he identified five levels of openness to inquiry and arranged them "in linear order on the basis of increasing ability to generate appropriate oral communication dealing with the nature of scientific inquiry" (p. 205). Thus, his levels were developed based on how articulate and thoroughly thought out he judged the teachers' responses to the interview questions.

Participants placed in the first level "did not address themselves directly to questions and problems concerning the role of inquiry in their classrooms. They exhibited an almost total orientation toward the content of the text and showed a lack of concern for any other dimension in the materials" (p. 205). These teachers seemed primarily interested in the traditional method of eliciting correct answers from students. The second general class of participants "picked up from the interviewer and attempted to utilize such phrases as 'inquiry,' 'models,' or 'the scientific method,' but perceived these terms as related mostly to the knowledge dimension of inquiry" (p. 205). Teachers in the second class seemed aware that the interviewer was interested in methods of scientific inquiry, but were not likely to have employed these methods in class. Those in the third class "contained fairly coherent but very general references to scientific inquiry. Such responses tended to be at about the level of the traditional 'five-step scientific method'" (pp. 206-207). Participants in the third class initiated the use of inquiry-like terms, rather than parroting the interviewer like second-class participants did. However, their responses lacked any reference to systematic relationships between variables or ideational factors, distinguishing them from participants in the fourth class. Teachers in this class had potentially taught inquiry as a five-step process, but there was no evidence that they were teaching it as a process where data might alter the methods or that they were comfortable allowing students to draw incorrect conclusions from this data.

The fourth class “includes those individuals whose verbalizations concerning scientific inquiry were judged to be comparable to the level of the materials they were teaching” (p. 207). These participants were comfortable describing scientific models as temporary explanations to be abandoned, if and when a better explanation was found. Teachers in this class were also comfortable discussing the limits of both scientific models and the materials at hand. Still, they were not “able to view the materials in terms of any larger context—that is, to go significantly beyond the level of discussion of the course materials themselves. Only two teachers demonstrated this competence. A fifth class was designated specifically for their responses” (p. 207). These teachers were able to discuss the limits of the course materials in a larger context of teaching science as inquiry.

Rezba, Auldridge, and Rhea (1999). In 1999, Rezba et al. developed a four-level model of inquiry instruction based on Schwab (1962) and Herron’s (1971) previous work. Their work is described by Bell et al. (2005) in their article “Simplifying Inquiry Instruction.” The Rezba et al. model illustrates how inquiry lessons range from being teacher-directed to student-centered. It also functions as a practical guide for designing lab activities at varying levels of inquiry, depending on wording and presentation. This allows teachers to tailor lessons to their class’s level of readiness. The four levels of inquiry are outlined below.

1. Confirmation—Students confirm a principle through an activity in which the *results are known in advance*.
2. Structured Inquiry—Students investigate a teacher-presented question through a *prescribed procedure.*
3. Guided Inquiry—Students investigate a teacher-presented question using *student designed/selected procedures.*
4. Open Inquiry—Students investigate topic-related questions that are *student formulated* through *student designed/selected procedures.*

Teachers can use these levels to modify their lessons. "A Level 1 activity can become a Level 2 by having students complete it prior to learning the targeted concept, and a Level 2 activity can be revised easily to level 3 simply by removing the procedural directions" (Bell, et al., 2005, pp. 3-4). "A Level 3 activity (guided inquiry), again, features a teacher-presented question but leaves the methods and solutions open to students" (Bell et al., 2005, p. 5). By providing instruction as to how to modify lessons to attain different levels, this level modification method increases a teacher's flexibility to tailor lessons to the abilities of the class both day to day and over the course of the school year.

Bell, et al. (2005) cite science fair projects as the most common Level 4 inquiry activities in science classrooms. They stress that "the inquiry scale should be seen as a continuum, so ideally students should progress gradually from lower to higher levels over the course of the year" (Bell et al., 2005, p. 5). Science fair projects represent students' best opportunity for self-guided inquiry learning and are therefore usually due at the end of a year of inquiry-based learning. After a full year of lessons that increase in inquiry level, students should be ready to formulate investigative questions and design procedures

Kim and Kellough (1994). In “A Resource Guide for Secondary School Teaching,” Kim and Kellough (1994) differentiated inquiry teaching from discovery learning, and described three levels of inquiry teaching. In both inquiry teaching and discovery leaning, “students are actively engaged in problem solving” (p. 420). However, a major difference between the two is “who identifies the problem. Another important difference is in the decisions that are made by the student” (p. 421).

In a level one inquiry lesson, “students are carefully guided through the investigation to (the predictable) ‘discovery’” (p. 421). This type of lesson is often called traditional, didactic, “cookbook” teaching, or guided inquiry/discovery. Because this level is manageable and predictable, it is best for teaching basic concepts and principles and this is a level with which nearly all teachers are comfortable. But level one does not represent true inquiry because it is a linear process and real-world problem solving is cyclic rather than linear. Teachers early in their career tend to favor teaching lessons at level one because it is often hard for them to let their students draw incorrect conclusions, even when the data support a wrong answer.

Kim and Kellough’s (1994) level one is similar to the level one ‘confirmation’ lesson and the level two “structured inquiry” lesson of Rezba et al. (1999) described by Bell et al. (2005). In these inquiry levels, students replicate a predictable set of instructions as set out by the teacher. A level one inquiry lesson asks students to act out an example of Schwab’s *Climactic Narrative with Downward Movement of Discussion* as a lesson (1962). Students follow a procedural narrative in a linear fashion toward a known conclusion. Teachers whose openness to inquiry Herron (1971) would describe as a class one or two might reliably choose to teach such a level one, confirmation less. Teachers who could be grouped into Herron’s third level of openness to inquiry may fall into this as well, depending on whether they allow room for uncertainty in the traditional ‘five step’ scientific method. Teachers early in their career or with a ‘cookbook’ understanding of science instruction might think lessons at taught at this level are true inquiry, when in fact—while lessons at this level have their use—they are not yet inquiry.

True inquiry begins at level two. In this level, “students actually decide and design the processes for their inquiry. In true inquiry teachers emphasize the tentative nature of conclusions, which makes the activity more like real-life problem solving, where decisions are always subject to revision if and when new data so prescribe” (p. 421). Students have more control of the methods used and process followed at this level. Students can pose additional problems to solve, but the teacher or the text still defines most of the problems.

Kim and Kellough’s (1994) level two inquiry is similar to level three, guided inquiry, as described by Rezba et al. (1999). In both of these, the teacher asks a question and the students determine a process to discover the answer. And in neither of these two described inquiry levels do students determine the primary question. Depending on how the lesson is taught, a level two inquiry lesson could perform either Schwab’s *Climactic Narrative with Upward Movement of Discussion*, which exhibits inquiry as a problem detecting and formulating process, or as his *Multilinear Exposition Narrative* that explores students’ alternate processes and conclusions (1962). In level two the nature of scientific conclusions as tentative becomes apparent and teachers must be flexible enough to accept the uncertainty involved. Teachers who could be grouped into Herron’s fourth class of openness to inquiry would be able to teach this level of lesson (1971). Their comfort with describing scientific models as temporary explanations to be discarded in the face of new data would help them facilitate lessons where students determine methods and collect data.

Level three inquiry occurs when "students recognize and identify the problem as well as decide the processes and reach a conclusion" (p. 422). Students can conduct level three inquiry through library research, hands-on experimentation, or a combination of both. They also determine which questions cannot be answered with the materials they have on hand. Level three inquiry frequently involves individual or independent projects and should be a major part of upper grade level instruction.

Table 1

Levels of Inquiry (Kim & Kellough, 1994)

	Level 1	Level 2	Level 3
Problem Definition	Teacher and/or Text Defined	Teacher and/or Text Defined	Student Defined
Problem Solving Methods	Chosen by Teacher and/or Text	Chosen by Students	Chosen by Students
Tentative Solution	Determined by Students	Determined by Students	Determined by Students

In addition to describing the levels of inquiry, Kim and Kellough (1994) discussed the processes involved in discovery and inquiry learning. "In true inquiry," they argued, "students generate ideas and then design ways to test those ideas. The various processes used represent the many critical thinking skills" (p. 422). These skills include those involved in generating and organizing data as well as creating and using ideas. Kim and Kellough (1994) pointed out that the skills involved in creating and using ideas are more complex mental operations, and recommended that students "be provided experiences that require these more complex, higher-level inquiry skills" (p. 422).

Inquiry learning "introduces the concept of the discrepant event, something that establishes cognitive disequilibrium (using the element of surprise…) to help students develop skills in observing and being alert for discrepancies. Such a strategy provides opportunities for students to investigate their own ideas about explanations" (p. 422). Kim and Kellough also pointed out that "experiences in inquiry help students understand the importance of suspending judgment and also the tentativeness of answers and solutions" (1994, pp. 422-423). These skills, the authors noted, are important not only in scientific inquiry, but also in many life situations.

Teacher beliefs and inquiry. In 2000, Carolyn W. Keys and Lynn A. Bryan published their article "Co-Constructing Inquiry-Based Science with Teachers: Essential Research for Lasting Reformed" in the *Journal of Research in Science Teaching*. They proposed a potential research agenda for the teaching and learning of science as inquiry. This agenda stressed the importance of new research into the areas of teachers' beliefs, knowledge, and practices of inquiry-based science in addition to student learning, because the efficacy of any education reforms is primarily dependent on the teachers who implement them (Keys & Bryan, 2000). The authors cited a large body of literature that affirms that teachers' beliefs regarding the nature of science, student learning, and the role of the science teacher substantially affects planning, teaching, and assessment. According to Keys and Bryan (2000), teachers will participate in inquiry teaching in ways that match their own beliefs and teaching styles. They argued that there is not one true definition of inquiry waiting to be discovered, since individuals construct their understanding of inquiry within the environment and culture in which they operate.

Grade level and degree of inquiry reached. In calling for more research on students' science processing skills, Keys and Bryan (2000) pointed out that older students are more capable of deep inquiry skills, while younger children engage with inquiry on simpler levels. Frequently, the authors noted, children around age 11 are skilled in observing phenomena, recording data, and identifying the effects of a single independent variable on a dependent variable. However, these students weren't able to draw meaningful inferences from the data, and performed more poorly when faced with continuous versus categorical variables. Third- and fourth-grade students were able to understand that they would find different results with repeated trials and experiments, but couldn't posit a theoretically perfect result or best representative measure. The authors recognized that students' ability to grapple with inquiry increases with age and experience, but they resisted the idea that inquiry investigations ought not be relegated into concrete activities based on developmental level, as research fails to support the belief that children's ability to reason scientifically is limited by developmental stages.

Early elementary/preschool. Because interest in science begins in elementary school, equipping teachers to promote student interest in science is essential. In "Creating a Love for Science for Elementary Students through Inquiry-based Learning," Trina Spencer and Tracy Walker (2011) explored inquiry-based instructional strategies as a method for generating student interest in science. They focused on two inquiry-based instructional strategies: the five-phase 5E model (engage, explore, explain, elaborate, and evaluate) discussed above in the section on upper elementary education, and the concept attainment model, which uses a process that allows students to create their own definitions and understanding.

The authors noted that the early elementary period is crucial because younger children tend to be more curious and motivated to learn. They argued that inquiry-based learning provides a vibrant, explorative process where young students make and test discoveries that engage them. The concept attainment model allows students to develop their own definitions and understanding. For instance, students might solve the 'mystery' of which animals on a list are predators based on teacher-given examples and pieces of information. The 5E and the concept attainment models allow students to form their own conclusions and engage with the material in an active and questioning way. Both of these methods require significant planning on the teacher's part.

Science learning and a love of science can start even before elementary school. In their article "Promoting Children's Science Inquiry and Learning through Water Investigations," Cindy Hoisington et al. (2014) discussed teaching strategies designed to support preschool and kindergarten students' science inquiry learning. Hoisington et al. (2014) also has shown that young children generate ideas about the world based on experiential evidence, and that while sometimes inaccurate (e.g. round things sink, red and black make purple) these ideas represent a blossoming understanding of science concepts. Research on early education settings has shown the benefit of having a teacher who intentionally structures explorations, integrates hands-on and minds-on experiences, and interacts with children to support reflection, theory-making, and understanding (Hoisington et al., 2014).

Over the course of the Hoisington et al.'s (2014) three-year investigation, five effective teaching practices emerged: a) Create a physical environment for science inquiry and learning, b) Facilitate direct experiences that promote conceptual learning, c) Promote the use of scientific inquiry and practices, d) Plan in-depth investigations, and e) Assess children's science inquiry and learning. The practices described in the paper encouraged a lot of structured play and questions that encouraged children to describe observations, explain procedures, and make predictions. This type of teaching required thoughtful planning of every aspect of the activity, from the structuring of the children's environment to the specific wording of the questions asked. This type of teaching would not come naturally to many teachers, and would require practice to facilitate.

Upper elementary school. In "The Effect of Inquiry-based Learning Method on Students' Academic Achievement in Science Course," Abdi (2014) studied a total of 40 fifth-grade students from two different classes, and found that the group instructed through inquiry-based learning achieved higher scores than the students instructed through the traditional lecture method. The inquiry-based learning in this experiment required instruction in five discrete elements. First, in *engagement*, learners' prior knowledge is assessed and students are helped to engage in a new concept using short activities that promote curiosity and make use of their prior knowledge. Second, in *exploration*, students are provided with activities in which current concepts (particularly misconceptions), processes, and skills are identified and conceptual change is facilitated. Third, in *explanation*, students' attention is focused on a skill, process, or concept. Fourth, *elaboration* includes discussion of concepts in closely related but new situations. Finally, in *evaluation*, students use the skills they acquired over the process of inquiry learning to evaluate their understanding.

In "Using Inquiry-based Instruction for Teaching Science to Students with Learning Disabilities," Aydeniz et. al (2012). examined the effects of inquiry-based science instruction on five students with learning disabilities. They measured the students' conceptual understanding of specific science concepts after they participated in inquiry-based activities surrounding these concepts, as well as the students' attitudes toward science. Their results indicate that all the students acquired the science content covered during the inquiry-based intervention, maintained their performance six weeks later, and additionally improved their attitudes toward science. The inquiry-based activities included students' making observations and recording data, related hands-on projects of increasing complexity, and students being challenged to describe phenomena as well as discuss practical applications (p. 192). In these projects, the teacher defined the problem but the students interpreted the data and posed multiple solutions.

Of special note in the study conducted by Aydeniz et al. (2012) were the implications for were the implications for student attitudes toward inquiry-based instruction and teacher confidence. The authors noted that limiting students' exposure to scientific ideas in early grades, along with low teacher confidence in the instruction of science, sets students up to develop negative attitudes toward science, especially for students with learning disabilities. This is especially concerning because the literature indicates that a significant number of elementary teachers do not feel well-prepared to teach science concepts effectively (e.g., Windschitl, 2004). Equipping early childhood educators to teach inquiry-based science lessons is thus vital to teachers' self-efficacy, and ultimately to their students' learning of science concepts and their attitudes toward science.

Conclusion

As digital social media has claimed a greater space in daily life, it has also found a place in the world of education, changing the way pre-service teachers interact with colleagues and acquire information. These developments have altered traditional approaches to teacher preparation, lesson design, and classroom management. In recent years, pre-service and in-service teachers have discovered that social media presents an excellent opportunity to communicate with other professionals, share instructional ideas, and participate in discussions about educational issues. Based in such platforms as Twitter, Facebook, and Pinterest, social media has advantages for teachers who are limited by time and by distance from traditional sources of professional development and from other educators. Social media reduces these barriers and opens new avenues to learning and collaboration for classroom teachers.

As attractive as this new technology is, its use in lesson planning presents challenges. In order to access digital resources, pre-service teachers must be provided with the resources to use it effectively: devices, training, support, and time to learn. Competency with and acceptance of new technology is governed by those factors, as well as by an individual's prior experiences. As people acquire new experience and knowledge of technology, they progress through levels of computer literacy to the more advanced level of computer fluency. Computer fluency implies that a user employs technology to solve problems and create ideas and artifacts which are personally relevant, in this case applications which enhance student learning.

The widespread use of social media also has significant implications for the teaching of science as inquiry. The teaching of science has evolved from a static, didactic recitation of inalterable facts toward a fluid process of experimentation leading to tentative, but expansive, conclusions. It is important to understand the spectrum of comfort that teachers have in teaching science in this more fluid, and more accurate way and what relation that comfort has to the increasingly impactful social media use of teachers. Kim and Kellough (1994) have most pertinently described teachers' comfort and ability to teach science as inquiry in terms of levels of inquiry, with level 1 being closest to the traditional, didactic form and level 3 representing true inquiry.

The purpose of this study is to explore how pre-service teachers use social media and its relationship to professional activities, specifically regarding inquiry-based instruction practices. To frame this research study, it is important to understand the research on the use of social media among new teachers and current theories regarding the teaching of science. Because relatively little research has been conducted in this area to date, the results of this study will help enhance our understanding of how social media affects professional activities, particularly regarding inquiry. These findings can potentially assist teacher preparation units to better support pre-service teachers' effective use of social media in their professional development.

Chapter 3: Research Design

The following chapter describes the methodological approach used in this study. The chapter describes the research design, restates the research questions, then describes the participants, instrumentation, procedures, and data analysis techniques. Finally, the chapter addresses the limitations of this study.

Research Design: Mixed Methods

This study explores how pre-service teachers use social media for educational purposes. A sequential, explanatory mixed-methods design was selected for this research, consisting of two phases: a survey followed by a qualitative phase featuring semi-structured interviews. The purpose of quantitative research is to examine patterns in data by applying numbers and statistical processes with the aim of achieving a result, which can be generalized to the larger population (Given, 2008). Qualitative research is aimed at understanding the meanings people construct, in order to uncover how they make sense of their world (Merriam, 1998). By using both of these methods, this dissertation sought to gather complementary data whereby themes developed from the qualitative data elaborate the results from the quantitative data. In this way, a mixed-methods approach can yield an understanding of pre-service teachers' use of social media and its influence on professional activities.

Research Questions

To examine pre-service teachers' use and implementation of social media as an educational tool, this study addresses three research questions. Questions 1 and 2 focus on qualitative data, while question 3 uses quantitative data.

1. How do elementary and middle-school pre-service teachers use different forms of social media in practice?

   a. How frequently do they access social media as a professional tool for educational use?
   b. How do they use it for communicating with other pre-service teachers?
   c. How do they use it as a tool to find teaching ideas and strategies?
2. How do pre-service teachers perceive the relationship between their social media usage and inquiry-based classroom practices?
3. What is the relationship between pre-service teachers' use of social media and inquiry science instruction?

This topic is particularly timely because of the growing use of social media, and because most pre-service teachers are avid users of social media. Pre-service teachers with the use of social media are not only skilled with digital resources, but in applying, modifying, and sharing ideas acquired via social media. They use social media to find resources more extensively than any other media source (Wankel, 2009). In class discussion, they often refer to Pinterest or some other social media site where they have found an artifact, and indicate that they have shared it on another site. Facebook groups also exist for pre-service teachers to communicate with classroom teachers who can share pertinent information about their profession. It is the purpose of this research to explore how social media is being used among this population, and to provide a platform for further discussion.

Participants

The sample for this study represents a population of pre-service teachers from a research-intensive university and a smaller reginal university located in the Midwest. Stratified sampling using intentional methods were used to select the pre-service teachers who received the surveys, although the number and variability of response rates of participants ultimately used for the analysis was unpredictable. The proposed assumption was that approximately 500 elementary and middle school pre-service teachers from the Midwest should be used as participants, the ideal sample for a quality study (Pilgrim & Bledsoe, 2011). Ultimately, 113 pre-service elementary and middle school teachers were selected for participation in this study. Although this number is smaller than an ideal sample size, this was the number of participants that were available. This sample size did allow for enough variation for this study. The ages of the participants varied, but all were in their third or fourth years in the education program. The participants came from two Midwest universities, one classified as public and one classified as a private institution. To protect the identity of the participants, the two universities are referred to as “Regional Comprehensive University” and “Public Research University.”

Regional Comprehensive University is a semi-private university with some public funding located in a small metropolitan area in the Midwest. Public Research University is a large, research-oriented university located in a small city located nearby a large metropolitan area, also located in the Midwest. The enrollment for Regional Comprehensive University in the spring of 2015 was around 6,600 and around 23,000 at Public Research University. In 2016-17, about 2,000 undergraduate students were enrolled in the School of Education at Regional Comprehensive University, and about 750 undergraduate students were enrolled in the School of Education at Public Research University, and Regional Comprehensive University was chosen because of its classification as a private university, its large population, and its principal city location. Public Research University was chosen because of its classification as a public university, its median population, and its location and urbanized area characteristics. It is not located in or near a principal city, but is within approximately 30 miles from two urban areas.

The university information was coded for confidentiality in the study. The following information is from the 2010 Census Report (Census, 2010):

Table 2

Demographic and Geographical Characteristics of the Selected Universities: Spring 2015

University	Population Density	City Population	University Enrollment
Regional Comprehensive University	2,118.5/sq. mile	127,473	6,600
Public Research University	2,611.5/sq. mile	87,643	23,000

At both universities, pre-service teachers were required to complete similar curriculum in order to fulfill their graduation requirements. In addition to major content courses, the teacher education sequences at both universities required courses that asked students to become proficient in writing lesson plans, developing unit plans, and taking part in practicum experiences such as teaching science lessons in actual classroom settings under the supervision of a professional teacher. Examples of required courses for both Regional Comprehensive University and Public Research University include Educational Psychology, Introduction to the Profession/Becoming an Educational Professional, Exceptional Learners, Foundations of Education, Methods in the Discipline, Classroom Management, and Student Teaching.

In order to ensure a safe and ethical survey and analysis process, approval from the Human Subjects Committee was sought from both universities prior to implementing the study. A consent form was provided to and signed by each study subject; the form provided information about the nature of the study and the right of the subject to opt out of participation. All data, including identifying participant information, was kept in a private, secured area.

Furthermore, a preliminary pilot study allowed the survey, the instructions, and the usability of the Qualtrics format to be tested. After the pilot study, each question on the survey was carefully considered. If any question did not appear to be clear and precise, it was rejected.

The semi-structured interview guide was also pilot tested on three teachers who were not participating in the study, but who have demographics similar to subjects in this study. This pilot test was conducted in order to determine if interviewees interpreted the questions as intended, and to provide an opportunity for necessary revisions before proceeding with the research study (Maxwell, 1998).

The target population of this earlier pilot study on this topic was in-service teachers from three school districts, classified into suburban, urban, or rural district population. The study intended to represent an age-diverse population of in-service teachers with varying levels of expertise. After the pilot study, it was determined that in-service teachers were too difficult to secure for participation. Also, the teachers' ages, levels of expertise, and social media usage patterns varied greatly. Ultimately, pre-service teachers with similar experience were a much more feasible population to approach, due to similarities across these key characteristics and ease of access through the universities.

To recruit participants, permission was obtained from the professors teaching the course *Science in the Elementary Classroom* at each of the two universities to present the study to the students enrolled in the class. Once permission was obtained, the research project was presented in person to the pre-service teachers that were currently enrolled in the course. All students present received hard copies of permission forms and the form was read aloud to all students (Appendix A). Students who signed permission forms were directed to a link on the Learning Management System used by the university, which are online platforms at the respective universities for students to access course information and participate in assignments, tests, surveys, etc. The link took the student to the Qualtrics site to participate in the online survey.

Everyone who was present in class the day I presented agreed to take the survey. However, 10 pre-service teachers only logged on, answered the demographic questions, and then logged out of the survey. Those 10 respondents were removed from the final sample, so the final sample of 113 participants represents those who actually completed the survey.

Instrumentation

The data for this study were collected primarily from survey responses and semi-structured interviews. The instrument (see Appendix C for the interview questions) was a three-part survey investigating pre-service teachers' use of social media and their approach to science education. The first part of the survey asked about the pre-service teachers' demographics. The second part of the survey was a validated survey on social media use (Forte et al., 2012) and featured questions about their use of social media. The final part of the survey was adapted from the National Survey of Science and Mathematics Education Survey (Horizon, 1997) which was featured as an instrument in the work of the Horizon Research Group, *Looking Inside the Classroom: A Study of K-12 Mathematics and Science Education in the United States* (Weiss et al., 2003) and asked about inquiry teaching and learning in the science classroom.

In an effort to reduce the number of survey questions respondents were asked to answer, the survey used skip logic to route participants through the survey based on their answers to previous questions. For example, if a participant answered "no" to the question "Do you have a Pinterest Account", they were automatically omitted from the Pinterest questions. The survey contained 90 questions (some with multiple parts per question). If a participant answered every question, they would answer 11 demographic questions, 22 questions about Pinterest, 22 questions about Facebook, 23 questions about Twitter, 3 general social media questions and 9 questions about science teaching and learning. The survey took an average of 15-20 minutes to complete.

My professional experience as an elementary teacher and science curriculum developer also supplemented the research. The survey questions generated targeted answers which guided the research. The subsequent semi-structured interviews were used to illustrate and amplify the data more fully. This study evaluated the type of social media used by the participant, in relationship to the grade the participant intends to teach, their opinion about the importance of social media and the amount of time on social media that is for professional use; these served as the independent variables. The type of instructional ideas the participant implemented in lesson planning, specifically in terms of inquiry instruction, was used as the dependent variable. All survey answers were analyzed and coded in order to determine patterns in social media use and inquiry teaching and learning methods.

Using Qualtrics, the survey questions were developed using two existing surveys as models. The first part of the survey examined teachers' use of social media and how it is related to professional activities (Forte et al., 2012). It has been used in previous research to investigate pre-service teachers in a setting similar to the one used in this study. As the Forte et al. (2012) survey was designed to examine the use of Twitter, specifically, it was modified to include multiple types of social media and their educational applications.

The second part of the survey examined pre-service teachers' ideas about instructional methods, focusing primarily on inquiry-based instruction (Weiss et al., 2003). It measured how often pre-service teachers use inquiry methods as defined by the NRC (2000). Because of the nature of inquiry-based instruction, most of these lessons stem from various science disciplines, and sometimes mathematics as well. This part of the survey assessed pre-service teachers' ideas about the professional learning environment, instructional methods, and assessment techniques they plan to use as part of their everyday lessons. Descriptive data on all of the measures used in this study, including means, standard deviations, range and Cronbach's alpha, are reported in the section on measures in Chapter 4.

The present study's survey used short answer and multiple-choice questions, featuring five-level Likert answer scales. The Likert scale ranged from 1-5, with 1 indicating strong disagreement/never and 5 indicating strong agreement/frequently. The Likert scale is the best tool for participants to use because they are likely to be familiar with the format (Pilgrim & Bledsoe, 2011). The first section of the survey elicited the participant's basic demographic information and professional experience working with children in educational settings.

The second section gathered information about how the participant uses social media both personally and professionally. This section was broken into four sub-sections that collected data regarding participants' use of Pinterest, Facebook, Twitter, and other social media platforms. Participants were asked whether they had each type of account, how often they accessed their accounts and for how long, how many social connections they had through each platform and how many those contacts represented personal and professional acquaintances, how many of each type of account they had, what devices they used to access these accounts, and whether and to what extent they categorized their use of each type of account as personal or professional.

The third section collected information about instructional methods, particularly regarding sciences. Participants were asked to rank how important it is that students possess a list of intellectual skills related to science learning and also to rank the importance of students performing a list of science-related activities in their science lessons. They were asked how strongly they agreed or disagreed with a number of science-related statements and how much they agreed or disagreed with a series of statements about learning science. Participants were asked how often they thought they should use certain science teaching techniques and how often students should perform a list of science classroom activities. They were asked to allot an ideal percentage of class time to be spent on various science related activities.

The data were coded and analyzed to examine the relationship between social media and perceptions of instruction. See Appendix B for the survey questions. To address the reliability of the survey, repeatability was a primary focus. I personally sent the survey to the participating pre-service teachers, giving the same directions to each participant and asking participants to answer questions without bias.

The semi-structured interview guide was modeled after Forte et al. (2012), and included fifteen open-ended questions. The questions developed for the interview guide focus on gaining a deeper understanding of how and why pre-service educators use social media. The interviews began by asking interviewees what brought them to the school of education, and what grade they plan to teach. Next, the interviewer asks questions about what social media platforms they use, their use of these platforms over time, and whether they use them professionally. Follow up questions are asked concerning professional use and which platforms they use professionally and in what ways. Next, the interview asks participants to elaborate on traditional information gathering and lesson planning verses newer, online methods. Then the interviewer asks what participants think both students and teachers ought to ideally do during a science lesson. Finally, the interviewer asked whether the participant had found a lesson via social media and, if applicable, whether they used the lesson in the classroom as part of their practicum or internship experiences, and asked them to offer a description of the lesson.

Each interviewee participated in a debriefing after the interviews were conducted, in order to clarify interview responses and their relevance to the study. Each interview was audio-recorded with the participant's permission, using the iRecord app on an iPad. I personally conducted the interviews to control for variability in question delivery.

To control for threats to validity, there were several safeguards in the study. I administered each survey and interview in a way that ensured delivery of the instructions was consistent. A digital video recorder was used for the interviews in order to minimize variations in interview approach, as well as to enable review of the interviews in order to monitor for discrepancies in technique and avoid discounting a particular interview.

Procedures

This study utilized a sequential mixed methods design: the first phase consisted of a survey, while the second phase was comprised of semi-structured interviews. Pre-service teachers from five different sections of undergraduate education program classes at both universities were asked to participate in the online survey. Each student was in his or her third or fourth year in the education program. I arranged a time with the class instructors to give a presentation about the study and implement the survey. That presentation included information about the research project, verification of approval from the Human Subjects Committees from both universities, and information on the format of the survey and interviews. The purpose of the survey was described as learning about the nature of pre-service teachers' instruction, technology usage, and views on how they planned to approach their teaching. It was stressed that there are no survey questions dealing with private or personal matters that would put anyone at risk, and that the survey should take 15-20 minutes to complete. Potential participants were offered computers and iPads to use to complete the survey, although many participants chose to use their personal devices. The pre-service teachers were also assured that their personal identities would be kept confidential, and they were thanked for their participation. Finally, I noted the part of the survey where participants could indicate their interest in participating in an interview at a location of their choice, in order to help me understand the survey data more completely.

The selection of the interview participants stemmed from the first phase. Survey participants indicated whether they were interested in participating in an interview, and maximal variation sampling was used to choose individuals that differed on a set of characteristics, specifically grade levels taught (elementary vs. middle-school), frequency of social media use, and age. This allowed me to gather data from a wide range of perspectives in order to represent a broad population better (Salkind & Rainwater, 2000).

Data Analysis

The two-phase research model of this study allowed for different types of information to be collected and analyzed. Both qualitative and quantitative data were collected in phase one through the surveys administered to a larger pool of pre-service teachers. Follow-up interviews in phase two, featuring questions informed by the survey data, were conducted with a smaller group of subjects, which helped to clarify and expand on the survey answers.

After participant surveys were completed, quantitative analysis was used to evaluate the item loading through factor analysis and MANOVA analysis methods were used to evaluate group differences regarding social media and how participants use it for professional activities. To conduct the quantitative analysis, the Statistical Package for Social Sciences software (SPSS) version 21.0 was used to conduct the statistical analysis. As social media is a nominal variable, it was necessary to code the variable. During the study design stage, this study proposed using non-media users as the reference group, assuming there were enough responses from this group. However, this ended up being unnecessary. If it had occurred, a reference group would have been chosen based on the responses, and group differences would have been explained. Another option was to have a purely random selection. It was anticipated that the data would reveal a relationship between use of social media and professional activities.

The steps of the qualitative analysis included (1) preliminary exploration of the data by reading the interview transcripts, (2) coding the transcripts by segmenting and labeling the text, (3) using codes to develop themes, (4) connecting and relating themes, and (5) constructing a narrative (Salkind & Rainwater, 2000). Pre-service teachers' responses to both the short-answer survey items and semi-structured interview items were subjected to descriptive analysis, coded qualitatively, and reviewed for emergent themes. Each interview was analyzed for patterns and commonalities in the participants' answers. The data were further examined to establish any relationships between the type of social media the pre-service teacher used and the type of instructional methods he/she employed in lesson preparation.

Interview Coding and Theme Identification

In general, the process of identifying research themes from data involves 1) looking at the data, 2) identifying emergent themes, and 3) further defining those themes. This process is further illuminated by Braun and Clarke (2006), who outline a six-phase process for identifying, developing, and refining themes in data sets. This process "starts when the analyst begins to notice, and look for, patterns of meaning and issues of potential interest in the data," the precursor to usable themes (p. 15).

In Phase 1 of Braun and Clarke's process, the key is to familiarize oneself with the data. "It is vital," the authors write, "that you immerse yourself with the depth and breadth of the content. Immersion usually involves 'repeated reading' of the data, and reading the data in an active way—searching for meanings, patterns, and so on" (p. 16). The authors recommend transcribing verbal data, such as those collected through interviews, into written form. A verbatim account is required and it ought to be punctuated in a way that remains true to the original audio.

Phase 2 involves generating initial codes. After becoming familiar with the data, the intent is to generate a general list of ideas (codes) about what the data indicate and what is interesting about the data. At this point the codes should "identify a feature of the data (semantic content or latent) that appears interesting to the analyst, and refer to the most basic segment, or element, of the raw data or information that can be assessed in a meaningful way regarding the phenomenon" (p. 18). In other words, Phase 2 organizes data into meaningful groups. This "coded data differs from the units of analysis (your themes) which are (often) broader" (p. 18). Coding depends on whether the themes are data-driven or theory-driven, where the researcher approaches the data with specific questions in mind. Braun and Clarke suggest that research code manually, "using highlighters or colored pens to indicate potential patterns" (p. 19). It is important for researchers to consider that extracts of data can be coded into as many themes as they fit into.

Phase 3 involves searching for themes. "This phase, which re-focuses the analysis at the broader level of themes, rather than codes, involves sorting the different codes into potential themes, and collecting all the relevant coded data extracts within the identified themes. Essentially you are starting to analyze your codes, and consider how different codes may combine to form an overarching theme" (p. 19). The key is to think about the relationship between codes, themes, and levels of themes. At the end of this phase, themes and sub-themes are identified and data extracts are coded accordingly. However, during this phase "it is uncertain whether the themes [will] hold as they are, or whether some need to be combined, refined and separated, or discarded" (p. 20).

Phase 4 involves the refinement of the set of candidate themes distilled in phases 1-3, and takes place in two levels. Level one examines candidate themes to see if they form a coherent pattern. If so, the theme moves to the second level. If not, the researcher considered whether it is the theme that is problematic or whether some data extracts do not fit within it. At level two, the researcher evaluated the validity of individual themes, both in relation to the data set and "whether your candidate thematic map 'accurately' reflects the meanings evident in the data set as a whole" (p. 21). According to Braun and Clarke (2006), "at the end of this phase, you should have a fairly good idea of what your different themes are, how they fit together, and the overall story they tell about the data" (p. 21).

The last two phases prepare the sorted data for analysis. Phase 5 involves defining and refining the themes to be presented in analysis, which involves. "identifying the 'essence' of what each theme is about (as well as themes overall), and determining what aspect of the data each theme captures" (p. 22). Phase 6, called 'producing the report,' involves writing up the themes in the actual manuscript. The purpose of this phase "is to tell the complicated story of your data in a way which convinces the reader of the merit and validity of your analysis" (p. 23).

Table 3

Coding Process Phases (Braun and Clarke, 2006)

Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
Familiarizing yourself with the data	Generating initial codes	Searching for themes	Reviewing themes	Defining theme names	Producing the report
Transcription of Verbal Data	*Organizes data into meaningful groups*	*Determines the relationship between codes, themes, and levels of themes*	*Examines themes to see if they form a coherent pattern. If so, move to next level. If not, consider removing the theme, but extracting data from within.*	*Determines what aspect of the data each theme captures*	*Writes up the themes in the actual manuscript*

Study Limitations

This study had many limitations, particularly the sample size and type of groups that were available to participate in the study. Although I was able to access classes at two different universities, a wider sample would be ideal. Also, some interviews were conducted on the phone. Overall, the phone interviews were much shorter and did not provide as much information, as the in-person interviews, so this idea would need to be adjusted if the participants were not onsite. Finally, classroom observations would be an ideal way to gather more information on inquiry teaching and learning in the classroom. This would pose an issue as well if I were not available to observe in person, but a recording could be conducted.

A larger number of participants would have potentially provided a more representative sample. This is a common limitation and should be considered in subsequent studies. Pre-service teachers from two universities were used for this study; expanding it to other universities could potentially increase sample size and would likely result in a more diverse sample and more varied answers. Furthermore, expanding to other regions of the United States would be helpful and provide additional diversity.

The survey could be reworded in some areas and in one case, there was a mistake. Three survey questions were found to have the wrong scale entered (1, 2, 3, 4, 6 instead of 1, 2, 3, 4, 5); therefore, scores of 6 on these items were changed to 5s. If this study was conducted again, this scale would be fixed.

Overall, a larger sample size from universities and colleges across the country and a larger sample size of participants reflecting the makeup of the U.S. teacher population would possibly provide better data. Teachers' inquiry practices could be best ascertained from observing actual classroom procedure, and related to their survey and interview responses.

Conclusion

Through a mixed-methods research design, this study analyzed social media usage among pre-service teachers and explored how different types of social media were used. The survey measured and correlated pre-service teachers' demographics, social media use, and instructional methods acquired from social media. The interviews extended the information collected from the surveys, providing insight into the quantitative results. Finally, the qualitative analysis illuminated the relationship between pre-service teacher's use of social media and their instructional methods.

Chapter 4: Analysis

This chapter includes findings from the survey (which includes both quantitative and qualitative data) and the findings from the semi-structured interviews (which includes only qualitative data). The survey population included the entire sample of 113 pre-service teachers, but the semi-structured interviews only included 14 pre-service teachers. Both the survey and the semi-structured interviews were designed to examine how pre-service teachers use social media and how their use relates to their science instruction.

Survey Results

Participant demographics. The survey was taken by 113 participants; 10 participants were removed from the original data set as they only logged on, answered the demographic questions, and then logged out of the survey as shown in Table 4. Of the original 113 participants, 9 are male (8%) and 104 are female (92%). Ninety-nine (88%) of the students were earning an A in their Science in the Elementary classroom course, while 13 (12%), were earning a B. No participants were earning below a B in this course. Sixty-nine participants (61%) were in their junior year of college, and 44 (39%) were in their senior year. With the exception of five participants, all the students were born between 1991 and 1994. Seventy-one of the participants studied at the larger university and 30 studied at the smaller, private university, while 12 did not identify which university they attended.

Three participants (3%) planned for their highest degree earned to be an Associate's Degree, 36 (32%) planned for a Bachelor's Degree, 71 (63%) planned for a Master's Degree, and three participants (3%) planned to earn a doctorate. In this study, one (1%) participant identified as American Indian, one (1%) identified as Asian or Pacific Islander, two (2%) identified as

Black/African American, six (5%) identified as Hispanic, 99 (88%) identified as non-Hispanic White, and four (4%) identified as Multiethnic.

Table 4

Survey Participant Demographics

Demographics		
Gender	Male	9
	Female	104
Current School		
	Public Research	70
	Regional Comprehensive	31
	Unknown	12
Current Year in School		
	Junior	69
	Senior	44
Current Grade in Science Elementary		
	A	100
	B	13
Ethnicity		
	American Indian	1
	Asian or Pacific Islander	1
	Black/African American	2
	Hispanic	6
	White, Non-Hispanic	99
	Multiethnic	4

When asked to recall their typical grades in high school science courses, 37 (33%) of participants recalled getting mainly As, 43 (38%) recalled mainly As and Bs, 21 (19%) recalled mainly Bs, 9 (8%) recalled Bs and Cs, and 3 (3%) recalled mainly Cs. When asked to recall their typical grades in all high school courses, 44 (39%) of participants recalled receiving mainly As, 57 (50%) recalled mainly As and Bs, 8 (7%) recalled mainly Bs, 3 (3%) recalled mainly Bs and Cs, and 1 (1%) recalled mainly Cs (See Table 5).

Table 5

Survey Participant Typical High School Grades

Grades in All High School Courses	
Mainly As	44 (39%)
Mainly As & Bs	57 (50%)
Mainly Bs	8 (7%)
Mainly Bs and Cs	3 (3%)
Mainly Cs	1 (1%)

Grades in High School Science Courses	
Mainly As	37 (33%)
Mainly As & Bs	43 (38%)
Mainly Bs	21 (19%)
Mainly Bs and Cs	9 (8%)
Mainly Cs	3 (3%)

Many of the pre-service teachers who responded indicated that they planned to teach more than one grade, with answer options ranging from pre-K to 12^{th} grade (See Table 6). Understanding the grade level the pre-service teachers planned to teach was important to the research questions. The grade level participants intended to teach was used to create the independent variable, Grade Level. Participants wanting to teach Pre-K through 2^{nd} grade were identified as early elementary, 3^{rd} grade through 5^{th} grade were identified as elementary, and 6^{th} grade and above were identified as 6^{th} and Above.

Table 6

Participants' Plans to Teach Particular Grade Levels in the Future

Grade	
Pre-K	17 (4%)
Kindergarten	56 (13%)
1st	67 (16%)
2nd	74 (18%)
3rd	62 (15%)
4th	42 (10%)
5th	38 (9%)
6th	26 (6%)
7th	16 (4%)
8th	12 (3%)
9th	2 (>1%)
10th	2 (>1%)
11th	1 (>1%)
12th	1 (>1%)
Other	3 (1%)

Participants' views and use of Pinterest as an educational tool. Participants were asked for their opinions of Pinterest's importance in providing educational and resource materials. Participants were also asked to report the percentage of time they spend on Pinterest for professional reasons. About a third of the sample (28.7%) felt Pinterest was not an important source for professional materials; slightly more (40.5%) felt Pinterest was a moderately important tool; and about a third (30.6%) participants reported that Pinterest was an important tool.

Table 7

Participants' View of Pinterest as an Important Tool

Level of Pinterest Importance	
Pinterest Important	31 (30.6%)
Pinterest Moderately Important	41 (40.5%)
Pinterest Unimportant	29 (28.7%)

Because Pinterest can be used for both personal and professional purposes, it was important to establish whether participants used Pinterest more for personal or professional use. About a third of the sample (32.7%) reported that they use Pinterest most of the time for professional use; another third (36.6%) reported that they use Pinterest about half the time for professional use. Finally, about a third of the sample (30.7%) reported that they use Pinterest most of the time for personal use. Notably, the proportions of participants who saw Pinterest as an important educational resource aligned very closely with the proportions of participants who actually used Pinterest for professional use.

> In addition to reporting how they spend their time when they use Pinterest, 101 participants also submitted text-based answers describing their reasons for using. A strong theme among the answers was that they could use Pinterest both personally and professionally, as 50 of the 101 responses specifically mentioned the dual persona and professional uses of Pinterest. For instance, one participant said, "I use Pinterest like a search engine. When I need an idea for a lesson plan or an idea for a hairstyle, I search it…I keep a lot of boards because I like to keep my thoughts organized. I don't use it the way I casually use Facebook and Twitter." Another participant said, "It [Pinterest] gives me some good ideas for lesson plans, but I can also use it for personal use such as style, design, and recipes" (Interview, Participant 2, 5/11/2015).

This dual use of the site is in keeping with the uses and gratifications model that Rohm, Kaltcheva, and Milne (2013) used to develop their research instrument. This model focuses "on individuals' use of media and technology for both rational and utilitarian reasons as well as hedonic purposes of fun seeking and enjoyment." Half of the participants (50) employ this utilitarian/hedonic duality to their Pinterest use. Twenty participants mentioned they mainly use

Pinterest professionally, including lesson planning, classroom management, classroom decoration and design, and lists of books desired for class libraries. One participant said, "This semester, I taught about six lessons and got about four lesson ideas from Pinterest. It is a GREAT tool" (Interview, Participant 12, 5/13/2015).

Seventeen participants indicated that they only use Pinterest for personal projects. Common personal uses included recipes, crafts, clothes and fashion, event and wedding planning, birthday ideas, gift ideas, trip planning, fitness ideas, jokes, and inspirational quotes. Another common theme among the responses was that Pinterest was good for general inspiration, ideas, and creativity. Seventeen participants indicated that this was their primary reason for turning to Pinterest. One participant uses Pinterest "to continually improve my life by trying new things and reinforcing the things I already do." Another said, "I like the pictures. And it lets me remind myself of things I like" (Interview, Participant 13, 5/13/2015).

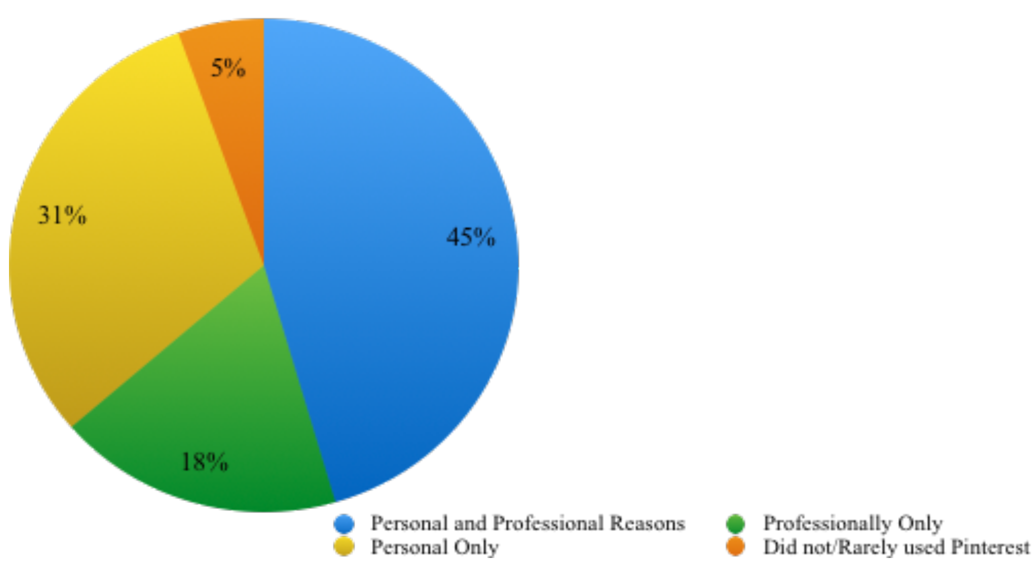

Figure 1. Reasons for using Pinterest.

Participants' Views of Inquiry-Based Science Teaching and Learning. This section provides an overview of the key survey results related to pre-service teachers' view of inquiry-based science teaching and learning. The results are summarized below; see Table 8 for details.

Regarding how important participants felt it was for students to remember scientific procedures to be good at science in school, 42.3% felt that memorization was very important, 52.3% felt it was somewhat important; and 4.5% felt that memorization was not important at all. It is encouraging that the largest percentage of participants assigned only moderate importance to memorization of procedures as it suggests a shift away from thinking of science learning as memorization.

In response to how important thinking in a sequential and procedural manner was to students' success in science, most (55.9%) felt it was very important, over a third (41.4%) said it was somewhat important, and a small proportion (2.7%) felt it was not important. While about two-thirds believed that thinking in a sequential and procedural manner is critical to science success, about forty percent thinks this skill is only somewhat important.

Participants were asked their perspectives on the importance of understanding scientific principles, concepts, and strategies for students to be good at science in school, and the majority (58.6%) felt that this was very important, over a third (41.4%) said that this was somewhat important, and no participants thought that this was unimportant.

Participants were also asked how important they thought being able to think creatively was to student success in science. A majority (67.6%) thought it was very important, 29.7% thought it was somewhat important, and 2.7% thought it was not important. It is encouraging to see pre-service teachers associate creative skills with success in science learning; this finding indicates that these participants believe that science involves creative thought as well as the analytical skills traditionally associated with the sciences.

Participants were asked to respond to how important understanding science in real world settings is for students' science success. The majority (89.2%) indicated that they felt real world application was very important.

The participants were asked how important they thought it was for students to be able to provide reasons to support their solutions. A majority (87.4%) thought it was very important, 12.6% thought it was somewhat important, and no participants though it was unimportant. Participants expressed an interest in understanding whether their students view science as an abstract subject or a formal method for representing the world and a practical guide to addressing real situations. Most participants agreed that science played a significant role in those respective areas.

Participants also answered questions about how often they believed they should apply certain techniques to teaching science; 53.2% felt that they should prompt the students to explain the reasoning behind an idea in every lesson, 38.7% felt that they should apply this technique in most lessons, and 8.1% felt that they should only apply this technique in some lessons.

The pre-service teachers were asked if students should assess the quality of their own work often, and 53.2% agreed; an additional 27% of teachers believed there should be some form of self-assessment in almost all lessons, while 18% felt that assessment should only happen sometimes. Overall, pre-service teachers agreed that assessment was important before and during a lesson, as, 28.8% agreed with this statement a lot, 43.2% agreed a little, 22.5% disagreed a little, and 5.4% disagreed a lot. The participants were asked if that students should take traditional tests that require multiple choice, true/false, or fill-in-the-blank questions, and 32.4% felt the students should never take this type of test, 46.8% said sometimes, 16.2% said often, and 4.5% said almost all the time.

Participants were in overall agreement that teachers should engage students often in hands-on activities as a practical approach to teaching science. Most pre-service teachers felt all or almost all lessons should be hands-on (56.8%), over a third said often (36.9%), and a small proportion (6.3%) said sometimes hands-on lessons should be used. This trend toward supporting hands-on learning was evident in all the hands-on questions asked throughout the survey.

Table 8

Participants' Views of Inquiry-Based Science Teaching and Learning

To be good at science at school, how important do you think it is for students to:

Variable	Not important *N* (%)	Somewhat important *N* (%)	Very important *N* (%)	Mean *SD*
Q1: Remember scientific procedures.	5 (4.5)	58 (52.3)	48 (42.3)	2.39 (.575)
Q2; Think in a sequential and procedural manner	3 (2.7)	46 (41.4)	62 (55.9)	2.53 (.553)
Q3; Understand science concepts, principles, and strategies.	0	46 (41.4)	65 (58.6)	2.59 (.495)
Q4; Be able to think creatively.	3 (2.7)	33 (29.7)	75 (67.6)	2.65 (.533)
Q5: Understand how science is used in real world settings.	2 (1.8)	10 (9.0)	98 (89.2)	2.87 (.384)
Q6: Be able to provide reasons to support their solutions.	0	14 (12.6)	97 (87.4)	2.87 (.333)

To what extent do you agree or disagree with each of the following statements?

Variable *N* = 113	Strongly Disagree *N* (%)	Disagree *N* (%)	Agree *N* (%)	Strongly Agree *N* (%)	Mean *SD*
Q7; Science is primarily an abstract subject.	7 (6.3)	51 (45.9)	52 (46.8)	1 (.90)	2.42 (.626)
Q8; A liking for and understanding of students are essential for teaching science.	20 (18)	17 (15.3)	57 (51.4)	17 (15.3)	2.64 (.951)

Q9; Science is primarily a formal way of representing the real world.	3 (2.7)	16 (14.4)	79 (71.2)	13 (11.7)	2.92 (.605)
Q10; Science is primarily a practical and structured guide for addressing real situations.	3 (2.7)	18 (16.2)	77 (69.4)	12 (10.8)	2.89 (.611)
Q11; If students are having difficulty, an effective approach is to give them more practice by themselves during the class.	6 (5.4)	54 (48.6)	45 (40.5)	6 (5.4)	2.46 (.685)
Q12: Some students have a natural talent for science and others do not.	13 (11.7)	27 (24.3)	61 (55.0)	10 (9.0)	2.61 (.811)
Q13; More than one representation (picture, concrete material, symbol set, etc.) should be used in teaching a science topic.	39 (35.1)	1 (.9)	41 (36.9)	30 (27.0)	2.56 (1.226)

In science lessons, how often do you think students should do the following?

Variable *N* = 113	None or Almost never *N* (%)	Some lessons *N* (%)	Most lessons *N* (%)	Every lesson *N* (%)	Mean *SD*
Q14: Explain the reasoning behind an idea.	0	9 (8.1)	43 (38.7)	59 (53.2)	3.45 (.643)
Q15: Represent and analyze relationships using tables, charts, or graphs.	0	45 (40.5)	56 (50.5)	10 (9.0)	2.68 (.632)
Q16: Work on problems for which there is no immediate obvious method of solution.	13 (11.7)	56 (50.5)	37 (33.3)	5 (4.5)	2.31 (.736)
Q17: Have conversations about the subject matter that last for five minutes or more.	2 (1.8)	12 (10.8)	54 (48.6)	43 (38.7)	3.24 (.716)
Q18: Organize, interpret, evaluate, and use information, instead of trying to remember or reproduce it.	1 (.9)	7 (6.3)	53 (47.7)	50 (45.0)	3.37 (.646)

In a typical month of lessons for a science class, what % of time do you think should spend on

Variable *N* = 113	Less than 5% *N* (%)	5-9% *N* (%)	10-19% *N* (%)	20% or more *N* (%)	Mean *SD*
Q19: Administrative tasks (not related to lesson's content/purpose)	22 (19.8)	56 (50.5)	27 (24.3)	6 (5.4)	6.08 (4.36)
Q20: Homework review	3 (2.7)	29 (26.1)	75 (67.6)	4 (3.6)	9.42 (3.97)
Q21: Lecture-style presentation by teacher	2 (1.8)	16 (22.4)	74 (66.6)	19 (25.2)	12.13(5.65)
Q22: Teacher-guided student practice	0	0	28 (25.2)	83 (74.8)	23.75(11.14)
Q23: Re-teaching and clarification of content/procedures	1 (.9)	7 (6.3)	85 (27.0)	18 (15.4)	13.18 (6.25)
Q24: Student independent practice	0	4 (3.6)	37 (33.3)	59 (63.1)	21.44(10.47)
Q25: Tests and quizzes	2 (1.8)	40 (36)	60 (54)	9 (8.1)	9.36 (4.96)
Q26: Other	55 (49.5)	35 (31.5)	12 (10.8)	9 (8.1)	4.63 (6.63)

About how often do you believe that each of the following teaching techniques should be used when you are teaching a science class?

Variable *N*=113	Rarely *N* (%)	Sometimes *N* (%)	Often *N* (%)	Almost all lessons *N* (%)	Mean *SD*
Q27: Introduce content through formal presentation.	10 (.9)	55 (49.5)	44(39.6)	2 (1.8)	3.34 (.667)
Q28: Demonstrate a science-related principle or phenomenon.	1 (.9)	23 (20.7)	70(63.1)	17 (15.3)	3.93 (.628)
Q29: Teach science using real-world contexts	0	9 (8.1)	38 (34.2)	64 (57.7)	4.50 (.645)
Q30: Arrange seating to facilitate student discussion.	2 (1.8)	17 (15.3)	49 (44.1)	43 (38.7)	4.20 (.761)
Q31: Use open-ended questions.	1 (.9)	14 (12.6)	40 (36.0)	55 (49.5)	4.35 (.737)
Q32: Require students to supply evidence to support their claims	2 (1.8)	11 (9.9)	40 (36.0)	58 (52.3)	4.39 (.741)
Q33: Encourage students to explain concepts to one another	1 (.9)	14 (12.6)	33 (29.7)	63 (56.8)	4.42 (.745)
Q34: Encourage students to consider alternative explanations.	1 (.9)	16 (14.4)	44 (39.6)	50 (45.0)	4.29 (.743)
Q35: Allow students to work at their own pace.	2 (1.8)	22 (19.8)	51 (45.9)	36 (32.4)	4.09 (.769)
Q36: Help students see connections between science and other disciplines.	0	9 (8.1)	44 (39.6)	58 (52.3)	4.44 (.642)
Q37: Use assessment to find out what students know before or during a unit.	6 (5.4)	25 (22.5)	48 (43.2)	32 (28.8)	3.95 (.857)
Q38: Embed assessment in regular class activities.	5 (4.5)	19 (17.1)	50 (45.0)	37 (33.3)	4.07 (.828)
Q39: Assign science homework.	28(23.2)	48 (43.2)	29 (26.1)	5 (4.5)	3.09 (.853)
Q40: Read and comment on the reflections students have written in their notebooks or journals.	0	26 (23.4)	42 (37.8)	43 (38.7)	4.15 (.777)

About how often do you think students should take part in each of the following types of activities?

Variable N=113	Never or Rarely N (%)	Sometimes N (%)	Often N (%)	All or Almost all Lessons N (%)	Mean SD
Q41: Formulate a science explanation	0	20 (18.0)	67 (60.4)	24 (21.6)	4.04 (.631)
Q42: Do hands-on activities to test different science explanations.	1 (.9)	7 (6.3)	35 (31.5)	67 (60.4)	4.53 (.660)
Q43: Record, represent, and/or analyze data.	0	9 (8.1)	62 (55.9)	40 (36.0)	4.28 (.606)
Q44: Write explanations about what was observed and why it happened.	1 (.9)	11 (9.9)	47 (42.3)	52 (46.8)	4.35 (.696)
Q45: Debate different science explanations.	8 (7.2)	28 (25.2)	51 (45.9)	24 (21.6)	3.82 (.855)
Q46: Discuss the nature of science.	6 (5.4)	30 (27.0)	54 (48.6)	20 (18.0)	3.80 (.799)

Q47: Assess the quality of their own work.	2 (1.8)	20 (18.0)	59 (53.2)	30 (27.0)	4.05 (.724)
Q48: Participate in student-led discussions.	2 (1.8)	24 (21.6)	57 (51.4)	28 (25.2)	4.00 (.739)
Q49: Participate in discussions with the teacher to further science understanding.	0	14 (12.6)	62 (55.9)	35 (31.5)	4.19 (.640)
Q50: Work in cooperative learning groups.	0	10 (9.0)	50 (45.0)	51 (45.9)	4.37 (.646)
Q51: Make formal presentations to the class.	25 (22.5)	54 (48.6)	25 (22.5)	7 (6.3)	3.13 (.832)
Q52: Read from a science textbook in class.	54 (48.6)	41 (36.9)	12 (10.8)	4 (3.6)	2.64 (.882)
Q53: Read other (non-textbook) science-related materials in class.	21 (18.9)	57 (51.4)	29 (26.1)	4 (3.6)	3.14 (.761)
Q54: Answer textbook/worksheet questions.	37 (33.3)	46 (41.4)	24 (21.6)	4 (3.6)	2.93 (.881)
Q55: Review homework/ worksheet assignments.	21 (18.9)	42 (37.8)	36 (32.4)	12 (10.8)	3.34 (.929)
Q56: Work on solving a real-world problem.	2 (1.8)	18 (16.2)	47 (42.3)	44 (39.6)	4.20 (.772)
Q57: Share ideas or solve problems with each other in small groups.	2 (1.8)	13 (11.7)	46 (41.4)	50 (45.0)	4.30 (.746)
Q58: Engage in hands-on science activities.	0	7 (6.3)	41 (36.9)	63 (56.8)	4.50 (.716)
Q59: Follow specific instructions in an activity or investigation	4 (3.6)	27 (24.3)	49 (44.1)	31 (27.9)	3.96 (.819)
Q60: Design or implement their own investigation.	2 (1.8)	37 (33.3)	52 (46.8)	20 (18.0)	3.81 (.745)
Q62: Work on science models or simulations.	4 (3.6)	25 (22.5)	66 (59.5)	16 (24.4)	3.84 (.733)
Q63: Work on extended science investigations or projects (a week or more in duration).	10 (9.0)	45 (40.5)	41 (36.9)	15 (13.5)	3.55 (.839)
Q64: Record, represent, and/or analyze data.	2 (1.8)	22 (19.8)	59 (53.2)	28 (25.2)	4.02 (.726)
Q65: Write reflections in a science notebook or journal.	7 (6.3)	20 (18.0)	40 (36.0)	44 (39.6)	4.09 (.910)
Q66: Prepare written science reports.	35 (30.5)	44 (39.6)	22 (19.8)	10 (9.0)	3.05 (.967)
Q67: Use science as a tool in problem-solving.	2 (1.8)	25 (22.5)	57 (51.4)	27 (24.3)	3.98 (.738)
Q68: Use calculators.	14 (12.6)	56 (50.5)	35 (31.5)	6 (5.4)	3.30 (.758)
Q69: Use computers for modeling and simulations.	14 (20.7)	44 (39.6)	45 (40.5)	8 (7.2)	3.41 (.825)
Q70: Use the Internet.	6 (5.4)	46 (41.4)	48 (43.2)	11 (9.9)	3.48 (.745)
Q71: Use electronic journals or bulletin boards.	10 (22.8)	46 (41.4)	43 (38.7)	9 (8.1)	3.07 (.860)
Q72: Work on portfolios.	28 (25.2)	50 (45.0)	28 (25.2)	5 (4.5)	2.89 (.878)

Q73: Take short answer tests (e.g., multiple choice, true/false, fill-in-the-blank).	36 (32.4)	52 (46.8)	18 (16.2)	5 (4.5)	3.32 (.896)
Q74: Take tests requiring open-ended responses (e.g., descriptions, explanations).	21 (18.9)	44 (39.6)	35 (31.5)	11 (9.9)	3.57 (.880)
Q75: Engage in performance tasks for assessment purposes.	11 (9.9)	44 (39.6)	38 (34.2)	18 (16.2)	3.06 (.742)
Q76: I usually do well in science.	1 (.9)	24 (21.6)	53 (47.7)	33 (29.7)	3.06 (.742)
Q77: I would like to take more science in school.	10 (9.0)	51 (45.9)	36 (32.4)	14 (12.6)	2.49 (.830)
Q78: Science is more difficult for me than for many of my classmates.	17 (15.3)	39 (35.1)	46 (41.4)	9 (8.1)	2.58 (.848)
Q79: I enjoy learning science.	4 (3.6)	23 (20.7)	61 (55.0)	23 (20.7)	2.93 (.747)
Q80: Science is not one of my strengths.	14 (12.6)	35 (31.5)	45 (40.5)	17 (15.3)	2.41 (.899)
Q81: I learn things quickly in science.	11 (9.9)	44 (39.6)	49 (44.1)	7 (6.3)	2.47 (.761)
Q82: Science is boring.	34 (30.6)	52 (46.8)	24 (21.6)	1 (.9)	3.07 (.747)
Q83: I like science.	1 (.9)	25 (22.5)	57 (51.4)	28 (25.2)	3.01 (.720)

Exploratory factor analysis. A variety of exploratory factor analyses were used to understand the statistically significant connections between pre-service teachers' professional use of Pinterest, their views of inquiry-based teaching and learning, and whether there were differences by the grade level the pre-service teachers planned to teach. The details of the exploratory analysis are provided in Appendix E and F. The key findings, that are based on a set of correlations between pre-service teachers' professional use of Pinterest, views on inquiry-based teaching, and grade level they planned to teach are reported here. Other findings, including insignificant findings, are also reported.

To evaluate and interpret the factors underlying the surveys and create factor scores to serve as the dependent variables in the variance analysis, an exploratory factor analysis (EFA) was conducted on both the teaching and learning surveys. First, missing data was reviewed; as noted previously, ten participants were deleted from the original data set as they only answered the demographic questions. These participants were removed instead of using imputation, as they had answered only one or two questions from the entire survey. By design, the surveys included some negative or reverse worded items; consequently, these item responses were reverse-scored prior to running any analysis. Additionally, three items were found to have the wrong scale entered (1, 2, 3, 4, 6 instead of 1, 2, 3, 4, 5); therefore, scores of 6 on these items were changed to 5.

Initially there were two surveys: one designed to evaluate participant activity on social media (the social media survey) and one that included items specific to teaching science (the education survey). The social media survey was used to create the independent variable groupings evaluating the professional use and importance of Pinterest. The education survey was divided into two components, and part of the questions asked the participants about how they felt about their own abilities to teach science, while the remaining items asked participants to consider student activities (not personal opinions about themselves). Because these items were asking fundamentally different questions, validity was a concern, as they would be measuring different ideas than the other items. Consequently, the survey analyzed two separate surveys: the teaching survey and the learning survey.

Teaching Factors

Teaching EFA

The teaching survey included 29 Likert-type items asking the participants to consider their opinions of, performance in, and abilities to learn science, while the learning survey included 45 Likert-type items asking the participants about their planned approach to teaching and common classroom activities such as assessment, discussion, and technology. Each survey was intended to be multidimensional as the dimensions were non-orthogonal, and therefore an oblique rotation was employed for both survey analyses. For the teaching survey, the initial evaluation of the eigenvalues and scree plot revealed nine factors with eigenvalues ranging from 1.01 to 5.94, which were found to explain approximately 56% of the variance for this set of variables. Next, the communalities were examined to determine the portion of variance in each variable accounted for by the solution. No value exceeded 1.00, so it was concluded that the results were appropriate for interpretation (See Appendix E). Some of the communalities were considered low, having a small amount of variance (6%) in common with the other variables in the analysis. Though this could indicate that the variables are only weakly related, the KMO indicates that the variables in the set are at least adequately related for factor analysis (See Appendix E).

Using the recommendations of Henson and Roberts (2006), the pattern matrix and the initial nine factors were also reviewed (see Table 9). Items that exhibited dual loadings or loaded less than .40 on a factor were eliminated, and only factors that had three or more item loadings were retained. Following these recommendations, two teaching factors were retained. The two factors that remained, Teaching factor 1, science teaching practices, take into account the encouragement by the teacher of the student to explain concepts to each other and consider alternative explanations (See Table 10). Teachers should be required to supply evidence to support their claims and demonstrate a science-related principal or phenomenon. They should use open ended questions and teach science using real world context. Teaching factor 2, attitude toward science, discusses whether one likes science or thinks it is boring (See Table 11). Using the item factor loading alignments, sum factor scores were created for use as the two dependent variables in the multivariate analysis of the teaching survey.

Table 9

Teaching Factor Pattern Matrix

Question	Factor								
	1	2	3	4	5	6	7	8	9
Q33	**.897**								
Q32	**.822**								
Q34	**.760**								
Q31	**.600**								
Q36	**.569**								
Q28	**.563**								-.308
Q29	**.501**								
Q35	.430								.401
Q76		**.827**							
Q80		**.781**							
Q81		**.712**							
Q83		**.710**					-.380		
Q77		**.632**							
Q79		**.629**							
Q82		**.620**							
Q78		**.618**							
Q8			.801						
Q13			.750						
Q10				1.003					
Q9				.326					
Q38					-.873				
Q37					-.731				
Q39					-.323				
Q40									
Q7						.886			
Q11							-.429		
Q30	.384							-.437	
Q27									
Q12									

Note. Extraction method: Principle axis factoring. Rotation method: Oblimin with Kaiser normalization

Table 10

Teaching Factor 1: Science Teaching Practices

SPSS File Variable	Question
Q33	Encourage students to explain concepts to one another.
Q32	Require students to supply evidence to support their claims.
Q34	Encourage students to consider alternative explanations.
Q31	Use open ended questions.
Q36	Help students see connections between science and other disciplines.
Q28	Demonstrate a science-related principal or phenomenon.
Q29	Teach science using real-world context.

Table 11

Teaching Factor 2: Attitude Toward Science

SPSS File Variable	Question
Q76	I would like to take more science in school.
Q80	I learn things quickly in science.
Q81	Science is boring.
Q77	Science is more difficult for me than many of my classmates.
Q79	Science is not one of my strengths.
Q82	I like science.
Q78	I enjoy learning science.

Teaching Factor Frequency Features

A feature of the data in the tables can appear at first glance to be incongruous. All the items that make up the Teaching Factors were scored on 5-point scales with1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always or Nearly Always. Therefore, the highest possible score is 5, not 4. However, many tables have only four columns because for most items, no participants gave an answer of "Never." Therefore, "Rarely" and "Never" were combined into a single column, and four columns instead of five (See Appendix E). However, the means and standard deviations for the Teaching and Learning Factors use all 5 possible levels. Each of the tables shows a mean score for several of the factors close to four.

The two teaching factors above demonstrate various instructors' attitudes about effective teaching and relating to students. Each of the representations made from this data was collated based on an average of approximately 113 participants. Thus, the results of this survey show the direction in which science pedagogy is trending.

The pre-service teachers were asked how often they believe they should use real-world situations when teaching a science class. Nine teachers said sometimes; 38 said often, and 64 said they plan to use real-world situations for almost all lessons. This indicates that the respondents agree that real-world science applications are important to science education. On another key parameter, 58 teachers said that in almost all lessons, they try to show students how science relates to other disciplines. Of the participants, 44 teachers said they often use the method while nine said they sometimes use this method.

Learning Factors

Learning EFA

For the learning survey, the initial evaluation of the eigenvalues and scree plot revealed twelve factors with eigenvalues ranging from 1.11 to 10.99 that were found to explain approximately 59% of the variance. See Appendix F for the set of variables. None of the communality values exceeded 1.00, so it was concluded that the results were appropriate for interpretation; the KMO (see Appendix F) also indicated that the set of variables are adequately related for factor analysis. Working with the recommendations of Henson and Roberts (2006), the pattern matrix revealed that the initial twelve factors were reduced to seven factors underlying the structure of the learning survey (Table 12). Using the item factor loading alignments, sum factor scores were created for use as the seven dependent variables in the multivariate analysis of the learning survey.

In summation, factors were selected for retention from the evaluation of the scree plot of the initial eigenvalues, the industry standard suggestions of Henson and Roberts (2006) for factor retention, and the pattern matrix to apply the factor retention suggestions of the above authors.

Table 12

Learning Factor Pattern Matrix

Variable	Factor											
	1	2	3	4	5	6	7	8	9	10	11	12
Q43	**.839**											
Q64	**.616**											
Q44	**.603**											
Q42	.455				.371							
Q65	.361											
Q54		**.805**										
Q52		.554									.395	
Q55		**.441**										
Q53		**.405**										
Q2			**.740**									
Q3			**.600**									
Q1			**.461**									
Q16				.691								
Q15				.516								
Q58					.522					.340		
Q68				.303	.331							
Q59					.312							
Q70						**-.713**						
Q71					-.304	**-.719**						
Q72						**-.516**						
Q69						**-.616**						
Q5							.763					
Q6			.310				.571					
Q67								**-.426**				.302
Q73								**-.435**				
Q74								**-.668**				
Q75								**-.509**				
Q66								-.323			.304	
Q62					.315			-.315				
Q14									**.624**			
Q17									**.692**			
Q18									**.562**			
Q41									**.471**			
Q48									.342			
Q4										.611		
Q50										.538		
Q57										.530		.371
Q51											.736	
Q60											.418	
Q63								-.316			.346	
Q45												**.535**
Q46												**.591**

Q47							**.852**
Q56						.356	.359
Q49			-.306			.323	.341

Note. Extraction method: Principle axis factoring. Rotation method: Oblimin with Kaiser normalization

Using the process described by Henson and Roberts (2006), seven learning factors remained, which are detailed below.

Learning factor 1: Student's ability to analyze and report data. Learning Factor 1 looks at student's ability to analyze and report data. It asks about how often students should be recording, representing, and/or analyzing data in the classroom. It also asks how often students should be writing explanations about what is observed and why it happens.

Learning factor 2: Students taking part in non-inquiry activities. Learning Factor 2 looks at the amount of participation in non-inquiry activities such as answering textbook/worksheet questions or homework/worksheet assignments.

Learning factor 3: Student's scientific knowledge. Learning Factor 3 looks at the importance of sequential thoughts, scientific procedures, concepts, principles, and strategies.

Learning factor 4: Students using electronic tools for assessment. Learning Factor 4 asks how often should students take part in the use of electronic journals, bulletin boards, the Internet, computers for modeling and similarities, and work on portfolios.

Learning factor 5: Types of student assessment. Learning Factor 5 looks at the type and frequency of student assessment. It asks how often should a student take tests with open ended responses versus short answer tests or ones with performance tasks for assessment purposes. It also questions the use of science as a problem-solving tool.

Learning factor 6: Student's ability to evaluate science information. Learning Factor 6 discusses the student's ability to evaluate science information. It asks how often should students have to organize, interpret, evaluate, and use information gained and should they hold discussions lasting five minutes or more as well as explain the reasoning behind the data.

Learning factor 7: Student's ability to examine science. Learning Factor 7 asks how often students should take part in their own assessment, the discussion of the nature of science, and the debate of different science explanations.

Table 13

Learning Factor 1: Student's Ability to Analyze and Report Data

SPSS File Variable	Question
Q43	About how often do you think students should take part in each of the following types of activity -Record, represent, and/or analyze data.
Q64	About how often do you think students should write reflections in a science notebook or journal?
Q44	About how often do you think students should take part in each of the following types of activity -Write explanations about what was observed and why it happened

Table 14

Learning Factor 2: Students Taking Part in Non-Inquiry Activities

SPSS File Variable	Question
Q54	About how often students take part in or answer textbook/worksheet questions.
Q55	About how often students take part in or review homework/worksheet assignments.
Q53	About how often students take part in or read other (non-textbook) science related materials in class.

Table 15

Learning Factor 3: Student's Scientific Knowledge

SPSS File Variable	Question
Q2	To be good at science in school, how important do you think it is for students to think in a sequential and procedural manner?
Q3	To be good at science in school, how important do you think it is for students to understand science concepts, principles, and strategies?

Q1	To be good at science in school, how important do you think it is for students to remember scientific procedures?

Table 16

Learning Factor 4: Students Using Electronic Tools for Assessment

SPSS File Variable	Question
Q71	About how often do you think students should take part in each of the following types of activities: Use electronic journals or bulletin boards?
Q70	About how often do you think students should take part in each of the following types of activities: Use the Internet?
Q69	About how often do you think students should take part in each of the following types of activities: Use computers for modeling and simulations.
Q72	About how often do you think students should take part in each of the following types of activities: Work on portfolios?

Table 17

Learning Factor 5: Types of Student Assessment

SPSS File Variable	Question
Q74	About how often do you think students should take part in each of the following types of activities: Take tests requiring open-ended responses (e.g., descriptions, explanations)?
Q75	Q75: About how often do you think students should take part in each of the following types of activities: Engage in performance tasks for assessment purposes?
Q73	Q73: About how often do you think students should take part in each of the following types of activities: Take short answer tests (e.g., multiple choice, true/false, fill-in-the-blank)?
Q67	Q67: About how often do you think students should take part in each of the following types of activities: Use science as a tool in problem-solving?

Table 18

Learning Factor 6: Student's Ability to Evaluate Science Information

SPSS File Variable	Question
Q17	In science lessons, how often do you think students should do the following: Have conversations about the subject matter that last for five minutes or more?
Q14	In science lessons, how often do you think students should do the following: Explain the reasoning behind an idea?

SPSS File Variable	Question
Q18	In science lessons, how often do you think students should do the following: Organize, interpret, evaluate, and use information instead of trying to remember or reproduce it?
Q41	About how often do you think students should take part in each of the following types of activities in a science class: Formulate a science explanation?

Table 19

Learning Factor 7: Student's Ability to Examine Science

SPSS File Variable	Question
Q47	About how often do you think students should take part in each of the following types of activities in a science class: Assess the quality of their own work?
Q46	About how often do you think students should take part in each of the following types of activities in a science class: Discuss the nature of science?
Q45	About how often do you think students should take part in each of the following types of activities in a science class: Debate different science explanations?

Learning Factor Frequency Features

All the items that comprised the Learning Factors were scored on 5-point scales of 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Always or Nearly Always. Therefore, the highest possible score is 5, not 4. However, on most items, no participants gave an answer of "Never." Therefore, "Rarely" and "Never" were combined into a single column in all tables (Appendix F). The means and standard deviations for the Learning Factors, used all five possible levels. The tables showed a mean score for several of the factors close to four.

The Learning Factors demonstrated what pre-service teachers perceived as important ways students can learn in the classroom. The factors included student's ability to analyze and report data, participate in non-inquiry activities, their scientific knowledge, the use of electronic tools for assessment, types of student assessment, ability to evaluate scientific information, and the ability to examine scientific information.

The participants were asked about how involved they think students should be in documenting and analyzing data; 0% said students should rarely do so, 8.1% said sometimes, 55.9% said often, and 36% said students should always document and analyze data. This indicated that the pre-service teachers believed it was not an overwhelming priority for students to be actively involved in the core activities of science procedure in every class. This could have been due to factors such as time, lack of the correct study tools, or the learning environment. However, science teaching and learning works best when students have a hands-on experience with true inquiry procedures, like collecting and analyzing data.

When teachers were asked how important it is for students to use computers for modeling and simulations during science class, 20.7% said it is rarely important, 39.6% said it was sometimes important, 40.5% said it was often important, and 7.2% said it was important for all lessons. Despite widespread use of computers in everyday life, the survey showed that pre-service teachers may not always embrace technology in the classroom. Other questions regarding the use of the Internet, electronic journals and bulletin boards revealed a similar pattern. When asked how often students ought to use the Internet, only 9.7% thought students should use it in all or almost all lessons, 43.7% thought often was best, 40.8% thought it should be used sometimes, and 5.6% thought it should never be used. 9.8% of the participants thought electronic journals or bulletin boards should never be used, 41.7% thought they should sometimes be used, 39.5% thought they should often be used, and only 9.0% thought they should be used in all or almost all lessons. Other underlying factors may prevent teachers from utilizing computers in class, but the results indicated that many teachers did not think that technology was central their teaching. This suggested that, while teachers may turn to social media for information or to plan lessons, they were less likely to incorporate social media as an assessment tool to be used in the classroom.

When pre-service teachers were asked how often they felt students should engage in conversations about science-related subjects for more than five minutes, 1.8% said none or almost never, 10.8% said in some lessons, 48.6% said most lessons, and 38.7% said every lesson should incorporate conversation about science-related subjects. This indicated that teachers believed that it was useful to create an atmosphere in which students can assimilate what they learn. It is important to embrace channels that will help improve pedagogy and impart scientific knowledge to students (Tang, Coffey, Elby, & Levin, 2010).

Teaching MANOVA

A three-way MANOVA was conducted to determine the effect of desired grade (Pre-K-2nd, 3rd-5th, or 6th and above), participant perception of the importance of Pinterest (unimportant, moderately important, or important) and professional use of Pinterest (0-39%, 40-59%, or 60-100%) on the two teaching factors. As suggested in Olson (1976), the Wilks Lambda statistic was used. The results indicate a significant three-way interaction [Wilks' Λ = .698, $F(16, 146) = 1.795$, $p = .04$, $\eta 2 = .16$]. For further analysis, a Bonferroni adjustment was used to protect against Type 1 errors, lowering the alpha level .05 to .025. According to the tests measuring between-subject effects, the three way interaction is limited to only one of the factors, Teaching_1, $F(8, 74) = 2.37$, $p = .025$, $\eta^2 = .20$.

Table 20

3-Way Interaction Tests of Between Subjects Effects

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared
Corrected Model	107.216[a]	26	4.124	1.682	.043	.371
Intercept	12895.605	1	12895.605	5258.954	.000	.986
Grade	12.610	2	6.305	2.571	.083	.065
Importance	9.126	2	4.563	1.861	.163	.048
Professional Use	24.424	2	12.212	4.980	.009	.119
Grade * Importance	23.054	4	5.764	2.350	.062	.113
Grade * Professional Use	4.651	4	1.163	.474	.755	.025
Importance * Professional Use	9.300	4	2.325	.948	.441	.049
Grade * Importance * Professional Use	42.605	8	5.326	2.172	.039	.190
Error	181.457	74	2.452			
Total	16612.000	101				
Corrected Total	288.673	100				

To evaluate the significant three-way interaction of grade, importance, and professional use, a follow-up analysis was conducted. The Levene's Test of Equality of Error Variances (See Appendix E) was significant (p = .029). The file was split by grade; consequently, grade data was grouped into early elementary (Pre-K-2), elementary (3-5), and grade 6 and above. A univariate analysis of variance was run and an additional Bonferroni adjustment was made to protect against Type 1 Errors; consequently, the significance level was lowered from $p = .025$ to $p = .008$.

For participants who want to teach early elementary grades, the interaction between importance and professional use was not significant, $F(4, 23) = 2.72$, $p = .055$, and neither were the main effects of professional use, $F(2, 23) = .66$, $p = .53$; however, Pinterest importance, $F(2, 23) = 3.72$, $p = .04$, was significant at the p = .05 threshold. For participants who planned to teach grades 3-5, the interaction between importance and professional use was not significant, $F(4, 33) = 2.79$, $p = .04$, and neither were the main effects of professional use, $F(2, 33) = 1.36$, $p = .27$, nor Pinterest importance, $F(2, 33) = 1.57$, $p = .22$. For participants who planned to teach sixth grade or above, the interaction between importance and professional use was not significant, $F(4, 18) = .79$, $p = .54$, and neither were the main effects of professional use, $F(2, 18) = .18$, $p = .84$, nor Pinterest importance, $F(2, 18) = .97$, $p = .40$.

The three-way interaction showed significance with Teaching Factor 1: Science Teaching Practices. After further analysis, Pinterest importance was considered significant at a p = .05 level, although interpreting the result at a .05 level also leads to a greater risk of encountering a Type-1 Error. This indicates that elementary teachers found Pinterest to be an important tool.

Learning MANOVA

To evaluate the potential group differences on the factors outlined by the EFA, a multivariate analysis of variance (MANOVA) was used for the teaching and learning surveys. For the learning survey, a three-way MANOVA was conducted to determine the effect of the desired grade (Pre-K-2nd, 3rd-5th, or 6th and above), participant perception of the importance of Pinterest (unimportant, moderately important, or important), and professional use of Pinterest (0-39%, 40-59%, or 60-100%) on the seven learning factors, or summed factor scores that resulted from the EFA of the learning survey. To evaluate the significant three-way interaction of grade, importance, and professional use, a follow-up analysis was conducted. A Levene's Test was used to verify the equality of variances in the samples (See Appendix F). As suggested in Olson (1976), the Wilks Lambda statistic was used. None of the interactions or main effects is significant ($p > .05$), though Pinterest importance is approaching significance. It is noticeable that the partial eta squared for Pinterest importance is above the medium effect size that Richardson and Liang (2008) suggests, while all the post-hoc ANOVAs for Pinterest importance are still insignificant ($p > .05$).

Table 21

The Omnibus MANOVA Test

Effect	Wilks Lambda	F	Hypothesis *df*	Error *df*	*p* values	Partial eta squared
Grade	.886	2.267	4	146	.065	.058
Importance	.985	.285	4	146	.888	.008
Grade*importance	.806	2.079	8	146	.041	.102

Table 22

3-Way Interaction: The Omnibus MANOVA Test (Multivariate Tests)

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	.009	1096.766[b]	7.000	68.000	.000	.991
Grade	.795	1.183[b]	14.000	136.000	.295	.109
Importance	.727	1.676[b]	14.000	136.000	.067	.147
Professional Use	.742	1.559[b]	14.000	136.000	.099	.138
Importance	.667	1.048	28.000	246.600	.404	.096
Grade * Professional Use	.634	1.185	28.000	246.600	.245	.108
Importance * Professional Use	.676	1.010	28.000	246.600	.456	.093
Grade * Importance * Professional Use	.424	1.146	56.000	371.502	.233	.115

Inquiry Level Indicated by Teaching and Learning Factors

To understand the pre-service teachers' opinions as they related to inquiry, it was important to be able to categorize their self-reported opinion-based responses on an inquiry scale. To analyze pre-service teachers' responses to the open-ended questions on the survey and the semi-structured interview questions, a three-level variable called "Teaching Level" that corresponded conceptually to Kim and Kellough's (1994) three-level model of inquiry-based teaching was used.

The research examined the correlations between the two Teaching Factors and the seven Learning Factors (see Table 23). This examination indicated there were reasonably strong correlations among Teaching Factor One and Learning Factors One, Six, and Seven. Inspection of the items comprising these factors suggested that addressed ideas that were consistent with inquiry-based teaching and learning; therefore, a single scale was constructed that included all the items in these four factors. This was possible because all the items had been scored on similar, five-point Likert-type scales. The "Inquiry Learning Scale" was created using the mean of item1, item 2, item 3, etc. The highest possible score was, therefore, five, and the lowest possible score was one.

Table 23

Correlations among All Teaching Factors and Learning Factors

		T 1	T 2	L 1	L 2	L 3	L 4	L 5	L 6	L 7
T 1	Pearson Correlation	1	.137	.597	.107	.154	.162	.228	.525	.481
	Sig. (2-tailed)		.151	.000	.264	.106	.089	.016	.000	.000
T 2	Pearson Correlation		1	.122	.108	.188	.021	.201	.190	.176
	Sig. (2-tailed)			.202	.267	.048	.829	.034	.046	.065
L 1	Pearson Correlation			1	.331	.288	.338	.416	.451	.456
	Sig. (2-tailed)				.000	.002	.000	.000	.000	.000
L 2	Pearson Correlation				1	.141	.328	.433	-.004	.387
	Sig. (2-tailed)					.141	.000	.000	.970	.000
L 3	Pearson Correlation					1	.085	.216	.165	.068
	Sig. (2-tailed)						.374	.023	.084	.480
L 4	Pearson Correlation						1	.503	.142	.430
	Sig. (2-tailed)							.000	.137	.000
L 5	Pearson Correlation							1	.117	.380
	Sig. (2-tailed)								.220	.000
L 6	Pearson Correlation								1	.362
	Sig. (2-tailed)									.000
L 7	Pearson Correlation									1
	Sig. (2-tailed)									

Note. N = 113; T = Teacher; L = Learning.

Next, participants were divided into three Teaching Levels of roughly equal size based on their score on the Inquiry Learning Scale. Participants in the lowest Teaching Level were those whose score on the Inquiry Learning Scale was less than 3.88; those in the highest Teaching Level were those whose score on the Inquiry Learning Scale was above 4.29.

There were other ways to construct the Teaching Level variable. For example, the lowest level could have been those teachers whose average item score on the Inquiry Teaching Scale was below 3; that is, those who said that they used various inquiry-based teaching strategies “never,” “rarely,” or “sometimes.” However, there would have been no members in the lowest level. It therefore seemed more useful to divide the sample into three groups that were as equal in size as possible.

Inquiry-Based Teaching Measurements

Inquiry-based teaching was measured by two scales. Teaching Factor 1 was a seven-item scale that assessed teachers' advocacy of various practices that were consistent with inquiry-based teaching. It included such items as use open-ended questions, require students to supply evidence to support their claims, and teach science using real-world contexts.

The Inquiry Learning Scale was a more comprehensive measure that includes all the items in Teaching Factor 1, Learning Factor 1, Learning Factor 6 and Learning Factor 7. Teaching Factor 2 was not included because it did not correlate with the other factors related to inquiry-based teaching. Additionally, the items asked about attitude toward science, not comfort with inquiry-based teaching.

Use of social media, specifically Pinterest, was also addressed by one measure. A single item, called Professional Use of Pinterest, which read, "How important is Pinterest as a resource for inquiry activities?" Grade Level was a single item variable, which asked teachers which of three grades levels they preferred to teach: Early Elementary (Pre-k-2), Elementary (3-5), and Upper-Elementary (6 and above).

Teaching Factor 1 was used to test whether pre-service teachers' professional use of Pinterest, views on inquiry-based teaching, and grade level were connected. Teaching factor 1 was a seven-item scale that assessed teachers' advocacy of various practices that were consistent with inquiry-based teaching. It included such items as use open-ended questions, require students to supply evidence to support their claims, and teach science using real-world contexts. Teaching Factor 1 was used because of the correlation between Pinterest and all the teaching and learning factors for all grade levels. The only correlation that was statistically significant was grade level difference and Teaching Factor 1 (Table 24).

Participants' responses to the question "How important is Pinterest as a resource for your inquiry-based activities?" served as the measure of pre-service teachers' professional use of Pinterest. In addition, the constructed Grade Level variable (Early Elementary, Elementary, and 6 and above was used.

Table 24

Correlation of Pinterest Scale with Teaching and Learning Factors, Organized by Preferred Grade Level

Factor	Early Elementary (Pre-K – 2) N=31	Elementary (3-5) N=41	6 and Above N=27	All Levels N = 99
Teaching Factor 1	-.087	.117	-.026	.004
Teaching Factor 2	.446*	-.053	-.271	.010
Learning Factor 1	.090	.206	.071	.125
Learning Factor 2	-.037	-.247	.080	-.088
Learning Factor 3	.213	.057	-.234	.011
Learning Factor 4	.016	-.084	.390*	.121
Learning Factor 5	-.053	-.096	.192	.007
Learning Factor 6	.012	.448**	.241	.258**
Learning Factor 7	.130	-.104	-.047	-.014

Note: The number in each cell is the correlation between the Factor and the Pinterest Scale, *The correlation is significant at the $p < .05$ level, ** The correlation is significant at the $p < .01$ level

Without adding grade level into the equation, the correlation between Teaching Factor 1 and participants' responses of how important Pinterest was as a resource for their inquiry-based activities (Table 25) was not statistically significant. When all grade levels were combined, there were no statistically significant correlations between how important participants felt Pinterest was as a resource and their views on inquiry-based learning.

Without adding grade level into the equation, the correlation between Teaching Factor 1 and participants' responses of how important Pinterest was as a resource for their inquiry-based activities (Table 25). When all grade levels were combined, there were no statistically significant correlations between how important participants felt Pinterest was as a resource and their views on inquiry-based learning.

Table 25

Correlations between Measure of Pinterest and Two Measures of Inquiry-based Teaching

		How important is Pinterest as a resource for your inquiry-based activities?	Teaching 1	Inquiry Teaching Scale
How important is Pinterest as a resource for your inquiry-based activities?	Pearson Correlation	1	.060	.113
	Sig. (2-tailed)		.548	.259
Teaching 1	Pearson Correlation		1	.901
	Sig. (2-tailed)			.000
Inquiry Teaching Scale	Pearson Correlation			1
	Sig. (2-tailed)			

However, when the participants were divided by their preferred grade level, an interesting difference emerged. Among those who preferred to teach the Early Elementary grades, there was a significant, positive correlation between Pinterest and Teaching Factor 1 ($r = .352$, $p = .048$) (Table 26); among those who preferred to teach the middle grade levels, there was a negative (but not statistically significant) correlation between Pinterest and Teaching Factor 1; among those who preferred to teach at the highest grade level, there was no relationship at all between Pinterest and Teaching Factor 1.

Table 26

Correlations between Importance of Pinterest and Teaching Factor 1, Organized by Preferred Grade Level

		Teaching Factor 1
Early Elementary (PK-2)	Pearson Correlation	.352
	Sig. (2-tailed)	.048
	N	36
Elementary (3-5)	Pearson Correlation	-.209
	Sig. (2-tailed)	.183
	N	42
Grade 6 and above	Pearson Correlation	-.016
	Sig. (2-tailed)	.938
	N	30

Note: * p < .05; ** p < .01

This was an unexpected and interesting finding because it indicated that pre-service teachers who plan to teach the early grades who were most interested in inquiry-based teaching were also most likely to use Pinterest. A possible explanation was that the material available on Pinterest was more suitable for students in the early grades. Therefore, those pre-service teachers who planned to teach older students could have been less likely to believe that Pinterest was a useful source for classroom activities. Suggestions for further exploration of these ideas were included in the section on future research.

Semi-Structured Interview Results

Fourteen participants participated in semi-structured interviews. Braun and Clarke's (2006) coding process (Table 27) was used to identify initial codes, emerging themes and the final themes used in this study:

Table 27

Coding Process Phases

Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
Familiarizing yourself with the data	Generating initial codes	Searching for themes	Reviewing themes	Defining theme names	Producing the report
Transcription of Verbal Data	*Organizes data into meaningful groups*	*Determines the relationship between codes, themes, and levels of themes*	*Examines themes to see if they form a coherent pattern. If so, move to next level. If not, consider removing the theme, but extracting data from within.*	*Determines what aspect of the data each theme captures*	*Writes up the themes in the actual manuscript*

A thorough analysis of the information led to an organization of the data into meaningful groups, therefore generating a list of initial codes for phase 2 (Table 28). The codes were derived from interesting data within groups. These codes signaled similarities within the data so they can be categorized into meaningful groups and discussed as a data set. The codes were data-driven, and as suggested by Braun and Clarke, each group was coded manually with highlighters to indicate potential patterns. Codes were developed based on common themes throughout the interviews.

Table 28

Initial Codes

Grade Level	Researcher’s hand written notes
Ease of Use	Dark Green
Type of Social Media used professionally	Green
How social media was used lesson planning, etc.	Orange
Student Engagement in Science Teaching	Pink
Science Learning and Student Questioning	Blue
Type of User	Yellow
How teachers use lessons found on social media	Researcher’s hand written notes

The initial codes are intended to lead to emerging themes. Grade Level and Type of User were not themes but instead were a separate section of data analysis. After analyzing the data, the codes led to the following initial themes (Table 29).

Table 29
Qualitative Interview Themes

Initial Code	Theme
Grade Level	Discarded and combined into all themes
Ease of Use	Theme 1: Ease of use and Sm vs LRC
Use of Social Media in Lesson Planning	Theme 4.1: Article Access
Type of Social Media used for Professional Use	Theme 4.2: Professional Usage
Student Engagement in Science Teaching	Theme 2: How teachers teach science
Science Learning and Student Questioning	Theme 3: How students learn science
Type of User	Discard and combined into all themes
Use of Social Media in Lesson Planning	Theme 5: Relationship between teaching methods and social media

Reviewing the initial themes led to more refined themes. Analyzing the initial themes, determining their validity, and rethinking how they better fit together led to the combination of Theme 4.1 and 4.2 Article Access and Professional Usage, respectively, because they naturally flowed into one theme, renamed as Enhancing Professional Development and Networking through Social Media. The final themes included:

Theme 1: Pre-service Teachers as Social Media Consumers

Theme 2: Science Teaching as Facilitating Hands-on Learning

Theme 3: Science Learning as Active Engagement

Theme 4: Enhancing Professional Development and Networking Through Social Media

Theme 5: Relationship Between Teaching Methods and the Use of Social Media

The following report of each theme tells a story of how pre-service teachers use social media for inquiry teaching and learning.

Theme 1: Pre-service teachers as social media consumers. In order to understand how pre-service teachers use social media in their classrooms, it is important to understand what forms of social media they use, how often they use them, and for how long they have had their accounts. The significance of three social media platforms emerged from the surveys: Facebook, Pinterest, and Twitter. The detailed results of the surveys are described earlier under qualitative results; however, semi-structured interviews followed up on pre-service teachers' use of these three social media platforms.

Theme 2: Science teaching as facilitating hands-on learning. Pre-service teachers' preferences for looking up lesson plans on Pinterest represents one powerful use of social media as a professional tool for teachers. As the pre-service teachers search the site, they are looking for lessons that not only fit their needs to convey the required information, but also that fit their perceptions of how a lesson is effectively taught. Most participant responses indicated that they aspire, whether consciously or not, to a particularly effective form of teaching known as inquiry. Inquiry-based learning encourages students to design and carry out activities to answer their own questions. Teachers and students alike must be taught to teach and learn this way. With practice, teachers get better at facilitating these lessons and students get better at learning this way. Pre-service teachers' responses to hands-on learning are organized using Kim and Kellough's levels of inquiry (1994).

Level one inquiry as ideal. When asked what teachers should be doing during a science lesson, eleven of the fourteen interviewees specifically mentioned that providing hands-on learning opportunities was important. While six of these participants expounded upon the idea of hands-on or interactive learning, five of them did not elaborate beyond these

> descriptors, keeping their ideal approach to teaching science squarely in level one inquiry. This is to be expected at this time in their careers.
>
> [Interviewer: When you are creating your lessons, what teaching techniques do you think you could be using when teaching science?] A lot of hands-on lessons. A part of it should be background knowledge and lecture, but most of the time should be spent where the kids can actually do hands-on lessons and learning (Interview, Participant 2, 5/11/2015).

Level one approaching level two as ideal. Four of the interview participants' responses indicated that their ideal teaching style was at a level one inquiry but approaching level two. Responses of this kind were signaled by indicating that 'hands-on' learning was important, but they expounded on this and signaled openness to student exploration. They did not explicitly indicate that students should select methods, but they used phrases like "try it themselves" and "figure it out on their own."

> [Interviewer: What should you as a teacher be doing during a science lesson]. More of a hands-on lesson. When I think of science, I think of more experiments and projects rather than just lecturing, because it is easier to get their attention and excitement to learn when they have something in front of them. I feel like it is easier for them to understand when they can try it themselves (Interview, Participant 12, 5/13/2015).

The idea of students "try[ing] it themselves" is still at a level one on the inquiry scale, but approaching level two. Participant 12's response suggests he is prepared to step back and let the students collect their own data. His reference to experimentation suggests openness to letting students draw their own conclusions, as in level two. Additionally, his reference to projects could mean that he is willing to let students come up with the problem to solve, as in level three, but it remains ambiguous as to whether he would allow students this much freedom in practice -.

Participant 4 said teachers should be "doing activities that stimulate [students'] minds, like demonstrations, experiments and hands-on work. [Teachers] should make sure that everyone is involved and get their input." Instead of adopting a passive, more objectively assessable science teaching methodology, Participant 4 and Participant 12 both prefer to engage their students actively on multiple levels. Although still operating at a level one on the inquiry scale in their lessons, these teachers are thinking towards the second level where students begin to choose their own methods to solve the problems in the experiment. Participant 4's reference to getting students' input suggests that she is willing to let students do more than collect data as directed, as in a level one inquiry. It shows a willingness for student input into possible methods, which verges on level two.

Level two inquiry as ideal. One participant's interview indicated that her ideal teaching style was solidly at a second level of inquiry. Participant 13 indicated that mini-lessons were helpful to give the students background prior to tackling a hands-on project, as were visuals, demonstrations, and other stimulating activities. But once the hands-on lesson had begun, teachers were there to provide guidance and model safety.

> The teacher should be setting up the environment for students to learn and guiding the lesson, but not doing anything for them. Maybe modeling safety procedures so that the students are safe, but not necessarily modeling carrying out the procedure (Interview, Participant 13, 5/13/2015).

Participant 13 is working with her students to become level two inquiry learners. In her description, she presents herself as a safety facilitator, while allowing the students to carry out the experiment fully to solve the problem. Participant 13 is still defining the problems that the students are working on, as is expected in levels one and two, but it is up to her students to carry out the methods and collect data.

Level two, approaching level three as ideal. One additional participant, Participant 10 signaled that the teacher ought to "step back" and let students determine methods of answering questions, the hallmark of level two inquiry. However, he goes a step further in his response, indicating a resistance to directing students, which approaches level three inquiry:

> You need to need to step back and let them do it, and you guide them as they go. You guide them through their process of thinking and learning, so that you are not just telling them. My science teacher did a mixture of lecturing and hands-on, and I think that mixture is nice because then they get that guidance, and they get the chance to do it themselves. I think the lecture is good, but also finding it for themselves helps them to learn better (Interview, Participant 10, 5/13/2015).

Participant 10's idea that if students find the solutions themselves, they learn better, is a level two or possibly even a level three technique. It resists directing students' experimentation to the correct conclusion. However, his indication that it is up to the teacher to guide students as they go indicates a reticence to give students absolute control over the process, which is consistent with levels one and two. The participants' responses indicate that they prefer their students explore independently, relying on the teacher only as a guide and not as the source of all answers. Six of the pre-service teachers interviewed are approaching or have at least partially reached a level two on the inquiry scale.

Table 30 indicates the number of responses that fell into each of the inquiry level categories.

Table 30

Number of Responses for Inquiry Level Categories

Level of Inquiry	Description	Number of Responses	Example Quote	Participants (participant numbers for coding purposes)
Non-level specific	No inquiry level could be ascertained from response	3	*What can I do to help [the students] learn and enjoy [science] more than I did?*	Participants 7,8, and 9
Level one	Signaled by reference to "hands-on" or "interactive" learning	5	*Most of the time should be spent where the kids can actually do hands-on lessons and learning*	Participants 1, 2, 5, 6, and 11
Level one approaching 2	Signaled by reference to letting students "try it themselves" or "figure it out"	4	*Most of it should be hands-on with them doing it themselves and figuring it out on their own.*	Participants 3, 4, 12, and 14
Level 2	Signaled by teachers "stepping back" or openness to students making mistakes	1	*I let the students come up with their own ideas.*	Participant 13
Level 2 approaching 3	Signaled by resisting directing student procedures or outcomes	1	*I think the lecture is good, but also finding [the solution] for themselves helps them to learn better.*	Participant 10

Other findings of note. While these findings did not fit squarely into Kim and Kellough's (1994) framework, they were interesting and added value to Theme 2, science teaching as facilitating hands-on learning. First, a few participants placed an emphasis on teacher performance. For instance, four of the pre-service teachers interviewed mentioned that they thought teachers ought to be doing a lot and providing a central focal point during science lessons. This could take the form of asking questions, providing demonstrations and visuals, or modeling the entire lesson while students took notes. Some of the responses in which participants mentioned teachers as central figures during lessons placed this in the context of inquiry.

> [Interviewer: As a teacher, what should you be doing during a science lesson?] I should be through, and be doing activities that stimulate their minds, and demonstrations, experiments, and hands-on work. I should make sure that everyone is involved and get their input. I should use lots of visuals (Interview, Participant 4, 5/14/2015).

Participant 4's use of words like "hands-on" and "everyone is involved" indicates that her ideal lessons are inquiry-based. Additionally, she emphasizes "visuals," "demonstrations," and "activities that stimulate [the students'] minds. Activities of this nature place classroom focus on the teacher, though they still facilitate inquiry. One response also placed focus on the teacher's activity, but without any reference to inquiry activities. When asked what she should be doing when teaching a science lesson, one participant said: "questioning skills to provoke critical thinking", (Interview, Participant 7, 5/12/2015).

Second, a few participants placed an emphasis on lecture. While most of the participants mentioned hands-on learning when asked what they should do as teachers, four of the fourteen participants indicated that lecture was important. Three of these participants mentioned that the lectures should be short and used to impart background knowledge before moving to the primary, hands-on lesson.

> I think there should be a short, mini-lecture just to make sure that the students understand the concepts, but most of it should be hands-on with them doing it themselves and figuring it out on their own, because if I am just lecturing to them the whole time, the students are just going to get really bored (Interview, Participant 3, 5/11/2015).

Participant 8 discussed lecture as the most important thing a teacher can do during a science lesson. Her response is detailed above in the non-level specific responses section.

Theme 3: Science learning as active engagement. The interviewees had ideas about the kind of science lesson plans they should provide for students (hands-on/inquiry) and what they, the teachers, should be doing during science lessons (providing guidance and direction). Additionally, they had definite ideas about what, ideally, their lessons would prompt students to do during class. When asked what students should be doing during a science lesson, most of the interview participants indicated that the students should be engaged in the lesson and participating. Based on their responses, this could take the form of working with materials or other hands-on activities, asking questions, and sharing ideas.

As the teachers described their student actions, they were mainly describing level one inquiry learners. Nine of the fourteen participants mentioned that students should be doing activities in their science lessons consistent with a level one inquiry lesson. Four of these pre-service teachers had the right ideas to move their students to a level two. Two of the participants thought their students should perform second level inquiry actions, and another two responses indicated openness to move toward a level three. In general, the teacher responses as to what their students should be doing were at higher inquiry levels than what they thought teachers should be doing.

Level one inquiry responses. Five of the interview participants responded that students ought to be doing activities in a science lesson that are in line with level one inquiry, which is to be expected at this point in their careers. Responses of this nature were signaled by phrases like hands-on and interactive learning as well as actively engaged or references to the five senses.

They did not elaborate on these responses, and there was no specific plan to carry out plans of this nature. Below are two examples of such responses.

> I think for science you need to actually see, touch, feel—use all of those five senses in order to fully understand what you are learning (Interview, Participant 2, 5/11/2015).
>
> The students should be involved and interactive with the materials (Interview, Participant 5, 5/14/2015.)

It is worth noting that two participants in this level one inquiry group had responses in different categories under Theme 2. Participant 7 had a vague non-inquiry specific response as to what teachers ought to be doing in a science lesson. But her response concerning what students ought to be doing was solidly level one inquiry. Participant 12, whose Theme 2 response was a level one approaching level two, indicated that students ought to perform experiments and communicate with others to "get it right."

> [Interviewer: What should the students be doing during the (science) lesson?] Listen during the instruction, be engaged in what is going on, and they need to be able to communicate and work with other people and share ideas, predictions, and results: so that they can know what they are doing is right (Interview, Participant 12, 5/13/2005).

In general, these participants offered as ideal student engagement examples of level one inquiry: students collect their own data, make their own observations, and are actively involved with the materials. Many of the teachers indicated a desire for students to participate in exploratory learning, but most frequently within boundaries set by the teachers.

Level one, verging on level two inquiry. Four of the participants' responses indicated that, while they were idealizing activities at a level one inquiry, they were open to higher levels of inquiry. This is signaled in their responses by phrases such as "making mistakes" or students "asking their own questions," but without follow-up on these ideas or any solid strategy discussed as to how to make this happen. Examples of this are included below.

> [Students should] be able to visualize and explore outside of the teacher telling them what to do (Interview, Participant 8, 5/12/2015)
>
> [Students] should be okay with making mistakes and just be open (Interview, Participant 9, 5/13/2015).

These responses indicate a movement toward higher inquiry levels, but do not note if the participants are willing to allow errors in the lessons or deviations from a prescribed problem. It is worth noting that both Participant 8 and Participant 9's responses to Theme 2 questions about what teachers ought to be doing during a science lesson were non-inquiry level specific. Their responses to the Theme 3 question indicate an openness to inquiry that was not apparent in their other answers.

Level two inquiry responses. Two participants' responses indicated that they thought the ideal activities for students to do during a science lesson were level two inquiry activities. This is signaled by not only indicating a willingness for students to formulate questions or make mistakes but also following up with specific ideas about how to accomplish this or formulating a plan for student engagement.

> [Interviewer: When you think about the students during your lesson planning, you said definitely hands-on project based, what would they be doing?] I think having them ask

their own questions, and if you are working with some hazardous material, obviously, you would want to outline exactly what they were supposed to do, but if it is something where they are free to explore a little more, and make mistakes, letting them kind of do that on their own, and figure out their own ideas instead of having to be like super guided. Then it can be more exciting to discover stuff out on your own instead of having the teacher tell you how to discover it (Interview, Participant 1, 5/11/2015).

Participant 1's response indicates a willingness to allow student questions to direct classroom procedure, and a willingness to let students' own questions and ideas guide their learning, which is the second level of inquiry. She perceives her students as completely independent learners and problem-solvers. Her response indicates a willingness on the part of the teacher to step back and allow students to let the data guide them. Her response to Theme 2 questions indicated that her ideal for what teachers should be doing was at a level one, but her Theme 3 response indicates a much greater openness to inquiry and a confidence in her students to explore.

Level two, approaching level three inquiry. Two participants' responses about what students ought to be ideally doing during a science lesson described level two, and possibly level three activities.

[Interviewer: Thinking about the students, what should they be doing?] The students should be paying attention, so that they won't miss anything or distract the other students. They also need to be open to other ideas that might change their opinion or ideas, and they need to be active (Interview, Participant 10, 5/13/2015).

Participant 10's response indicates a comfort with the tentative nature of science and a desire to help students understand this, which is a keystone of level two inquiry and approaches level three (Kim & Kellough, 1994). Another participant indicated that the teacher provides environmental safety, but it is up to the students to come up with their own ideas and work with the materials. Responses of this kind indicate a great degree of comfort and confidence in student exploration. Table 31 contains a breakdown of the inquiry levels the pre-service teachers indicated students ought to ideally be learning.

Table 31

Ideal Inquiry Levels

Level of Inquiry	Description	Number of Participants	Sample Quote	Participants
Non-level specific	No indication of inquiry-based learning	1	*They should be watching what is going on and taking notes.*	Participant 6
Level one	Signaled by "hands-on" or "interactive" learning or "five senses" or being "engaged"	5	*You need to actually see, touch, feel, you know all of those five senses in order to fully understand what you are learning.*	Participants 2, 5, 7, 11, and 12
Level one, verging on two	Signaled by "making mistakes" or "asking their own questions"	4	*They should be able to visualize and explore outside of the teacher telling them what to do.*	Participants 4, 8, 9, and 14
Level two	Signaled by "making mistakes" but with elaboration	2	*…something where they are free to explore a little more and make mistakes…*	Participants 1 and 3
Level two, verging on three	Openness to changing opinion, coming up with their own project ideas	2	*(The students) also need to be open to other ideas that might change their opinion or ideas…*	Participants 10 and 13

Theme 4: Enhancing professional development and networking through social media. As technologies emerge, they provide new tools that can support the professional growth of new teachers. For example, when asked to describe the differences between using social media to find teacher tools and using traditional methods, like the Learning Resource Center (LRC), nearly all the pre-service teachers indicated that searching for these tools was easier and

faster via social media. This is unsurprising, since social media use in general is becoming more prevalent among adult Internet users. According to the Pew Research Center (2014), "fifty-two percent of online adults used two or more social media sites, a significant increase from 2013, when it stood at forty-two percent of Internet users." Additionally, 71% of adult Internet users and 58% of the entire adult population are on Facebook.

Three of the participants specifically indicated that information found via social media was better organized. Additionally, four interviewees specifically mentioned the convenience of being able to search online anywhere at any time versus finding transportation to a library or LRC with limited hours of operation. Interviewees also indicated that they perceived differences in the materials available from the LRC versus the materials available online via social media. Eight of the pre-service teachers indicated that they perceived that either the options available from the LRC were limited or that the options available via social media were unlimited or more varied.

> [Interviewer: Thinking about how you used social media for teaching and lesson planning, how does it differ from using traditional resources like here in the LRC?] The LRC is limited to what you have (Interview, Participant 3, 5/11/2015)
> There are a vast variety of lesson ideas all over the world, [including] what works vs. what didn't when you find information on social media vs. finding stuff in the LRC (Interview, Participant 5, 5/14/2015).

The perceived reliability of the materials was also a difference several of the pre-service teachers mentioned. Four interviewees indicated that materials available online via social media were less reliable than LRC materials, possibly due to author bias: "You don't get as many biased lesson plans when you get the information from the LRC" (Interview, Participant 5, 5/14/2015).

However, Participant 11 expressed concerns that LRC materials could potentially be outdated: "Using the traditional way [LRC] might get you outdated information, where on the Internet, your information is infinite." Participant 11 also acknowledged that with the Internet, you must be careful about the credibility of what you find (Interview, Participant 11, 5/13/2015).

A perceived advantage of LRC materials over social media materials was the fact that LRC materials are tangible. Seven of the participants indicated that having physical copies of books, papers, and toolkits was important: "The pros [sic] of having the traditional way is that you have the materials in front of you and you can touch those materials" (Interview, Participant 10, 5/13/2015). Participant 14, Heather, said that online sources can be problematic: "It is also really hard because sometimes they tell you about an activity, but they don't give you the materials you need" (Interview, Participant 14, 5/13/2015).

Participant 9 indicated that another advantage of LRC materials was that they were always free while sometimes online materials carried a fee to access: "[With LRC materials] you have the stuff with you as soon as you find it, and you don't have to go buy it" (Interview, Participant 9, 5/13/2015).

Three participants indicated that, while they had used social media to look for teacher tools or ideas, they had never actually used the LRC: "I haven't really used the LRC because Pinterest is so easy" (Interview, Participant 2, 5/11/2015). Participant 5 said, "I have never used the LRC because there is so much variety online" (Interview, Participant 5, 5/14/2015).

Table 32 shows the number of times participants mentioned certain perceived advantages or disadvantages of using social media or the LRC. Interviewees might mention only one or several aspects concerning the use of materials gathered from either the LRC or social media.

Table 32

Number of Times Participants Mentioned Perceived Advantages and Disadvantages of the LRC

	LRC	Social Media
Connectivity/dynamic materials	0	4
Greater variety of information	0	8
Reliable materials	4	1
Tangible materials as a positive	7	0
Well organized	1	3
Faster, easier, more convenient	1	12

In addition to the convenience of accessing social media anywhere, at any time, social media content can be customized to users' educational needs (Scheffer, 2012). Awareness of this customizable, dynamic content was echoed in the interviews. Another difference the interview participants perceived between looking for ideas via social media and looking at the LRC was connectivity and feedback. Four participants indicated that one advantage of using social media was that they could read reviews and posts from teachers who had already tried the methods they were researching, to learn what had and had not worked in their classrooms: "Finding stuff in the LRC you don't really know how stuff worked for those teachers" (Interview, Participant 5, 5/14/2015).

Additionally, some felt they could request feedback on their own ideas or connect to teacher blogs via social media:

> I think when you are using something online, the fact that there can be pictures and the actual teacher who put it into practice can tell you about it is really nice. Whereas, you

> come to the LRC and there are textbooks… [online social media] seems more adaptable, and you can see more of a potential in it (Interview, Participant 1, 5/11/2015).

This idea of connectivity, feedback, and contribution is echoed by Rohm et al. (2013). Though Rohm et al.'s study specifically addresses customer interactions with brands for marketing; some of the same concepts are relevant. One of the essential five elements to consumer engagement in social media uncovered by the study was "facilitating conversation and dialogue rather than delivering one-way marketing communications monologues" (p. 298). Because the lesson plans that pre-service teachers access through social media come with attached feedback and suggestions from teachers who have tried the lesson, they can access a dialogue on the subject or add their own questions or experiences. In this way, lesson planning becomes a conversation and not a static list of steps that an LRC lesson might have.

This process looks very much like the consumer engagement described by Rohm et al. (2013):

> In this socially-charged era in, which peers influence each other as much as companies do, good customers can't be identified solely by their purchases…customers contribute to company success (beyond direct sales) through approaches such as fostering word of mouth and by helping uncover new product ideas generated from customer co-creation efforts (p. 305).

Rohm et al. (2013) suggest "that brands should view social media as not just a platform with which to promote and sell, yet also as a platform that enables customer co-creation in the product development process and that allows the brand to quickly react to customer service issues and customer feedback in a proactive manner" (p. 307). While pre-service teachers are not purchasing the lessons but instead implementing them, the analogy holds up. Teachers help each other and contribute to student learning by reviewing and tweaking lessons, and spreading their ideas via social media. The use of social media by pre-service teachers to create a dynamic conversation can help them avoid both the isolation and creative stagnation that can accompany a schedule with limited time to collaborate and commiserate with colleagues (Forte et al., 2012).

Many of the pre-service teachers didn't use social media as simply one of many ways to find lesson plans. They adamantly believed that social media in general, and Pinterest in particular, is the preferred place to search for lesson plans. While she had not yet used social media directly in her teaching methods as a student, Participant 1 planned to use Pinterest to find creative, adaptable ideas in her upcoming work as a student teacher: "I think when you are using something online, the fact that there can be pictures, and the actual teacher who put (the teacher tool) into practice can tell you about it, that's really nice…I feel like it seems more adaptable, and you can see more of a potential in it" (Interview, Participant 1, 5/11/2015).

When given a choice and a chance to be creative, the participants overwhelmingly turned to Pinterest to plan their lessons:

> This past semester, when we were in practica in fourth grade, all of our lessons were assigned to us, we didn't get any room for creativity. So, last fall was when I really used Pinterest as a key to learn more about different lesson plans for my first-grade practicing classroom. The last lesson I found on Pinterest that I used was a writing activity. It was a matching game that the kids had to find what word rhymed with the other word. I haven't really used the [Learning Resource Center] because with Pinterest it is so easy (Interview, Participant 2, 5/11/2015).

When asked what she would do if she had to use the Learning Resource Center to plan her lessons, Participant 2 replied that Pinterest was preferable by far:

> I know I would be okay, but I would probably want somebody to walk me through the book, so that I can get an idea for what it is like. But I could go on Pinterest and it would be a lot easier. Another great thing I found about Pinterest is when you go to the different links and stuff it takes you onto different teacher blogs, and that is another way that I have even learned more lesson plans (Interview, Participant 2, 5/11/2015).

These responses are in line with Rohm et al. (2013) findings. The researchers highlighted "five classes of consumers' motives and desired outcomes regarding brand-consumer engagement via social media: (1) for timely customer service and for accessing current content; (2) for product information; (3) for entertainment; (4) for greater engagement (connection and identification) with the respective brand; and (5) for incentives and promotions." The responses indicate that accessing current content (motive 1) and entertainment (motive 3) factor heavily into pre-service teachers' motives for searching for lesson plans on Pinterest. Though Rohm et al (2013) highlights "the functional as well as hedonic nature of social media brand-consumer interactions," the teachers are not acting like the brand consumers in the Rohm article who seek self-entertainment. Rather, the teachers' motives are to find fresh and timely lesson plans that allow both teachers and students to exercise creativity. While they are seeking pleasure as they look for lesson plans via social media, they seem to be speaking of the generative pleasure of creating and learning rather than the hedonistic pleasure of consuming.

Theme 5: The relationship between planned teaching methods and use of social media. Another theme identified through the interview process is the relationship between planned teaching methods and the use of social media. All but one of the fourteen pre-service teachers interviewed said that they used social media to find lesson plans. Twelve of them could describe at least one activity found on social media that they had personally implemented in a classroom setting. Of the two who did not, one had not used social media to search for lesson plans, and the other had found lesson plans, but she had not yet entered practica. Similarly, when asked to describe an activity they'd found on social media, twelve of the fourteen pre-service teachers interviewed described in detail at least one lesson that was likely an inquiry-based (though not necessarily a science) lesson.

The pre-service teachers found activities that were versatile and could be taught as either a demonstration or an inquiry-based lesson. Participant 4 described one such activity that she found on social media:

> There is a jar and you put a saucer on top and put ice on that. You use a hair dryer and when it melts, it causes rain. It teaches the condensation method. The students would be watching and listening during the activity, or each table group could be doing it. If the groups were doing it, I would be walking around asking (the students) questions (interview, Participant 4, 5/14/2015).

This is an example of a level one to two inquiry-based lesson when performed by groups of students. The teacher has given the students the steps to follow and has left it up to them to conduct the procedure, collect the data, and ask questions or make observations.

Many of the pre-service teachers mentioned inquiry-based math or science lessons that they had found using social media. Participant 7 describes one money-based activity she found:

> There was a game that I found for money value that I thought was really interesting. There was a mat that you printed off. I laminated it. On it, you roll the dice, and you pick up however many pennies are in the pile. When you get five pennies you throw them back into the pile, and you pick out a nickel. Whichever person gets to the dollar

> first wins the game. I thought it was a really fun way for the students to learn (Interview, Participant 7, 5/12/2015).

A few participants also found inquiry-based social studies lessons:

> Last semester on the social studies block, I found a voting activity on Pinterest. You read (the students) a book about the voting process, and I brought in a Coke and a Pepsi. Each student had two states, and they had to draw an advertisement for which soda they preferred and present to the class why the soda was better and put their vote on the back of their state. Then they had to go over the tallies and see which soda won. And they all got soda when it was over (Interview, Participant 9, 5/13/2015).

These two lessons are at the second level of inquiry. Students play the coin game or vote for a soda on their own, and the teacher relinquishes control over the results of the processes and the results. The winner of the game is determined by a throw of the dice and the students' own abilities to correctly count change. The election's winner is determined by a vote. These are not third level lessons, first because the teacher still sets the lesson's goals and the rules (be the first to reach $1.00 or vote for your favorite), and second because there is no room for new, emergent data to change the results of these exercises.

Two participants used social media to find second level inquiry lessons, which is interesting because their ideal pictures of what teachers ought to be doing during a science lesson and what students ought to be doing were at lower levels. Findings like this prompted an identification of the level of inquiry of each lesson described by participants and compare it to the participants' inquiry levels described in Themes 2 and 3 (See Table 33).

Table 33

Inquiry Lesson Level

Name	Level in theme 2	Level in theme 3	Lesson level found on social media
Participant 1	1	2	Possible 1
Participant 2	1	1	1
Participant 3	1-2	2	Non-inquiry
Participant 4	1-2	1-2	1-2
Participant 5	1	1	1
Participant 6	1	Non-level specific	1
Participant 7	Non-level specific	1	2
Participant 8	Non-level specific	1-2	Possible 1
Participant 9	Non-level specific	1-2	2
Participant 10	2-3	2-3	NA
Participant 11	1	1	1-2
Participant 12	1-2	1	1
Participant 13	2	2-3	2-3
Participant 14	1-2	1-2	Possible 1

Possible level one inquiry lessons were those that had the potential to be inquiry if they were implemented in a certain way. Participant 14 provided a possible level one example lesson:

> An activity that I really liked was creating rain. You put shaving cream onto water, and then you put food coloring on it, and it starts coming down into the water, so that was really cool and the kids loved it (Interview, Participant 14, 5/13/2015).

Participant 14's description could be an inquiry-based lesson if children are allowed to perform it or answer questions, but it is unclear if she implemented the lesson as a hands-on activity with a scientific question to answer or whether it was simply a demonstration. Since it could be either, it is called a possible level one lesson.

One finding of note was that, while three of the pre-service teachers discussed lesson plans found on social media that were at higher inquiry levels than they had discussed in Themes 2 and 3 and three found lessons at lower levels, seven of the interviewees discussed lessons at the same inquiry levels as they described as being ideal in Themes 2 and 3. Themes 2 and 3 covered, respectively, what pre-service teachers thought teachers and students ought to be doing during science lessons. In their responses, pre-service teachers voiced specific ideals for what kind of lessons they thought provided the best educational experience.

The pattern in the chart relates to another interesting pattern uncovered in the interviews. Seven of the fourteen pre-service teachers interviewed used social media's variety of easily searchable ideas to find lesson plans and activities that reinforce the preferred teaching methods they discussed in Themes 2 and 3. The teaching methods they preferred usually fit the description of a level one inquiry lesson and sometimes a level two lesson. As previously mentioned, this is to be expected at this point in the pre-service teachers' careers.

When asked what teaching techniques she could be using while teaching her science lessons, Participant 2 mentioned that teachers should give students hands-on lessons and that students need to be using their five senses to fully understand what they are learning. Interestingly, when asked to describe a lesson she had found on social media and implemented in her classes, Participant 2 discussed a sensory-based science lesson that involved hands-on learning.

> [Interviewer: When you think about your lessons, and what the students are doing, can you think back to any of the ideas that you found on social media?] We did one science lesson from Pinterest. They were doing one over teeth, so we soaked eggs in coke, or coffee, and I think the other one was vinegar, and we let it sit out for twenty-four hours.

> The kids got to see and touch and feel how the different eggs reacted to the different (liquids). There were a lot of mixed emotions. It was really fun, though. They were like, 'now we get it' (Interview, Participant 2, 5/11/2015).

Many other pre-service teachers described implementing similar lesson plans. Participant 5 had specific ideas about what teachers needed to be doing in a science lesson:

> [Interviewer: Thinking about yourself as a teacher, what would you be doing during a science lesson?] For science, I really think that interactive modeling is probably the best thing you can do, especially with experiments, so that the students can see how it should be done (Interview Participant 5, 5/14/2015).

When Participant 5 was asked to describe an activity she found on social media that she had implemented in her classroom, the activity she remembered and described involved interactive modeling, her ideal form of teaching science:

> There was one (activity) I did that was demonstrating kinetic energy, and it had the teacher modeling what was going on with a bow and arrow, and the students would watch and write down what they thought was happening. And then the students would take turns doing that. And at the end the teacher would introduce kinetic potential energy (Interview, Participant 5, 5/14/2015).

Participant 11 provided another example of an interviewee having implemented a lesson on social media that resembled their ideal lesson type as described in their Theme 2 and 3 answers. [Interviewer: As a science teacher, what should you be doing as a teacher?] "The teacher needs to do as many hands-on activities to help the students, so that they can remember more and actually learn more" (Interview, Participant 11, 5/13/2015).

When Participant 11 described an activity found on social media that she had implemented in a classroom she described a hands-on activity that requires the students to manipulate objects with their hands to find various solutions to a proposed problem.

> [Interviewer: Thinking about your lesson, is there a specific lesson that you have found on social media that you can describe?] I was doing Kindergarten for my practicum. I had pipe cleaners, and I put ten beads on them and I would show [the students] how to move them so they had five on one side and five on the other side. It was a hands-on way to teach them different ways to count to ten (Interview, Participant 11, 5/13/2015).

Participant 13 believes in self-directed learning. When asked what she ought to be doing when teaching science (Theme 2), she gave an answer at a solid second level of inquiry where students were determining the methods and solutions to a teacher-proposed problem:

> The teacher should be setting up the environment for students to learn, and guiding the lesson, but not doing anything for them. Maybe modeling safety procedures, so that the students are safe, but not necessarily modeling carrying out the procedure. I feel like the students should be able to have a hands-on experience. The teacher is there for the environmental setup and safety (interview, Participant 13, 5/13/2015).

When she described an activity she found on Pinterest, Participant 13 mentioned that her students came up with their own ideas while performing the activity, a second (and possibly third) level inquiry lesson that involves the teacher stepping back:

> [Interviewer: Tell me about the most recent thing that you have found on social media. It could be an activity that you used, or lesson planning.] I did a shape activity back in February. That is the most recent one that I have actually used that I pinned. It was an anchorage art of shapes. In the first column, there were pictures of shapes, and in the

> second column it was name the number of sides and corners. And a column for something this (shape) looks like in real life. I let the students come up with their own ideas (Interview, Participant 13, 5/13/2015).

This is an example of level two approaching on the inquiry scale. Participant 13's Pinterest activity had her setting up an environment for her students to explore on their own with minimal teacher involvement. This matches her ideal form of self-directed learning, which she mentioned in a later interview response.

Pre-service teachers used social media's seemingly unlimited number and variety of lesson plans to find activities that reflect their own teaching ideals. Many of the lessons they describe finding on Pinterest are at a first or second inquiry level, which is consistent with the kinds of lessons they are comfortable with teaching at this point in their careers as students. Social media is thus helping pre-service teachers provide the kind of lessons they believe will best help their students learn. A possible direction for further inquiry into Pinterest's relationship with classroom teaching practices might be to determine whether teachers later in their careers are using Pinterest to "pin" more level three inquiry lessons. Another possible direction would be to ascertain if level three inquiry lessons are available on Pinterest at all, or whether the use of Pinterest might stunt teacher development toward the third inquiry level.

One final finding was the way social media impacted pre-service teachers' attitudes toward their students. Three of the interviewees specifically mentioned articles they found on social media that influenced their holistic approach to relating to their students:

> Last semester, I was really interested in diversity. I didn't realize that wasn't part of everyone's growing up until I got to college, and I noticed that everyone's opinions and conversations were much different than mine. I've definitely found a lot of articles on

> Facebook about diversity and how to incorporate that into the classroom. I saw on Facebook a video about eye color. The teacher did an experiment on how blue eye color was good and brown eye color was bad, and how the students performed. That was really interesting to me and it made me start thinking about how to make learning equitable. (Interview, Participant 7, 5/12/2015).

Another interview participant similarly said she had used Pinterest to search for teaching tips and discovered advice on relating to her students (Mekeel, 2014).

> I found one [article] about building relationships with your students for classroom management on Pinterest. It talked about how to talk to your students, get to know them, get to know each other, and it taught the importance of building those relationships, and I really liked that (Interview, Participant 13, 5/13/2015).

Comparison to Other Studies

In 2003, Horizon Research, Inc. funded a study by Weiss, Pasley, Smith, Banilower, & Heck titled L*ooking Inside the Classroom: A Study of K-12 Mathematics and Science Education in the United States.* The purpose of the study was to provide education research and policy communities with snapshots of math and science education in a variety of US classroom contexts. These snapshots include both the instruction that takes place and the factors that shape that instruction (Weiss et al., 2003).

Part of this study included an adaptation of the same survey instrument originally developed by Horizon Research, Inc. that the present study uses. The instrument is designed to assess the quality of the design and implementation of math and science lessons (Weiss et al., 2003).

The *Inside the Classroom* study visited 31 schools that were generally comparable to schools throughout the nation. They observed teachers and interviewed them in addition to the use of the survey instrument. The study ranked the instruction of the math and science lessons from high to low quality on various scales including lesson design, content, implementation, and classroom culture (Weiss et al., 2003).

The study found that the key factors that distinguished high quality lessons from lessons of low quality are their ability to engage students with the content, create an environment conducive to learning, ensure that all students have access to the lesson and help students make sense of the math and science content. For example, high quality lessons often involved engaging with the content through experiences, real-world examples, or other engaging learning contexts (Weiss et al., 2003).

High quality lessons also included effective teacher questioning to provoke deeper thinking, rather than “yes/no” or fill-in-the-blank answers. Additionally, demonstrations coupled with discussion or writing could promote student sense-making. Indeed, lesson quality seemed to center on the lesson’s ability to help students make sense of the science or math content.

Interviews with teachers asked about factors that might influence the content and instruction in the observed lessons. Content, state, and district-level standards were the most commonly cited influential factor (the content of 7 of 10 science and math lessons in the United States is determined by standards). However, the strategy for delivering the instruction was another matter. Content delivery was dependent on teachers’ beliefs (9 in 10 math and science lessons were delivered in line with teachers’ beliefs about educational strategies). Some teachers favored hands-on lessons while others favored traditional methods. Still others thought repetition and review were important, so they used this delivery method no matter what the state-prescribed content was (Weiss et al., 2003).

Huffman, Goldberg, and Michlin's 2003 study used data from 23 high school physics classes and 13 teachers to examine the extent that computers could be used to help teachers create a constructivist learning environment in the science classroom. The study reported survey responses obtained from three groups of students: those taught by experienced users of the new, computer-based pedagogy; those taught by teachers who were beginner users of the new pedagogy; and students taught by teachers who used only traditional materials. Huffman et al. (2003) assessed the students' experience using a 17-item scale derived from Horizon Research Incorporated (1997). Their scale was similar to that used in the present study.

Although the two studies asked similar questions, it is not possible to compare their results directly with each other. The current study measured teachers' perceptions of how often students should do various activities, while Huffman et al.'s (2003) study measured how often students thought they were engaged in those activities. Nevertheless, it is interesting that the pre-service teachers in the current study aspired to ideals that aligned with the practices of the teachers in Huffman et al.'s study who were most experienced at using the new forms of instruction.

The current study focused on pre-service teachers and could not analyze their students' scores. At first glance, it may appear that the pre-service teachers in the present study had mean scores that were virtually identical to the lead teachers in Huffman et al.'s (2003) study and substantially higher than the other two groups of teachers in Huffman's study. However, since the current study measured teacher perceptions of how often students should do activities while Huffman's measured how often students thought they were doing the same activities, the comparison is imprecise. It is interesting that the pre-service teachers in the current study aspired to ideals that aligned with the practices of the teachers in Huffman's study who were most effective at facilitating science achievement in their students.

Conclusion

This chapter described the qualitative and quantitative findings regarding pre-service teachers' social media use related to instructional methods, particularly in science education. Quantitative results indicated that Pinterest was the social media platform most participants used in a professional context. The professional importance of Pinterest to Early Elementary pre-service teachers was statistically significant.

Qualitative results were gleaned from two sources: semi-structured interviews and survey questions. The survey questions indicated that Pinterest has become a viable online resource for pre-service teachers, and it is used both personally and professionally by half of all survey participants. Pre-service teachers prefer using Pinterest as a resource for inquiry-based lessons over other social media options and over historically used sources like the Learning Resource Center. Pre-service teachers turn to this platform more to find lesson plans than to connect with other professionals or to read publications.

The semi-structured interviews indicate that pre-service teachers' use of social media has moved away from a purely personal, entertainment-based activity and more toward professional use. Responses regarding science education indicate that pre-service teachers favor inquiry instruction, particularly the lower levels of inquiry instruction. They use Pinterest to search for lessons that promote inquiry instruction and implement them in their classrooms.

Chapter 5: Discussion

This study examined how pre-service teachers planned to approach inquiry-based teaching and learning methods, their use of social media as a professional tool, and the relationship between these factors and the grade level they intend to teach. This chapter begins with a brief summary of the study, followed by an overview of the quantitative and qualitative findings. The chapter concludes with a discussion of implications of the findings for postsecondary teacher education and suggestions for future research.

Project Summary

The original intent of this study was to investigate three sorts of social media: Pinterest, Facebook, and Twitter. However, it quickly became apparent that pre-service teachers relied chiefly on Pinterest for their professional activities and used Facebook and Twitter for more personal communications. Therefore, the research evolved to focus on Pinterest, which is reflected in the discussion of the quantitative and qualitative findings.

Overview of Key Findings

Four important findings emerged from the quantitative and qualitative data about pre-service teachers, social media tools, and their views on inquiry-based teaching. First, pre-service teachers seemed to value an inquiry-based approach to teaching and they were using social media as a way to access resources on inquiry-based lessons. They seemed to understand that a traditional, didactic science lesson was not the most effective or desirable way to teach science. Most participants in this study aspired to a form of science education that approached inquiry. They wanted their students actively working on science projects and asking their own questions. Often, this resembled Kim and Kellough's (1994) Level One Inquiry Teaching, where the teacher prescribes the problem and methods, but a student actively explores a scientific concept by collecting data and drawing conclusions. Pre-service teachers in this study both valued inquiry-based lessons for teaching science, and embraced social media as a way to access those inquiry-based resources.

A second key finding is that Pinterest was overwhelmingly the most popular type of social media used professionally by pre-service teachers when compared to Twitter and Facebook. While participants used Facebook and Twitter for more personal communication, or to read articles and education news, the vast majority of participants used a lesson they found on Pinterest. Pre-service teachers often found quality lessons by doing a quick search on Pinterest or relating a lesson to something another educator posted. The idea that pre-service teachers find Pinterest to be useful is echoed in the research literature (e.g., Davidson, 2013; Hamel, 2015; Merkel, 2014; Rayburn, 2014). There are high-value resources posted on social media, which pre-service teachers have recognized and are accessing for inquiry-based lesson building. Importantly, pre-service teachers who planned to teach early-elementary grades felt Pinterest was an important tool for accessing inquiry-based resources, at a statistically significant level above other groups.

Third, all pre-service teachers (not just early elementary) seemed to be turning away from resources such as the Teacher's Resource Library in favor of using social media sites like Pinterest, because they did not offer the same ease and availability of social media sites. The majority of the interviewees indicated that they preferred to search for lesson plans and classroom organizational ideas online, rather than searching the Teacher's Resource Library for similar materials. This finding was important because it highlighted a shift in the kinds of resources pre-service teachers access. Instead of adding social media sites to the repository of resources they access, pre-service teachers were choosing social media-based resources over more traditional resources like the Teacher's Resource Library. Finally, although most participants liked the idea of inquiry-based teaching and learning, in practice they were not actually conducting true inquiry-type activities. They knew inquiry was a best practice and hoped to get closer to inquiry in the future.

In short, this study suggests that pre-service teachers aspire to use inquiry-based techniques; that they identify Pinterest as a useful source to find resources for inquiry-based techniques (especially early elementary pre-service teachers); that they use Pinterest at the expense of other potential sources like the Teacher's Resource Library; but they are simultaneously not quite able to implement these lessons in practice. These findings are important because they improve our understanding of how pre-service teachers interact with and view social media as a resource and because they carry clear implications for how we educate pre-service teachers. Previous research has shown that teachers are increasingly relying on digital media for their own professional development (Vockley & Lang, 2009). Technology has given teachers access to more resources than ever before; however, they may not have received training to best use this technology to enhance student learning (Culp et al., 2005). The findings from this study support the idea of a mismatch between the tools pre-service teachers are using, and the education that is provided to them in a postsecondary setting. The findings of this study support the inclusion of social media in teacher training curricula. Among other things, pre-service teachers should better understand how social media could enhance their inquiry-based teaching activities once they are in the classroom. Postsecondary training on how to use social media may also help pre-service teachers bridge the gap between wanting to use inquiry-based teaching techniques, and actually using them.

This context about pre-service teachers' desires, their postsecondary education and training, and their thoughts about social media as a teaching tool were informed by five important themes that emerged from this research.

Theme 1: Pre-service teachers as social media consumers. Participants in this study reported a change over time in their use of social media. Almost all reported they started their Pinterest account with the intention of personal use, but changed to more professional use over time. This move from the personal to the professional represents both a maturation of the pre-service teachers—most of whom opened their accounts in middle school or high school and who are now looking to launch their professional careers—and also a maturation of social media's use in society in general. As the professional world has become increasingly digital, social media has expanded to support this increased reliance on digital connections with other people (Landsbergen, 2011). Like other professionals, the participants are looking to social media for professional development including lesson plans, classroom management techniques, and community (Vockley & Lang, 2009).

Theme 2: Science teaching as facilitating hands-on learning. The interviews revealed most pre-service teachers in this study had views about teaching that indicated they would teach at a Level One per Kim and Kellough's (1994) framework. They controlled the lesson by defining both the problem and the methods to solve it. This finding was not surprising given that teachers early in their careers commonly default to this more manageable style of lesson. Most participants at least thought inquiry was the best method, but many were not sure exactly how to carry it out in practice (one participant, Emily, thought direct, didactic instruction was best—this was not a typical response). Eleven of the fourteen interview participants fell into Level One on the inquiry scale: they said that “hands-on” learning was important, but did not elaborate on what they meant by “hands on” or give examples.

Four participants approached Level Two Inquiry Teaching. These participants defined the problem to be solved, but allowed the students determine the methods best suited to find a solution. Only one of the pre-service teachers approached Level Three Inquiry Teaching. For instance, this participant said the teacher should step back and allow students to determine methods of answering questions. He also showed reluctance to direct students; instead he suggested that the students should lead the way.

Theme 3: Science learning as active engagement. This theme focused on what students ought to be doing during a science lesson. Here too, most participants described student engagement at Level One on Kim and Kellough’s (1994) inquiry scale. Five interviewees at this level described the “hands-on” type of student involvement in lessons without clear descriptions of what the students should be learning with their hands. Four additional interviewees approached Level Two inquiry by adding the concept that students should be “asking their own questions” or “making mistakes” to the notion of “active engagement.” This indicated openness to allowing students to control more of the process. There were two Level Two responses where the interviewees mentioned specific plans to facilitate the desired “engaged” student learning. Two additional interviewees’ responses indicated they were at Level Two, approaching Level Three; they mentioned that students should be open to changing their opinions and that teachers must create a safe environment for students to explore the problem on their own. One respondent said that “active engagement” meant students were paying attention and taking notes. This response does not reflect any specific level of inquiry.

Notably, ten of the fourteen interview participants reflected either traditional didactic or a largely discredited student-led education strategy called “Discovery Learning” (Furtak et al., 2012; Minner et al., 2010). It is important to encourage pre-service teachers to move to higher levels because inquiry, unlike either didactic or Discovery Learning instructional methods, has been shown in studies to be effective (Furtak et al., 2012).

Theme 4: Enhancing professional development and networking through social media. Interview participants preferred social media over traditional library resources for finding lesson planning resources. Participants preferred the convenience of being able to search for lessons anywhere at any time and better organization for searching. Eight participants also mentioned the great variety of lesson planning materials available online.

The harmony between Themes 1 and 4 emphasized the growing importance of social media to the teaching profession and signals a need for teaching colleges to guide students in their effective utilization. This need was echoed in the literature (Culp et al., 2005) and became more apparent as the participants mentioned differences in perceived reliability for traditional library sources versus online resources. Some participants mentioned that the validity of online resources could not always be trusted, while others expressed concern that library resources could be out of date, biased, or lack advice from teachers who had personally implemented the lesson plans.

Theme 5: Relationship between teaching methods and the use of social media. Finally, the interviews revealed a link between preservice teachers’ social media use and their views on inquiry teaching practices. All but one of the pre-service teachers interviewed had used social media to find lesson plans. Many of the lessons they described finding involved the kind of “hands-on” or “active engagement” lessons that they had described as their opinion of an ideal science lesson.

These results indicated that pre-service teachers used social media to search for lessons that reflected their own teaching ideals. If they stated that they valued “hands on” learning, most often they searched Pinterest for lessons that had students carrying out procedures by hand. If they mentioned that students should use their “five senses,” most often those teachers searched for lessons on Pinterest that required students to collect data with their senses. This finding points again to a need for teachers’ colleges to incorporate social media use training into the curriculum.

In summary, this study found considerable evidence that pre-service teachers were committed, at least in principle, to inquiry-based learning, although it also found that most teachers had difficulty implementing inquiry-based learning and often did so at only the most basic level. Additionally, it found that these teachers made use of social media, especially Pinterest, to find classroom activities consistent with inquiry-based learning. Whether helping pre-service teachers become more adept at using social media professionally could facilitate inquiry-based teaching and learning remains to be seen.

Implications for Teacher Education

Much of the data gathered in this study pointed to two ideas. First, teacher education programs in universities and colleges should plan instruction around social media use for classroom purposes. As technology changes, so should pedagogy expand to match the new available tools that teachers will encounter. Second, when it comes to science instruction, teacher colleges should make every effort to help pre-service teachers learn how to teach using science as inquiry. Students should become confident and comfortable enough with inquiry to critically examine any lesson plans they find, whether through traditional methods, online social media, or other emerging technologies. Without a firm grasp of science as inquiry, teachers will not be able to select or effectively communicate science lessons.

Previous literature has suggested that teachers' education is designed to prepare students to live and work in an increasingly global society (Wood, 2005), in which technology and social media play a vital and expanding role. On the surface, we know pre-service teachers 1) are using social media and 2) know inquiry is a good approach. What is needed is an understanding of how this can be implemented into teacher education programs to increase pre-service teachers' understanding and use of inquiry as well as effective ways to use social media to facilitate inquiry instruction.

Research has shown that teachers increasingly rely on digital media for their own professional development (Vockley & Lang, 2009). This project overwhelmingly showed that pre-service teachers use social media—particularly Pinterest—to find resources. Teachers now have more resources available than ever; however, they might not have received the training to best use this technology to enhance student learning (Culp et al., 2005). Pre-service teachers use Pinterest and other types of social media to find lesson plans and classroom organization ideas. A question that remains is: how do professors at a university level respond to this changing environment?

The findings of this study support awareness and inclusion of the use of social media in teacher education curriculum; this requires an understanding of how pre-service teachers utilize this technology. More importantly, teachers should acquire a better understanding of how the use of social media relates to their planned approach to using inquiry activities for teaching and learning in the classroom. This will allow for a more modern education program that reaches more students on their level.

Pinterest is currently the social media platform of choice for finding lesson plans, but that could change in the future. It is less important for teacher colleges to provide specific instruction on the use of Pinterest than it is for them to provide instruction on properly vetting lesson plans for effectiveness and usefulness in teaching science as inquiry. To do this, it is most important for schools of education to provide pre-service teachers with more instruction on inquiry-based learning, so they can examine lesson plans critically in light of this method and implement them effectively.

Implications for Future Research

This study was designed to examine how pre-service teachers use social media and how it relates to inquiry teaching and student learning. Like other professionals-in-training, pre-service teachers had ideas about the best way to do their jobs, even though they lacked professional teaching experience (outside of supervised teaching as part of their degree program). Therefore, their ideas about optimal strategies were untested at the time of the survey. Future research studies should consider using participants who have been teaching, since the survey measures usage of classroom activities and strategies. This will allow future researchers to measure social media's actual impact on real classroom practices rather than on the hypothetical future classrooms of pre-service teachers.

One of this study's findings of note was that while pre-service teachers valued inquiry and understood that inquiry led to more effective student learning of science, they did not seem to understand inquiry well enough to implement it effectively in a classroom. The interviews mentioned active engagement and hands-on learning, but there was no concrete bridge between these learning activities and students' understanding of science. This quirk of inquiry teaching is not a new finding and echoes the concerns of previous educational theory. Furtak et al. (2012) voiced concern that teachers suppose they are teaching science as inquiry when in fact they are merely stepping back while "students engage in self-guided, hands-on activities of dubious value" (Furtak et al. p 301). Past research suggests that this lack of understanding is not limited to pre-service teachers or teachers early in their careers. Even the *Looking Inside the Classroom* study, which measured the quality of science lessons across US classrooms, deemed the hands-on lessons to be the lessons of highest quality with no further conditions on them other than that students were taking an active role in the classroom (Weiss, 2003).

It is important for future research to examine why these early career teachers aren't using inquiry methods and potential obstacles they face in teaching true inquiry. It seems an interesting problem to solve: pre-service teachers like the idea of inquiry and recognize that inquiry is important, but do not perform inquiry-based teaching in the classrooms. Potential obstacles could include a lack of training, a high student to teacher ratio, a lack of adequate lesson planning resources, the diversity of ability among their students, and a lack of confidence in the process of inquiry. It is vital to the training of future teachers to determine the challenges to teaching science as inquiry and determine why there is a gap between idea and practice.

Additionally, further research could also explore the translation of research best practices regarding inquiry instruction into practice in the classroom. Teachers could be given lesson plans and curricula that align with inquiry best practices as described by Kim and Kellough (1995), Furtak et al.'s epistemic, social, and procedural inquiry, or other validated inquiry-based teaching theory. Then, barriers to implementation could be assessed. Future research should consider developing measurements both of the depth of inquiry teaching and students' understanding relating to the lesson taught.

One of the challenges to implementing effective science teaching in the classroom identified by the *Looking Inside the Classroom* study (Weiss, 2003) was the diversity of student ability both across classrooms and within the same classroom. Part of the promise of social media is its offering of individualized education and lesson plans available to teachers at their convenience (Scheffer, 2012). Using online lesson plans and communities, teachers can find a variety of resources that can address their individual classroom situations—including classrooms with students who have a diversity of special learning needs (Scheffer, 2012). Future research could involve a quasi-experimental study that compare educators who use social media to those who do not in an attempt to ascertain if these groups teach differently from one another and if one group is more effective than the other at teaching inquiry to students with varying learning needs. The contemporary research literature on this topic does not feature studies that have determined and described differences in the teaching methods of teachers who use social media and those who do not. Further distinctions could be made between those teachers who specifically make use of social media in their classrooms to those who do not, depending on whether they use social media at all or whether they only use social media in non-professional contexts.

Another avenue of research that could prove beneficial is focusing on Kim and Kellough's (1995) three levels of inquiry as they apply to science lessons at specific grade levels. A study of this kind might involve surveying and interviewing either elementary school teachers or high school teachers in order to ascertain what true inquiry looks like at these grade levels and how difficult true inquiry is to implement at varying grade levels.

One possible avenue of exploration into inquiry as it relates to grade level is the relationship between grade level and teachers' use of creative social media sites like Pinterest. This study found that teachers who aspired to teach early elementary found Pinterest to be important, so further research could investigate the reasons these groups use the platform more than the other teachers. It may have something to do with the types of activities—Pinterest provides a plethora of appealing ideas that are well suited to early education. Early elementary teachers are still doing task analysis to measure student knowledge. Another reason could be the breadth and depth of content knowledge—early education teachers have to teach a mixture of almost all subjects (excluding special courses such as physical education and music), whereas upper elementary, middle school, and high school teachers are more subject-based and have a deeper knowledge of a specific subject, like biology. A middle school teacher can focus on teaching biology, for example, after developing a deep knowledge of and confidence with the subject, while an early elementary school teacher may have had minimal formal biology instruction and must instead teach biological principles in conjunction with spelling, mathematics, or reading skills. Additionally, a biology teacher has access to specific curricula at grade level, but an elementary school teacher might not have lesson plans available through traditional sources that would be helpful to their specific classroom. Previous research (Keys and Bryan, 2000) has discussed how students at higher grade levels can perform deeper inquiry-based learning activities and how inquiry-based teaching requires students to think in complicated ways and to carry out complex assignments. Examples of this higher-order thought could include developing hypotheses, planning and conducting experiments, recording data and explaining their results. Furthermore, the higher-grade levels are more likely to be taught teachers who specialize in science, whereas the early elementary grades are more likely to include those who teach multiple subjects. For both of these reasons, it seemed plausible to imagine that pre-service teachers who teach science in the higher grades would engage more in inquiry activities.

The *Looking Inside the Classroom* study found that state and district curricula requirements are one of the biggest influences on the lessons that teachers will actually implement in the classroom (Weiss, 2003). Future research could examine curriculum requirements alongside the lessons that early elementary educators find on creative social media sites like Pinterest to determine whether there is overlap between requirements and social media lessons implemented.

Another idea for future research is to follow-up with the interview participants and examine what type of teachers they actually became in the classroom. A follow up study could ascertain if they grow into using inquiry–based teaching methods, since this study found that they planned to do so prior to launching into their actual teaching careers. For those who are using inquiry-based methods, the research could seek to learn how often they use them and how they implement this kind of instruction. If not, the research could focus on barriers to inquiry that prevent teachers from implementing the kind of instruction they aspired to when they were college students.

One theme uncovered in this study was how pre-service teachers moved from a purely personal use of social media toward a more professional use. This evolving use of social media could be explored by studying social media usage after the first few years of a professional teaching career. Kim and Kellough (1997) posited that teachers' implementation of inquiry matures over their careers and Valazza (2011) suggests that professional development, feedback, and community formed through social media help teachers gain confidence to meet new challenges. Future research could examine whether and how professional social media usage matures as well. This could be done by examining whether teachers tend to use more inquiry-based teaching methods the more experienced they are (and thus, the more comfortable they get with classroom management and the flow of content through the school year). This type of follow up research could look into whether and how they are seeking to incorporate more ambitious ideas to improve student experiences in their classroom. It would also be interesting to explore any teacher transitions from didactic instruction to inquiry. For those who transitioned, what can they articulate about this transition (how it came about, what resources facilitated that shift, etc.)?

Conclusion

As different forms of social media continue to proliferate and expand in scope, they offer more ways to communicate ideas, more ways to search for relevant content, and more ways to store content electronically than ever before. Research and trends indicate that social media play a growing role in many professions. The teaching profession is no exception to this trend. Through social media platforms, teachers are finding ways to connect, share information, and find ideas to implement in their classrooms. This study focused on three popular platforms—however, it is important to keep in mind that specific platform popularity changes over time. Additionally, the type of content posted to social media platforms matures as its users mature. In examining teachers' professional use of sites—such as Pinterest and the lesson sharing site Teachers Pay Teachers—it becomes evident that online content is increasingly important to the teaching profession. Social media holds a great deal of promise for more effective teaching, as active and passionate communities of educators collaborate by curating and sharing content. By commenting, reviewing, posting new lessons, and sharing posts, for example, educators will be able to become co-contributors to the very curricula that they teach. This has promising implications for the implementation of new and effective methods, such as Inquiry-based teaching.

Teachers can feel isolated while teaching their respective grade levels or subject areas; they often feel like they lack guidance on how to take their teaching to the next level, or lack mentors or peers who can give advice when they are facing a challenge. The future of social media in education may offer part of a solution. Teachers immersed in a professional online community, all passionately dedicated to education, will be able to find support, tips, and resources in order to achieve their own goals for their students' learning.

Teachers are drawn to inquiry-based instruction. They understand that it is an effective way for students to learn, and teachers are passionate about their students' learning. With an effective and dynamic community that updates and shares current practices, teachers will be more empowered to teach inquiry and incorporate other best practices.

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Appendix A

Survey Permission Form

Dear Pre-Service Teacher,

You have been selected to participate in a study designed to understand more about the use of social media (Facebook, Twitter, Pinterest, etc.) as an instructional tool in Midwestern elementary and middle school classrooms. Within the next month, I will send you a survey by e-mail, which asks you information about your use of social media and about your classroom instructional practices. On the survey, there are no questions dealing with private or personal matters.

The survey is part of my dissertation research in the University of Kansas School of Education. The information that you provide will be used in my research and the results will help guide course design and support of student teachers. You should be able to complete the survey in 15-20 minutes.

Your responses to this survey are confidential and available only to the researchers, Bria Klotz and Douglas Huffman, University of Kansas. Your participation is voluntary and you may skip any question that you don't want to answer. You may participate anonymously; however, if you are willing to be contacted for a follow-up interview, you may include your email address at the end of the study. This information will be used only to contact you and then it will be removed from the dataset and will not be stored. Published reports of the research will not refer to the actual name of any school or specific individual participating in the study.

There is no foreseeable risk to you. While I do not anticipate that you will experience immediate or personal benefits from participating, your answers will help better understand how teachers are using social media for educational purposes.

By completing this survey and submitting it, you indicate that you understand that the data will be used for research purposes and that you are allowing the researchers, Bria Klotz and Douglas Huffman, to use your data in her study. If you have further questions about this survey or the research project, please contact Bria Klotz (bklotz@ku.edu) or the Human Subjects Committee at the University of Kansas (irb@ku.edu).

Information Statement

The Department of Curriculum and Teaching at the University of Kansas supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You should be aware that even if you agree to participate, you are free to withdraw at any time without penalty.
We are conducting this study to better understand how social media is used in education. This will entail your completion of a survey. Your participation is expected to take approximately 10-

15 minutes to complete. The content of the survey should cause no more discomfort than you would experience in your everyday life.

Although participation may not benefit you directly, we believe that the information obtained from this study will help us gain a better understanding of social media in an educational setting. Your participation is solicited, although strictly voluntary. Your name will not be associated in any way with the research findings. Your identifiable information will not be shared unless you give written permission. If you wish to participate in an interview, you will be asked to provide your name and contact information at the end of the survey. If you do not provide your name and contact information, you will remain anonymous. It is possible, however, with Internet communications, that through intent or accident someone other than the intended recipient may see your response.

If you would like additional information concerning this study before or after it is completed, please feel free to contact us by phone or mail.

Completion of the survey indicates your willingness to take part in this study and that you are at least 18 years old. If you have any additional questions about your rights as a research participant, you may call (785) 864-7429 or write the Human Subjects Committee Lawrence Campus (HSCL), University of Kansas, 2385 Irving Hill Road, Lawrence, Kansas 66045-7563, email irb@ku.edu.

Sincerely,

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Appendix B

Survey Questions

Dear Pre-Service Elementary Teacher:

The purpose of this survey is to learn about the nature of instruction and your views of teaching. The survey asks for your best estimates of the frequency of selected activities and for your candid opinions on aspects of school. We recognize that in some circles, certain responses may be considered more "socially desirable" than others, but hope that you will not let this influence your answers. There are no questions dealing with private or personal matters that would put any teacher at risk. It can usually be completed in 10-15 minutes.

Many thanks for your help!

Today's Date: ________________________

Initials (*please print)*___________________

Date of Birth:_________________________

Demographic

Q1. What is your gender?

- Male
- Female

Q2. What year were you born?

Q3. What is your current grade in your college course: Science in the Elementary Classroom?

- A
- B
- C
- D
- F

Q4. Typical Grades in High School Science Courses:

- Mainly A’s
- Mainly A’s and B’s
- Mainly B’s
- Mainly B’s and C’s
- Mainly C’s

Q5. Typical Grades in ALL High School Courses:

- Mainly A’s
- Mainly A’s and B’s
- Mainly B’s
- Mainly B’s and C’s
- Mainly C’s

Q6. As a pre-service teacher, how many years have you worked with children in an educational setting (practicum field experiences, etc.)?

- Less than 1 year
- 1-2 years
- 3-4 years
- 4-5 years
- More than 5 years

Q7. What grade(s) do you plan to teach? (K-12)

Q8. What year of school are you currently?

- Freshman
- Sophomore
- Junior

- Senior
- Graduate Student

Q9. Where do you attend school? (City, State, School Name)

Q10. What is the highest degree you plan to earn?

- Associate Degree
- Bachelor's Degree
- Master's Degree
- Doctorate

Q11. Which of these categories best describes you? (choose one)

- American Indian
- Asian or Pacific Islander
- Black/African American
- Hispanic
- White, non-Hispanic
- Multiethnic
- Other

Pinterest

Q12. Do you have a Pinterest Account?

- Yes
- No

Q13. How many years have you had the Pinterest account?

- Less than 1 year
- 1-2 years

- 2-3 years
- 3-4 years
- 4-5 years

Q14. What percent of your overall time on Pinterest is for professional use (lesson planning, classroom ideas, etc.)? What percent of your overall time is for personal use (house decorating, baking, home repair, etc.)? Will add up to 100% total.

- Pinterest professional use:
- Pinterest personal use:
- Total:

Q15. Do you have more than one Pinterest account?

- Yes
  - Briefly explain why you keep multiple Pinterest accounts.
- No

For the following questions, please answer about the account that you consider most "professional." If you keep multiple professional accounts, answer about the account you use most.

Q16. How many followers do you have on Pinterest? (available on your profile page)

Q17. How many people do you follow on Pinterest? (available on your profile page)

Q18. Approximately how much time do you spend on Pinterest each day?

- Less than 30 minutes
- 31-60 minutes
- Over an hour each day

Q19. On average, how frequently do you check Pinterest?

- Continuously runs in the background
- Several times a day
- Once a day
- A few times a week
- Once a week
- Less than once a week

Q20. How frequently do you pin to your boards?

- Several times a day
- Once a day
- A few times a week
- Once a week
- Less than once a week

Q21. What devices do you use to access Pinterest?

- Cell phone
- iPad/tablet
- Laptop
- Desktop
- Other

Q22. How many FOLLOWERS do you have on Pinterest?

- Less than 99 followers
- 100-200 followers
- 201-300 followers

- 301-400 followers
- More than 400 followers

Q23. How many people do YOU FOLLOW on Pinterest?

- Less than 99 followers
- 100-200 followers
- 201-300 followers
- 301-400 followers
- More than 400 followers

Q24. Briefly describe why you use Pinterest:

Q25. How would you characterize your Pinterest use?

- Exclusively personal
- Mostly personal
- A mix of personal and professional
- Mostly professional
- Exclusively professional

Q26. When you pin on Pinterest, how often do you share information for the benefit of the following audiences?

- Other Pre-Service Teachers:
    - Never
    - Less than once a month
    - Once a month
    - 2-3 times a month
    - Once a week

- ○ 2-3 times a week
- ○ Daily

- In-Service Teachers:
  - ○ Never
  - ○ Less than once a month
  - ○ Once a month
  - ○ 2-3 times a month
  - ○ Once a week
  - ○ 2-3 times a week
  - ○ Daily
- Personal Friends/Acquaintances:
  - ○ Never
  - ○ Less than once a month
  - ○ Once a month
  - ○ 2-3 times a month
  - ○ Once a week
  - ○ 2-3 times a week
  - ○ Daily

Q27. Do you follow other pre-service teachers on Pinterest?

- Yes
- No

Q28. If you answered 'Yes' in Q27, how many?

- Less than 10 pre-service teachers

- 10-19 pre-service teachers
- 20-29 pre-service teachers
- 30-39 pre-service teachers
- more than 40 pre-service teachers

Q29. Do other pre-service teachers follow you on Pinterest?

- Yes
- No

Q30. If you answered 'Yes' in Q29, how many?

- Less than 10 pre-service teachers
- 10-19 pre-service teachers
- 20-29 pre-service teachers
- 30-39 pre-service teachers
- more than 40 pre-service teachers

Q31. Do you follow any education-related publications on Pinterest? If so, list them below.

Q32. How important is Pinterest as a resource for your inquiry-based activities?

- Unimportant
- Of little importance
- Moderately Important
- Important
- Very Important

Facebook

Q33. Do you have a Facebook account?

- Yes

- No

Q34. How many years have you had the Facebook account?

- Less than 1 year
- 1-3 years
- 4-6 years
- 7-9 years
- 10 or more years

Q35. Approximately how much time do you spend on Facebook each day?

- Less than 30 minutes each day
- 31-60 minutes
- More than an hour each day

Q36. How many friends do you have on Facebook?

- Less than 99 friends
- 100-200 friends
- 201-300 friends
- 301-400 friends
- more than 400 friends

Q37. What percent of your time on Facebook is for professional use (connecting with other professionals, reading education-related articles, sharing classroom ideas, etc.)? What percent is for personal use (sharing personal pictures, chatting with friends, etc.)? Will add up to 100% total.

- Facebook Professional Use:
- Facebook Personal Use:
- Total:

Q38. Do you have more than one Facebook account?

- Yes
    - Briefly Explain why you keep multiple accounts on Facebook.
- No

For the following questions, please answer about the account that you consider most "professional." If you keep multiple professional accounts, answer about the account you use most.

Q39. How many followers do you have on Facebook? (available on your profile page)

Q40. How many people do you follow on Facebook? (available on your profile page)

Q41. On average, how frequently do you check Facebook?

- Continuously runs in the background
- Several times a day
- Once a day
- A few times a week
- Once a week
- Less than once a week

Q42. How frequently do you post?

- Several times a day
- Once a day
- A few times a week
- Once a week
- Less than once a week

Q43. What devices do you use to access Facebook?

- Cell phone
- iPad/tablet
- Laptop
- Desktop
- Other

Q44. Briefly describe why you use Facebook.

Q45. How would you characterize your Facebook use?

- Exclusively personal
- Mostly personal
- A mix of personal and professional
- Mostly professional
- Exclusively professional

Q46. When you post on Facebook, how often do you share information for the benefit of the following audiences?

- Other Pre-Service Teachers:
    - Never
    - Less than once a month
    - Once a month
    - 2-3 times a month
    - Once a week
    - 2-3 times a week
    - Daily
- In-Service Teachers:

- Never
- Less than once a month
- Once a month
- 2-3 times a month
- Once a week
- 2-3 times a week
- Daily

- Personal Friends/Acquaintances:
  - Never
  - Less than once a month
  - Once a month
  - 2-3 times a month
  - Once a week
  - 2-3 times a week
  - Daily

Q47. Do you follow other pre-service teachers on Facebook?

- Yes
- No

Q48. If you answered 'Yes' in Q47, how many?

- Less than 10 pre-service teachers
- 10-19 pre-service teachers
- 20-29 pre-service teachers
- 30-39 pre-service teachers

- more than 40 pre-service teachers

Q49. Do other pre-service teachers follow you on Facebook?

- Yes
- No

Q50. If you answered 'Yes' in Q49, how many?

- Less than 10 pre-service teachers
- 10-19 pre-service teachers
- 20-29 pre-service teachers
- 30-39 pre-service teachers
- more than 40 pre-service teachers

Q51. Do you follow any education-related publications on Facebook? If so, list them below.

Q52. If you have conversations with other pre-service teachers on Facebook, what is included in your conversations?

Q53. Do you share education-related information on Facebook, such as links? If so, describe what you share.

Q54. How important is Facebook as a resource for your inquiry-based activities?

- Unimportant
- Of little importance
- Moderately Important
- Important
- Very Important

Twitter

Q55. Do you have a Twitter account?

- Yes
- No

Q56. How many years have you had the Twitter account?

- Less than one year
- 1-2 years
- 3-4 years
- 5-6 years
- 7 or more years

Q57. Approximately how much time do you spend on Twitter each day?

- Less than 30 minutes each day
- 31-60 minutes
- More than an hour each day

Q58. How many people are you FOLLOWING on Twitter?

- Less than 99 people
- 100-200 people
- 201-300 people
- 301-400 people
- more than 400 people

Q59. How many FOLLOWERS do you have on Twitter?

- Less than 99 people
- 100-200 people
- 201-300 people
- 301-400 people

- more than 400 people

Q60. Do you have more than one Twitter account?

- Yes
- No

Q61. Briefly explain why you keep multiple accounts.

For the following questions, please answer about the account that you consider most "professional." If you keep multiple professional accounts, answer about the account you use most.

Q62. How many followers do you have on Twitter? (available on your profile page)

Q63. How many people do you follow on Twitter? (available on your profile page)

Q64. What percent of your time on Twitter is for professional use (connecting with professionals, reading education news, etc.)? What percent is for personal use (sports stats, shopping, etc.)? (should add up to 100%)

- Twitter Professional Use:
- Twitter Personal Use:
- Total:

Q65. On average, how frequently do you check Twitter?

- Continuously runs in the background
- Several times a day
- Once a day
- A few times a week
- Once a week
- Less than once a week

Q66. How frequently do you usually post on Twitter?

- Several times a day
- Once a day
- A few times a week
- Once a week
- Less than once a week

Q67. What devices do you use to access Twitter?

- Cell phone
- iPad/tablet
- Laptop
- Desktop
- Other

Q68. Briefly describe why you use Twitter.

Q69. How would you characterize your Twitter use?

- Exclusively personal
- Mostly personal
- A mix of personal and professional
- Mostly professional
- Exclusively professional

Q70. When you post on Twitter, how often do you share information for the benefit of the following audiences?

- Other Pre-Service Teachers:
    - Never

    - Less than once a month
    - Once a month
    - 2-3 times a month
    - Once a week
    - 2-3 times a week
    - Daily
- In-Service Teachers:
    - Never
    - Less than once a month
    - Once a month
    - 2-3 times a month
    - Once a week
    - 2-3 times a week
    - Daily
- Personal Friends/Acquaintances:
    - Never
    - Less than once a month
    - Once a month
    - 2-3 times a month
    - Once a week
    - 2-3 times a week
    - Daily

Q71. Do you follow other pre-service teachers?

- Yes
- No

Q72. If you answered ‘Yes’ to Q71, how many?

- Less than 10 pre-service teachers
- 10-19 pre-service teachers
- 20-29 pre-service teachers
- 30-39 pre-service teachers
- more than 40 pre-service teachers

Q73. Do other pre-service teachers follow you on Twitter?

- Yes
- No

Q74. If you answered ‘Yes’ to Q73, how many?

- Less than 10 pre-service teachers
- 10-19 pre-service teachers
- 20-29 pre-service teachers
- 30-39 pre-service teachers
- more than 40 pre-service teachers

Q75. Do you follow any education-related publications on Twitter? If so, list them below.

Q76. Do you connect with other pre-service teachers on Twitter? If so, what is included in your conversations?

Q77. Do you share information on Twitter, such as links? If so, describe what you share.

Q78. How important is Twitter as a resource for your inquiry-based activities?

- Unimportant

- Of little importance
- Moderately Important
- Important
- Very Important

Other Types of Social Media

Q79. Have you ever used any of the following as part of a lesson?

- Wiki
- Blog
- Twitter
- Facebook
- Social Media

Q80. Please list the other types of social media you've used.

Q81. On an average day, how often do you access the following sites? (Check one for each item.)

- Facebook:
    - Never
    - Less than once a month
    - Once a month
    - 2-3 times a month
    - Once a week
    - 2-3 times a week
    - Daily
- LinkedIn:

  - Never
  - Less than once a month
  - Once a month
  - 2-3 times a month
  - Once a week
  - 2-3 times a week
  - Daily
- Blogs:
  - Never
  - Less than once a month
  - Once a month
  - 2-3 times a month
  - Once a week
  - 2-3 times a week
  - Daily
- Your own sites, where others write comments (e.g., your own blog):
  - Never
  - Less than once a month
  - Once a month
  - 2-3 times a month
  - Once a week
  - 2-3 times a week
  - Daily

- Wikipedia:
  - Never
  - Less than once a month
  - Once a month
  - 2-3 times a month
  - Once a week
  - 2-3 times a week
  - Daily

Science Teaching and Learning

Q 82. To be good at science at school, how important do you think it is for students to…

	Not Important	**Somewhat Important**	**Very Important**
Remember Scientific Procedures:			
Think in a sequential and procedural manner:			
Understand science concepts, principles, and strategies:			
Be able to think creatively:			
Understand how science is used in real world settings:			
Be able to provide reasons to support their solutions:			

Q83. To what extent do you agree or disagree with each of the following statements?

	Strongly Agree	Agree	Disagree	Strongly Disagree
Science is primarily an abstract subject:				
Science is primarily a formal way of representing the real world:				
Science is primarily a practical and structured guide for addressing real situations:				
If students are having difficulty, an effective approach is to give them more practice by themselves during the class:				
Some students have a natural talent for science and others do not:				
More than one representation (picture, concrete material, symbol set, etc.) should be used in teaching a science topic:				
A liking for and understanding of students are essential for teaching science:				

Q84. In science lessons, how often do you think students should do the following?

	Never or Almost Never	Some Lessons	Most Lessons	Every Lesson
Explain the reasoning behind an idea:				
Represent and analyze relationships using tables, charts, or graphs:				
Work on problems for which there is no immediate obvious method of solution:				
Have conversations about the subject matter that last for five minutes or more:				
Organize, interpret, evaluate, and use information, instead of trying to remember or reproduce it:				

Q85. In a typical month of lessons for a science class, what percentage of time do you think should be spent on each of the following activities? (The 8 items should total 100%)

Administrative Tasks:
Homework Review:
Lecture-style Presented by Teacher:
Teacher-Guided Student Practice:
Re-teaching and clarification of content/procedures:
Student independent practice:
Tests and quizzes:
Other:
Total:

Q86. About how often do you believe that each of the following teaching techniques should be used when teaching science?

	Never	Rarely (e.g. a few times)	Sometimes (e.g. every other week)	Often (e.g., once or twice a week)	All or almost all science lessons
Introduce content through formal presentation:					
Demonstrate a science-related principle or phenomenon:					
Teach science using real-world contexts:					
Arrange seating to facilitate student discussion:					
Use open-ended questions:					
Require students to supply evidence to support their claims:					
Encourage students to explain concepts to one another:					
Encourage students to consider alternative explanations:					
Allow students to work at their own pace:					
Help students see connections between science					

	Never	Rarely (e.g. a few times)	Sometimes (e.g. every other week)	Often (e.g., once or twice a week)	All or almost all science lessons
and other disciplines:					
Use assessment to find out what students know before or during a unit:					
Embed assessment in regular class activities:					
Assign science homework:					
Read and comment on the reflections students have written in their notebooks or journals:					

Q87. About how often do you think students should take part in each of the following types of activities in a science class?

	Never	Rarely (e.g. a few times)	Sometimes (e.g. every other week)	Often (e.g., once or twice a week)	All or almost all science lessons
Formulate a science explanation:					
Do hands-on activities to test different science explanations:					
Record, represent, and/or analyze data:					
Write explanations about what was observed and why it happened:					
Debate different science explanations:					
Discuss the nature of science:					
Assess the quality of their own work:					

Q88. About how often do you think students should take part in each of the following types of activities?

	Never	Rarely (e.g. a few times)	Sometimes (e.g. every other week)	Often (e.g., once or twice a week)	All or almost all science lessons
Participate in student-led discussions:					
Participate in discussions with the teacher to further science understanding:					
Work in cooperative learning groups:					
Make formal presentations to the class:					
Read from a science textbook in class:					
Read other (non-textbook) science-related materials in class:					
Answer textbook/worksheet questions:					
Review homework/worksheet assignments:					

	Never	**Rarely (e.g. a few times)**	**Sometimes (e.g. every other week)**	**Often (e.g., once or twice a week)**	**All or almost all science lessons**
Work on solving a real-world problem:					
Share ideas or solve problems with each other in small groups:					
Engage in hands-on science activities:					
Follow specific instructions in an activity or investigation:					
Design or implement their own investigation:					

Q89. About how often do you think students should take part in each of the following types of activities?

	Never	**Rarely (e.g. a few times)**	**Sometimes (e.g. every other week)**	**Often (e.g., once or twice a week)**	**All or almost all science lessons**
Work on science models or simulations:					
Work on extended science investigations or projects (a week or more in duration):					
Record, represent, and/or analyze data:					
Write reflections in a science notebook or journal:					
Prepare written science reports:					
Use science as a tool in problem-solving:					
Use Calculators:					
Use computers for modeling and simulations:					

	Never	Rarely (e.g. a few times)	Sometimes (e.g. every other week)	Often (e.g., once or twice a week)	All or almost all science lessons
Use the Internet:					
Use electronic journals or bulletin boards:					
Work on portfolios:					
Take short answer tests (e.g., multiple choice, true/false, fill-in-the-blank):					
Take tests requiring open-ended responses (e.g., descriptions, explanations):					
Engage in performance tasks for assessment purposes:					

Q90. How much do you agree with each of the following statements about learning science?

	Disagree A Lot	**Disagree A Little**	**Agree A little**	**Agree A Lot**
I usually do well in science:				
I would like to take more science in school:				
Science is more difficult for me than for many of my classmates:				
I enjoy learning science:				
Science is not one of my strengths:				
I learn things quickly in science:				
Science is boring:				
I like science:				

Appendix C

Interview Questions

The following represents a list of questions posed to the fourteen participants in the oral interview. Since the questions were asked in the context of a dynamic conversation, the following list provides an outline of the interview. The wording of questions during live interviews may have differed slightly or there may have been follow up questions based on a participant's answer.

1. What brings you to the school of education?
2. When you graduate, what grade do you plan to teach and why?
3. When did you start using Twitter, Facebook, and Pinterest?
4. Do you use any social media sites professionally? If so, which ones?
5. How do you use social media sites professionally? To connect with other pre-service teachers or get lesson ideas?
6. How has your social media use changed over time?
7. What is the most recent idea that you found on social media that you used for a lesson or activity?
8. What are the pros and cons of using the traditional method of going to the LRC for information vs. using social media?
9. As a teacher, what should you be doing during a science lesson?
10. What should students be doing during a science lesson?
11. Can you think of a publication or article you read on a social media site related to education or that helped you develop a lesson?
12. Tell me about another activity you found on social media.

Appendix D

Survey Results

When you pin on Pinterest, how often do you share information for the benefit of other pre-service teachers?

	Frequency	Percent
Never	36	32.4
Less than once a month	24	21.6
Once a month	10	9.0
2-3 Times a Month	8	7.2
Once a week	5	4.5
2-3 Times a Week	13	11.7
Daily	4	3.6
Missing	11	9.9
Total	113	100

When you pin on Pinterest, how often do you share information for the benefit of other In-service teachers?

	Frequency	Percent
Never	44	39.6
Less than once a month	24	21.6
Once a month	5	4.5
2-3 Times a Month	8	7.2
Once a week	6	5.4
2-3 Times a Week	8	7.2
Daily	4	3.6
Missing	12	10.8
Total	113	100

How important is Pinterest as a resource for your inquiry-based activities?

	Frequency	Percent
Unimportant	5	4.5
Of Little Importance	24	21.6
Moderately Important	41	36.9
Important	20	18.0
Very Important	11	9.9
Missing	10	9.0
Total	113	100

Appendix E

Teaching Factor Tables

Table E1

Communalities

	Initial	Extraction
Q7	.37	.84
Q8	.55	.67
Q9	.39	.25
Q10	.36	.96
Q11	.24	.25
Q12	.20	.13
Q13	.56	.65
Q27	.17	.07
Q28	.50	.64
Q29	.54	.50
Q30	.53	.53
Q31	.59	.54
Q32	.73	.72
Q33	.77	.78
Q34	.63	.71
Q35	.44	.42
Q36	.67	.58
Q37	.56	.60
Q38	.60	.77
Q39	.20	.14
Q40	.45	.49
Q76	.67	.68
Q77	.60	.55
Q78	.51	.48
Q79	.62	.58
Q80	.69	.66
Q81	.56	.53
Q82	.67	.61
Q83	.72	.78

Note: Extraction method: Principal axis factoring.

Table E2

Total Variance Explained by the Factors – Teaching Survey

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	5.94	20.50	20.50	5.56	19.19	19.19	4.82
2	4.34	14.98	35.48	3.96	13.66	32.85	4.22
3	2.10	7.24	42.72	1.69	5.82	38.66	1.59
4	1.54	5.32	48.04	1.20	4.13	42.79	1.37
5	1.42	4.88	52.92	1.04	3.57	46.37	2.95
6	1.22	4.21	57.13	.90	3.09	49.46	1.29
7	1.13	3.90	61.03	.65	2.24	51.70	.99
8	1.09	3.75	64.78	.59	2.02	53.72	1.27
9	1.01	3.50	68.28	.53	1.82	55.54	.68
10	.91	3.12	71.40				
11	.89	3.05	74.46				
12	.84	2.89	77.34				
13	.72	2.50	79.84				
14	.69	2.36	82.20				
15	.64	2.20	84.40				
16	.57	1.96	86.36				
17	.53	1.83	88.19				
18	.46	1.59	89.78				
19	.44	1.53	91.32				
20	.40	1.39	92.70				
21	.35	1.20	93.90				
22	.32	1.11	95.01				
23	.30	1.04	96.05				
24	.27	.92	96.97				
25	.25	.85	97.82				
26	.20	.68	98.50				
27	.17	.58	99.08				
28	.14	.49	99.58				
29	.12	.42	100.00				

Note: Extraction method: Principal axis factoring.

a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance

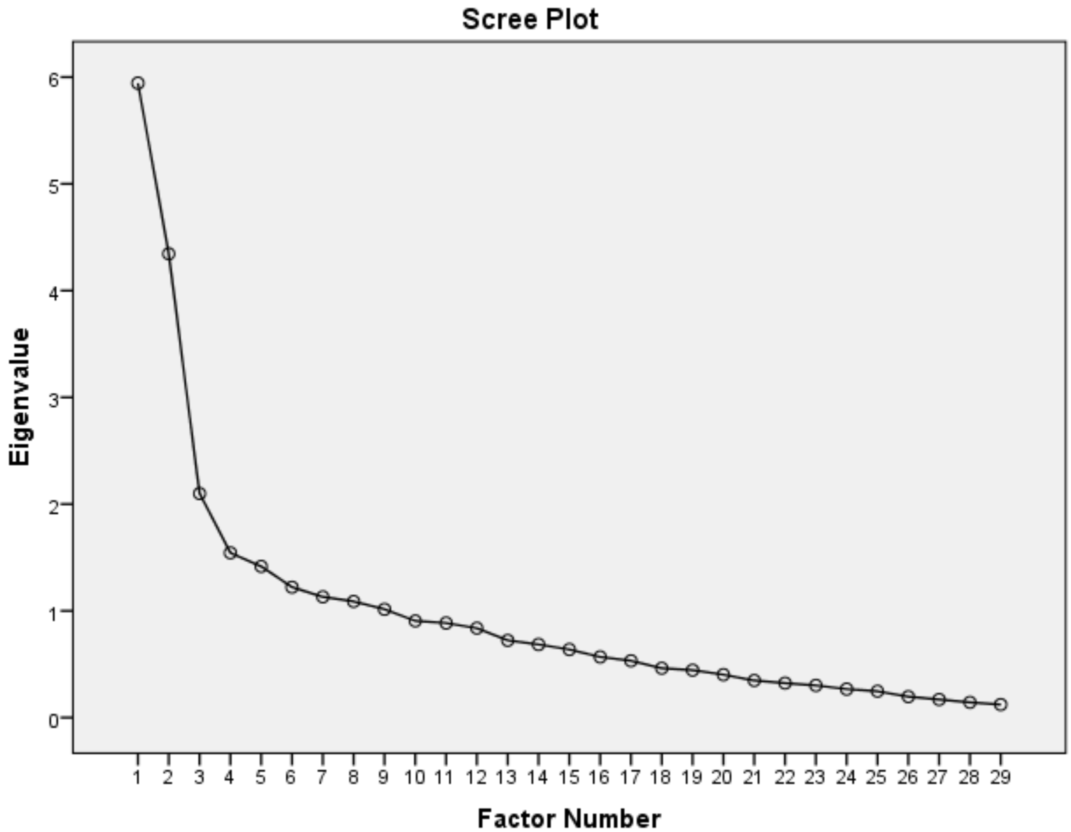

Figure E1. Scree plot for teaching survey

Table E3

Rotated Factor Matrix for Teaching Factors

Variable	Component 1	Component 2
Concepts	.040	.855
Evidence	.043	.861
Alternatives	.146	.744
Open-ended	-.083	.738
Connections	-.008	.776
Demonstrate	.133	.631
Teach Real World	-.007	.714
Do Well	.790	.057
Not Strength	.788	.000
Learn Quickly	.696	-.131
Like Science	.809	.032
Take More Science	.758	.045
Enjoy Learning Science	.746	.158
Science Boring	.745	.244
Science Difficult	.631	-.034

Table E4

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.844
Bartlett's Test of Sphericity	Approx. Chi-Square	832.908
	df	105
	Sig.	.000

Table E5

Teaching Factor 1: About How Often Do You Believe that Each of the Following Teaching Techniques Should be used when you are Teaching a Science Class?

Variable	Never or Rarely *N* (%)	Sometimes *N* (%)	Often *N* (%)	Almost all lessons *N* (%)	Mean (*SD*)
Q28: Demonstrate a science-related principle or phenomenon.	1 (.9)	23 (20.7)	70 (63.1)	17 (15.3)	3.93 (.628)
Q29: Teach science using real-world contexts	0	9 (8.1)	38 (34.2)	64 (57.7)	4.50 (.645)
Q31: Use open-ended questions.	1 (.9)	14 (12.6)	40 (36.0)	55 (49.5)	4.35 (.737)
Q32: Require students to supply evidence to support their claims	2 (1.8)	11 (9.9)	40 (36.0)	58 (52.3)	4.39 (.741)
Q33: Encourage students to explain concepts to one another	1 (.9)	14 (12.6)	33 (29.7)	63 (56.8)	4.42 (.745)
Q34: Encourage students to consider alternative explanations.	1 (.9)	16 (14.4)	44 (39.6)	50 (45.0)	4.29 (.743)
Q36: Help students see connections between science and other disciplines.	0	9 (8.1)	44 (39.6)	58 (52.3)	4.44 (.642)

Table E6

Teaching Factor 2: Attitude toward Science

Variable	Disagree a lot *N* (%)	Disagree a little *N* (%)	Agree a little *N* (%)	Agree a lot *N* (%)	Mean (*SD*)
Q76: I usually do well in science.	1 (.9)	24 (21.6)	53 (47.7)	33 (29.7)	3.06 (.742)
Q77: I would like to take more science in school.	10 (9.0)	51 (45.9)	36 (32.4)	14 (12.6)	2.49 (.830)
Q78: Science is more difficult for me than for many of my classmates.	17 (15.3)	39 (35.1)	46 (41.4)	9 (8.1)	2.58 (.848)
Q79: I enjoy learning science.	4 (3.6)	23 (20.7)	61 (55.0)	23 (20.7)	2.93 (.747)
Q80: Science is not one of my strengths.	14 (12.6)	35 (31.5)	45 (40.5)	17 (15.3)	2.41 (.899)
Q81: I learn things quickly in science.	11 (9.9)	44 (39.6)	49 (44.1)	7 (6.3)	2.47 (.761)
Q82: Science is boring.	34 (30.6)	52 (46.8)	24 (21.6)	1 (.9)	3.07 (.747)
Q83: I like science.	1 (.9)	25 (22.5)	57 (51.4)	28 (25.2)	3.01 (.720)

Table E7

Levene's Test of Equality of Error Variances

	F	*df*1	*df*2	Sig.
Teaching 1	1.777	26	74	.029
Teaching 2	1.355	26	74	.156

Appendix F

Learning Factor Tables

Table F1

Total Variance Explained for Initial Analysis – Learning Survey

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	11.00	24.44	24.44	10.61	23.58	23.58	5.74
2	4.40	9.78	34.22	4.03	8.95	32.53	3.12
3	2.40	5.33	39.55	1.96	4.36	36.89	2.36
4	2.07	4.59	44.14	1.65	3.66	40.56	1.97
5	1.94	4.31	48.45	1.54	3.43	43.99	2.63
6	1.76	3.92	52.36	1.36	3.02	47.01	3.89
7	1.51	3.35	55.71	1.14	2.53	49.54	2.16
8	1.48	3.29	59.00	1.09	2.42	51.96	4.60
9	1.35	3.00	62.01	.93	2.06	54.02	3.81
10	1.26	2.81	64.81	.89	1.97	55.99	3.92
11	1.20	2.66	67.47	.78	1.72	57.71	3.16
12	1.11	2.47	69.94	.70	1.56	59.27	5.43
13	.97	2.16	72.11				
14	.95	2.10	74.21				
15	.91	2.03	76.24				
16	.87	1.94	78.17				
17	.75	1.67	79.84				
18	.72	1.61	81.45				
19	.69	1.53	82.98				
20	.59	1.30	84.29				
21	.56	1.25	85.54				
22	.53	1.18	86.72				
23	.53	1.17	87.90				
24	.50	1.11	89.00				
25	.47	1.05	90.05				
26	.42	.94	90.99				
27	.37	.83	91.82				
28	.36	.80	92.62				
29	.34	.76	93.38				
30	.32	.71	94.09				
31	.31	.68	94.77				
32	.29	.64	95.40				
33	.27	.59	96.00				

34	.25	.56	96.56
35	.24	.53	97.09
36	.21	.46	97.54
37	.20	.45	98.00
38	.17	.38	98.38
39	.14	.30	98.68
40	.13	.28	98.97
41	.12	.26	99.23
42	.11	.24	99.47
43	.10	.22	99.69
44	.08	.19	99.88
45	.06	.12	100.00

Note: Extraction method: Principal axis factoring, a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.

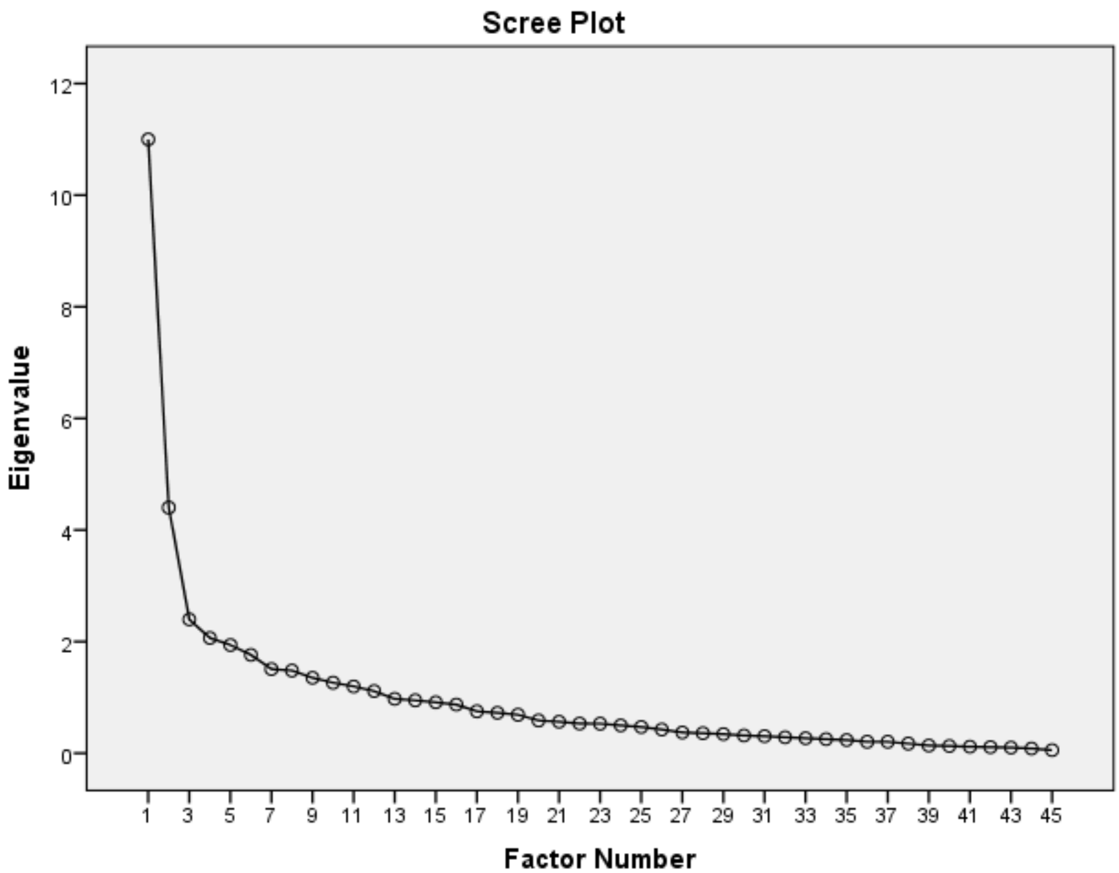

Figure F1. Scree plot for initial analysis for learning survey

Table F2

Rotated Factor Matrix for Teaching Factors

Variable	Component						
	1	2	3	4	5	6	7
Record Data (Q43)	.226	.097	.808	.165	.099	.016	.097
Record Data (Q64)	.145	.064	.724	.195	.239	.161	.020
Write Explanations	-.013	.352	.655	.282	.121	.202	.053
Worksheets	.154	.104	.139	-.204	.148	-.022	.795
Review Homework	.084	.179	.072	.067	.062	.150	.789
Read Other	.286	.285	.540	-.308	.058	-.007	.246
Sequential	.025	.099	.072	-.188	.131	.777	-.083
Concepts	-.134	.005	.289	.121	.021	.687	.081
Procedures	.129	-.087	-.061	.215	.043	.739	.170
Electronic Journals	.738	.351	.157	-.038	.058	.059	.072
Internet	.816	-.007	.224	.071	-.006	.009	.154
Computers	.748	-.006	.033	.148	.318	-.068	.160
Portfolios	.591	.416	.032	-.167	.365	.038	-.215
Open-ended Tests	.128	.095	.151	-.001	.820	.044	.108
Performance Assessment	.151	.077	.134	.007	.799	.123	.026
Multiple Choice Tests	.396	.103	.037	-.208	.467	.079	.378
Problem Solving	-.048	.467	.258	.169	.456	.023	.232
Conversations	.124	.095	-.066	.792	.046	-.059	-.061
Explain Reasoning	.005	.048	.185	.788	.013	.102	-.051
Organize Info	-.078	.164	.243	.623	-.132	.055	-.064
Explanation	.068	.325	.406	.522	.147	.106	.154
Debate	.403	.631	.261	.227	.005	.051	.030
Nature of Science	.109	.775	.103	.113	.035	.009	.145
Assess Own Work	.077	.821	.119	.114	.167	-.037	.114

Table F3

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.744
Bartlett's Test of Sphericity	Approx. Chi-Square	1102.104
	df	276
	Sig.	.000

Table F4

Learning Factor 1: Student's Ability to Analyze and Report Data

About how often do you think students should take part in each of the following types of activities?

Variable	Never or Rarely N (%)	Sometimes N (%)	Often N (%)	All or Almost all Lessons N (%)	Mean SD
Q43: Record, represent, and/or analyze data.	0	9 (8.1)	62 (55.9)	40 (36.0)	4.28 .606
Q44: Write explanations about what was observed and why it happened.	1 (.9)	11 (9.9)	47 (42.3)	52 (46.8)	4.35 .696
Q64: About how often do you think students should write reflections in a science notebook or journal?	2 (1.8)	22 (19.8)	59 (53.2)	28 (25.2)	4.02 .726

Table F5

Learning Factor 2: Students Taking Part in Non-Inquiry Activities

About how often do you think students should take part in each of the following types of activities?

Variable	Never or Rarely N (%)	Sometimes N (%)	Often N (%)	All or Almost all Lessons N (%)	Mean SD
Q53: Read other (non-textbook)	21	57	29	4	3.14
science-related materials in class.	(18.9)	(51.4)	(26.1)	(3.6)	.761
Q54: Answer textbook/worksheet	37	46	24	4	2.93
questions.	(33.3)	(41.4)	(21.6)	(3.6)	.881
Q55: Review homework/	21	42	36	12	3.34
worksheet assignments.	(18.9)	(37.8)	(32.4)	(10.8)	.929

Table F6

Learning Factor 3: Student's Scientific Knowledge

To be good at science at school, how important do you think it is for students to…

Variable	Not important *N* (%)	Somewhat important *N* (%)	Very important *N* (%)	Mean (*SD*)
Q1: Remember scientific procedures.	5 (4.5)	58 (52.3)	48 (42.3)	2.39 (.575)
Q2: Think in a sequential and procedural manner	3 (2.7)	46 (41.4)	62 (55.9)	2.53 (.553)
Q3: Understand science concepts, principles, and strategies.	0	46 (41.4)	65 (58.6)	2.59 (.495)

Table F7

Learning Factor 4: Students Using Electronic Tools for Assessment

About how often do you think students should take part in each of the following types of activities?

Variable	Never or Rarely *N* (%)	Sometimes *N* (%)	Often *N* (%)	All or Almost all Lessons *N* (%)	Mean (*SD*)
Q69: Use computers for modeling and simulations.	14 (20.7)	44 (39.6)	45 (40.5)	8 (7.2)	3.41 (.825)
Q70: Use the Internet.	6 (5.4)	46 (41.4)	48 (43.2)	11 (9.9)	3.48 (.745)
Q71: Use electronic journals or bulletin boards.	10 (22.8)	46 (41.4)	43 (38.7)	9 (8.1)	3.07 (.860)
Q72: Work on portfolios.	28 (25.2)	50 (45.0)	28 (25.2)	5 (4.5)	2.89 (.878)

Table F8

Learning Factor 5: Types of Student Assessment

About how often do you think students should take part in each of the following types of activities?

Variable	Never or Rarely *N* (%)	Sometimes *N* (%)	Often *N* (%)	All or Almost all Lessons *N* (%)	Mean (*SD*)
Q67: Use science as a tool in problem-solving.	2 (1.8)	25 (22.5)	57 (51.4)	27 (24.3)	3.98 (.738)
Q73: Take short answer tests (e.g., multiple choice, true/false, fill-in-the-blank).	36 (32.4)	52 (46.8)	18 (16.2)	5 (4.5)	3.32 (.896)
Q74: Take tests requiring open-ended responses (e.g., descriptions, explanations).	21 (18.9)	44 (39.6)	35 (31.5)	11 (9.9)	3.57 (.880)
Q75: Engage in performance tasks for assessment purposes.	11 (9.9)	44 (39.6)	38 (34.2)	18 (16.2)	3.06 (.742)

Table F9

Learning Factor 6: Student's Ability to Evaluate Science Information

In science lessons, how often do you think students should do the following?

Variable	None or Almost never *N* (%)	Some lessons *N* (%)	Most lessons *N* (%)	Every lesson *N* (%)	Mean (*SD*)
Q14: Explain the reasoning behind an idea.	0	9 (8.1)	43 (38.7)	59 (53.2)	3.45 (.643)
Q17: Have conversations about the subject matter that last for five minutes or more.	2 (1.8)	12 (10.8)	54 (48.6)	43 (38.7)	3.24 (.716)
Q18: Organize, interpret, evaluate, and use information, instead of trying to remember or reproduce it.	1 (.9)	7 (6.3)	53 (47.7)	50 (45.0)	3.37 (.646)
Q41: Formulate a science explanation	0	20 (18.0)	67 (60.4)	24 (21.6)	4.04 (.631)

Table F10

Learning Factor 7: Student's Ability to Examine Science

About how often do you think students should take part in each of the following types of activities?

Variable	Never or Rarely *N* (%)	Sometimes *N* (%)	Often *N* (%)	All or Almost all Lessons *N* (%)	Mean (*SD*)
Q45: Debate different science explanations.	8 (7.2)	28 (25.2)	51 (45.9)	24 (21.6)	3.82 (.855)
Q46: Discuss the nature of science.	6 (5.4)	30 (27.0)	54 (48.6)	20 (18.0)	3.80 (.799)
Q47: Assess the quality of their own work.	2 (1.8)	20 (18.0)	59 (53.2)	30 (27.0)	4.05 (.724)

Table F11

Levene's Test of Equality of Error Variances

	F	*df*1	*df*2	Sig.
Learning 1	2.134	26	74	.006
Learning 2	1.957	26	74	.013
Learning 3	1.530	26	74	.080
Learning 4	2.425	26	74	.002
Learning 5	1.867	26	74	.019
Learning 6	1.262	26	74	.217
Learning 7	1.850	26	74	.021