Spring 2014

To What Extent Does Professional Development Influence Constructivist Science Teaching in Classrooms?: A Comparative Study of Education in the United States of America and Finland

Michelle A. Caton
The College at Brockport, michellecaton@rocketmail.com

To What Extent Does Professional Development Influence Constructivist Science Teaching In Classrooms?: A Comparative Study of Education in the United States of America and Finland

by

Michelle Caton

A project submitted to the

Department of Education and Human Development of the

State University of New York College at Brockport

in partial fulfillment of the requirements for the degree of

Master of Science in Education

May 29, 2014

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Literature Review

Introduction to Constructivism

"Cognitive constructivism is a theory that describes learning as taking new ideas or experiences and fitting them into a complex system that includes the learner's entire prior learning. In other words, students arrive with pre-existing 'constructs,' and in order to learn, must modify these existing structures by removing, replacing, adding, or shifting information in them." (Hartle, Baviskar, & Smith, 2012). Differing from this theory, social constructionism is based in sociology and encompasses the idea that beliefs of a society are constructed through the social interactions people have with others (Hartle et al., 2012). While these theories are completely different, the constructivist teaching seen in education not only include cognitive constructivism but also social constructionism and inquiry. However, Hartle et al. (2012) describe four criteria that are essential to the foundation of constructivism, regardless of whether or not inquiry or social constructionism is implemented into teaching methods. The criteria for constructivism are ordered as follows:

1. Eliciting prior knowledge
2. Creating cognitive dissonance
3. Applying new knowledge with feedback
4. Reflecting on learning (metacognition)

(Hartle et al., 2012)

The first criterion of constructivism is to elicit prior knowledge (Hartle et al., 2012). The main goal of constructivism is for students to be able to construct their own knowledge by adjusting and adding to the constructs they already have; this knowledge is also described as prior knowledge or background knowledge (Hartle et al., 2012). In order to elicit students' prior knowledge, activities should be created in ways that allow the teacher to learn what constructs

the student has while allowing students to focus attention on how their mental constructs will be modified or extended by the lesson or activity (Hartle et al., 2012).

Relating to this, the knowledge students possess connects to create their individual mental construct; the facts, concepts, experiences, emotions, and values they have and encounter all connect together to form mental constructs (Hartle et al., 2012). In order to create cognitive dissonance, students must be aware of their own constructs and how they differ from the information they are learning within their current environment (Hartle et al., 2012). Hartle et al., (2012) describes cognitive dissonance as a source of motivation, because if students recognize disparity between what they know and what they encounter they will try to make sense and understanding of where those differences or insufficiencies lie.

Once students expand and extend upon their prior knowledge, it is vital that they apply this new knowledge through activities and interactions with others (Hartle et al., 2012). Application of new knowledge is an important criterion of constructivism because it asserts and adjusts the new construct while also providing repetition in a variety of contexts in order to help students reinforce what they have learned (Hartle et al., 2012). Applying their new knowledge can also bring out any misconceptions or further cognitive dissonance. Hartle et al., (2012) illustrates the need for student application to be coupled with authentic feedback. The most effective feedback doesn't necessarily come from the teacher, especially in a constructivist sense; formative feedback is most efficient when it comes from students' peers or the activity they are working on (Hartle et al., 2012). One strategy Hartle et al. (2012) suggests is conducting small group discussions; in these small groups, students can productively discuss the assignment they have been working on and how their present performance differs from past performance. Through these small group discussions, misconceptions can be discovered and

taken care of while students exchange feedback in a timely and beneficial manner (Hartle et al., 2012).

The last criterion of constructivist teaching is metacognition (Hartle et al., 2012). Constructivism is meant to be student-centered rather than teacher-centered; this allows for students to be responsible for their own learning (Hartle et al., 2012). Hartle et al. (2012) defines metacognition as "the act of thinking about your own thinking." By motivating students to consider what they are learning as well as how they are learning it, they become more actively responsible in expanding their mental constructs (Hartle et al., 2012). Students are encouraged to reflect on the activities they participate in as well as the assignments they complete in order to comprehend what they have learned and how it changes and expands upon their prior knowledge (Hartle et al., 2012). This opens up the door for students to approach their education and learning in a sensible and efficient way (Hartle et al., 2012).

Considering the criteria of constructivism, what is the teacher's role with their students and classrooms? It is different than traditional instruction because the teacher's role is to create a classroom environment that gives learners the initiative to want to learn; in order to motivate learners, teachers must be able to link students' prior knowledge to the content they teach, the resources they make available, and the questions they pose (Baviskar, Hartle, & Whitney, 2009). It is important that students are aware of where lessons fit into their prior knowledge as well as the purpose of each lesson so they can extend upon what they already know (Hartle et al., 2012). Keeping in mind the four essential criteria of constructivism, making these connections is extremely important so that students don't focus on just memorizing lessons; similarly, students need to understand where lessons fit so that they do not place new information into the wrong topic or mental construct (Hartle et al., 2012). In order to move beyond rote memorization,

students need to be able to apply their mental constructs to different situations while making connections within their construct; by receiving feedback from the teacher and participating in a student-centered learning environment, the changes made to students' knowledge constructs can become permanent instead of temporary (Baviskar et al., 2009).

A central part of the teacher's role in constructivist teaching is planning activities and instruction that encompasses the four essential criteria of this theory. It is important that teachers do not strictly associate group work as being automatically constructivist in nature; just because peers are talking and working together does not mean the teaching methods and instruction being implemented is constructivist (Hartle et al., 2012). In order for group work to be a constructivist learning strategy it must be implemented appropriately (Baviskar et al., 2009). The most constructivist activities, including using group work as a strategy, are those that require students to use their prior knowledge in ways that the teacher can witness and decipher (Hartle et al., 2012). Group work is one strategy that can illustrate these qualities; demonstrations can also be a useful tool if they require student engagement (Hartle et al., 2012). Hartle et al. (2012) also suggests students participating in open-ended discussions of their own background knowledge and how it can be applied to solve a problem there is not yet a solution for. Student discussions that encompass their understanding of topics focuses students' thinking on what they know, what they are learning, and how their knowledge can be applied in different contexts (Hartle et al., 2012). Similarly, considering how these discussions apply to students' lives also helps them to continually access their prior knowledge in order to allow them to make connections with the activities they participate in as well as the knowledge they are gaining (Hartle et al., 2012).

It is important for teachers to be conscious of the four essential criteria of constructivism in order to assure that the instruction they implement actually aligns with the theory. For

example, activities that simply check whether or not students complete the assigned task or reading do not encompass the criteria (Hartle et al., 2012). Constructivism should not focus on student grades; the focus is on students actively participating and engaging in activities in pursuance of adding to their mental constructs (Hartle et al., 2012). Constructivism is indeed a student-centered learning theory but this does not mean that they make instructional decisions and do whatever they want to; it is up to teachers to plan instruction to be engaging and motivating while building on students' prior knowledge (Hartle et al., 2012). For example, inquiry is a student-directed activity and as long as it taps into and extends students' background knowledge, it can be emphasized as a constructivist teaching strategy (Hartle et al., 2012).

Science teaching often emphasizes inquiry and the need for students to explore, engage, and build their own knowledge in order to become higher-order thinkers who are able to succeed in future schooling (Seimears, Graves, Schroyer & Staver, 2012). A study conducted by Lorsbach and Tobin (1992) illustrates that children learn through what they bring to school, their senses; children learn through what they see, hear, touch, smell, and taste (Seimears et al., 2012). This is an important consideration to keep in mind when teaching science; the five senses have such a strong impact on student knowledge and making connections with their environments and it is the educator's role to provide students with opportunities to use their prior knowledge in order to construct new understandings.

Currently, there are educational reforms taking place within other countries as well as the United States; these educational reforms aim at building science literacy in order for students to expand their knowledge and make meaning out of their scientific experiences (Yore, Anderson, & Shymansky, 2005). Science literacy is an interdisciplinary teaching concept; creating scientific literacy involves encompassing other subject areas in order to allow students to use

skills gained in other content areas (Yore et al., 2005). By increasing scientific literacy, students are given the opportunity to understand big ideas in science by making meaning out of their experiences (Yore et al., 2005).

Previous research has debated teaching in alignment with the constructivist model versus the transmission model (Seimears et al., 2012). If constructivist teaching has been at the head of educational reform for so long, why are educators consistently moving back to the traditional, transmission model of teaching? Furthermore, why are some educators not moving away from the transmission model at all?

Opposition to Constructivism in America

Analyzing a study conducted by Pajares (1992), the authors of this study discuss the difficulty of change when there is no belief to back it up (Haney, Czerniak & Lumpe, 2003). If school personnel or the community do not believe in the principles of constructivism, the implementation of it within classrooms becomes extremely difficult (Haney et al., 2003). Haney et al. (2003) discuss an aspect of constructivism that is rarely stated; when you ask most people in the American population what they imagine a classroom looking like, they describe students sitting in rows and listening intently to what the teacher is saying. The authors of this study note that because of this impression, many teachers find it difficult to implement constructivist teaching practices in their classroom due to the differing perspectives of its use by other teachers, parents, administrators, and the community (Haney et al., 2003). Due to the contrast in beliefs among members of the school and community, Haney et al. (2003) question the lack of support for the theory of constructivism and the doubt some hold regarding its effectiveness.

Similar to the results of the study done by Haney et al. (2003), Yore et al. (2005) found a discrepancy between in-service teachers and the administrative support being received through

their research; there is little advocacy for current, constructivist science teaching from administration in many elementary schools and this affects the teachers trying to better and reform science education (Yore et al., 2005). This lack of administrative support is another reason it has been difficult to implement constructivist teaching practices in the past and currently; although teachers are often eager and willing to implement this form of instruction, many administrators deem the style as ineffective due to the lack of evidence (Beamer, Van Sickle, Harrison, & Temple, 2008).

Baviskar et al. (2009) points out that because constructivism is a theory of learning rather than an explicit form of instruction, it is often misused or misunderstood by teachers. Similarly, the differences between personal constructivism, social constructivism, and cognitive constructivism also add to confusion (Baviskar et al., 2009). Although there has been research published that discuss the theory of constructivism, there has been little research illustrating how constructivism can be put into practice (Baviskar et al., 2009). Baviskar et al. (2009) conceptualizes that the difficulty in the definition of constructivism as well as how to implement the theory in classrooms as a practical methodology is a result of misconceptions between theories and their implementation. For example, many lesson plans have claimed to be of a constructivist nature, yet they don't actually include all of the elements that constructivism requires (Baviskar et al., 2009). Research done by Baviskar et al. (2009) illustrates that many educators think that if group work is a part of their lesson then it is constructivist due to students learning through interactions with their peers; however, group work is not an essential element of constructivism. In order for a lesson to be constructivist, it needs to include all elements of constructivism while refraining from including other elements that deviate from the theory as well (Baviskar et al., 2009).

Although there may have been and continues to be misconceptions, opposition, and lack of support behind the implementation of constructivism, The NSES (National Science Education Standards) continues to emphasize the need for quality within student learning experiences; in order to increase the quality of instruction and student experiences, it is suggested that teachers instruct within the constructivist framework in order to build science literacy in students (Yore et al., 2005). However, The *No Child Left Behind Act* (NCLB) of 2002 changed education for the United States; this act set requirements for all school districts to set rigorous course standards for science education (Seimears et al., 2012). As a result of these changes, there has been a lot of debate regarding the implementation of constructivist teaching; similarly, constructivist instructional strategies have becomes less apparent in classrooms due to the raised level of student expectations (Seimears et al., 2012). A teaching theory that has been at the forefront of educational reform for decades and is continually supported by the National Education Standards (NES) has been replaced with the more commonly used and understood, traditional instruction (Seimears et al., J., 2012). Although the instructional practice of constructivist principle has sparked a debate in regards to which form of instruction is most effective, it has not been easily put into practice in the classroom (Ledoux & McHenry, 2004).

Traditional instruction, similar to the transmission model, has been used most often because it is the form of instruction that most teachers received as students and are most familiar with. Therefore, it is much more commonly practiced and seen in classrooms. This form of instruction is similar to that described by Haney et al. (2003), as students sitting appropriately at their desks while the teacher stands at the front of the room and delivers all instruction; students are then expected to remember the information given to them so they can meet performance standards on state exams (Seimears et al., 2012). This falls in line with the behaviorist approach

to teaching, which is described as teacher-led instruction (Ledoux & McHenry, 2004). Traditional instruction is what most are familiar with; however, science is a content area that many teachers are not familiar with and therefore have discomfort at the thought of teaching it in an elementary classroom (Bleicher & Lindgren, 2005).

Due to current and preservice teachers being unfamiliar with constructivist strategies and uncomfortable teaching science, the opportunities students are given to maximize learning in the classroom are weakened. Because of these reports from previous research, a need for professional development has been suggested (Bleicher & Lindgren, 2005); by providing professional development to inservice teachers and hands-on, constructivist teaching experiences for preservice method students, constructivist teaching may prove to be a more effective form of instruction for teaching science in elementary schools.

Implications

Although traditional instruction is common and has shown growth in student performance (Poncy et al., 2010), research suggests that teaching should be student-centered, with real-world problems students are able to relate to (Kroesbergen & van Luit, 2002). It is clear that teachers must take the needs of their students into consideration when planning for instruction. Siegel (2005) has noted that teaching styles vary for different types of classes; teachers choose how to instruct their classes based on their perceived notions of student needs. In a qualitative study conducted by Siegel (2005), the teacher readily admits that employing instructional techniques that are not familiar is a difficult and complex process; there are many factors that affect how a teacher chooses to apply instruction in practice. While this study has little generalizability in other contexts due to a single teacher executing instruction, the exploratory methodology used provides a deeper insight of teacher beliefs; the results suggest the

need to consider how a teacher's previous experiences and philosophy of education may affect their implementation of teaching strategies.

There have been many research studies done previously regarding the actual theory of inquiry-based teaching, but there is little research explaining and providing examples of teachers actually implementing this theory- based instruction (Tan & Wong, 2012). Studies like Ledoux & McHenry's (2004) imply that more research is needed to assess the effects of professional development on preservice and in-service teachers' ability to implement constructivist instruction in classrooms; similarly, it would be beneficial in order to determine the effects of professional development on teacher and student attitudes and achievement in regards to science and inquiry-based instructional environments. Forbes (2011) suggests that future research should assess long-term effects of inquiry-based methods courses for preservice teachers as well as the effects of professional development on in-service teachers; this will provide more information as to how preservice and in-service teachers develop in terms of implementing inquiry-based learning in their instruction (Forbes, 2011). Similarly, more research needs to be done regarding how teachers use curriculum materials; it is important that materials are scaffolded in order to increase student participation and inquiry (Forbes, 2011).

Overall, every classroom is different and as a result, so is the atmosphere each classroom environment holds. It is vital to establish a firm grounding for how the students with function within the classroom environment as soon as they enter; this will allow the teacher to accommodate the needs of diverse communities within a constructivist learning environment (Kovalainen & Kumpulainen, 2007). Students need to be provided with the resources that are conducive to learning in a constructive atmosphere; if resources are not differentiated to meet student needs nor provided consistently, it is difficult to encourage and continue active student

engagement (Kovalainen & Kumpulainen, 2007). Tan & Wong (2012) expand on this idea by noting, "Science textbooks that are provided by schools often hinder the ability to teach constructively; many teachers find it difficult to balance the amount of time spend on direct instruction from the textbook and the time spent on inquiry." As a result, there have been many reports regarding the inadequacy of preservice and in-service teachers' ability to actually implement inquiry-based instruction in classrooms; teachers need to be aware of how to balance their instruction to meet the needs of all students (Tan & Wong, 2012).

Constructivism and Professional Development in American Education

Constructivism in American Education

Differing from the direct, teacher-mediated foundations of traditional instruction, constructivism focuses on how students learn rather than creating a uniform process for all that simply covers the material recommended by state standards and government initiatives (Pitt & Kirkwood, 2010). Constructivism is an inquiry-based approach to teaching and learning where students build their own knowledge, rather than having teachers build it for them. Students are given multiple opportunities to explore ideas that interest them; they become active participants of the learning processes they create (Kroesbergen & van Luit, 2002). Constructivism is often referred to as guided instruction because teachers are encouraged to refrain from being a controlling force that sets the direction for instruction; instead, it is recommended that teachers guide students towards a realistic approach of education (Siegel, 2005). By forming instruction as an inquiry-based, constructivist approach, students are able to acquire new concepts and information through lived experiences and realistic situations presented in the classroom (Siegel, 2005).

Knowledge is an active process created and obtained by students as they interact with their physical environment and engage in problem-solving activities that are meaningful and naturally occurring (Siegel, 2005). Individual contributions made by students are a fundamental piece of this process. Students are significantly perceptive to the situations they encounter in life outside of the classroom; students learn from their lived experiences and make meaning of experiences they encounter (Pitt & Kirkwood, 2010). The ability of students to actively engage with their friends and family begins the social construction of their individual knowledge and perceptions; the construction of their understanding is a natural process that can be extended upon when used in school settings, as inferred by the constructivist theory (Pitt & Kirkwood, 2010).

The exploratory and reflective methodology used in the study conducted by Pitt & Kirkwood (2010) allowed the teacher to consider what factors needed changing in order to create a classroom environment conducive to constructivism; the teacher was able to shift instruction toward student interest and working together rather than individually. The physical arrangement of the classroom was changed in order to provide a social, student workspace; the teacher also considered how his own biases towards constructivism and how his entire approach to teaching needed to change in order establish the new learning environment being constructed (Pitt & Kirkwood, 2010).

The NSES (National Science Education Standards) emphasizes the need for quality within student learning experiences; in order to increase the quality of instruction and student experiences, it is suggested that teachers instruct within the constructivist framework in order to build science literacy in students (Yore et al., 2005). Haney et al. (2003) define constructivism as a philosophy that encourages students to construct their own understanding and knowledge;

this instructional theory has become popular in current educational reform and is being recommended for implementation. Although the definitions of constructivism vary, the overall idea is to allow students to explore their own ideas, plan their own experiments, and to question what they see or what is described by the teacher throughout instruction (Haney et al., 2003). Constructivist classrooms are designed to facilitate student exploration; they participate in activities using manipulatives in environments where they are encouraged to ask questions and create meaning out of their experiences (Beamer et al., 2008).

Skepticism has been raised over the actual implementation of constructivist learning environments because it is based on a theory and teachers must have a strong foundation of content knowledge in order to facilitate in student exploration (Beamer et al., 2008). Especially in elementary school, teachers not only need to have a strong foundation of science content but it is very broad as well (Bulunuz & Jarrett, 2010). Elementary teachers are required to teach a variety of science concepts and they need to teach these difficult concepts effectively; many concepts are taught at different grade levels with differing amounts of intensity within the elementary curriculum (Bulunuz & Jarrett, 2010). Unfortunately however, research has shown that preservice and inservice elementary teachers have many misconceptions in regards to science topics and content; many of these misconceptions are similar to those held by their students (Bulunuz & Jarrett, 2010). For example, a study done by Bulunuz & Jarrett (2010) showed results similar to previous research indicating a variety of misconceptions regarding earth and space concepts among preservice and inservice elementary teachers. These misconceptions illustrate that many teachers do not have nearly enough understanding of science concepts in order to teach this information to students (Bulunuz & Jarrett, 2010). Bulunuz & Jarrett (2010) recommend a need for intervention in order to decrease misconceptions among

elementary science teachers and increase the quality of instruction for students. If many teachers do not have a firm understanding of science content knowledge, how could they possibly implement instruction aligned with the theory of constructivism? In order to create engaging instruction that extends beyond student's background knowledge, teachers need to be able to identify misconceptions as students come across them in order to give them the feedback that is such a large part of constructivist teaching.

In the United States, most undergraduate teaching programs only include two science courses to meet the requirements for an elementary teacher certification; Nadelson et al., (2013) argues that this is not nearly enough preparation to learn the content knowledge necessary to teach science curriculum in elementary school. In order to move beyond this challenge, teachers should continually pursue opportunities to further their education (Nadelson et al., 2013). Professional development is one resource that may be critical for helping teachers become more effectively prepared to teach the broad range of science content (Nadelson et al., 2013). By participating in professional development teachers can more adequately meet the needs of their students during science instruction (Nadelson et al., 2013).

"Teaching science, technology, engineering, and mathematics (STEM) content at the elementary level is filled with opportunities and challenges" (Nadelson et al., 2013). However, it is up to teachers to seize the opportunities and face the challenges head on in order to implement effective instruction aligned with the theory of constructivism. Young learners tend to be more enthusiastic because they are approaching situations and learning that they have never come across before; teachers should aim to capitalize on their enthusiasm in order to increase their desire to expand their prior knowledge of science concepts (Nadelson et al., 2013). Nadelson et al. (2013) points out that due to there being more flexibility in the elementary curriculum,

teachers should be using innovative approaches like constructivism to teach science to students. However, there are many challenges teachers face that often refute this innovation. Nadelson et al. (2013) recognizes these challenges but also provides an idea to move beyond them. "The challenges include access to appropriate resources, the overwhelming focus on English language arts and mathematics learning standards, and teacher preparedness to teach STEM curriculum. Meeting these opportunities and challenges is likely to require teachers to engage in ongoing professional development" (Nadelson et al., 2013).

Professional Development in American Education

It is common for preservice and inservice elementary teachers to express concerns about teaching science and technology in the classroom; this is often due to a lack of background knowledge and confidence in both subject areas (Bencze, 2010). These concerns raise questions about teachers' beliefs regarding knowledge and learning; similarly, how might teachers' beliefs affect how they implement instruction (Howard, McGee, Schwartz, & Purcell, 2000)? "Teacher epistemology has been shown to affect teachers' use of teaching strategies, their use of problem-solving approaches, their efforts in curriculum adaptation, their use of textbooks, their openness to student alternative conceptions, their preservice training needs, their students' reading practices, and their students' use of higher-level thinking skills" (Howard et al., 2000). Due to increases in constructivist learning approaches, assessing teacher's beliefs has become even more important (Howard et al., 2000). Considering that constructivism places emphasis on active learning through student-led activities, naïve epistemologies can have a major impact on a teacher's ability to implement this form of instruction (Howard et al., 2000).

Another concern of constructivism stems from a lack of understanding of how to actually implement it. Although there has been a lot of research concerning the use and implementation

of constructivist teaching practices, there is often a gap between the theory of constructivism and the actual practice of it in a classroom; teachers rarely use this strategy when instructing students in science (Bencze, 2010). Because the constructivist approach to teaching and learning increases enthusiasm, motivation, and student success, it is imperative that preservice and inservice teachers are familiar with this theory and how it is implemented in classrooms in order to make instruction more effective (Beamer et al., 2008). A research study conducted by Forbes (2011), concluded similar findings; this study implicates that in order for inquiry-based teaching methods to be implemented constructively in classrooms, elementary teachers need to be able to use the curriculum and materials provided effectively.

Howard et al. (2000) conducted a training which aimed to change teachers' prior beliefs through a variety of strategies that combined content in a living and learning context. Through the content, teachers were introduced to constructivist curricular tools as well as technological resources (Howard et al., 2000). Strategies used in this training included writing, reflection, and informal discussions; through these interactions, the training also challenged existing beliefs held by the teachers participating (Howard et al., 2000). Through formal feedback from the instructor as well as informal discussions with peers, the training also gave support to teachers in their accommodation of new beliefs (Howard et al., 2000). The technology resources also accommodated new beliefs by being constructivist-oriented; being of a constructivist nature allowed multiple opportunities for teachers to interact with one another while becoming more knowledgeable about constructivist learning and how this theory can be put into practice through classroom instruction (Howard et al., 2000). The results of the training indicated that teacher beliefs were significantly changed and their epistemologies were shown to be more constructivist; these results indicate that through training and professional development, teachers

can come to understand constructivism as well as change their beliefs about teaching-centered instruction as long as they are given the opportunity to participate in activities like those they should be implementing with students (Howard et al., 2000).

Yore et al. (2005) conducted a research study in order to assess the effects of the Science PALs (parents, activities, and literature) project as professional development for preservice and in-service elementary teachers. The results of this study show that preservice teachers need to be given opportunities to participate in professional development in order to evolve their teaching practices and understanding of constructivist, interdisciplinary teaching (Yore et al., 2005). Research conducted by Bleicher and Lindgren (2005) aimed to answer similar questions. Bleicher and Lindgren's study (2005) assessed the effect of preservice teachers' self-efficacy and the effect it had on their implementation of science instruction; by implementing hands-on, constructivist teaching methods in a methods classroom, preservice teachers were able to increase their self-efficacy and settle concerns previously held about teaching science to students (Bleicher & Lindgren, 2005). All of the preservice teachers participating in this study showed a growth in confidence of their science teaching abilities at the end of the course; Bleicher & Lindgren (2005) suggest that this results from these teachers being provided with inquiry-based instruction which increased their knowledge of core science concepts as well as their ability to think abstractly (Bleicher & Lindgren, 2005).

Extending the implications found from these studies, a two-year study conducted by Beamer et al. (2008) aimed to assess the use of constructivist teaching methods in classrooms. The results of this study show that providing professional development to preservice and inservice teachers can increase the use of constructivist teaching practices in classrooms (Beamer, Van Sickle, Harrison, & Temple, 2008). This result is similar to the findings of Forbes

(2011), which implicated the need for professional development in order for teachers to be able to implement constructivist teaching methods while using materials provided properly.

Later, a study in 2010 (Bencze) aimed to increase preservice teachers' knowledge of engaging students in real-life experiences when teaching science; the instruction and practices used were in alignment with the constructivist theory in order to expand teachers' expertise of the content area as well as increase their knowledge of applying constructivist teaching methods in the classroom (Bencze, 2010). The results of this study showed that preservice teachers did gain self-efficacy and more confidence in their knowledge of science and the application of constructivist teaching methods in the classroom (Bencze, 2010).

Furthermore, Forbes (2011) contributed to this research by conducting a study researching how preservice teachers translate the use of curriculum materials into their teaching methods with their students. The aim of this research study was to decipher whether or not preservice teachers are able to use curriculum materials effectively by promoting student engagement and inquiry; this teaching style allows students to explore and make meaning of their scientific experiences (Forbes, 2011). Findings from Forbes' study (2011) illustrate that when preservice teachers are provided the opportunity to learn in an inquiry-style environment, they are better able to reflect these teaching practices in their classrooms. Similarly, it is important to give preservice teachers opportunities to differentiate and scaffold curriculum materials in methods classes so they increase their ability to adapt materials when they are working in the field (Forbes, 2011). By participating in inquiry-based classroom environments in methods courses, preservice teachers are able to gain insight on constructivist teaching methods and form a connection between the instructive practices they experienced with the methods that currently effective (Forbes, 2011).

Why then, does there remain such strong opposition to implementing constructivism in classrooms? Haney et al. (2003) reflected the notion that if education reforms, such as constructivist science teaching, are going to work in a classroom setting, then there must be support provided by educators, administrators, and the community. Through their study of beliefs among teachers, administrators, parents, and students showed that professional development being provided to teachers and administrators may help to increase positive beliefs about constructivism and how well it works in a classroom (Haney et al., 2003). Similarly, Anderson (2005) references the need for preservice teachers to be placed into open-ended situations in order to gain the experience of constructively building their own knowledge through discovery; if preservice and current in-service teachers are not familiar with the process of learning constructively personally, it will be difficult to implement these values for engagement and responsibility into classroom instruction (Anderson, 2005).

The implications of multiple research studies suggest that professional development for teachers is vital to providing effective instruction; it is equally important to have the community involved with educational reform as well (Haney et al., 2003). It also shows that participating in inquiry-based courses in college helps teachers understand inquiry and how it can be used in their own classrooms. For example, when comparing traditionally taught and inquiry-based classes in college, research shows that the hands-on activities led to an increase of conceptual understanding; interviews conducted with students in these courses also illustrated that they enjoyed this type of instruction and that they came to better understandings through the use of hands-on activities (Bulunuz & Jarrett, 2010). The research conducted by Bulunuz & Jarrett (2010) aimed to assess whether inquiry-based teaching practices and hands-on activities would expand students' content knowledge as well as clear misconceptions. This study did show that

hands-on teaching methods can help teachers become more knowledgeable with science content; similarly, allowing preservice and inservice teachers to participate in hands-on learning centers and then develop their own can increase conceptual understanding and provide experience for teachers to implement constructivist teaching methods in their classrooms (Bulunuz & Jarrett, 2010).

Implications

"A teacher who holds naïve epistemologies along all five dimensions generally believes that knowledge (1) resides in authorities and is thus unchanging, (2) concepts are learned quickly or not at all, (3) learning ability is innate, and (4) knowledge is simple, clear, and specific" (Howard et al., 2000). Bulunuz & Jarrett (2010) suggest that the way teachers were taught as they went through school can significantly impact their beliefs and epistemologies about knowledge; for example, they may not see a problem with memorizing facts and algorithms without connecting to their background knowledge and making connections. However, their conceptual thinking and beliefs can be changed if they are given the opportunity to have their beliefs challenged through participating in constructivist activities themselves.

Howard et al. (2000) proposes that when teachers have more practical and sophisticated epistemologies their beliefs are much different. For example, these teachers believe that knowledge is complex; they believe that it can be learned progressively through reasoning and that it can be composed by the learner (Howard et al., 2000). The study conducted by Nadelson et al. (2013) provides evidence that even if professional development interventions are short, they can still effectively change teacher beliefs held by teachers by instilling confidence and value in their knowledge of science concepts as well as how to teach them (Nadelson et al., 2013). The results of research conducted by Bulunuz & Jarrett (2010) imply similar findings;

their presentation of new ideas and real-world, hands-on instruction suggests that conceptual change for teachers is achievable.

However, research also shows that changing a teacher's beliefs and epistemologies is not the only contributing factor to increasing the ability to implement science instruction aligned with constructivism. Teachers also need to be better prepared to teach science; professional development should not only focus on changing their beliefs about traditional instruction but also increasing their knowledge of science content. Nadelson et al. (2013) points out that teachers must have a broad and factual base of science content in order to teach effectively and amend misconceptions students may have. Research studies have shown that many teachers initially hold a large number of misconceptions themselves; Bulunuz & Jarrett (2010) suggest that science method courses and professional development should include clarification of complicated science content that they are expected to teach. Research implies that there is confined preparation for teaching science, especially at the elementary level (Nadelson et al., 2013).

Considering the new implementation of Common Core State Standards and the expectation for curriculum reformation, it is vital that teachers strive to refine their knowledge of science content in order to meet the needs of all students in alignment with the adjustments brought with the new standards (Llewelly, 2013). Bulunuz & Jarrett (2010) suggest that constructivist, hands-on learning activities should be included in undergraduate science courses, teacher training courses, as well as inservice professional development; by incorporating activities like these throughout a teacher's professional career can not only further develop their content knowledge but also their pedagogical knowledge. In the training conducted by Howard

et al. (2000), it was shown that in order for teachers to learn about constructivism, they need to actually participate in constructivism.

Overall, research shows that in order for teachers to implement constructivism in their classrooms, there is a need to increase their knowledge of science content and how to develop activities that encompass the four criteria of this learning theory. Similarly, many teachers and administrators still oppose the idea of constructivism due to a preference in traditional, teacher-centered instruction. However, by challenging these beliefs through lived experience and professional development, there could be an educational reform in the United States and their ways of teaching science. Research implies that we all need to work a little bit harder and open up our minds to new ideas in order to better meet the needs of our students and to implement instruction that is more meaningful and engaging for students; by doing this, students will not only become more knowledgeable, but better prepared to succeed outside of the classroom.

Constructivism and Professional Development in Finnish Education

Constructivism in Finnish Education

Similar to educational reform in the United States, pedagogical practices in Finland have also been undergoing reform due to research implying that instruction should be focused as a community of inquiry while highlighting the importance of making meaning of educational experiences (Kovalainen, Kumpulainen, & Vasama, 2001). Educational policy is similar to the United States as there is a national curriculum; however, their national curriculum only outlines the "goals and norms" for the entire country (Wrigley, 2010). Unlike the United States which has specific standards, objectives, and rules embellished throughout the Common Core Learning Standards, Finland's national curriculum is very flexible (Wrigley, 2010). The details of their national curriculum are developed locally between schools and municipalities, which are the

local levels of administration that act as self-governing units in the country (Wrigley, 2010). Teachers are actually part of the curriculum development process; they have a say in what is included (Wrigley, 2010).

Wrigley (2010) illustrates how this is such a big impact on their success in education as well as their abilities to adapt to new forms of teaching when quoting David Hopkins: "Teachers are valued as experts in curriculum development with the curriculum seen more as a process than a product, and have a central role in school improvement. This results in schools and teachers owning the curriculum rather than feeling it is imposed (Hopkins, 2007)." The implementation of constructivist teaching in Finland has not been nearly as controversial as in the United States because teachers are a part of the process in developing their curriculum (Wrigley, 2010). As a result, teachers have been open to the concept of altering their classroom environments to encourage student-centered instruction and participation; these classroom environments encompass the idea that students are responsible for constructing their knowledge and expanding their learning (Kovalainen & Kumpulainen, 2007). Although not nearly as controversial as implementing constructivist teaching practices in the United States, many studies have shown that it is still challenging for teachers and students to adjust to the changes in instruction (Kovalainen & Kumpulainen, 2007).

"In the conventional classroom, the practice of teaching has mainly consisted of lecturing, explaining and questioning the convergent, factual and already existing knowledge in the community of inquiry; the activity of teaching and learning is socially negotiated and constructed into being in the ongoing social interactions of the classroom" (Kovalainen et al., 2001). Finland sees a community of inquiry just as we picture constructivism; however, Finland goes a step beyond the basic principles of constructivism by contributing sociocultural factors

into its implementation (Kovalainen et al., 2001). In this perspective, language and interactions are necessary components in the creation of mental constructs; learning is considered to be a social and cultural progression (Kovalainen et al., 2001). Kovalainen et al. (2001) explains that these components are important because the social interactions and shared experiences students participate allows for students to learn from others that may be more knowledgeable. Through these interactions, meaning-making is shared among the group which introduces new viewpoints and angles to be further discovered (Kovalainen et al., 2001). "Specific value is placed on the learner's personal experiences, curiosity, and authority in learning" (Kovalainen & Kumpulainen, 2007). With teacher guidance, students are able to explore questions and problems in order to make discoveries that are meaningful because they truly relate to their prior knowledge and experiences; their learning translates to their life outside of the classroom because they are given the opportunity to use what they know in order to expand upon what they are learning (Kovalainen et al., 2001).

"These learning practices aim at providing learners with spaces and tools to participate in collective meaning-making as legitimized and authorized individuals" (Kovalainen & Kumpulainen, 2007). A teacher's role in a constructivist, communal inquiry classroom is to provide students with opportunities to participate in a classroom that is open to sharing thoughts and opinions; when students participate in these environments, they are comfortable and eager to share what they have to say as well as challenge others respectively (Kovalainen et al., 2001). Another role of the teacher is to take a step back and let constructivist routes taken in class go as they are developed, rather than trying to control situations or correct student responses (Kovalainen et al., 2001). "The teacher's role in collective discussions could be summarized as a fosterer of inquiry, facilitator of dialogue, a guarantor of impartiality and as an investigator of

thinking" (Kovalainen et al., 2001). The teacher takes a step back from traditional instruction, but is not an inactive member of the classroom; teachers simply work towards letting students be the ones to lead their discussions (Kovalainen & Kumpulainen, 2007).

However, because teachers and students are not initially used to switching roles in the classroom, both groups have had trouble defining their new roles as well as new boundaries within their classroom communities of learning (Kovalainen & Kumpulainen, 2007). Teachers have an especially difficult time trying to create and use strategies that organize and provide scaffolds to make their classrooms communal and inquiry based (Kovalainen et al., 2001). Due to minimal research regarding teacher's situated strategies in whole-class situations and communities of inquiry, studies aimed to assess the ability of teachers to Kovalainen et al. (2001) conducted a study aiming to assess how the ability of teachers to face the challenges of creating constructive classroom communities as well as the effectiveness of this form of instruction.

The results show that working in this type of community changes what students originally considered to be learning and knowledge (Kovalainen et al., 2001). "In this classroom, the reproduction of knowledge appeared to be less important. Instead, learning seemed to be equal with participation in social practices entailing learning to question, to reason, to contribute to problem solving, to argue and to listen to others" (Kovalainen et al., 2001). Students engaged in uninhibited expression and the classroom worked together to elaborate and make sense of their learning (Kovalainen et al., 2001). Students were able to make their own choices and control topics discussed and investigated, resulting in increased levels of participation and motivation (Kovalainen et al., 2001).

From the results of their study, Kovalainen et al. (2001) identify four categories of involvement that reinforce constructivist teaching that include and recognize cognitive, social,

and cultural factors. The first category is the evocative mode; this category encompasses the idea that students are encouraged to be vocal within the society of the classroom (Kovalainen et al., 2001). Students are encouraged to share their ideas, ask questions, speak their opinions, and what they are thinking (Kovalainen et al., 2001). The second category is a facilitative mode; this encompasses how a teacher scaffolds the analyses students make within their shared investigations and examinations (Kovalainen et al., 2001). Scaffolding done by the teacher aims at socially making meaning through student discussion; negotiations made among students are molded by their prior knowledge, experiences, and perceptions they each have to contribute (Kovalainen et al., 2001). Kovalainen et al. (2001) defines the third approach of communal inquiry at the collective mode; teachers strive to create a classroom environment in which students feel supported and open in order to contribute equally with their peers and respect what others have to share, even when their peers ideas and opinions differ from their own perspectives. Lastly, the appreciative mode of participation requires teachers to be enthusiastic about what students share in the classroom as well as grateful for their contributions (Kovalainen et al., 2001).

Later, Kovalainen & Kumplainen (2007) assessed classroom participation and interactions and identified to them to be constructed socially. Changes in roles of students become flexible and interchangeable as they participate and work together (Kovalainen & Kumplainen, 2007). Through this study, the researchers focused on the cultural rules that governed students' contributions as well as how these rules have an effect on the formation of student roles and responsibilities within the classroom; as students in classroom communities work together in the creation of knowledge, the rights and roles of each student differ in order to come to a collective understanding (Kovalainen & Kumplainen, 2007). Kovalainen &

Kumplainen (2007) came to results similar to previous research; the classroom interactions they witnessed were dependent on the community of the students collectively; the learning opportunities students encountered were dependent on an understanding of each student's role in the process of expanding their knowledge by engaging with peers.

Initial teacher education in Finland not only includes content-based courses but also explorations within the field that aim to observe and assess other teachers as well as their own (Toom et al., 2010). It is not uncommon that there are concerns addressed in many countries regarding the quality of teacher education and if it is sufficient in training teachers to be effective educators in the field (Toom et al., 2010). The teaching methods used in content-based courses are aligned with the instructional processes that teachers will implement in their classrooms; initial teacher education is designed in this way so that preservice teachers gain the attitude and understanding needed to approach teaching in line with scientific inquiry and constructivism (Tool et al., 2010). "The Finnish National Curriculum promotes a socio-constructivist view of learning and knowledge which is in line with the ideas of research-based teacher education. Because inquiry-oriented teachers observe or study their own teaching, they also serve as an example and guide their students [preservice teachers] towards inquiring learning" (Tool et al., 2010). In preservice teacher education, Finland goes beyond drilling science content into their future teachers' brains; universities implement inquiry-based teaching practices so that students are already familiar with the teaching style before they begin practicing independently in the field.

"Teachers play a key role in school reform, whether concerning the quality of teaching and learning, curricular development, the planning of learning environments, or the development of the school as a work community (Kosunen & Mikkola, 2002). In order for school reform to

be effective, it is imperative that teachers are able align improvement with their own knowledge and activities (Kosunen & Mikkola, 2002). The school community also has a large impact on school reform; cultures are created within school environments which may result in the development of opposition to a change in teaching practices (Kosunen & Mikkola, 2002). However, Finland encourages teachers to not only teach, but to be researchers as well; as a result, teachers actively strive to create, instruct, and assess their methodologies (Kosunen & Mikkola, 2002). Because teachers in Finland also act as researchers, they continuously expand their content knowledge while assessing their abilities implement research-based instruction (Kosunen & Mikkola, 2002).

Webb, Vulliamy, Sarja, Hamalainen, & Poikonen (2009) describe professional learning communities and how they apply in education. "The term professional learning community (PLC) has become a globally fashionable one for describing schools with its realization viewed as essential for bringing about substantial and successful change in school policy and practice leading to improved pupil learning and attainment" (Webb et al., 2009). Ideally, professional learning communities strive to consider new designs of thinking, cooperatively discuss and act upon ambitions, and persistently learn and expand their knowledge collectively (Webb et al., 2009). However, in order for professional learning communities to be successful, certain criteria must be acknowledged and mutually understood. Professional learning communities cherish, encourage, and are maintained by teachers' participation in professional development consistently throughout their careers (Webb et al., 2010).

Professional Development in Finnish Education

Since the knowledge of how these types of classrooms has expanded due to research, there is still a question remaining regarding whether or not instructional changes can be

implemented consistently and efficiently (Raino, 2008). Even when teachers have knowledge of these innovations as well as how they plan to implement them, they still have difficulty letting go of the control that used to control their traditional styles of teaching (Raino, 2008). Professional development is one tool that can help teachers move beyond the difficulty to let go of complete control in their teaching. However, professional development is not considered to be an infrequent, or one-time aid; professional development should be continuously available and utilized in order for teachers to gain knowledge and skills to enhance their instruction (Webb et al., 2009).

Webb et al. (2009) defines professional development as "any activity that increases teachers' knowledge or understanding and their effectiveness in school and can help raise children's standards and improve teachers' job satisfaction." They also consider other attributes, such as teachers being able to transfer the values and appraisal taken from professional development activities into the development of policies and standards for their educational practices (Webb et al., 2009). The studies conducted by Kovalainen et al. (2001) and Kovalainen & Kumpulainen (2007), they both outlined the idea to continually assess teaching practices as well as how communal inquiry classrooms are constructed and change over time; both studies outlined the main principles of professional development, what it can assess, and how it needs to be an ongoing tool used by teachers. By assessing their own instruction and how to adjust it to meet the needs of students, teachers were constantly aware of the values and responsibilities that are a part of ongoing professional development.

Webb et al. (2009) identifies several factors that contribute to teachers' ability to create professional learning communities that use the knowledge gained from continuing professional development. Their research found key characteristics necessary to be embedded within

professional learning communities: “Shared values and vision; collective responsibility for pupils’ learning; collaboration focused on learning; individual and collective professional learning; reflective professional enquiry; openness; networks and partnerships; inclusive membership; mutual trust, respect, and support” (Webb et al., 2009). These characteristics suggest that through professional development activities, assessing one’s own teaching practices, and working with colleagues in professional learning communities can positively affect abilities to expand original thinking and to alter teaching methods to include new ideas, like constructivism and communal inquiry.

Professional development also has the ability to change and challenge teacher beliefs about education and instruction. For example, Kaasila, Hannula, Laine, & Pehkonen (2008) conducted a narrative case study focused on assessing preservice teachers’ views of mathematics from the beginning to the end of this particular education course. Kaasila et al. (2008) used two questionnaires in order to evaluate changes; “the aim of the questionnaires was to measure students’ experience of mathematics, their views of mathematics, and their mathematical skills” (Kaasila et al., 2008). From the information represented by these questionnaires, Kaasila et al. (2008) assembled an outline of the phases that contribute to changes in teachers’ instruction and their ability to implement it in their teaching practice. Although this research focuses mainly on the content of mathematics, the process teachers undergo in order to change their classroom communities can be transferred to all content areas, especially science. The model constructed by Kaasila et al. (2008) is outlined below:

One	Problematizing current beliefs and practices, in which students accept that their views of mathematics are not the best possible for teaching pupils effectively.
Two	Becoming aware of a new approach, in which students create new personal visions of what mathematics learning and teaching should look like
Three	Exploring and testing alternative beliefs and practices during the mathematics education course, in teaching or in verbalizing new beliefs

Four	Reflectively analyzing benefits, in which students become more convinced of new beliefs they adopt
Five	Changing one's views of mathematics and one's teaching practices

(Kaasila et al., 2008)

Rather than focusing on views of mathematics, teachers can use this model to make similar changes in other content areas; the focus can be adjusted for teacher's to use when teaching science and engaging students in communal inquiry and constructivist learning. The model described above came from assessments of mathematics student teachers; Kaasila et al. (2008) found that in order for teachers to change their views of mathematics and teaching practices, they don't only need to be successful in their math content courses but also in the area of teaching. If teachers are unable to experience success in the actual application of this teaching style, it will be very difficult for them to adopt forms of instruction that focus on student-centered beliefs (Kaasila et al., 2008).

Although it is difficult to completely override a teacher's previous beliefs, the study conducted by Kaasila et al. (2008) shows that by allowing teachers to participate in activities that challenge their epistemologies and assess their knowledge of content, teachers can exhibit a significant amount of change. If continuous education occurs, there is no limit to allowing teachers expand their content knowledge and their ability to implement instruction that differs from that they are most used to (Kaasila et al., 2008).

Raino (2008) conducted an intervention in order to assess the ability of changing traditional classrooms; the three perspectives considered in their study were: "(1) overcoming the gap between adults and children in pedagogical situations, (2) developing children's involvement and agency, and (3) bringing the elements of play and drama to the classroom" (Raino, 2008). While dramatic play is not an essential piece of constructivist teaching or communal inquiry, it is

a strategy that can be helpful in building this type of classroom atmosphere and implementing student-centered instruction. The implications of this study illustrate that although an instructional strategy may not align with traditional practices, it can still affect students and become an integral part of classroom experiences (Raino, 2008). However, Raino (2008) notes the importance of teachers not only planning the activities in open interactions but also participating with students. Relating to the research found by Kovalainen et al. (2001), regardless of which constructivist teaching strategy is implemented, the teacher has many different roles of participation within a community of inquiry. Teachers do not participate to shape what students are learning and discovering; they are a part of the community of learners where students and teachers interact with one another in discussion and activities to promote self-monitored and motivated learning (Kovalainen & Kumpulainen, 2007). The teaching strategies gained during professional development aligned with constructivist teaching cannot just be learned; they need to be put into practice by teachers, reflected upon continuously, and discussed with colleagues in order collectively work together to assess the effectiveness of teaching in alignment with the constructivist theory.

Continuing professional development is not only practiced by Finnish teachers, it is a part of initial teacher education that carries over into the field (Kosunen & Mikkola, 2002). In Finland, there is a much stronger focus on the overall goals of professional development rather than just accruing new knowledge to add to previous mental constructs. Research studies not only aimed at assessing the effectiveness of professional development assisting in teachers being more apt to implementing constructivist instruction but more importantly, they focused on how to actually take the information gained from professional development and put it to practice. The learning communities illustrated by Webb et al. (2009) give a picture of how to focus less on the

products of professional development and more on the process of putting it into practice. Continuing education is only a small part of professional development in Finland; the main purpose of professional development is to use knowledge gained within teachers' professional learning communities (Webb et al., 2009).

Implications

Educational colleagues must be able to use what they have learned and practiced in order to challenge and extend upon other teacher's beliefs and systems practiced in other classrooms (Webb et al., 2009). Due to this being a main goal in the Finnish education system, constructivist learning principles have been more easily instilled within their learning communities. Kovalainen et al. (2001) produced research results that illustrate that communities of inquiry encompass other factors besides the four essential criteria of constructivism; sociocultural values also play a large role in creating classroom environments where students actively engage in the learning process. "From the social viewpoint, the students practice skills in learning to listen to others, giving rationale arguments, respecting different views and critically and constructively responding to them as well as encouraging others to take part in collective meaning making" (Kovalainen et al., 2001). This extends upon the principles of inquiry and constructivism by showing the importance sociological factors play on the ability to build classrooms that are student-centered (Kovalainen et al., 2001).

Research also implicates that the role a teacher chooses to play has a large influence on creating these types of classrooms. "The strategies the teacher was found to use for strengthening collectiveness in the classroom, were orchestrating turns to speak, promoting collective responsibility, and active participation, as well as recalling the rules of participation in the community of inquiry" (Kovalainen et al., 2001). Using these strategies as a tool helps to

increase a student's awareness of the value of their participation as well as the realization that they need to view and exert themselves as members of the classroom community (Kovalainen et al., 2001). Similarly, using the four modes of participation described by Kovalainen et al. (2001) allows students to realize that the teacher is still actively participating; this also helps students to see that the teacher not only enjoys being a part of the community but that teachers learn from the student-led community as well.

Because teachers are open to new forms of instruction as well as assessing the best ways to implement them, constructivist teaching and communal inquiry is heavily engrained into Finnish education across all subject areas. Teachers continuously assess their own teaching strategies and reflect upon their effectiveness individually; however, they also consider all of these factors collectively within professional learning communities (Webb et al., 2009). Webb et al. (2009) identifies characteristics that are key within Finnish school communities: "sharing responsibility and decision-making, inclusiveness (bringing the whole staff together to promote a sense of community and positive relationships and to encourage teamwork and a shared vision for the school.); there is cooperation within schools as well as between school which is essential to the effectiveness of professional learning communities (Webb et al., 2009).

Finland has shown that by providing an educational climate where teachers are trusted, work to develop curriculum together, and challenge each other constructively and respectfully, professional learning communities are created that allow for changes away from traditional instruction (Webb et al., 2009). Although it does take time, by allowing opportunities for social interaction, student-centered engagement, and open communication, 'individuals have the power to reconstruct their social and cultural practices of the learning community through the moment-by-moment interactions across time' (Kovalainen & Kumpulainen, 2007). This applies to

students within their classrooms as well as teachers within their professional learning communities.

A Comparison of America and Finland

An Overview of Education in America and Finland

In order assess how professional development affects constructivist science teaching in America and Finland, it is important to consider the educational policies within each country. Educational policies in the United States are much different than they are in Finland; this may influence the varying abilities to adapt to new types of science teaching with the aid of professional development.

"Finland has attracted considerable attention since 2000, when the Programme for International Student Assessment (PISA) revealed not only the highest level of success but a very little talk of underachievement and a negligible difference between schools. It has sustained this achievement since, ranking at the top in reading, in mathematics, and in science in 2003 and 2006" (Wrigley, 2010). Finland's success has been attributed to the quality of their teachers who are not only highly educated, but also highly trusted (Wrigley, 2010). Teachers work together in order to discuss their issues and apprehensions; by being a part of such a trusting, sharing culture of professionals, teachers are able to generate meaningful solutions with their colleagues which can then be implemented in classrooms to make changes that address previous concerns (Webb et al., 2009). Teachers not only trust each other, but they are trusted by their administration and higher levels of educational staff.

In the United States, there is a set of learning standards that govern the curriculum implemented in classrooms as well as specific, defined learning standards and objectives that must be met at each grade level. Most recently, the Common Core State Standards, employed

nationally, have been adopted by forty-four of fifty states in the nation (National Governors Association, 2010). The national standards used in America were designed by education chiefs and administrators from forty-eight states; the learning standards are focused on education for students in kindergarten through twelfth grade in mathematics and English language arts (National Governors Association, 2010). The mission statement of the Common Core State Standards is as follows: "The Common Core State Standards provide a consistent, clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers. With American students fully prepared for the future, our communities will be best positioned to compete successfully in the global economy" (Zhao, 2012)

As educational professionals gathered in the drafting of these national learning standards, attention was paid to learning standards previously existing among states as well as the knowledgeable and practical experience of various members of the education field; feedback that was given from the public community was also considered during the development as well (National Governors Association, 2010). The website for the Common Core learning standards claims that teachers, parents, administration, and educational professionals from states throughout the entire country were active participants; as a result, this provides evidence that the standards are not only research based but also realistic and applicable in real-world classrooms. (National Governors Association, 2010).

Although these learning standards do not include science or social studies, there are standards that reflect literacy and mathematics as they relate to science and social studies. Although states are considering the Next Generation Standards for science in the future, each

state currently remains using the set of state standards they had used prior to the Common Core's implementation. In New York State, their learning standards and core curriculum are outlined; resources for implementation are also provided (New York State Education Department, 2013). Considering that the Common Core State Standards also include clear objectives as English language arts and mathematics are integrated into science instruction, both documents need to be used and met when teaching the science curriculum outlined by each individual state.

Coupled with state and national learning standards, standardized testing is also mandated at the state and national level. Students are annually assessed on a national level through Common Core assessments (English language arts and mathematics); they are assessed on a state level for social studies and science exams. For example, in New York State, students take performance-based based science exams in fourth and eighth grade (New York State Education Department, 2013). Students are also assessed throughout the school year by their teachers through formal and informal assessments; they are graded on various tests as well as activities and projects assigned by teachers in order to assess their performance and content knowledge. Not all assignments are graded; however, those that are given grades outline a student's performance throughout the school year and are reported to parents and administration quarterly. Education in America is greatly centered on the learning objectives and assessments that are required at the state and national level. Teaching methodologies and curriculum design is chosen for teachers; they are required to adapt to the standards imposed upon them and use the resources given to them within their school district.

Similar to America, Finland has also identified a national curriculum for the country (Brueggeman, 2008). However, the national curriculum used in Finland only illustrates universal goals of education as well as how many lessons teachers are required to teach per week

in order to meet them (Brueggeman, 2008). There are no objectives specified for each content area because teachers and administrators work together to plan the details of their curriculum locally in order to meet the goals of the national standards (Wrigley, 2010). As a result, methodologies and curriculum materials can vary greatly from classroom to classroom because teachers are allowed to choose what they want to use and how they will implement it (Brueggeman, 2008). Although teachers have more individual control over their curriculum and how to put it into practice, schools across Finland are not very different from one another (Wrigley, 2010).

Students in Finland begin school later than students in America; they begin primary school at the age of seven and finish secondary school around fifteen to sixteen years old (Wrigley, 2010). They do not give nation-wide standardized tests to students for which they are held accountable; like the choosing of methodologies and curriculum materials, tests given in Finland created by each individual teacher and given at the teacher's discretion (Brueggeman, 2008). Similarly, schools in Finland assess student progress without using grades until levels five or six, which is at the end of their primary schooling (Brueggeman, 2008). Rather than giving students grades, teachers in Finland create portfolios for each of their students that include student work samples that display their progress developmentally; teachers then evaluate, examine portfolios, and obtain evidence from work samples to describe student progress on report cards (Brueggeman, 2008). Report cards are given to parents twice a year during conferences; however, the evaluations are responses to students' portfolios rather than a classification of grades (Brueggeman, 2008).

Although there are national standards for education in America and Finland, the influence of standards varies greatly between the two countries. Due to the flexibility with Finland's

national standards, the roles teachers play in curriculum development differ greatly. As a result, teachers of each country approach implementing instruction in completely different ways. The question remains whether these differences affect the inclusion of constructivist teaching in science classrooms.

Similarities & Differences: Constructivist Science Teaching & Professional Development

Constructivism

The NSES (National Science Education Standards) in the United States emphasizes the need for quality within learning experiences and inquiry-based, constructivist science instruction is one way for this to be accomplished (Yore et al., 2005). Similarly, Finland recognizes constructivist science teaching as an instructional tool that allows students to build upon their previous knowledge to make meaningful connections to new experiences they encounter (Kovalainen et al., 2001). Both countries encompass similar definitions of the constructivist theory and how it can be implemented in science classrooms. When students recognize variables of their prior knowledge, they can use it to expand and extend their learning through hands-on activities and interactions with their peers (Hartle et al., 2012). Students are active participants of the learning processes they create and indulge in with their peers (Kroesbergen & van Luit, 2002).

There is an obvious similarity between how Finland and America define constructivist science teaching and how it can be implemented effectively in classrooms; each country defines the roles of teachers in this type of instruction similarly as well. Teachers are encouraged to refrain from being the controlling factor that directs instruction, activities students participate in, as well as the discussions they are a part of (Siegel, 2005). Teachers are encouraged to provide students with opportunities to explore questions and problems they encounter instead; this allows

for discoveries to take their own shape based on student contribution (Kovalainen et al., 2001). By taking the backseat in driving instruction to reach a certain predetermined goal, discoveries make and knowledge gained from experiences are more meaningful for students (Kovalainen et al., 2001).

Considering the teacher's role in the classroom, both countries refer to the fact that this does not mean that teachers are inactive members of the classroom environment (Kovalainen & Kumpulainen, 2007). Instead, teachers need to consider factors that need to be adjusted from traditional science instruction in order to create classroom environments that are conducive to inquiry, exploration, and student-led discussions (Pitt & Kirkwood, 2010). Kovalainen & Kumpulainen (2007) describe the importance of defining roles within the classroom environment as well; especially for students who are not familiar with these types of science classrooms, teachers need to allow students opportunities to explore their roles and boundaries within classroom communities of learning.

In Finland, they also focus on sociocultural aspects engrained within the constructivist framework. In America, social factors are considered but not necessarily at the forefront of their implementation of constructivist science teaching. Similarly, in America, inquiry-based learning is more common in science classrooms but rarely seen in other content areas. This differs from Finland, whose classroom environments have continuously been built to incorporate student-led activities and discussions across all content areas; one reason for this may attribute to their view of sociocultural factors being a significant part of effective instruction.

Overall, both countries have similar viewpoints regarding the definition of constructivist science teaching and how classroom environments should be conducive to allowing student-led discussions and explorations. Finland and America define the roles teachers play within this

form of instruction similarly as well; within both frameworks, constructivism cannot be successfully implemented if teachers do not adjust their classroom environments to allow students to be more active but also comfortable sharing their thoughts and ideas. In order to be prepared to do so, Finland and America recommend the need for professional development, continuing education, and being a part of hands-on constructivist experiences as well.

Professional Development

Research has been done in the United States as well as Finland to assess how professional development can influence a teacher's ability to switch from traditional science instruction to a more student-centered constructivist learning environment. Although research in both countries varied in terms of results, there are similarities seen among the controlling factors that can promote, or reduce, the ability of teachers to effectively implement constructivist science instruction. In Finland and America, teacher epistemologies and beliefs and science content knowledge are shown to affect their application of inquiry-based learning within their classrooms (Beamer et al., 2008). In both countries, professional development has the ability to change and challenge teacher beliefs about instructional methodologies, especially as they apply to constructivism. For example, a study conducted by Bencze (2010) showed that when teachers participate in professional development, their beliefs can be changed, they are able to gain confidence in the application of constructivist teaching methods; similarly, professional development helped teachers to increase their content knowledge which helped them feel better prepared to teach science. Raino (2008) illustrated that professional development is a tool that can be used to help teachers release some control by making classrooms more student-centered.

Another factor contributing to professional development having successful effects on teacher instruction is that teachers need to actually participate in constructivist learning

environments themselves (Forbes, 2011). This goes right along with the theory of constructivism itself; if students are expected to learn through the experiences and discussions they encounter, it is important that teachers are able to participate in this type of learning environment in order to actually understand how it is done. Kaasila et al. (2008) shows that teachers to participate in constructivist learning experiences enables them to gain a deeper understanding of why this form of instruction is recommended for use with students. Although teachers may have been taught in traditional-style classrooms, their participation in student-led learning environments can help them steer away from the instruction they are used to.

Professional development is a tool used within both countries to increase teacher content knowledge, challenge their previous beliefs and epistemologies, as well as increase their knowledge of different instructional methodologies. However, especially concerning constructivist science teaching, professional development looks much different between Finland and America as it is practiced. While teachers in America undergo professional development as required to keep their certifications and as mandated by the school districts they work at, Finland goes a step beyond by continuing professional development as it applies to creating effective, professional learning communities.

According to Webb et al. (2009), "Finnish teachers work in in more democratic and equitable school climate with greater opportunities to identify school limitations and to determine creative ways forward." Teachers, administrators, and educational professionals work collaboratively in professional learning communities in order to go beyond continuing professional development by using the knowledge and information gained to adjust instruction to better meet the needs of students. Responsibility is shared and decisions are made inclusively among professionals in Finland's primary schools (Webb et al., 2009). Because teachers have

direct access to curriculum and the ability to modify it, professional development can be utilized more applicably in Finland.

Although educators in the United States participate in professional development that focuses on constructivist teaching, research has shown a discrepancy between in-service teachers and the administrative support being received; there is little advocacy for current, constructivist science teaching from administration in many elementary schools and this affects the teachers trying to better and reform science education (Yore et al., 2005). This varies greatly from teachers in Finland; they are trusted by administration and as a result, they are able to reform their science education based on the professional development experiences they have as well as information shared within their professional learning communities.

Implications

"In the US, criticism of teacher education and education as a discipline has flourished for decades. Targets of this criticism include the low intellectual demands of teacher education and the weak academic qualifications of students and professors" (Toom et al., 2010). Research has shown that although the theory of constructivist science teaching is fairly consistent between the United States and Finland, the implementation of its teaching methodology varies greatly (Webb et al., 2009). Teachers in both countries have participated in professional development aiming to increase knowledge and awareness of constructivist teaching practices; however, there is still a large gap between knowledge and practice, especially when comparing Finland and America.

Because teachers in both countries have access to professional development that supports science inquiry while expanding teachers' content knowledge and challenges previously held beliefs, research implies that professional development is not the lone factor impacting the implementation of constructivist science teaching. Research has shown that in order for

professional development to affect a teacher's current teaching practices, it can't just be a single-time exploration with no support to back it up. Collectively, studies done in the United States and Finland have shown that when teachers are active participants in professional development, great changes can be made within their beliefs and implemented methodologies. However, teachers in Finland have shown to be more apt to grow from these changes due to a more active participation in professional learning communities. Similarly, teachers in Finland are highly trusted and receive a tremendous amount of confidence and support from their administration Wrigley, 2010).

There are many implications resulting from comparing science education and professional development in Finland and the United States. First, educators in the United States need to take on the role of being 'teacher researchers,' rather than just teachers of students (Kosunen & Mikkola, 2002). These types of teachers have been present within Finland's school systems for a very long time; they not only focus on student learning, but they consider their experiences, reflect on previous instructional techniques and student responses, continuously expand pedagogical thinking, and combine teaching methodologies in order to optimize student learning (Kosunen & Mikkola, 2002). According to Kosunen & Mikkola (2002), "A lifelong reflective approach is important for a teacher. By participating in the activities of critical teacher communities working 'in the field', teachers and student teachers adopt an investigative attitude, a research-oriented approach to teaching, learning, and education."

Second, teachers in the United States need the support of their administration and colleagues in order to implement constructivist teaching practices more effectively (Beamer et al., 2008). Yore et al. (2005) found a huge discrepancy between in-service teachers and the amount of administrative support teacher's received; there is little advocacy for current,

constructivist science teaching from administration in many elementary schools and this affects teachers who are trying to better and reform science education. If school personnel or the community do not believe in the principles of constructivism, the implementation of it within classrooms is extremely difficult (Haney et al., 2003).

Lastly, teachers need to participate in inquiry-based learning environments in order to gain insight on constructivist teaching methods as well as form connections between the instructive practices they've previously experienced and methods that are currently effective (Forbes, 2011). "When provided with useful models, teachers tend to be open to modifications within their teaching" (Nadelson et al., 2013). By giving teachers opportunities to engage and participate in hands-on, 'student-centered', professional development activities, teachers can come to understand the principles of constructivism by actually doing constructivism (Howard et al., 2000).

Projections

It is obvious that educational policies vary greatly from country to country; however, both Finland and the United States have learning standards that focus on continual improvement and higher achievement of their students (Learning from Finland, 2012). Currently, the Common Core Learning Standards are changing instruction throughout the United States; according to Llewelly (2013), "Adjusting to this reform requires science teachers to shed 'old skins' and tweak the emphasis of their time-honored labs. This will require ongoing professional development. Now is the time for teachers and leaders to work together to embrace this new wave of reform."

Since national learning standards are always going to be at the forefront of our educational policy within America, it is time for teachers to roll with the changes and use

evidence-based teaching methodologies to meet the requirements set forth by the Common Core Learning Standards and Next Generation Science Standards. Romano (2013) argues, "Depending on your school, the subject you teach, or the population of your students, your role in this climate saturated with standards and controversy over standardized testing is highly variable. But all science teachers—including new ones—have a responsibility to advance the progress of science in our schools and communities (Romano, 2013). It is vital that teachers do not continue to fall into the trap of 'teaching to the test'; instead, teachers should use the changes in learning standards in order to implement constructivist science teaching so that students actually expand upon their previous knowledge in a meaningful way so that they can use the knowledge built in order to perform well on mandated tests.

Administrative support is crucial to helping teachers advocate for science as well as implementing hands-on, student-centered instruction. It is also vital for administrators to provide opportunities for teachers to participate in professional development and continuing education that broadens their content knowledge as well as allows them to participate in inquiry-based learning environments so they can expand their knowledge of how constructivist teaching works and how it can be implemented into classrooms. "Within the CCSS curricular approach, one clearly finds a promotion of a basic component of inquiry. Knowledge is to be constructed on open and fair assimilation of new information with that held by the student and teacher" (Callison, 2013). Considering these adjustments and the focus placed on inquiry within the Common Core State Standards, educational professionals are now obligated to allow students to participate in investigations, make discoveries, expand upon their prior knowledge, challenge previously held beliefs, and continuously be active participants in building their own knowledge.

In turn, science education has the opportunity to undergo a reform that students, teachers, and educational professionals can all benefit from.

However, in order for science education to undergo reform, America needs to put less focus on 'learning' standards and more effort into providing effective instruction for students. While the Common Core State Standards include elements of inquiry, it is up to teachers to actually use this type of instruction in their classrooms. "What PISA shows is that a few countries manage to have both high standards of education and equity, ensuring a good education for all. They share certain features of their education systems, including high levels of cooperation, comprehensive secondary schools and long term policy consistency. Such policies can be and are pursued by parties across the political spectrum. These are the countries that have learned successfully from Finland" (Learning from Finland, 2012). By adjusting approaches to instruction and professional development, America can become one of the few countries that not only learn from Finland, but prosper and continue to grow as well.

Moore (2013) identifies Finland's education system as it has consistently ranked at the top of international education performance comparisons. However, research has shown that the United States ranks at the complete opposite end of the spectrum just as consistently. Adjustments made to instruction and professional development are only two elements that influence America's ability to reform education. Clearly, there are many more differences between the two countries other than professional development and constructivist science teaching. Moore (2013) suggests that Finland's education system is so successful because the country goes 'against the evaluation-driven, centralized model' that America and many other Western countries use. The chart below comprehensively outlines the differences between education in Finland and education in the United States:

United States		*Finland*
♦ Students begin school between the ages of 5-6	⇔	♦ Students don't begin school until age 7
♦ Schools are ranked and compared to one another based on test results	⇔	♦ There are no rankings, comparisons, or competition between students, schools, or regions
♦ Standardized tests are mandatory from elementary school through high school graduation	⇔	♦ There is only one mandatory standardized test in Finland, taken when children are 16
♦ US teachers spend a lot of instruction time preparing for and taking tests	⇔	♦ Finland prepares students how to learn, not how to take a test
♦ At each grade level, there are general, special, and inclusive education classrooms	⇔	♦ All students are taught in the same classroom regardless of performance
♦ On average, elementary students get 27 minutes of recess per day	⇔	♦ Elementary students get 75 minutes of recess per day
♦ Degree requirements vary based on each state's teacher certification requirements	⇔	♦ Teachers must have a master's degree (which is subsidized)
♦ The national curriculum is specific and each learning standard is addressed	⇔	♦ The national curriculum is only broad guidelines
♦ There are public schools, private schools, and charter schools	⇔	♦ There are no private schools; all schools are public, state-funded schools
♦ The people in the government agencies and private sectors running schools include business people, military leaders, and career politicians	⇔	♦ The people in the government agencies running schools, from national officials to local authorities, are educators
♦ The US spends approximately 30% more per student	⇔	♦ Finland spends approximately 30% less per student
♦ US high school graduation rates are 17.5% points less than Finland	⇔	♦ 93% of Finnish students graduate from academic or vocational high schools
♦ The US tries to afford equal opportunities for learning but there are socio-economic status has large influences on education	⇔	♦ All students enjoy the same equal educational system regardless of their family backgrounds, social status, races and ethnicities
♦ Only low-SES students that fall under certain criteria are given free breakfast and lunch	⇔	♦ All students receive free meals and lunches at school
♦ Students are given a ton of homework from elementary school on; there is less focus on creative play and more on 'academics'	⇔	♦ Finland teachers give less homework and focus more on creative play
♦ Teachers are not viewed in the same status group as doctors or lawyers	⇔	♦ Teaching is viewed as a prestigious profession and are given the same status as doctors and lawyers
♦ On average, teachers spend 8 hours a day at school and participate in professional development during conference days mandated by their districts	⇔	♦ Teachers spend less hours at school, 4 hours a day, and take 2 hours a week for professional development

(Moore, 2013)

Looking at education in America and Finland more comprehensively shows that there are many more differences than each country's approach to professional development and their abilities to implement constructivist-based science instruction. Although there are hopes that the Common Core State Standards will reform education in the United States, Finland's success shows that implementing new standards is not the only solution; in fact, the standards may make education worse for students by limiting their opportunities to explore and be creative in the classroom.

In order for educational reform to happen in the United States, maybe we need to focus less on learning standards and the politics of education in order to put a greater focus on the quality of instruction and experiences teachers are providing students. In Finland, teachers spend approximately half of the amount of time in school that teachers spend in the United States (Moore, 2013); this is a huge gap considering Finnish students consistently rank at the top of the charts and American students rank much lower.

What Finland continues to show America is that their students succeed because education is valued by students, parents, and the community; similarly, teachers are respected and trusted with students' education and the curriculum implemented. Perhaps the businesses and government of the United States needs to take a step away from education and let the real professionals have a say in what students need. After all, teachers choose to enter this profession because they are passionate and dedicated to the field; teachers are professionals with the knowledge, hands-on experience, and management skills that should be considered well before implementing 'national' standards that all must abide by.

In order for the United States to learn from Finland and strive to reach their levels of educational excellence, it is important to remember that many different elements come into play

and there is no single solution to reforming education; schools face a variety of problems that are complex and solutions must be multi-faceted (Learning from Finland, 2012). Similarly, reforming education is not something that can be done quickly. Learning from Finland (2012) notes that "Finland's 'miracle' mix of high standards and high levels of equity took forty years to achieve." In sum, it not only took time, but there was also a mutual agreement in Finland regarding 'what was needed, limited political involvement in the implementation of policy and, largely as a result, consistency over several decades' (Learning from Finland, 2012).

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