Contrast of the Science Teaching Practices of Two Pre-Service Early Childhood Educators

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Most pre-service and beginning teachers need time and experiences to support their teaching practices as they move from the beginning stages of teaching during internship experiences into teaching in their own classroom. Many early childhood teachers do not have a strong background in science to support inquiry-teaching practices. Teachers are more likely to teach inquiry science when they have experienced it previously and when they have a good understanding of science content.

This case study research investigated the teaching practices of two pre-service early childhood educators during their junior and senior internship experiences while teaching science. Both pre-service teachers had a similar program of study and both used educative curriculum materials during their senior internship teaching experiences to teach science.

The Views of Science Inquiry instrument was used at the beginning and end of the research along with observations and interviews to explore their science teaching practices. Results of this research confirm that although teachers may have access to the same curriculum, their own background, experiences and beliefs influence their classroom practices especially regarding the implementation of scientific inquiry. Educative curriculum materials supported the teachers in teaching through inquiry practices but the extent to which they integrated inquiry was based upon their own beliefs and understandings of teaching.

Introduction

Pre-service teachers are provided internship experiences to support their growing knowledge of teaching practice; this practical experience provides them a platform to learn in action. It provides opportunities to experience what they have learned about in the college classroom setting and encourages putting the theories into practice (Black, 2004). A solid foundation of theory is intended to be taken to the classroom and practiced in this time to complete the final portion of the formal learning process of the undergraduate degree program.

Previous research suggests that beginning teachers lack the skills necessary to manage the classroom and the pedagogical content knowledge that supports them in the
specific teaching of science. Shulman (1996) defines pedagogical content knowledge as the subject matter knowledge that supports appropriate teaching practices. Early childhood teachers are also considered ‘generalists’ and may not have a strong science background to support teaching for conceptual understanding (Weiss, et al., 2001). Lastly, many teachers lack specific experiences in scientific inquiry and therefore may not practice this in their teaching of science (Davis, et al., 2006). This study explores the journey of learning to teach science for two early childhood students during their junior and senior internship experiences.

**Review of Literature**

Teachers have years of classroom experiences as a student that influence their thinking and practice. They tend to teach ways that are comfortable to them, which generally involves a replay of past experiences. Everett, Luera and Otto (2006) indicate that teaching is the only profession where people have been involved in observations for years prior to their professional studies in the field. Plevyak (2007) explains that most experiences the pre-service PreK-3 teachers have had in science involved direct instruction. These previous experiences did not involve the learner in science and did not promote higher-order thinking skills or inquiry practices.

**Teaching Skills**

Teachers develop many skills through their experiences of teaching these include pedagogical skills and pedagogical content knowledge. Pedagogical knowledge refers to general strategies for teaching. Pedagogy is the art of being a teacher and pedagogical knowledge includes the style or methods of teaching. Gee et al (1996) emphasize the use of social interaction in learning, building instruction on prior knowledge, problem solving and higher level learning as important components of pedagogical knowledge. Hudson (2004) has also identified different aspects of pedagogical knowledge that support new teachers in teaching science. Some skills include planning, timetabling, preparation, implementation, classroom management strategies and questioning skills.

One challenge for teachers is to create a classroom learning environment that is productive and manageable. Davis, et al (2006) states that although new teachers want their classrooms to be student-centered the concerns they have about classroom management may work against that goal and lead them into engaging in less reform-oriented practices. Research on teaching abilities has expanded to include more than just general teaching practices to support classroom learning. Shulman (1996) identified three categories of content knowledge including subject matter content knowledge, pedagogical content knowledge and curricular knowledge.

Content knowledge refers to the amount and organization of knowledge, which goes beyond knowledge of facts and concepts into an understanding of the structures of the subject matter. Pedagogical content knowledge (PCK) deals with the subject matter knowledge for teaching. PCK includes the ways of representing and formulating the subject so it is understandable. Curricular knowledge has to do with the curriculum and the range of programs designed for teaching different subjects or topics at various grade levels. In this area, teachers must consider the curricular alternatives that are appropriate for instruction
when teaching specific subjects of the curriculum. These types of knowledge affect teacher practice and their ability to implement inquiry.

**Teacher Inquiry**

Inquiry is a teaching method aligned with research on how children learn and is a central component of the Content Standards for Science. According to the National Research Council (2000) inquiry “encompasses not only an ability to engage in inquiry but an understanding of inquiry and of how inquiry results in scientific knowledge” (p. 13). Inquiry is advocated as an important practice in teaching science. It has benefits for children because it is aligned with how children learn. Inquiry learning is a dynamic and interactive process where children bring their current ideas, and through interactions with the environment, teachers and other students, they can reorganize, redefine or replace their initial explanations.

The National Research Council (1996, 2000) has identified five essential features of inquiry. These features include: engaging in scientifically oriented questions, gathering evidence, developing explanations based on evidence, evaluating explanations in light of alternative explanations and communicating and justifying proposed explanations. Some inquiry activities will not be considered full inquiry because they will be missing some of the essential features of inquiry and will, therefore, be considered partial inquiries. “The degree to which teachers structure what students do is sometimes referred to as ‘guided’ verses ‘open’ inquiry (NRC, 2000, p. 29). These distinctions are made according to the degree of control or responsibility the students have in regard to asking questions, developing investigations and communicating their findings.

Guided inquiry indicates that the teacher has more control in the structure of the lessons and in open inquiry the students gain more control in the overall inquiries. Many early childhood educators are not equipped to teach through inquiry, as suggested by the National Science Education Standards. Davis, et al. (2006) discussed that to teach inquiry-oriented science, teachers must have strong understandings of inquiry and abilities to teach inquiry. Her analysis of findings emphasized that many pre-service teachers have unsophisticated understandings of inquiry which would not facilitate teaching with this approach.

The National Research Council emphasizes the need to prepare teachers for inquiry-based teaching. “For students to understand inquiry and use it to learn science, their teachers need to be well-versed in inquiry and inquiry based methods (2000, p. 87). They further emphasize that most teachers have not experienced science through inquiry or conducted scientific inquiry themselves.

Weiss (2001), indicated from survey results of elementary teachers, that 65 percent of teachers reported a moderate or substantial need to learn more regarding how to use inquiry-oriented teaching strategies and 63 percent of teachers surveyed indicated they need support in understanding students’ thinking in science. These pedagogical gaps relate to areas specific to the teaching of science.
Methodology/Data Collection

This research was guided by a case study approach. Two pre-service early childhood teachers participated. The teachers completed the Views of Science Inquiry instrument (Lederman and Ko, 2003) followed by an interview which encouraged them to clarify their own ideas on the instrument. Next, each teacher was observed teaching science in their internship site. They were initially observed teaching lessons of their choice guided by their internship teacher.

Observations were conducted using the Field Supervisor Observation Instrument developed by Windschitl (2004). The pre-service teachers were then observed with the same instrument teaching a science unit based upon the CASES educative curriculum materials. The Curriculum Access System for Elementary Science (CASES) curriculum was developed by the CASES research group at the University of Michigan (http://cases.soe.umich.edu/index.html).

During the science teaching, the pre-service teachers were asked to reflect upon their teaching. While teachers were using the CASES curriculum, they were interviewed to ascertain their use of the educative curriculum materials and how they were supportive in their teaching. At the conclusion of the research, the Views of Science Inquiry was once again administered along with an interview to obtain changes in teachers’ knowledge, beliefs and understandings of science and teaching inquiry.

Views of Scientific Inquiry Instrument

The VOSI-E (Views of Scientific Inquiry- Elementary School Version, Lederman & Ko, 2003) seeks to understand views about what work scientists do and what entails doing science. The goal is to seek an understanding of perceptions related to science inquiry. Specifically, this instrument assesses the development of the following ideas related to scientific inquiry. One, investigations have multiple methods and purposes. Two, there should be a consistency between evidence and conclusions. Three, data can be interpreted in multiple ways. Four, there is a difference between data and evidence. Five, data analysis involves the development of patterns and explanations.

The CASES Curriculum

The CASES website has two K-2 early childhood science units that have been developed with educative features and eight unit/lessons that have been developed for grades three to five. The educative features of these curriculum units include an introduction, driving questions, standards, science background, students’ alternative ideas, unit lessons, assessment and ideas and resources. The CASES curriculum units have outlined educative supports including Use of Inquiry Practices, PCK Instructional Strategies, PCK Curricular Rationales, PCK Alternative Ideas and Subject Matter Knowledge.
Data Analysis

Data analysis for this research involved an evaluation of the Views of Science Inquiry – Elementary version (VOSI-E) instrument. Analysis also included examining, categorizing and tabulating the data from the Field Supervisor Observation instrument (Windschitl, 2004) along with the teacher reflections (Yin, 2003). Specific techniques included pattern matching and explanation building. Data was organized topically and sorted to look for patterns.

Merriam indicates that “in addition to the participants’ own categories, classification schemes can be borrowed from sources outside the study at hand” (p. 137). Categories were established that connected to scientific inquiry to ascertain how the pre-service teacher is integrating these into teaching practices. Specifically, the five essential features of inquiry were identified in lessons to indicate if teachers were able to implement inquiry with students: engaging in scientifically oriented questions, gathering evidence, and developing explanations based on evidence, evaluating explanations in light of alternative explanations and communicating and justifying proposed explanations (NRC, 2000).

Case One: Pippa

Pippa is a Caucasian female in her early forties. She was a nontraditional student who earned her degree over an extended period of time. At the beginning of the study, Pippa was in her junior internship experience in a third grade self-contained classroom in a public school. In the second part of the study, Pippa was participating in her senior internship experience in a kindergarten classroom. Pippa had prior experiences with teaching in the school system. A review of the initial instrument used with Pippa indicates that she has naive views of scientific inquiry and is not confident in her ability to teach science.

On the Views of Science Inquiry (VOSI) instrument, Pippa responded in a general way to the question, “What types of activities do scientists do to learn about the natural world? She explained that scientists attempt to explain and discover events occur in nature. She further explained scientists are guided by the science process skills in doing their work, but in the interview added that this could follow a scientific method format but could be broader. She was not aware of how this method might change; only that it may not be a strict lock-step method.

The VOSI instrument provided an example of a scientist that observed birds and made decisions based upon her observations, asking if this work was scientific. Here, Pippa indicated the work was not truly scientific because she did not investigate the birds’ beaks. Her response shows a more limited view of scientific inquiry because she believes that in an experiment you would need identification and manipulation of variables and controls which aligns with previous research by Schwartz (Schwartz, 2004). Pippa believed that it was not an experiment and she explained that it was observation. She didn’t have an understanding that even though it was not an experiment, it can still be scientific in terms of a broader view of scientific inquiry.
Science Teaching

Pre-CASES Lessons

In the lessons Pippa implemented prior to the CASES curriculum, Pippa indicated that science content was an issue during her preparation and implementation of the lessons she taught and that some of the lessons would not really qualify as actual science lessons but reading lesson with a science text. The observations of Pippa’s lessons did not show strong components of scientific inquiry.

The five areas identified by the National Research Council (2000) and Windschitl (2004) related to inquiry are: scientifically-oriented questions, analysis of data, scientific explanations, connects explanations and communicates and justifies explanations. In the first two lessons, Pippa only engaged in scientifically oriented questions but did not delve further into inquiry. They were also at the lowest variation of questioning, “Learner engages in question provided by teacher, materials, or other source” (Windschitl, 2004). Also, the questions were not driving questions but used to interact with students and to ascertain their knowledge of a topic.

The focus of the lessons was not inquiry. The last lesson, which was based on reading a science text selection on light, did not include any actual science investigations. In this lesson, Pippa used a KWL chart; this did allow Pippa to move from the lower end of the spectrum where the learner engages in questions provided by the teacher to a higher level in which the learner poses the question. T

This is the first lesson that included the higher level of inquiry, which allowed children to consider their own questions. Students developed a number of questions on the topic of light such as; Would a light bulb melt ice? Would a bulb burn out if you kept it on for an hour? Why are stars so bright at night? And, why does light bounce off mirrors?

CASES Lessons

Pippa taught five lessons from the CASES plant unit during her senior internship in a kindergarten classroom. The classroom consisted of 16 students. Pippa indicated she was excited to teach the lessons from the CASES curriculum. Her senior internship site was a kindergarten classroom, which did not implement much science. She taught the CASES science lessons on the topic of plants one day a week over a five-week period. Pippa followed the CASES lessons in a very specific manner. She enacted them very closely to the way they were developed.

Pippa seemed very comfortable and even excited about the lessons and the student involvement during them. Her own excitement was visible as she introduced each lesson and engaged children in the topic of seeds. The children in the classroom showed their own excitement about the lessons.

“Whether I did a good job teaching or not, I really enjoyed doing (science) with those poor science starved children. They seemed to have a good time too, which is even more rewarding. (It really does concern me that this area of the curriculum is so neglected)”.

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Several aspects of scientific inquiry were visible in the CASES lessons.

“I feel that they were involved with inquiry, but at its most basic level of guided inquiry due to the questions begin provided for them. This, I think is an appropriate level for kindergarten students due to their limited exposure to science and consequently limited background knowledge”.

When referring to the essential features of inquiry, many aspects were apparent in the CASES lessons taught by Pippa. Each lesson was developed around a central question. These questions came out in each lesson. Questioning is a key feature of scientific inquiry. The CASES lessons used generally provided the question for students to pursue. In the lessons taught by Pippa, students did not engage in any questions that they developed themselves.

Another aspect of inquiry is evidence gathering, students collected evidence in each lesson that was taught in the plants unit. Communication was another aspect of the CASES lessons that was integral in Pippa’s teaching. All of the lessons that Pippa taught included at least 4 or 5 of the five essential features of inquiry.

Overall, Pippa implemented the science lessons in ways that facilitated children’s thinking and inquiry practices. She proved to be thoughtful regarding the management of lessons and prepared carefully and thoroughly.

Crawford (1999) felt that most teachers would have difficulty with inquiry because they lack the understandings of pedagogical content knowledge and the ability to make the learning of specific science content accessible for students.

Pippa did use resources available to her in considering inquiry and the teaching of plants to her students but she was able to use the curriculum to meet the needs of her students. She conducted research on the science topics to develop her own understandings, she collected and analyzed seeds to fully experience and understand the lessons prior to her implementation. She also spoke to other educators she considered to be resources to consider the implications of instruction and how different aspects of the instruction would play out in the enactment of lessons.

Pippa commented that the CASES curriculum was a ‘thinking’ curriculum. “You don’t need to bribe kids to get involved because it is engaging”. Pippa felt that using the CASES curriculum was her first real experience in teaching science. She did teach the pre-CASES lessons but did not really consider them science lessons. “They were mostly reading or review lessons with some science topics but not actual science”.

Two features that she felt were very valuable to her in planning and teaching with the educative curriculum were the background information and children's alternative ideas related to the content. "If you don’t have an understanding of what most children think on the topic, you can’t really address those ideas in your lessons.”
The CASES curriculum helped her to understand what students might be thinking regarding the topic of plants. It also helped her to know how to respond if the alternative ideas came up in the lesson.

At the end of the research, Pippa was given the Views of Scientific Inquiry instrument again. Initially, her answers to this instrument seemed quite similar to the initial instrument, but her interview proved insightful into Pippa’s developing beliefs regarding scientific inquiry.

She was asked if there was just one scientific method that should be followed in investigations. “Inquiry is broader. I was thinking about the two and confused them. I don’t think it (science inquiry) followed step-by-step method. The scientific method is portrayed that way in science projects.” Then referring to her science investigations with students, she said “We were not going in a linear fashion but rather coming around revisiting things. You see connections and you go back to something again and revisit... not step-by-step - more learning takes place. The terminology (scientific method) remains from science projects in the past”. This response indicates that Pippa, through her teaching experiences, has expanded and broadened her view of scientific inquiry.

Case Two: Alexis

Alexis is a Caucasian female in her late twenties. She was not a traditional student but earned her degree over an extended period of time. Alexis was in her junior internship experience in a first grade team teaching classroom in a Central Florida public school. Two teachers co-taught in this room with a total of 28 children. Alexis' senior internship placement was in a Kindergarten classroom. Her first experience teaching took place in her junior internship classroom when she first taught science for this project.

Alexis’s overall responses on the VOSI instrument showed that she has a variety of ideas related to scientific inquiry, some accurate and some not. When asked about the kind of work scientists do, Alexis provided a general answer. “They do experiments to find a better way for us to live longer and healthier”. When provided with the example of a scientist observing animals, she believed the work was scientific but not an experiment.

Here she indicated the scientist only observed. When further asked how the observation could be made an experiment, she said she didn’t know how. She also added that experiments were more fun but that observation was fine also. Here her belief seems to be that experiments were not necessary to gather scientific evidence.

This response shows some understandings of a broader view of multiple methods to conduct scientific inquiry but she is not able to clearly articulate additional methods. The comment regarding experiments being more fun does not adequately express that observations are a part of experiments and they can be the basis of scientific information if they are conducted over time and they develop patterns.

Regarding why scientists have different ideas about the extinction of dinosaurs, she emphasized this was due to religious beliefs. She believed some scientists are moving beyond scientific facts and are influenced by their religion. In the interview, she addressed
that evidence was needed for drawing conclusions. When regarding the development of new medicine, she said, “Scientists need hard evidence and to be able to back it up”. On the one hand she sees the need for hard evidence but indicates that some scientist may not use hard evidence or the facts due to their religious background. These views appear to be contradictory.

Alexis also provided an example of her daughter, who just does experiments without even knowing it, as opposed to what might be done in a classroom or by a scientist. It seems she realizes to some extent that there are different methods to do science but she appears to still be clarifying her own understandings of scientific inquiry.

Science Teaching

Pre-CASES lessons

Alexis' first internship experience took place in a first grade classroom with 28 students and two teachers in a team teaching situation. Alexis taught her first science lessons from a scripted curriculum that was used by the school. The lessons included a flip chart with pictures and facts for students to review. In her lesson reflection, she indicated that in the first lesson, she was not prepared to teach and that she needed more information regarding the background of energy.

Alexis was also overwhelmed trying to provide hands-on activities to 28 children in the lessons she taught. The science lessons were Alexis’ first teaching experiences, as she did not have prior experiences in the classroom environment. In all of the pre CASES lessons that Alexis taught, scientific inquiry was not a strong component. Questioning was used in most lessons but at the lowest level where the learner engages in questions provided by the teacher, materials or other sources (NRC, 2000: Windschitl, 2004).

Most questions were used in a question/answer format to facilitate discussions. In the last lesson taught by Alexis, she also integrated communication at the lowest level, "Learner given steps and procedures for communication" (Windschitl, 2004). In this lesson on insects, children shared their ideas about their favorite insect. Alexis’ implementation of the pre CASES lessons did not demonstrate scientific inquiry, strong pedagogical knowledge or pedagogical content knowledge. Some factors that influenced the struggle with these lessons were a general lack of support from her teachers and classroom management issues.

CASES Lessons

For her senior internship experience, Alexis interned in a kindergarten classroom. Science was not a strong focus in this classroom but Alexis had a certain amount of autonomy and flexibility to include science in her whole group activity time or circle time. The inclusion of science in circle time created a more direct instruction approach to science along with center type activities.

The direct instruction included Alexis reviewing important concepts with the whole group and then during center time, students were involved in activities related to the
concept. Alexis taught 4 lessons from the CASES unit on plants in her senior internship classroom. Schneider and Krajcik (2002) found evidence from classroom enactment that indicated teachers did use the educative features in the lessons. Examples from Alexis’ lessons also indicate that she was using the features provided in the CASES curriculum to support her teaching practice. She used a number of the strategies to support teachers in her implementation of the lessons.

Scientifically oriented questions, data collection and communication of findings were the three essential features of scientific inquiry that were most apparent in Alexis’ teaching. She also implemented explanations to some level in her CASES lessons. The extent to which the CASES curriculum materials were supportive in this research was dependent upon “how the opportunity is used by the individual” (Davis and Krajcik, 2005, p. 4).

This research appears to indicate Alexis was limited in her full acceptance and implementation of the curriculum materials because of other classroom factors such as the science time during the circle time in the classroom, and the management of students during the science lessons.

Alexis indicated that she really liked the CASES curriculum and felt that it was supportive in her efforts to teach science inquiry.

“I actually like science, I do like it better, and I feel more comfortable with it now that I have some research. The program [CASES] does give you all the facts you don’t have to do much digging. To me it was a hard subject to teach because you need to know all the facts; you don’t have to do too much digging”.

Some adaptations were made to the curriculum in the CASES lessons. Beyond the materials that were provided for her, Alexis still found that she used the internet to support her own background knowledge when teaching the lessons. She mentioned that she searched the topic of plants to support her own learning prior to teaching students.

Alexis decided her students needed additional support or background knowledge in her lessons. In most CASES lessons, she added a review of pertinent concepts to support her children’s ideas. She also included a literature selection at the beginning of one lesson. She indicated the book helped children to understand how seeds might move. These adaptations do display Alexis’ belief that children need support in their learning and that the scientific activities will not provide sufficient experiences to build their understandings in science.

Forbes and Davis (2007) discussed the tension that many teachers have between textbooks guided lessons and inquiry-based activities. Although Alexis indicates she believes inquiry is important, she still believes the textbook or other sources have vital information that the students should know up front. She mentioned that she had read the book and changed other aspects of some of the lessons.
When asked if this took away from the lessons being inquiry, she said, “At this age level, no, because I think they need some background knowledge. They wouldn’t have predicted the way seeds moved.”

Alexis’ ideas in the pre- and post-Views of Scientific Inquiry instrument were similar. Her main belief is that experiments are the main avenue for scientists to do their work but did indicate they could use observations and research. She also indicated that she thought the scientific method was a “more like a procedure and that inquiry is just looking and digging for stuff without an explanation at the end, without knowing the outcome”.

So although she does seem to understand science could involve more than just experiments, she could not clarify how observations would be considered research. Also, her definition of inquiry initially may sound like it is just messing around or playing around but she did clarify that in inquiry you don’t know the outcome. She had not clarified her stance on data and evidence and why they are significant in inquiry. On the whole, these beliefs demonstrate some understanding of inquiry but not an in-depth knowledge.

**Contrasting the Two Teachers**

The pre-service teachers used the CASES curriculum materials in a variety of ways. The ways materials were used contributed to their enactment of lessons and further to their development as teachers of science in this research. Davis and Forbes (2007) state, “Curriculum materials possibly exert the most direct influence on day-to-day classroom activity in which teachers and students engage” (p. 2).

The CASES curriculum materials did prove to be influential in science teaching practices. Pippa implemented the CASES curriculum in ways that were aligned with the intention of the materials. She did not appear to experience conflict regarding the implementation. Alexis was constrained in her use of the materials by time and classroom management.

Science was not a priority in her class but integrated into the broader learning goals of circle time. She took away from other content areas to accomplish the lessons that she did teach. She also looked to find lessons that would fit into the time frame, which further influenced her enactment of the curriculum. Thus causing her to disregard the overall building of ideas through the curriculum, instead, picking and choosing lessons that fit the criteria.

The extent to which the CASES curriculum materials were supportive in this research was also dependent upon “how the opportunity is used by the individual” (Davis and Krajcik, 2005, p. 4). Pippa clearly strived to reach understanding of the materials and how they would be supportive of children in their inquiry and in the content of plants. She further used the materials along with her own research to pursue a true understanding of the content and the lessons.

Alexis was willing to do the science lessons but adapted them based on her own ideas about science, how children learn and their abilities. For each lesson she taught, she
did not allow the children an opportunity to develop their ideas about science concepts on their own, but began each lesson with the information up front.

One interesting area that surfaced in this study was teachers’ ability to implement scientific inquiry. In order for teachers to implement scientific inquiry, they needed stronger knowledge and experience in how to manage the classroom during the active learning that took place. Pre-service teachers do need support in teaching science and in particular teaching through scientific inquiry.

Previous research has shown that “pre-service teachers, given certain caveats and adequate support can feasibly create inquiry-based environments similar to those advocated in the standards” (Crawford, 1999, p.37). Gado (2005) also advocated for support for early childhood teachers to develop their competence and comprehension of teaching inquiry.

The CASES curriculum does provide the built-in supports for teaching inquiry. During this research, both teachers included more components of science inquiry when using the CASES educative curriculum compared to when they taught on their own science lessons. The CASES curriculum does provide specific supports that are built-in to the curriculum so that teachers can better implement scientific inquiry.

These findings align with previous research by Petish (2004) regarding the use of educative materials which served to expand the teachers’ repertoire of instructional strategies related to inquiry. Questions were a big part of the curriculum and inquiry. Pippa included the use of driving questions in her lessons and both Pippa and Alexis used scientifically oriented questions as a focus for lessons.

Other features of inquiry that were present in the teaching included evidence gathering. Both teachers implemented some evidence gathering or data collection practices in the CASES lessons. This was mainly in the form of observations and classification. Pippa worked with students to emphasize the need for accuracy when making observations and encouraged children to make detailed drawings and use the correct colors, "so that if someone else looked at your drawing they would know what you had drawn".

Alexis provided information to students at the beginning of the lesson instead of allowing them to gather their own evidence, if students made observations she did not always have them record their findings. Neither of the teachers went further in the area of evidence gathering to support students in analyzing information in the following ways: double check information, repeat experiments or verify accuracy as suggested by the NRC (2000).

The development of scientific explanations is an important aspect of inquiry because it helps children make sense of science (NRC, 2000). The third essential feature of inquiry is the learner formulates explanations. The CASES curriculum emphasizes the process of having children make a claim using their evidence to explain why. Pippa regularly asked children to explain why they thought something. For example, when the students indicated they thought a seed would travel by water, she asked, "What was it about the seed that made you think that?" Alexis did ask students to explain their ideas during
science lessons but she also began the lessons with explanations in the form of a mini lesson of the content.

The fourth feature of scientific inquiry that was a part of the CASES curriculum was “learners connect explanations to scientific knowledge” (NRC, 2000). In the CASES curriculum this aspect of inquiry was incorporated into the formation of scientific knowledge aspect. The NRC (2000) clarifies that investigations provide the context for developing definitions and the associated science understandings.

Pippa was comfortable with allowing her students to construct their knowledge on their own. She did bring in scientific knowledge when it was a part of the curriculum such as the inside a seed lesson where she shared a diagram of the seed and its parts with students at the end of the lesson. In one lesson Alexis began by reading a book about how seeds travel, students then examined the seeds. Next she asked the students to explain their ideas into a microphone. She would respond to the students saying, "Why do you think so?" So she did emphasize the need for children to consider their ideas but she also provided information before the actual student involvement to support their development of ideas.

Aligned with the development of explanations as a feature of inquiry is communication. As mentioned above, Alexis did encourage this when students shared their ideas by talking into a microphone. This communication can also support clarification of ideas for the students as they share their ideas with others. Pippa also included a variety of ways that allowed children to communicate their understandings including drawings, verbal explanations in class, class charts and seed charts as ways for children to share their ideas and understandings of the content.

Classroom management skills and pedagogical skills were a factor when comparing the two pre-service teachers and their ability to teach science. The findings indicate that Pippa was better able to manage the classroom in order to teach science. Science may be a more active subject area when children are engaged in their learning and therefore harder for new teachers to manage.

Pippa had previous experience with children in schools which appeared to support her ability to manage the science lessons. Alexis struggled to maintain control of the students while teaching science. She worked through each lesson she taught in order to find ways to manage and facilitate the active nature of teaching science.

**Conclusion**

Research from Crawford has indicated many beginning teachers would have difficulty with inquiry because of their lack of pedagogical content knowledge. “The ability to adapt and mold instruction in response to student-centered inquiry appears a likely stumbling block for novice teachers who have difficulty with improvisation during interactive teaching” (Crawford, 1999, p. 7). In this study, Alexis was focused on general management strategies and, therefore, was not able to really consider the most effective strategies to support children’s learning of science. This finding may indicate that teachers must reach a certain level of competency in management prior to moving forward in inquiry practices and the strong consideration of how they support children’s learning. Pippa was
the exception to Crawford's ideas in this case study. She was able to overcome obstacles in order to fully accept and understand how to teach using this curriculum including the use of many inquiry practices.

In the field of early childhood education we realize that each child is unique and brings a wide range of experiences that impact their understandings of content. Teachers also bring to their teaching a wide variety of experiences, which have formed their views of teaching. We must look to these views and beliefs to help us understand and support teachers in their movement towards inquiry based teaching practices.

This research demonstrates that although educative curriculum does provide supports for teachers when implementing scientific inquiry, other factors must also be considered. A teacher's willingness and openness to learn and teach inquiry can also be influenced by the teachers' classroom management and beliefs about children's abilities and how they learn. Teachers ideas and understandings of scientific inquiry also influence how they use curriculum materials in practice.

References


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