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Developing an Online/Onsite Community of Practice to Support K-8 Teachers' Improvement in Nature of Science Conceptions

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1. Introduction

Research shows that teachers do not have adequate conceptions of science as inquiry and must be exposed to both content and pedagogical demands of inquiry to effectively teach using inquiry (Anderson, 2002). These results are especially unfortunate for the teacher and the learner because understanding of science as inquiry is reciprocally related to understanding important aspects of the nature of science (NOS) (Akerson, et al., 2008). This problem is coupled with the need to teach NOS and inquiry throughout all elementary grades (NSTA, 2000). Most elementary teacher preparation programs do not include specific courses on NOS or inquiry, and what teachers learn is usually embedded in a science methods course (Backus & Thompson, 2006). Certainly teachers can conceptualize and teach NOS once they understand it, are convinced of its importance, and have strategies to teach it to their own students. Professional development programs can help teachers attain these goals. We have found communities of practice (CoP) (Wenger, 1998) especially useful when working with inservice teachers in terms of helping them conceptualize and to teach NOS when used in an on-site professional development program (Akerson et al, 2009; Wenger, 2002). The CoP enabled the teachers to be committed to a vision of reform in their teaching, and to share ideas and provide peer feedback. To develop a COP there must be *mutual engagement* around a shared theme in which participants are engaged with colleagues, and share and respond to ideas in the context of the theme (in our case, NOS). In addition, a CoP should have a shared mission (*joint enterprise)* in which the community works toward a common purpose (for us, improving science teaching). Also, a CoP must include a *shared repertoire* of ideas, techniques, practices, terminology, as a needed outcome for the CoP and its participants (for us, shared strategies for NOS instruction) (Kerwald, 2008; Wenger, 1998; Wenger, 2006).

CoPs are useful in improving NOS conceptions and practice for inservice teachers (Akerson, et al., 2009). However, inservice elementary and middle school teachers may have difficulty attending traditional university science education courses or professional development programs meant to serve as CoPs due to their proximity to universities, work constraints, families and other various responsibilities, which may limit their participation in a NOS CoP. Research shows that teachers do not have adequate conceptions of NOS that would allow them to teach NOS to their students (Akerson, et al 2009), therefore it is vital to explore alternative communities that can support teachers in developing their views and practices. We created and tested the influence of a online/onsite CoP on teachers' NOS conceptions by means of a master's-level graduate course that included inservice and preservice teachers. With the benefits of integrating online coursework and face-to-face discourse, interaction, and hands-on activities, the teachers had opportunities to explicitly reflect on NOS conceptions online and receive feedback from their peers, as well as interact face to face to receive professional development and share ideas. Our research questions were (1) how can we develop a on-site/on-line online/on site CoP to improve K-8 teachers' NOS conceptions and (2) what is the influence of this CoP on teachers' conceptions of NOS?

2. Theoretical framework

We view learning as social in nature that encompasses teacher learning recommendations as forwarded by Putnam and Borko (2000) such as learning being situated in social contexts, takes place by the individual, with other persons, and through the use of tools. We agree with Putnam and Borko that learning takes place through interactions with others, which can be accomplished through a community of practice (CoP). Wegner et al. (2002) define CoPs as "groups of people who share concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis (p. 4)." In our study teachers were involved with refining their science teaching and knowledge of NOS, through interacting in an on-line and on-site forum in an ongoing basis. CoPs have been noted to have many common characteristics. Some important aspects of a learning community include (1) Commonality, which includes participants' shared beliefs, interests, and purposes, (2) Interdependence, which is supported when there is a need and opportunity for a community to interconnect, and (3) Infrastructure, which are the tools, support, and the opportunity for the community of practice to be facilitated (Barab & Duffy, 2000; Barab, Kling, & Gray, 2004; Hung & Chen, 2001; Reil & Polin, 2004). We used this structure of commonality, interdependence and infrastructure to design our CoP as well as to assess how well teachers were interacting in the CoP. Commonality was used through the teachers' interest in improving their teaching of science by taking this course. Interdependence was supported by the on-site discussions and supports provided by peers as well as the on line discussions surrounding science teaching issues. The infrastructure was the on line community that enabled teachers from remote locations to interact with peers, as well as the on site component that allowed for face to face interactions and explorations.

While we know that a solely face to face CoP has been effective for inservice (Akerson, Cullen, & Hanson, 2009) and preservice teachers (Akerson, Donnelly, Riggs, & Eastwood, in press), we acknowledge that other models of developing a CoP may be as effective with the ability to support and provide outreach to a larger number of teachers. One such model could be a on-site/on-line model that could integrate face-to-face as well as on-line communities to allow teachers from remote areas to interact with teachers who may be fortunate enough to be close to on site professional development opportunities. The on-site/on-line model we explored had an in-depth and reflective on-line component, as well as an on-site face-to-face component that enabled teachers to interact with instructors through inquiry activities that supported their NOS learning as well as share ideas and feedback on site.

3. Literature review

In this section we describe the literature that informed our development of the on-site/on-line course for NOS instruction. We explore literature related to on-line communities as professional development, improving teachers' conceptions of NOS and how CoPs have been used as to improve teacher knowledge and practice.

3.1 On-line communities

Research has shown that on-line communities have been successfully developed through the use of various tools. Vavasseur and MacGregor (2008) found that opportunities to engage in online communities have increased teachers' self-efficacy through the sharing of ideas, discussion of issues, and the making of connections with colleagues and principals. They also found that online discussion allowed teachers to communicate more frequently than in face-to-face only courses. Stagg, Peterson and Slotta (2009) noted that reserved teachers who may not have participated in face-to-face activities were very engaged in online communication. Online forums allow the instructor and students to think about the discussion topic and respond to one another directly. Additionally, Stagg Peterson and Slotta found that the "lasting aspect of written ideas allows students to more easily respond to and build on contributions of others, leading to a more resonant development of ideas" (p.122).

3.2 Communities of practice

Of course, "creating a CoP" cannot be solely the responsibility of the professional developers. That would be imposing a community on others. Therefore the learning experiences must be open and flexible, and facilitators need to be willing to personalize the CoP for the participants. We endeavored to connect teachers from different types of school communities as well as two different states together and to provide them with supports to enable them to engage and communicate with one another. We used Robertson's (2007) recommendations for building a CoP: (a) fostering dedication of the teachers to the program and the process, (b) holding open communication between all participants, including facilitators, (c) respecting and striving to understand different perspectives, (d) motivating and developing ownership toward a shared vision, and (e) establishing a positive collaborative environment.

Leite (2006) has found that teachers want to be part of a CoP. Teachers enjoy and appreciate the community they find even if they are isolated in their own school settings. Within a CoP teachers need to be free to raise and discuss issues (Leite, 2006) and provide feedback to one another (Shen, Zhen, & Poppink, 2007). Multiple voices of teachers should be heard and encouraged in the CoP. This encouragement should take the form of the facilitators structuring "good conversations" that trigger teachers to take perspectives, develop personal and professional authority, as well as helping teachers learn to engage with students (Snow-Gerano, 2005).

3.3 Nature of science

We recognize that there are components of NOS that are not applicable to K-8 classrooms, and have decided to use the NSTA Position Statement for K-12 students and National Science Education Standards requirements for K-4 and 5-8 because they are what teachers will be responsible for teaching (NRC, 1996; NSTA, 2000). Though our teachers who participated in this program were not high school teachers, we believed it important that they understand all NOS aspects that twelfth grade students should understand upon graduation. These aspects are (a) scientific knowledge is reliable and tentative, (b) no single scientific method exists, though there are shared characteristics of scientific approaches (e.g. inquiry approaches that require empirical data), (c) imagination and creativity play a role in the development of scientific knowledge, (d) there is a crucial distinction between observations and inferences, (e) though science strives for objectivity there is always an element of subjectivity in the development of scientific knowledge, and (f) social and cultural contexts play a role in the development of scientific knowledge (NRC, 1996; NSTA, 2000).

For teachers to be able to include NOS in their instruction, they need to understand the elements above, as well as conceptualize ways to teach NOS to their own students. Prior research has shown that professional development programs can be successful in preparing elementary teachers to conceptualize NOS (e.g. Akerson et al, 2007; 2009) as well as teach NOS (Akerson & Hanuscin, 2007; Akerson & Buzzelli, & Donnelly, 2010). In a previous study we have found that teachers who engaged in a professional development program that took place through a CoP framework improved their NOS conceptions and their teaching practice. The teachers' conceptions of NOS improved substantially as they grappled with ways of thinking about teaching these ideas to their own students. Sharing their ideas with their peers that were members of this CoP enabled them to try strategies and gain feedback in a safe setting. We believe that this kind of CoP, that enables teachers to discuss NOS ideas and teaching practice from their own contexts, can be further enhanced by including teachers that may have even more diverse contexts. In fact, these contexts can be so diverse that it may be difficult for them to attend an on-site class meeting on a regular basis. Therefore, using an online format through which teachers can discuss NOS ideas as well as ways to teach NOS to their own students in their own contexts could prove fruitful for all teachers who are members of this CoP.

4. Context

This CoP included teachers who had registered for an on-line on-site advanced science methods course. We believed that a CoP would benefit most teachers in terms of enabling them to develop their conceptions of NOS and of teaching NOS. The participants represented teachers from areas that were close to the universities and teachers from remote rural districts who were driving long distances due to their lack of proximity to the onsite locations.

4.1 The participants

This master's-level course consisted of seventeen teachers (9 middle school and 8 elementary). Fifteen of the teachers were inservice teachers ranging between 1-20 years of experience. Two of the participants were preservice middle school teachers newly enrolled in a MAT (Master of Arts in Teaching) transition to teaching program.

Of the eight elementary teachers in the class, two taught solely as fourth grade science teachers in which they taught three fourth grade science courses each day. The remaining elementary teachers in the program stated they did teach science in some form during the school year, although it was reported in different amounts ranging from 20-40 minutes every day to teaching it in six week spurts alternating with social studies. Of the nine middle school teachers, at least four of them taught science in the seventh grade. This is of significance because science is tested as part of the statewide accountability testing system in the fourth, seventh, and eleventh grades. Two of the middle school teachers taught ninth grade physical science courses and were allowed to register for the course due to their desire for more professional development in pedagogy and the implementation of various aspects of NOS into their classrooms. Both ninth grade teachers were finishing up the MAT (transition to teaching) program and had just completed their first year of teaching.

At least five participants were from in-state elementary or middle schools, but lived and taught in remote areas of rural Central Appalachia. Due to the distance and type of driving the teachers had to do, some drove 2-3 hours one way each Friday to attend the class. The remaining in-state participants lived closer and driving time and distance were somewhat less of a concern. Two of the teacher participants were from another state and met with one of the two science education professors at their local university for the onsite meetings. They participated in basically the same professional development activities and participated completely in the online aspects of the course. This on-site/on-line onsite/online course model was developed to help provide outreach to teachers who might not otherwise be able to travel or have the time to participate in such a science education professional development or MA-level course.

This course was taught onsite at two different universities by two different science education professors collaborating on the project. They worked closely to ensure the same topics and concepts were covered weekly for the participants at the two different on-campus sites. However, the experiences were the same for all participants for the online aspect of the course because the instructors combined both classes on the same Blackboard course site. We endeavored to develop a CoP for our professional development program to capitalize on the strengths of social interaction. We developed a on-site/on-line model so teachers from two different geographical locations (i.e., Kentucky and Indiana), as well as distances across locations, could interact with one another, share ideas, and provide feedback. Our CoP developed over the term of our course, and used features that are common to CoPs. For example, though we had two different states represented in the community, this allowed us to have both opportunities that are relevant to the local communities, as well as a more global community (Wenger, 1998). Therefore there was a local community at each university site, as well as a larger community that included teachers from both sites. However, teachers at each site were also part of larger communities in their own areas. We sought to create mutual engagement in these communities through the unifying theme (nature of science), shared mission (improving science teaching), and fostering a shared repertoire by providing opportunities to share ideas and strategies for teaching science. These are the components of CoP that are deemed important by Wenger (1998).

4.2 The intervention

The course was designed to introduce concepts of NOS by creating a space through which teachers could interact in a university onsite summer course that was supplemented with online readings, professional development videos, reflection assignments, and discussion board postings that followed and expanded upon the in-class experiences. Appendix A describes the structure and concepts for both the weekly onsite and online experiences and provides a listing of the prompts. The course met during the summer for 4.5 hours on six consecutive Fridays. The onsite aspect of the course used explicit reflective NOS instruction that has been previously shown to be effective in changing teachers' NOS views (Akerson, Townsend, Donnelly, Hanson, Tira, & White, 2008), but extended it by including the on-site/on-line on-line CoP aspect. Teachers were placed in online forum groups based on the grade level they taught (two middle school and two elementary groups) and participated in several weekly activities that involved them implicitly in various aspects of inquiry and NOS. Teachers were encouraged to participate in the activities and reflect on how the various activities related to concepts, their required standards, their classrooms, and their overall philosophy of science teaching. After participating in each activity, aspects of inquiry and NOS were explicitly addressed, usually through group and class discussions, in ways that promoted teacher understanding of science as aspects of content/concept, process, and habit of mind. Also, specific aspects of inquiry such as process skills, essential elements of inquiry (NSES, 1996), and aspects of NOS involving specific values and epistemological assumptions underlying these activities (Lederman, Abd-El-Khalick, Bell, & Schwartz, 2002) were explicitly addressed by participant reflection and class discussion.

The weekly onsite course sessions were supplemented with online components following each of the first five Friday class meetings. The weekly online supplemental components involved 2-3 assigned readings relating to inquiry and NOS from various sources, two professional development videos (from Annenberg Media) illustrating various aspects of inquiry teaching (pertaining to the previous week's onsite course activities), reflection questions for each video that allowed teachers to relate the video to various aspects of inquiry or NOS, and one or two discussion board prompts, such as “What common themes do you see between science as inquiry and the nature of science (NOS) at this point?” that encouraged participants to synthesize ideas from both the onsite and online aspects of class and post them to the discussion board for weekly interactions. The discussion board prompts were used as culminating assignments each week as a means to allow teachers to synthesize concepts based on the previous onsite and online experiences. Participants were given a multi-part question or statement and were asked to respond in full and post their responses on the discussion board. Finally, each participant was required to reply to a minimum of three other participants regarding the others’ initial responses to the prompt and respond to questions posed to them by others. Course instructors found that this created much interaction in which teachers made statements of support, asked questions of one another and the course instructors, asked for peer clarification, and exchanged ideas about classroom implementation of inquiry and NOS instruction. To promote higher-level discourse, instructors often participated in discussion board interactions by asking participants for clarification and identifying possible misconceptions, much like they did in the onsite classroom meetings. The numbers of initial postings, along with responses to other members, were tallied each week by the instructors as a means to ensure full online participation in the learning community. Participants nearly always made far more online forum postings and responses than the minimum of three responses required each week.

5. Methods

The study adopted an interpretive stance (Bogdan & Biklen, 2003) and focused on exploring teachers' conceptions of NOS as well as their conversations through the on-site/on-line community regarding teaching NOS through inquiry. We collected a variety of data through interviews, bulletin board discussions, and teacher reflections that enabled us to develop themes related to learning about and teaching NOS. These methods will be described in the sections below.

5.1 Data collection

The study used a combination of methods to track the progress of the on-site/on-line course on teachers' views of NOS. Qualitative data included pre and post surveys of teachers' conceptions of NOS, one-on-one interviews to enable teachers to elaborate on their NOS conceptions, teacher reflections of NOS readings and viewings of instructional videos, and discussion board reflections and interactions.

Participants' conceptions of NOS were assessed before and after the summer class. Participants were sent an electronic copy of the *Views of Nature of Science Form B (VNOS-B)* (Lederman, Abd-El-Khalick, Bell, & Schwartz, 2002) prior to entering the course. They were instructed to complete the surveys without looking up outside information and to return them to the authors via email. Afterward, phone interviews were conducted with all teachers to allow them to elaborate on their written responses. Interviews lasted between thirty-five and sixty minutes. Teachers also responded to the VNOS-B after the course was completed, and follow-up interviews were conducted with each teacher by phone or on-site.

Each week, along with watching the weekly professional development videos, teachers were asked to respond to and submit (via Blackboard online social media) reflection questions that pertained to the video, their experiences in the previous class meeting, and their own experiences as teachers and students themselves. Weekly discussion board postings were also used as a data source. The primary uses of the discussion board were the analyses of teachers' responses to prompts and participant interaction with one another and the course instructors. The reflection responses and the progression of discussion board postings were both used to triangulate the findings from the pre and post VNOS-B interviews. Discussion board and reflection data were also used to identify emerging themes or patterns regarding teacher knowledge of NOS or teaching NOS, attitudes, or ideas in relation to the posted prompts as the course progressed.

5.2 Data analysis

Data analysis took place in two phases. The first phase included a review of the VNOS-B interviews regarding teachers' conceptions of NOS by two researchers reviewing the transcripts. Profiles of individual teachers' conceptions of NOS were developed first of pre instruction conceptions, and then of post instruction conceptions of NOS. We independently coded their responses to the questionnaire inadequate, adequate, and informed by NOS aspect, and then compared our analyses. Any differences, which were few, were resolved by discussion and further consultation of the data. The same procedure was followed for the post questionnaire VNOS-B data. We then independently compared the pre and post profiles to determine any change in NOS understandings. Changes in NOS conceptions were noted.

To determine the kinds of interactions that took place in the on-line community, two researchers reviewed all discussion board prompt conversations and teacher reflection responses that were archived through the Blackboard site. We used open-coding to search for themes related to conceptualizing NOS ideas as well as teaching NOS to K-8 students. We noted the kinds of conversations teachers engaged in with grade-level peers in the on-line community, searching for evidence of teachers sharing ideas, developing a repertoire for teaching NOS, and being mutually engaged in the content and conversation. The two researchers independently coded these conversations and teacher reflections and met to compare analyses. Any discrepancies were resolved through discussion and further consultation of the data.

6. Results

In this section we will share the teachers' pre instruction conceptions of NOS. We then share results regarding their participation in the on-line on-site CoP through the themes identified through weekly individual reflections pertaining to online professional development videos in addition to group online discussion board postings and interactions of the teachers as they progressed from the major topics as the class progressed. These themes were: (1) commonalities between NOS and scientific inquiry, (2) creating science lessons to better teach aspects of NOS, and (3) using aspects of NOS as a means of assessing children's understanding of science content. Finally, teachers' post-instruction NOS conceptions are shared to show the overall change in teacher' ideas over the span of the summer course.

6.1 Pre-instruction NOS conceptions

We had eight teachers for whom we had complete pre-instruction NOS conception data. This data was collected through the VNOS-B surveys as well as individual interviews. As expected, most teachers held inadequate with a few adequate views of the NOS aspects prior to participating in the on-line community. We will describe these views by NOS aspect in the sections below.

6.1.1 Tentative NOS

While all teachers believed that scientific theories could change, seven still held the misconception that these theories changed only due to adding new evidence, generally through technology, and one teacher held the idea that the scientific theory would change when it became a law. For instance, Melissa said "Theories change because new discoveries are made, especially through technology." Missing from her description of the tentative NOS is the idea that theories could change with reinterpretation of the evidence. Cynthia showed her belief that theories become laws, and included the element of technology when she stated "Everything starts with a theory and then it eventually becomes a law. It could change if we have new technology and have to re-experiment."

6.1.2 Observation and inference

There were a variety of conceptions related to the distinction between observation and inference, from those who thought scientists need to actually view something to make scientific claims, to a more adequate view that scientists make inferences about data. For example, one teacher (Sam) stated "They get really high-powered microscopes so they can see them, and then draw their models in the right way." [talking about scientists' development of models of the atom]. The remainder of the teachers (seven) all believed that scientists developed models of the atom through tests and observations of reactions. They were not clear about what kinds of tests they might have used, but these teachers realized that the scientists did not need to see the atoms to develop a model. Melissa stated "I don't think they are sure about what atoms look like. I think they are still inferring about them." However, Cynthia, who also stated they did not need to see atoms to make a model, stated "They probably saw them react like magnets and built their theory from there." It is clear that though the teachers generally recognize that scientists do not need to actually see an atom to infer their existence, they do not have adequate conceptions of how this inference takes place.

6.1.3 The relationship between theory and law

All eight teachers stated that theories were weaker forms of scientific knowledge that would eventually become laws when and if enough evidence could be found. They believed that laws were unchanging, and theories could change, mostly because they would become laws. For instance, Katy stated, "Theory attempts to explain occurrences and generally holds true, but a law is something that works all the time and there is no refutable evidence that it wouldn't work. A theory would become a law if there were enough evidence." Katy's response was typical of all teachers interviewed, and illustrates their inadequate conceptions of theory and law.

6.1.4 Empirical NOS

Regarding the empirical NOS, six teachers agreed that science has standardized procedures to guide inquiry. Sam stated "In science there are rules to follow. You have to go through a scientific method in order for people to accept what you come up with." Katy held a better conception of the role empirical data in developing scientific knowledge as evidenced in her statement "Science keeps raising new questions and uses evidence to answer them." Cynthia simply stated "Science is more tangible," which illustrates her confusion as to how scientific knowledge is developed.

6.1.5 Creative and imaginative NOS

While all eight teachers acknowledge that science is creative and imaginative, they have inadequate interpretations of how that creativity and imagination helps to build scientific knowledge. Three teachers stated that scientists cannot be creative or imaginative in collecting or interpreting data because "you have to accurately represent the data. You can't imagine it." Two teachers also spoke about removing creativity and imagination from scientific knowledge development in terms of leaving out subjectivity. Their belief was that science is objective, and if scientists used creativity or imagination they would be including subjectivity, as illustrated by Karen's statement "Things in science have to be very controlled. You have to maintain validity if you are doing research. You have to leave out subjectivity." Two other teachers stated that "they can be creative in how they present their scientific ideas, what kinds of graphs they use, appealing ways to display their data." In other words, they can create interesting ways to display their knowledge, but cannot use creativity or imagination in developing the knowledge. Tina held a more adequate view that creativity can help identify patterns in data as illustrated by her statement "Scientists use creativity before and after data collection. Outside the box thinkers may see patterns less creative people will not see."

6.1.6 Subjectivity

There was a range of inadequate and adequate conceptions of the subjective NOS. Sam's response illustrated his inadequate conceptions of the relationship of law and theory, and applied that to the role of subjectivity in developing scientific knowledge "Where there is no law in play then many theories can be made, and it is all based on how people perceive them."Three teachers believed that scientists intentionally looked at data in a way that supported their views, as is illustrated by Tina's statement "They can put a spin on the data to make it say what they want." Four teachers had more adequate views of the subjective NOS as illustrated by Karin's statement "scientists are creative in their interpretations of data, and come from different backgrounds, have different experiences, so look at the data differently and draw different conclusions."

6.2 Interactions in the online community of practice

Data were collected as part of the regular course assignments and progression during this six-week summer course. In addition to the five on-site class meetings, teachers interacted with one another and the course instructors in various ways in this on-site/on-line CoP. For instance, the culminating task each week was to respond to a discussion board prompt that promoted the teachers to synthesize ideas from the experiences, interactions, activities, and assignments from the previous onsite course meeting and the online assignments that occurred during the week after each onsite class meeting. These experiences and prompts ensured mutual engagement surrounding similar ideas and peer and instructor feedback enabled teachers to develop a shared repertoire of strategies for teaching and assessing NOS. Below are results regarding the online interactions to show participants' progression in understanding concepts as a result of the online aspects of the CoP. We provide representative quotes from these discussions to share the commonalities of teachers' interactions and the participants' interdependence within the learning community that helped them build understanding of NOS and of teaching NOS.

6.2.1 Common themes between inquiry and NOS

The first prompt (after the pre-interview and prior to the first onsite meeting) asked the teachers to reflect on their prior beliefs, their reading assignments and the professional development (PD) videos they watched. The discussion board posting for this week asked the teachers to post a response describing the commonalities they found, up to that point, between the nature of science and the practice of scientific inquiry. They were also asked to share any themes they noticed emerging from the two concepts. After teachers posted a response to the prompt, they were instructed to respond a minimum of three times to other teachers by asking questions, making comments and generally partaking in dialogue about the topic. In nearly every session of the online CoP teachers responded to one another well more than the minimum of three times on the weekly discussion board. This made for a rich interaction of dialogue for the duration of the class, and provided evidence of their mutual engagement in the topic

While all teachers showed initial signs of increase in understanding of both NOS and scientific inquiry in their interactions, there were many signs that the teachers had a difficult time conceptualizing the difference between NOS and inquiry. For instance, Tina said "One common idea is that students are actively exploring the world around them. Children are using their senses to make observations and change their thinking as new information becomes available. Both [NOS and inquiry] have children exploring, investigating, and discovering with their curiosity being the driving force. In each, teachers are facilitators instead of giving direct instruction." Although Tina uses ideas evidenced in the process of scientific inquiry, she simply inserts terminology from her reading to relate to the nature of science as a process of forming knowledge. Sam shares similar ideas in his initial posting:

> Commonalities and themes found between science as inquiry AND nature of science is that they rely on questioning and exploring the concepts introduced. Both questions and exploration are student led or initiated. This format gives more ownership for the learner and allows learning to occur at the pace best for students.

Although Sam does share some ideas that may be considered as best practices in science education, he is not yet able to distinguish between ideas relating to the process of science inquiry and the overall nature of science itself.

Cynthia posts a stronger statement during her initial posting that shows a connection, but leans more toward discussing inquiry in the end. She stated:

> NOS and inquiry have several common threads. One of these is the children are actively involved in their own learning. Exploration of the natural world is done actively through the senses. Thinking skills such as inferring are used regularly. Higher order thinking is a hallmark of both. Children change original inferences when knowledge is gained to do so. Inquiry and NOS are both curiosity driven and group interaction is at the center of learning. In both, the children design the method to acquire needed knowledge, and the teacher helps facilitate the learning...I am certainly going to evaluate my own teaching methods.

Although it is apparent that Cynthia is integrating characteristics of NOS such as science as being tentative but durable, observations and inferences, and somewhat implied, no single, rote scientific method, she is does still tend to focus on the pedagogical aspect of inquiry in comparing the two.

As the discussion board progressed during the first week of class, the majority of teachers responded in support of one another in feeling that they needed to rethink about how they teach or even perceive science in their own classrooms. In responding to Cynthia's response about the commonalities and her reflecting on her teaching practices, Amy replied:

> Cynthia, it caused me to think a lot about the way I did things this year too. I feel like after seeing the first grade classroom lesson [in the video] on sharks that I totally did my students a HUGE injustice this year. I think this class will definitely assist me with obtaining new ideas.

In an act of sharing empathy, Katy posted "I am almost wishing I could go back to the beginning of the school year and apologize to many of my students and parents….Man, I feel like the worst teacher ever." In response, the instructor replied to Katy's posting to share that it is very common for teachers (himself included) to feel that way about earlier teaching practices and he, himself, felt that way as he learned more about using aspects of inquiry and NOS in the classroom.

Based on the interactions on the discussion board for the first week, participants showed somewhat naïve views when comparing inquiry and NOS, but they readily shared teaching experiences, feelings of inadequacy, and readiness to learn more about the topics as the class continued. These kinds of interactions indicated the mutual engagement and joint enterprise components that were taking place in the on-line portion of the CoP.

6.2.2 Identifying aspects of NOS in instruction

After finishing the first week of the online CoP, the class met at the onsite locations for the first time. During the first class meeting, the participants were engaged in basic lessons regarding important aspects of NOS and inquiry and experiencing aspects of NOS for themselves both implicitly and explicitly. After the first class session, teachers each had reading assignments, two online PD videos from a series about inquiry, and online reflection questions pertaining to the videos and their own classroom experiences. The teachers were then asked to synthesize ideas from the onsite and online experiences by identifying three aspects of the implicit use of NOS from the video and/or the previous week's onsite meeting and sharing them in the discussion forum. This question asked them to focus on NOS from an inquiry-based perspective regarding their own learning or the classrooms shown in the video. This discussion board prompt was not related to NOS from a historical perspective.

The majority of initial postings regarding the aspects of NOS as identified by the teachers centered around the concepts of science being evidence-based (4), the presence of scientific creativity (7), the distinction between observations versus inferences (5), and science as being influenced by social and cultural factors (4). Although they were mentioned, there were fewer responses related to concepts of subjectivity (1), tentativeness (2), and the functions and relationships between theory and law (1). In referring to a video with kindergarteners observing earthworms, Haley describes an instance in which the students in a video were experiencing the empirical nature of science:

> This can be illustrated in the earthworm activity with kindergarteners. The children are each given their own earthworm and gummy worm to observe. They are able to collect evidence and make observations based on sight, touch, smell, etc. The children make observations such as, 'worms are wiggly, if feels squishy, etc.' This is a clear example of using one's senses to draw out empirical scientific evidence, even with young children.

Cynthia followed Haley's discussion about the children's experience with evidence (empirical nature of science) by furthering the post by relating evidence to observation and inference. She stated "The kindergarten clip I agree definitely shows the direct connection between observation and evidence. Their observations of the earthworms led to inferences about worms." Several other posts were made by teachers in the class about the simplicity and effectiveness of the inquiry activity portrayed in the video. Cynthia's post was followed by a post from one of the course instructors who was intentionally provoking ideas regarding the teaching of NOS both implicitly and explicitly:

> I love the discussions about observations and inferences and evidence. Even though the teachers in the videos did not generally use those terms, it seems that the students were implicitly getting those messages. I wonder how much more powerful the lessons would have been had the teachers actually used the terms 'observations, inferences, and evidence' even with very young children?

The online aspect of the CoP allowed the teachers to readily respond to one another and the course instructor to add to the dialogue and ask questions to further facilitate the conversation, providing further evidence of mutual engagement and joint enterprise.

It was common for teachers in the online community to exchange ideas both about what they saw in the PD videos and what they have experienced in their own classrooms. Although the time spent in the onsite aspect of this learning community was limited, the online aspect allowed the teachers to interact over the course of an entire week. For example, Katy, a fourth grade teacher who only taught science in a departmentalized setting, posted a strand on the discussion board regarding the use of creativity in the classroom, and it created an exchange among teachers that led to concerns about their own classrooms. Katy stated the following during a 9:45 PM posting:

> The first example of NOS this week that stood out in the videos is creativity. During the lesson on sound, there was one little boy who came up with his own investigation based on his teacher's presentation of the oscilloscope. Many students simply accept what the teacher says during a lesson, but it was evident that the students in this classroom feel very comfortable, and have no fear of giving input about their ideas. I thought it was great that the teacher followed up with his idea and took the class into the music room to investigate.

Amy, another fourth grade teacher who primarily taught science in a departmentalized setting, responded to Katy's initial strand post at 4:21 PM the next afternoon:

> Katy, do you feel like the creativity level that many of these students exhibited is at a much higher level than the students in your own classroom? I feel like many of my students lack a certain level of individual creativity therefore whenever anything is slightly creative is said I feel like it is wonderful. Is this 'lowering' expectations?

Even though Katy had responded to several other teachers in the classroom regarding various postings in different places, she replied to Amy's question:

> I agree that my students lack a certain degree of [scientific] creativity…but I think this is a result of many years of inquiry-deficient classrooms. In order for our students to rediscover their [scientifically] creative side, we will have to work extra hard to foster

> this skill! Once the students see how creative they can actually be, they will feel more comfortable to come out of their comfort zone that previous teachers have gotten them into!

Much like the abovementioned exchange between Katy and Amy, the other teachers began making important connections about regarding concepts and terminology they had not heard of or possibly thought about two weeks earlier. Based on the responses and interactive posts from all the teachers on this prompt, the community had quickly grown in both identifying and understanding aspects of NOS when seeing it taught in the context of inquiry-based lessons. Because of the joint enterprise developed through the CoP they were able to discuss issues regarding NOS teaching and enhanced their repertoire for teach NOS, further developing their shared repertoire through the CoP.

6.2.3 Creating lessons utilizing inquiry and nature of science

After finishing the third week of the online community and the second onsite meeting, teachers were asked to synthesize the ideas from the previous onsite meeting, the readings, and the PD video to reflect how they would take lessons from their classrooms, or future classrooms (for the participants in the transition to teaching program), and think about how they would change their science lessons to (1) be more inquiry-based and (2) purposefully integrate aspects of NOS explicitly in their own teaching.

This week the discussion board allowed the teachers to post their lesson ideas to the forum and receive feedback from their community of practice colleagues. The majority of the teachers chose to post units or lessons for which they had the most trouble in implementing in their classrooms, inviting feedback and advice from peers. For example, Sam, who teaches in a gifted program, shared about the unit he does with his fifth graders:

> A unit I struggle with is Force and Motion. This should naturally allow for hands-on inquiry, but it falls within a bad time during my county's curriculum framework. I am forced to either rush through it or drop it because it is in competition with testing. I can make it more inquiry-based by creating a challenge to solve a real-world problem… possibly by using historical evidence regarding the building of pyramids or other large structures locally (such as the capitol building and river transportation…maybe have the class design a system to move stones based on technology past civilizations had to use.

In his discussion board entry Sam further elaborated that he could implement aspects of NOS into the lesson by allowing the students to compare the various types of technology pertaining to force and motion at different times in order to make the connection to social/cultural context. He stated "The context of time affects the creation of both…for example, how would slides look if they were build 100 years ago or how long would it take to build similar structures today with current technology."

As the course progressed, the teachers became more comfortable in their online dialogue to the point of offering more critical suggestions to one another. In a sequence between Katy and Melissa, one challenged what the other posted and they constructively exchanged ideas about the aspect of time spent on inquiry in their own lessons. Katy made a posting about changes she plans on making with her fourth graders about sound. She said that she did not give them enough time to explore and she hoped to foster student creativity by allowing them to explore on their own for an extension aspect of the lesson. She further elaborated:

> While watching the video dealing with sound for this class, I realized that it is ok to let go of the reigns and let the children come up with different ways to explore sound and demonstrate the way sound behaves and travels. Next year, I may have one day dedicated to letting students be creative by thinking of various models that will demonstrate the vibrations created when sounds occurs.

Another teacher, Melissa, posted a response to Katy stating:

> A few red flags in your statements, "I may have one day dedicated…" Inquiry based learning takes a lot longer than lecturing and demonstrating. If your kids are not used to learning this way, it may take a while for them to grasp the concept…You will have to model and demonstrate the process and they will have to learn to work together in groups, and listen to and respect each other. This will take more than one day, but the time spent will result in the students understanding the material, instead of memorizing it.

Rather than getting upset with Melissa's response, Katy responded with agreement that it will take more than a day and that it would be a challenge, especially to stay on track with the other fourth grade teachers with whom she must team-plan. In furthering her concern for straying from the plan of her grade level team, she wrote "I will just have to help them see that using inquiry in their classrooms as well would be beneficial to us all."

Although this discussion board prompt encouraged the teachers to post their own lessons and provide constructive criticism to others' lessons, the majority of postings resulted in a chance for a group of teachers posting ideas and sharing lessons with one another in a true CoP teachers facilitated by their instructors. The slightly more critical postings about slight disagreements were found to be both respectful and constructive. There were elements of mutual engagement as they discussed ideas and provided feedback to one another, joint enterprise, as they sought to improve their teaching, and shared repertoire as they developed strategies for teaching NOS in collaboration with one another.

6.2.4 Assessing learning with aspects of NOS

We found throughout the course that teachers readily talked about and showed progression of the knowledge of implementing more inquiry in their classrooms and integrating NOS into those lessons. However, we found the teachers to have fewer ideas regarding how they could use aspects of NOS as a regular part of inquiry in the classroom. Although few comments were made on the nature of "implicitly and explicitly," many teachers did mention they would use end-of-lesson or unit NOS reflection as a form of assessment. When referring to using aspects of NOS at the end of a lesson, Karen wrote "I think this should be part of your closure, or you could even point them out during your activities at first until the students become more familiar with them. I like the idea of possibly making flash cards with aspects of NOS on them and using them throughout a lesson when the opportunity arose." In a response to Karen's discussion board response, Karen wrote:

> Karen, in looking with your ideas about NOS and assessment, I agree that it is ok to ask students whether they have used concepts in what they are doing. We saw this in the video of the first grade class doing inquiry. She asked the students "did we make comparisons today, did we make observations by looking closely at our data, did we communicate with others (little scientists) about what we found?" I think this is a good way to teach processes and to get into the habit of using NOS and inquiry as we go through investigations with our students and help them arrive at conclusions.

Based on teacher-teacher and teacher-student interactions through the discussion board, we see that teachers have progressively grown regarding their knowledge and connections made in the understanding of both NOS and inquiry.

6.3 Post-instruction NOS conceptions

In this section we will report on the post-CoP NOS conceptions held by the teachers. After participating in the CoP they had many improvements in their NOS ideas. After instruction, most teachers held adequate views of the NOS aspects. We will describe these views by NOS aspect in the sections below.

6.3.1 Tentative NOS

All eleven teachers believed that scientific theories could change, and nine believed these theories changed due to new evidence collected. For example Karen stated "Theories do change because the nature of science is tentative and subject to change when new evidence becomes available." The others simply stated that theories could change. Six teachers also described the role of technology in changing scientific claims, as illustrated by Melissa's statement "Yes theories change because technologies change as well as new discoveries are made."

6.3.2 Observation and inference

Post instruction all teachers realized that scientists do not need to actually see something to make inferences leading to a scientific claim. All teachers recognized that scientists are fairly certain about their claims, but not 100% sure due to the fact that they could collect more data, and because they do not necessarily see it through their senses they are making inferences. They stated that scientists developed a model of the atom, for instance, by using evidence of the behavior of "things around the atom." Melissa stated "they base the model on current evidence that they have, they are relatively certain about the structure of atoms. The specific kind of evidence I think scientists used to determine what an atom looks like is observations of behavior of atoms." Her response was typical of all teachers, and illustrates that the teachers also used the NOS terminology.

6.3.3 The relationship between theory and law

Eleven of the teachers stated that theories seek to explain why something occurs and laws describe how it occurs, which is an adequate conception of the relationship between theory and law. Teachers recognized that theories do not become laws, but in fact, are a different type of scientific knowledge. For example, Tina stated "Scientific theory is an attempt to explain why…scientific theories tend to be tentative and can change as new evidence comes to light. Scientific laws explain how something happens and usually has a mathematical equation to go along with it. Laws are universally accepted, but changes can be made." Indeed, teachers recognized that theories and laws could change if evidence, or interpretation of the evidence, warranted it. Only one teacher (Karen) retained the view that "laws are factual, and theories are what we believe."

6.3.4 Empircal NOS

Regarding the empirical NOS, all teachers agreed that science uses observations and inferences to make scientific claims. Indeed, they also described the need for collecting data, as well as conducting inquiries. Amy stated "scientists make observations and then inferences from those experiences." All teachers realized that scientific knowledge is based on empirical evidence. For example, Tina stated "Having scientific knowledge means that you can carry out a test, collect data, and realize when you have or haven't controlled all your variables." Karen shared her view by stating "Scientific knowledge is based on empirical evidence which involves observable phenomena either through the senses or technology" which also showed an adequate understanding of the inferential NOS.

6.3.5 Creative and imaginative NOS

All eleven teachers held adequate conceptions of the creative and imaginative NOS at the conclusion of instruction. Sam stated "Creativity in science comes from the questions that are asked and the investigations that are developed to answer questions." Karen agreed, and also noted that scientists "use creativity in looking for patterns, collecting, and analyzing data." Teachers also noted that scientists need to use creativity and imagination in order to develop scientific knowledge, as is illustrated by Melissa's statement "I think scientists use the data, evidence and observations to develop their theories." It is clear to see that no teachers retained the understanding that using creativity and imagination would cause scientists to develop incorrect knowledge, but rather that the use of creativity and imagination was a necessary component of the development of scientific knowledge, in terms of interpreting results, as well as raising questions and designing investigations from the outset.

6.3.6 Subjectivity

All eleven teachers recognized that though scientists strive for objectivity, there is an element of subjectivity inherent in the development of scientific knowledge. Teachers recognized the role of background knowledge and personal experience in the development of scientific knowledge, as illustrated by Jeremy's statement "The fact that individuals have different experiences, temperaments, and moral views create different interpretations. This allows for many different inferences to be made with the data that they have collected. None are necessarily correct or incorrect rather they are different conclusions that attempt to explain the data that is presented to them." Kent also reinforced the idea of the influence of the larger culture on scientific interpretations through his view that "part of the subjectivity is based on the social and cultural background of the scientist."

7. Discussion

In investigating our primary research question regarding the development of this on-site/on-line onsite/online CoP and teachers' conceptions of NOS, we found that teachers in the on-site/on-line onsite/online CoP improved their understanding of NOS and how to explicitly embed it into their classrooms. The majority of the teachers held inadequate conceptions of aspects of NOS prior to instruction. However, analysis of the ongoing discussion boards showed the teachers progressively changing in their ideas over time. Initial postings regarding common ideas between NOS and inquiry indicated the teachers could not yet distinguish between the various important aspects of NOS and the actual classroom practices of inquiry. As the course progressed through implementing onsite activities that modeled inquiry-based lessons that integrated aspects of NOS explicitly, the teachers began to readily recognize ways in which NOS was utilized in the various PD videos that were part of the online course assignments. Teachers shared a mutual goal, mutual engagement regarding teaching NOS, and developed a shared repertoire for teaching NOS (Wenger, 1998), by raising questions, discussing ideas, and providing feedback to one another through the on-line community discussions.

During the week following the third onsite course meeting, teachers were readily able to discuss ways in which they could improve their own lessons regarding the use of inquiry, and were able to specifically state how they could use NOS to supplement these lessons for better student understanding. By the last week of the online discussion forum, teachers were able to not only discuss how they could implement aspects of NOS in their inquiry-based lessons, they were also able to elaborate regarding several ways they could use NOS as a form of assessment. For example, one elementary teacher stated "We saw us some of the assessment pieces collected from 3rd graders this past year.. For example, she had done an observation and inference activity with them on solids and liquids where she created a written assessment where they noted their observations and their inferences. By doing this she was able to see which student had a clear understanding of the difference between the two. I think that you can choose to use the 7 concepts for pedagogical issue or assessment depending on the activity and any other assessment options you may already have for that activity. "

This ability to focus on NOS teaching as well as assessment is evident in the comparison of pre interview data, progression of dialogue during the weekly reflections and online discussion board postings, and the post interviews in which the majority of teachers were identified as having adequate views of NOS.

Onsite CoPs have been found to be influential in not only helping inservice teachers better conceptualize NOS, but to implement it in their teaching practices (Akerson, et al., 2009). The results of this online/onsite study indicate that teachers can effectively learn NOS through CoPs that are created by on-site/on-line (onsite/online) experiences. These on-line communities allow teachers to share ideas, raise questions, and ask for feedback regarding their ideas as well as their teaching strategies. Such communities, possibly most beneficial in areas in which teachers may live significant distances from campus, enable more teachers to fully participate in graduate coursework or professional development opportunities. This experience enabled teachers from around the state, and between states, to join the community and make significant growth regarding their understanding about NOS both contexts. Despite the limitations of being a single, MA-level graduate course, several important aspects of a CoP emerged. A practice of mutual engagement was obtained because all stakeholders, both instructors and participants, were immersed in the shared theme of NOS in the science classroom. Another important element of any CoP, a shared mission (joint enterprise), was practiced throughout as the teacher-participants continually worked, with the facilitation of the course instructors, towards learning more about major aspects of NOS and how to implement them into their classrooms. After participating in this CoP, the instructors feel the teachers improved in nearly all areas of their understanding of NOS and its implementation in the classroom. Finally, due to the group's shared growth regarding ideas, terminology, teaching techniques and practices, and overall knowledge and experiences regarding NOS, the group of teachers emerged with a shared repertoire they could implement in their own classrooms.

This on-site/on-line summer course created a CoP which helped resolve the issue of some teachers being reluctant to initially share their ideas with their peers. They were able to choose to share ideas in a written forum instead which may have led to their being more verbally involved in the onsite class meetings. Finally, instructors found this on-site/on-line model of teacher professional development to be beneficial because it allowed teachers from many different areas, backgrounds, and experiences to interact both online and onsite to improve their knowledge of science teaching. Many of the course participants made end-of-course evaluation requests suggesting a successful CoP. Teachers requested that the course Blackboard site be left open so they could continue to remain in contact with one another for ideas, post ongoing discussion forums, and upload documents and lessons for sharing. Also, several participants suggested that the instructors conduct one or two school-year follow up professional development workshops that focused on specific topics such as assessing content knowledge when content specific NOS and inquiry-based activities, which points further to the need for the on-site component of the CoP.

8. Implications and recommendations for professional development

We found that the use of a on-site/on-line online/onsite CoP is a beneficial and convenient method for providing necessary outreach to busy, practicing teachers, especially those who may be distant from professional development locations. It allowed participants, the overwhelming majority of whom had never previously heard the phrase, "nature of science," to discuss among peers on site as well as through a written format their ideas about the concepts as well as about teaching the concepts. Many of the participants had very few initial ideas of NOS or how it could effectively be used in teaching science. The evidence collected shows that participants grew in their understanding of NOS, and in ideas for including it in their classrooms. We believe that the mutual engagement teachers had toward this joint enterprise aided in their development of NOS conceptions as well as developing a shared repertoire for teaching NOS.

There were slight difficulties for the science education professors at each university to incorporate the same NOS activities during the same weeks. However, this was only a slight problem because both the overarching weekly and course-long themes were always the same. We plan to keep the same on-site/on-line model in which onsite meetings at the course locations are followed by combined online experiences. We plan to find ways to further expand this professional development experience for teachers further into isolated regions of Central Appalachia and rural areas of the Midwest. We also plan to align with science educators from other universities in the country in need of professional development outreach for teachers who have a difficult time attending the opportunities, training, or support they need. This model will allow the corresponding onsite workshops to take place in different geographic regions only to allow the teacher participants to come together in the online learning community to share knowledge, experiences, and growth. We think it would be beneficial to follow up the summer on-site/on-line experience with school-year follow-ups addressing teacher-requested topics such as planning and assessment. These follow-ups could be on-site once each semester, with on-line interactions throughout the semester. We feel such additions will allow participants to further their knowledge and share their experiences in implementing these changes, all with the support of the professional development coordinators. We recommend that the facilitators target NOS and scientific inquiry through context-appropriate activities that enable and encourage discussion amongst all teachers in the on-line community.

This CoP was well-supported due to its group of teachers with a common goal and shared resources, as well as their development of a shared repertoire for teaching NOS as part of scientific inquiry from participating in the same course. The onsite experiences which allowed the teachers to interact in face-to-face activities and discussion were supplemented by shared online resources and dialogue. Teachers benefited from both components of the CoP. Teachers who were more quiet during the on-site portion were verbally active in the on-line portion and were clearly developing their NOS ideas and strategies for teaching NOS. The primary difficulty of this CoP, however, was the situation itself. This professional development experience was based solely on two master's level courses in two states. Although it did allow teachers from rural areas of Central Appalachia and the Midwest to participate in a on-site/on-line CoP in two distinct geographic locations to be supplemented by a single online community, it lasted only a short amount of time after the six-week course was completed. It is our intention to create a more independent and longer-lasting CoP by including more participants in more onsite locations while maintaining the shared online community.

Despite the limitations of using a master's level course as a foundation for this CoP, we found the teachers showed significant amounts of growth in conceptualizing several aspects of NOS without having to meet onsite numerous times to participate in the professional development community In addition, the teachers were able to participate in an online community where they could more comfortably interact with one another, share ideas, ask questions, and allow important concepts to resonate throughout the community. It is our intention to use the short-term success of this CoP to expand both in terms of region and sustainability. Therefore we believe that an on-site/on-line approach for developing a NOS CoP is at least as effective as a solely on-site approach to professional development. More research is needed to explore variations of the amount of time spent in each component. We are curious whether an entirely on-line CoP could help teachers achieve the same results in terms of being able to develop strategies for teaching NOS to elementary students. Indeed, could a solely on-line course develop into a CoP?

9. Appendix A

Course Outline:

Week 1 (No Formal Course Meeting):

Pre-Interview (Written and Oral):

Main Topic: *What is Inquiry and Why Do It?*

- Watch Workshop Video #1 (www.learner.org k-8 inquiry)
- Chapters #1 & #2 Llewellyn
    - Upload Video #1 Reflection Questions to Bb (Word Document)

Discussion board prompt & responses (post video & chapter readings) Week One:

There were some common themes in this introductory week in the readings (Ch's 1 & 2 from Llewellyn and the NOS and Science Process Skills chapter) and in Workshop Video #1.

- The NOS and inquiry concepts
    - We'll get into this much deeper (especially when we start meeting face-to-face), but what commonalities/themes do you see between "science as inquiry" and the "nature of Science (NOS) at this point?
- Student learning
    - What themes do you see emerging from concepts of "scientific inquiry" and the "nature of science" that make you think about regarding the process(es)/sequence(s) of the **way students in grades k-8 may learn?**

***All discussion board threads required one initial response posting and three meaningful responses.*

Week 2

Main Topics: *Creating a Learning Community and Getting Started with Prior Knowledge*

1. NOS Activities (Observation/Inference)
2. Inquiry Activity for ELE and MS

After Week 2 Class Meeting:

- Inquiry Workshop Videos #2 & #3
- Chapters #4 & #5 Llewellyn Text
- Nature of Science (NOS) Science Process Skills (SPS) Reading→
    - Upload Reflection Questions for Video #2 and Video #3 (a different set for each video) to Bb

Discussion Board Prompts Week Two:

Your videos this week (#2: Establishing a Learning Community and #3: Launching the Inquiry Exploration) are based on getting things started in the inquiry classroom. As we are getting started in this process known as inquiry, let's reflect about a concept/philosophy that is probably pretty new (at least to some degree) to most of us-- the Nature of Science (NOS).

Think about the two videos and the students you observed in the early stages of inquiry in various content areas, grade levels, and contexts. Now think of your "7 Aspects of Nature of Science We can Reasonably Teach" sheet and any information you have that can go with that (national standards information, etc).

Pick Three of the NOS concepts that really stood out to you based on what you noticedin the videos when the students were participating in the early stages of inquiry. List each concept in your opening strand, what you observed the teachers/students doing that modeled this NOS concept, and *elaborate* on how what you observed in the video modeled each concept so well. Of course, you don't have to limit yourself to one activity…it is recommended that you choose different activities for your different NOS concepts—it is up to you. You'll want to list each NOS concept and explanation separately, however.

If you would like, your third listing cou7ld be something we did in class with the NOS activities for the little snippet of the sound lesson last week. The first two, however, need to be from Workshop Videos 2 and/or 3.

Once you create your own strand first, you can then do your minimum of three follow-ups by scouting out what others have said and engaging in conversation with their ideas. Do you agree/disagree? Have questions? Need further elaboration? Have any general comments? etc...

Week 3

Main Topics: *Inquiry Design, Collecting Data, and Drawing Conclusions*

In Class

1. NOS Activities (Creativity & Empirical)
2. Inquiry Activity for ELE and MS

After Week 3 Class Meeting:

- Inquiry Workshop videos #4 & #5
- Chapters #6 & #7 Llewellyn
  - Video Reflection Questions

Discussion Board Prompts for Week Three:

- Think of two lessons or units, either ones you do or want to do, and think about (1) what are the two lessons/activities (be specific), (2) what can you do to make them more inquiry-based (investigative of some type), and (3) how can you possibly implement some aspect(s) of NOS into each lesson that support(s) your "young scientists" doing real science like "professional scientists?"
- If you don't currently teach science (don't currently have your own classroom (you will soon!) or you teach math or language arts full time), then think about how you can integrate science and/or NOS/Inquiry into *specific* activities you do or will do.

Week 4

Student Processing and Interpretation; Teacher Assessment of Inquiry

In Class

1. NOS Activities (Subjectivity, Social/Cultural, Tentativeness)
2. Inquiry Activity for ELE and MS

After week 4:

- Inquiry Workshop Videos #6 & #7
- Chapters #9 & #10 Llewellyn
    - Video Reflection Questions (2 sets @ 20 points each)

Discussion Board Prompts Week Four:

- After having participated in class, doing the readings, watching the videos, and of course, your own life and teaching experiences, there are surely some questions, concerns, and excitement regarding the two major topics this week: student processing/interpreting of information (evidence) and assessing that entire learning process. Therefore this question has three different parts—they are big ideas and will require some elaboration.
    1. Processing Information: It can be very rewarding, but also a bit tricky, when giving students the opportunity to construct concepts for themselves rather than simply "telling" them someone else's conclusions written in a textbook (even though we know, in science, telling isn't really teaching). Once a teacher works hard to get students set up and to the point of allowing them to collect data and interpret their findings via inquiry (in order to begin constructing knowledge for themselves---how to think, not what to think), sometimes it can be tough to ensure they are constructing ideas that agree with the scientific community's ideas. What are some of the dangers you feel exist in allowing this and what can you do to ensure the students are processing information in a way that helps them build true conceptual understanding?
    2. Assessment: It seems obvious from the video that inquiry lends itself much more to formative assessment than more "traditional" lessons. What are some things you need to keep in mind—REALLY keep in mind—when assessing students to measure what they know, what they're learning, and how far they've come?
    3. NOS: Finally, given that you now know more about this huge concept of "nature of science" (how many teachers know as much about NOS as you now know?), how can you personally use ideas from the "7 Aspects of NOS You Can Reasonably Teach" for both formative and summative assessment in your current or future classroom? Really, how can we use those ideas to ensure students are learning content/concepts we all are required to teach using these seven big concepts? Can these NOS aspects help you assess more accurately? If so, how? If they are good for pedagogical issues, but not necessarily for assessment purposes, please elaborate why? Either way, please be specific.

Week 5

Professional Development/Guest Speaker:

Science as a Human Endeavor (NOS) and Inquiry: A Reciprocal Relationship

In Class

1. Inquiry Activity for ELE and MS

After Week 5:

- Inquiry Workshop Video #8
- Chapter #8 Llewellyn
- Free Book: Teaching NOS Through Science Process Skills (SPS): Grades 3-8
    - 1 Set of Video Reflection Questions
    - 1 Discussion Board (shorter)
    - Read (and enjoy) NOS & SPS text!

Week 6

No on site class for Week 6

Post-Interview

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11. References

Akerson, V. L., Buzzelli, C. A., & Donnelly, L. A. (2010). On the nature of teaching nature of science: Preservice early childhood teachers' instruction in preschool and elementary settings. *Journal of Research in Science Teaching, 47,* 213-233.

Akerson, V. L., Cullen, T. A., & Hanson, D. L. (2009). Fostering a community of practice through a professional development program to improve elementary teachers' views of nature of science and teaching practice. *Journal of Research in Science Teaching.*

Akerson, V.L., Donnelly, L. A., Riggs, M. L., & Eastwood, J. (accepted) Supporting preservice elementary teachers' nature of science instruction through a community of practice. *International Journal of Science Education.*

Akerson, V. L., & Hanuscin, D. L. (2007). Teaching nature of science through inquiry: The results of a three-year professional development program. *Journal of Research in Science Teaching, 44,* 653-680.

Akerson, V.L., Townsend, J.S., Donnelly, L.A., Hanson, D.L., Tira, P., & White, O. (2008). Scientific modeling for inquiring teachers' network (SMIT'N): The influence on elementary teachers' views of nature of science, inquiry, and modeling, *Journal of Science Teacher Education,* 20(1): 21-40.

Anderson, R. (2002). Reforming science teaching: What research says about inquiry. *Journal of Science Teacher Education*. 13(1): 1-12.

Backus, D.A.,& Thompson,K.W. (2006). Addressing the nature of science in preservice science teacher preparation programs: Science educator perspectives. *Journal of Science Teacher Education, 17,* 65–81.

Barab, S. A., & Duffy, T. M. (2000). From practice fields to communities of practice. In D. H. Jonassen & S. M. Land (Eds.), *Theoretical foundations*

Barab, S. A., Kling, R., & Gray, J. H. (Eds.). (2004). *Designing for virtual communities in the service of learning*. Cambridge, UK: Cambridge University Press.

Bogdan, R. C & Biklen, S. K. (2003). Qualitative Research for Education: An introduction toTheories and Methods (4th ed.). New York: Pearson Education group

Hung, D. W. L., & Chen, D.-T. (2001). Situated cognition, Vygotskian thought and learning from the communities of practice perspective: Implications for the design of web-based e-learning. *Education Media International, 38*(1), 3-12.

Hung, D. W. L., & Chen, D.-T. (2002). Learning within the context of communities of practice: A reconceptualization of tools, rules and roles of the activity system. *Education Media International,39*(3&4), 247-255.

Kehrwald, B. (2008). Towards community based learner support: A case study. In Hello! Where are you in the landscape of educational technology? Proceedings ascilite Melbourne 2008.
http://www.ascilite.org.au/conferences/melbourne08/procs/kerwald.pdf

Lederman, N. G. (1992). Students' and teachers' conceptions about the nature of science: A review of the research. *Journal of Research in Science Teaching, 29*, 331-359.

Lederman, N. G., Abd-El-Khalick, F., Bell, R. L., & Schwartz, R. (2002). Views of nature of science questionnaire (VNOS): Toward valid and meaningful assessment of learners' conceptions of nature of science. *Journal of Research in Science Teaching, 39,* 497-521.

Learning Science Through Inquiry. (n.d.). Retreived June 30, 2009 from Annenberg Media website: http://www.learner.org/resources/series129.html

Leite, L. (2006). Prospective physical sciences teachers' willingness to engage in learning communities. *European Journal of Teacher Education, 29(*1), 3–22.

Merriam, S.B. (1998). *Qualitative research and case study applications in education*. San Francisco: Jossey-Bass Publishers.

National Research Council, (1996). National science education standards. Washington, DC: National Academy Press

National Science Teachers Association (2000). *NSTA position statement: The nature of science.* Document retrieved 12/08/08. http://www.nsta.org/159&psid=22

Putnam, R.T., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher, 29*(1), 4–15.

Reil, M., & Polin, L. (2004). Online learning communities: Common ground and critical differences in designing technical environments. In S. A. Barab, R. Kling & J. H. Gray (Eds.), *Designing for virtual communities in the service of learning* (pp. 16-50). Cambridge, UK: Cambridge University Press.

Robertson, A. (2007). Development of shared vision: Lessons from a science education community collaborative. *Journal of Research in Science Teaching, 44,* 681–705.

Shen, J., Zhen, J., & Poppink, S. (2007). Open lessons: A practice to develop a learning community for teachers. *Educational Horizons, 85*(3), 181–191.

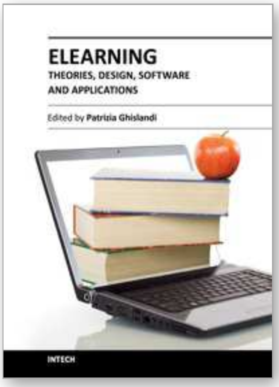
Snow-Gerono, J.L. (2005). Professional development in a culture of inquiry: PDS teachers identify the benefits of professional learning communities. *Teaching and Teacher Education, 21*, 241–256.

Stagg Peterson, S., & Slotta, J. (2009). Saying yes to online learning: A first-time experience teaching an online graduate course in literacy education. *Literacy Research and Instruction, 48*, 120-136.

Vavasseur, C.B., & MacGregor, S.K. (2008). Extending content-focused professional development through online communities of practice. *Journal of Research on Technology in Education, 40*(4), 517-536.

Wenger, E. (1998) *Communities of practice: learning, meaning and identity*. New York, NY: Cambridge University Press.

Wenger, E. McDermott, R. & Snyder, W.M. (2002). *Cultivating Communities of Practice.* Cambridge, MA: Harvard Business School Press.



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The term was coined when electronics, with the personal computer, was very popular and internet was still at its dawn. It is a very successful term, by now firmly in schools, universities, and SMEs education and training. Just to give an example 3.5 millions of students were engaged in some online courses in higher education institutions in 2006 in the USA1.eLearning today refers to the use of the network technologies to design, deliver, select, manage and broaden learning and the possibilities made available by internet to offer to the users synchronous and asynchronous learning, so that they can access the courses content anytime and wherever there is an internet connection.

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