TEACHER RESEARCH NETWORK
PROFILE ANALYSIS 2000-2001 STUDY
SciMath[mn]

Submitted by: Dr. Dori Tonnis

CONTEXT:

Profiles for nine elementary teachers who taught science during the 2000-2001 school year in grades 3-6 were prepared for analysis. The teacher participants completed CLES 2(20), and STEBI forms, pre and post observations forms, had their students complete the student CLES 2(20), were observed at least twice by a researcher, and completed a face-to-face interview with a researcher for this study. The researcher conducted an initial analysis of all data collected and wrote a profile of his/her teacher participant(s). This is an analysis of the nine profiles submitted by the researchers.

Of the nine teacher participants, 3 were male and 6 female. Three teachers were in their second year of teaching. The remaining participants were first year teachers. One first-year teacher was in her second year of this TRN study. One second-year teacher was participating in this study for his third year. All elementary grade levels were represented in this study, with one teacher teaching science to students in grades 1-5 in a K-8 private school. In this case, the researcher observed 4th grade students for the purpose of the study. One first-year teacher teaches in a Native American charter school, and teaches special education students in grades 3-6. One other teacher teaches 3rd & 4th grade students. One first-year teacher teaches all 4th grade students in a private school in addition to teaching all subjects to one class of fourth graders.

Two teachers have earned masters degrees and one is currently working toward a masters degree. The remaining participants have undergraduate degrees with an elementary teaching licensure. Five of the teachers completed a science/math elementary education co-major as part of their undergraduate degree. One first-year teacher was a non-traditional undergraduate student, earning a GED in her 20s and attending college and completing the degree in her early 30s. She also has a significant learning disability. This is the teacher that instructs special education students at the Native American charter school in an urban environment. It is important to note that Mr. Mattr taught 6th grade for four years as an unlicensed teacher prior to becoming licensed. Thus he is a newly licensed teacher with significant teaching experience. Mr. Goodman was a naturalist, teaching groups of young children at the nature center prior to becoming licensed to teach. These two teachers will be highlighted in the “analyzer’s comments” at the end of this report to determine if there are any significant differences for them compared to the other new teachers.

The teachers work in a wide range of elementary school environments. Two participants taught in small urban charter schools. One charter school was for Native American students, and the other served a large Asian population. Two participants taught in larger private suburban schools, and the remainder of the teachers taught in public schools in both rural, suburban and urban settings. One teacher in particular, taught at a public school in a large urban community that drew from 9 school districts for the purpose of providing a diverse student population. The school also was based upon a problem-solving approach to learning and has an open concept structure. One second-year teacher taught in a small North Dakota school, but earned her licensure from a MN institution.

The number of students in a class ranged from 13-30. The rural classroom had little ethnic/cultural diversity. The private schools also had little ethnic diversity. The charter schools were purposefully serving distinct populations of students. One school that served 9 school districts demonstrated diverse ethnic/cultural diversity. All classrooms contained the expected intellectual and learning style diversities. The classes of students were nearly equally divided between males and females.

Six teachers used FOSS kits as their science curriculum. All but one used these kits exclusively for science. One teacher used FOSS kits and AIMS lessons. One teacher used the Discovery Works science curriculum adopted by the school district. The remaining two teachers developed their own science curriculum.

Classrooms were arranged in a variety of ways. Some classrooms contained tables for students to conduct group work. This was the case for the teacher dedicated to teaching grades 1-5 science. Other classrooms were arranged in groups of two to four desks. Yet another classroom was arranged in rows of desks perpendicular to the blackboard with two rows of desks facing each other so students could easily work in pairs. One classroom was arranged with the desks along the perimeter of the room to reduce distractions for students (this was the special education class). However, students were able to move their desks to accommodate the group activities associated with their science lessons. Some classrooms had no sinks. The dedicated science classroom contained both a sink and an eye wash. Two classrooms were part of open concept schools and were divided only by partial wall partitions.

There was also a range of constraints indicated by the teachers. Two teachers were confined by the mandated science curriculum. Other teachers mentioned that the limited budget reduced their ability to go beyond using the FOSS kits. Classroom size was also a concern of some teachers, especially for the teacher with 30 students. One teacher conducted class in a basement room. Classroom size and availability of science materials were additional constraints listed by the teachers.

The lessons observed were from numerous units including, Earth/Space Science (Galaxies & Stars; Geology & Rocks/minerals), Physical Science (Sound, Pulleys & Levers, Chromatography, Mirrors & Inventions), and Life Science (Plants & Trees, Oceans, Water & Aquatic Habitats, Classification, Human Systems). The represented units ranged from 2 to 6 weeks in duration. All researchers had at least some degree of understanding of the science content they observed. All researchers have a science background, some in science disciplines and others in schools or departments of education.

Two teachers had no previous contact with the researchers. The other seven teacher participants had varying degrees of prior contact with the researchers ranging from seminar contact to being students in science methods classes with the researchers.

KNOWING SCIENCE CONTENT

IMPORTANT CONTENT: Six of the nine teachers relied on the school's/district's curriculum for science content. Ms Christianson stated, "Basically I just go by the curriculum we are required as a 5th grade to teach…" This meant, for most of the teachers, that they used FOSS kits to teach science. Only 2 teachers stated that they developed their own curriculum to teach science. Ms Vee, the teacher of the grades 3-6 special education class at a charter school had no curriculum and no expectation from administration to teach science at all to her students. She developed the curriculum that would integrate with other subject areas so students would "not have to wait to get science in junior high." Only two teachers mentioned that they attempted to use the state Science Frameworks or National Science Education Standards to influence what science content they teach. The science content taught in all observed lessons appeared important in that the FOSS activities and AIMS lessons recommend the science content for the grade levels observed. One teacher said that she talked to students about the importance of gathering information through observations, record keeping, and then drawing conclusions from the data. Her students were seen observing, recording their observations and attempting to draw conclusions about mock rocks. In the case of the two teachers using their own developed curriculum, both teachers did extensive research into the units of study to ensure that the information was appropriate to their grade level(s). Ms Vee mentioned that she also took into consideration the Native American cultural environmental perspective, and polled the students to determine their interests before developing the science units. Mr. Mattr, the other teacher who developed his own curriculum, remarked that he selected science units in large part based upon the ability to make science relevant to students' lives. Thus this was a primary focus of unit development.

Students followed a form of inquiry in the lessons observed, doing observations, recording data in booklets, asking each other questions, attempting to draw conclusions. In the case of Mr. Mattr, there was some evidence that students manipulated variables to and formed testable hypotheses during the observation times. Teachers reviewed the lesson's primary objectives at the end of the lessons to check for student understanding. But only two teachers mentioned that they attempted to determine students' misconceptions and correct them. There was no observable evidence that teachers further probed students' open-ended questions that arose from the lessons.

ACCURATE CONTENT: All but one teacher stated that they felt confident in their own science knowledge. They believed they had adequate science backgrounds. The teachers using the FOSS kits and AIMS lessons relied on the resource integrity for importance and accuracy of science content. There is no evidence that two teachers considered importance, accuracy or appropriateness in selection of the activities for the students beyond the mandated curriculum. Observations by researchers supported this perception. The content in all observations was accurate.

One researcher, however, commented that at times the application of science content becomes lost to students or is not seen as personally relevant to them, and that students get the impression that science is about discovering what is supposed to happen rather than learning about what happens and trying to make sense of it (nature of science).. For instance, one researcher remarked that Ms Christianson corrected some students' conclusions that were drawn from their light spectrum activity (Galaxies/Stars unit) and said this is what "you should have seen", and "you should have seen something else".

Some teachers believed they had a clear understanding of fact, hypothesis and theory. Others became confused when attempting to define and give examples of each. This is represented in Ms Kantor's response to define each. She said, "In an elementary setting, the facts would be the stuff that they have in the book. Hypotheses would be something that you're thinking about but you haven't really tested it that well. And then a theory would be something that you tested a couple of times, but haven't done a lot. There are so many things that used to be facts that are now not facts that I have a difficult time defining what a fact is. I suppose a fact is something that has just been tested and tested and tested and so far nothing has proved (it) wrong." Additionally, Ms. Christianson explained, "I think of it as an educated guess 'cause that's what I've always been taught. And I teach the students that they can form a hypothesis by taking information that they have seen, performed, and learned, and then they can make a hypothesis, but it's not a fact 'cause it's not totally proven."

APPROPRIATE CONTENT: Again, the teachers who used FOSS kits believed that the science content and process was appropriate for their students, because the schools or districts in which they teach selected the kits for them. The teachers who designed their own curriculum took into consideration the students' abilities, interests and needs. They also used examples that related to students' lives, such as talking about Michael Jordon's coordination in reference to muscles and tendons. One teacher remarked that he did not necessarily agree the FOSS kits were appropriate for the grade levels for which they were intended. Two teachers felt the lessons that were observed were appropriate for their grade level because they taught the students about observing natural phenomena, recording data and drawing conclusions from data.

Ms Cam conducted a lesson in which many students were not engaged. The students were off task and did not complete their work. She commented that next time she would do the activity "more slowly" and did not consider the appropriateness of the lesson for the students as a possible reason for the off task behavior.

SCIENCE & MATH FOR ALL: The CLES 2(20) for some teachers were quite different from students' responses about science being relevant and meaningful to them. Although teachers believed they provided lessons that were relevant to all the students, the students did not agree. Ms Brandon, stated, "I still need to work on accommodating the higher ones (students) and the lower ones." During observations, researchers saw teachers monitor special needs students more closely, but that the lessons were not designed necessarily to accommodate students' differences in either learning style, behavior or intellectual ability. Ms Vee appeared to have specifically designed science units with student needs and differences in mind. She began teaching science to her special education students as "Fun Fridays" devoted to science and science videos. Student participation was optional. Over time, all students began to participate. The Fun Friday discussions resulted in the design of the units of study for science during the year. Even though students were at quite different levels of skill in reading and math, they were all studying science together so that skills such as communication and social behavior could be facilitated too. Mr. Mattr commented, "there are several levels and styles of learning in my class, and the method of instruction will accommodate for these."

NATURE OF SCIENCE & MATH: Teachers believed that they were effective in helping students understand the nature of science and its uniqueness from other areas of study. However, there were significant differences on CLES 2(20) scores between most teachers and their students. In the observations researchers did not see students test their conclusions or come to consensus or see patterns in nature. Typical teacher responses about the nature of science as a "way of looking at the world" or seeing the world "through scientist's eyes". Mr. Mattr explained that he attempts to use the scientific method and expects students to make connections – reasons thinks work the way they do and apply that understanding to new situations. He used an example of balance in habitats and balance of systems in a healthy body. He believes students should work to see and understand similarities and patterns in science.

Teachers also believed they were teaching students through an inquiry approach. They believed that in-depth inquiry is critical to learning science and that the process of inquiry is important. Ms Kelly explained, "Science is a process. It involves building on the knowledge you have, using what you know, forming a hypothesis, making a prediction, what do you think will happen, and not just stopping at that, taking a step further. If I know this, if I think this will happen, what can I do to find out?… How am I going to test what I think? And then forming a conclusion." Observations provided evidence that students were involved in inquiry to some degree, but they were not given opportunities to answer the "what if" questions that emerged from their efforts, with the exception of Mr. Mattr's students. Teachers typically wanted to do more inquiry but sited time as a factor that limited their ability to teach beyond the hands-on discovery manner.

CURRICULUM CONSTRAINTS: Curriculum constraints were primarily due to pre-selection of programs (Discovery Works, FOSS kits) for the teachers. Teachers also mentioned that time constraints limited their ability to teach beyond the dictated curriculum. Even though FOSS kits were generally the accepted curriculum, some teachers determined which activities within the kits to use with the students. Very few teachers thought about or determined whether the units aligned with either the state or national science standards. Two teachers talked about their understanding of the science standards and were convinced that their units fit the standards. Ms Vee specifically aligned her units with the state science standards.

KNOWING PEDEGOGY:

KINDS OF ACTIVITIES: Most teachers who used FOSS kits did not make the selection of activities/units because their schools or districts made the selections. Some activities within the kits not selected were because of time constraints or because the teachers felt the other activities could not easily be accomplished by their students. Mr. Goodman, selected units at random based upon what was available. Ms Brandon determined which FOSS kits to use with her 4th grade students based upon those used by 3rd grade and 5th grade teachers at the school. Mr. Mattr selected the activities based upon his perceived needs and interests of the students in his class, and for variety. He believed in using cooperative learning groups and incorporated that into his activity selection. Ms Vee also selected units/activities based upon student interests, abilities, and linked to their cultural beliefs. She stated that she made sure the activities met the objectives outlined in the state science standards. She believed the activities should not only help students understand content, but also integrate with other subjects. Mr Bean explained that he tried to use the FOSS kit activities to help students generate their own questions in science.

All teachers felt it was important for students to be actively involved in “doing” science. Teachers were asked to define activity. Ms. Christianson’s explanation was typical of the responses. She remarked, “Every time they (the students) do something with another person I feel is an activity.” Others used the term “hands-on” to describe science activities. It was apparent that the teachers held a strong belief about students being involved in active science learning. To Ms Kelly activity meant, “some kind of ‘hands-on’, kinesthetic activity’ requiring students to do some thinking and figure some things out”. Few, however, talked about the need to have students engaged in thinking throughout the activities. Most teachers distinguished science from other subject areas, saying that in science it is critical for students to be “doing” rather than “hearing about”. Other subjects, some thought, could be taught by providing information. Ms Kelly went on to say, “Science has those qualities to it as well, but it’s also more of a problem-solving, left brain kind of approach, where you’re really needing to think all aspects of it through, trying to get the whole picture before you make your final statement (conclusion).” The teachers agreed that cooperative group work was necessary to accomplish learning with a scientific perspective.

Most teachers in this study specifically selected students for group work in science. Many suggested that they select a variety of students such as “low” students, “high” students and then some in between. This refers to students’ abilities to grasp science. Mr Goodman mentioned, “I’ll put certain students together because I know they will function as a group because of how well they can get along with others, or work with others. I also group them so some lows are with some average learners so they can help each other. Maybe some highs are with some average learners so that their groups are made up of enough different types of ability levels and learning styles that they can kind of enhance each other'’ learning."”

APPROPRIATE ACTIVITIES: Teachers using FOSS kits assumed the activities were appropriate for their students based upon the integrity of the kits themselves, and the recommendation of their schools/districts. The kits are popular and the materials are contained within the kits for ease of use. Ms Brandon stated that she thought the kits were appropriate for her students because they encourage students to "struggle a little bit with the activity". Still others believe that the kits are student-centered, and are thus appropriate for students. Mr. Goodman suggested that the FOSS activities were appropriate because they allowed students to manipulate and learn about themselves and science without being told. Ms. Vee related appropriateness of activities to not only learning about science content, but to other needs of her students. For her students the FOSS kits would be too fast for them. She explained that her papermaking activity was designed to develop students' social skills, link to issues of recycling and forest products, and encourage problem solving skill development.

KINDS OF THINKING USED & CLASSROOM DISCOURSE: Teachers talked about having students problem solve and draw conclusions through their participation in the science activities. Many teachers thought the FOSS kits promoted scientific thinking process among students, asking them to make inferences, draw conclusions, identify patterns, and manipulate data. Most researchers observed the teachers asking low level, and "right answer" questions of students during whole group and small group activities even though teachers believed that they were helping students develop in-depth thinking skills. Ms Brandon used numerous questions throughout her science lessons, but most were observations questions ('What did you observe? Or 'What did you write in your logs?') rather than more open-ended questions ('What if…? Or 'I wonder what would happen if…'). However, in her interview, she stated that she encouraged students to share their thoughts and ideas by saying, "That's a great idea. Let's think about that for a minute… Let's see what we can find out outside the class." The researcher found no evidence of this in the lessons observed. Researchers concluded that much of the whole group discussions were primarily teacher directed and students predominantly answered questions that the teachers asked.

TEACHER'S ROLE IN CLASSROOM & DISCOURSE: Teachers described their role as "facilitator" or "guide". It is evident that the teachers had become familiar with these terms in their teacher preparation programs. Some explained that they are responsible to get students to answer questions, lead discussions, monitor 'on-task' behavior, encourage science exploration and orchestrate student experiences. Mr. Mattr's comments were representative of the teachers' views. He stated that he was "to kind of get things started, opened it (lesson) up with a little discussion and introduction." Ms Vee said she also prodded students to explore their ideas.

Teachers were observed facilitating and guiding to varying degrees. However, the teachers were predominantly directing the work in a teacher-centered rather than student-centered environment. Ms Vee's class appeared to be more student-generated science than the other observed lessons. Mr. Goodman's lessons focused more on classroom management and discipline rather than teaching/learning about science.

ASSESSMENTS: The main forms of assessments used by the teachers of this study were informal, formative assessments. The list includes observations, notebook/log entries, responses in whole group and small group discussions, pictures, written responses, worksheet responses, and on-task behavior observations. The teachers did not give specific examples of what they were looking for in their observations other than students following directions or behaving appropriately. Teachers were observed walking around their classrooms and interacting with students throughout the inquiry lessons. Ms Cam held a daily morning meeting in which she reviewed science concepts with students and the responses helped her to determine how to modify the day's afternoon science lesson. This was not observed. Some teachers mentioned that the FOSS kits contained written assessment questions and worksheets that helped them determine if students understood science concepts. Only three teachers used tests as formal assessments of students. Mr. Bean also asked students to periodically evaluate group members in group projects/activities.

STUDENT LEARNING ACHIEVED: It is apparent that teachers are not confident in knowing whether students have achieved the specified goals and objectives of the science lessons they are teaching. Mr. Goodman stated, "my assessment of them isn't to the point where I really clue into that." Ms Vee suggested that it is easy for her to determine whether students had met the behavioral goals of the lessons. Ms Cam said that she checks content and attacks misconceptions, but she does not provide information about how she accomplishes this. She doid not say how she identified misconceptions that students may have. Some teachers suggested they use the KWL method to determine whether students understood science concepts and information. In addition, Ms Kelly remarked that the students' report card grade for science is based upon effort. Ms Christianson explained that she combines observations and test scores to determine students achievement of learning goals and objectives. However, she did not suggest what she looks for in her observations that provides her the necessary information. She also assumed that with well placed groups, goals will be achieved.

EXTERNAL RESOURCES: External resources that were listed involved mentor teachers, the web/computers and CDRoms. One teacher is assisted in the science budget by having the school's aluminum can recycling money ($400-$500/month) used for elementary and middle school science materials. This provides the program with money to purchase necessary materials for projects developed by students and teachers.

KNOWING STUDENTS:

APPROPRIATE TO STUDENTS: Teachers use a variety of criteria to select student work groups for the science activities such as: students' ability to work with others, students' ability to grasp science concepts, students' language skills, students' communication skills, and students' interests. For example, Ms Christianson's development of a power point "Who wants to be a Millionaire" review game was evidence of knowing her students' interests and what sparks their participation in the review. Some teachers conducted pre-activity discussions or used the KWL approach to accommodate for students' differences in the activities. Ms Kelly stated she does not directly address the diverse needs of the students because the FOSS kits take that into account. She did, however, say that she works with the other 3rd grade team teachers and may slightly modify activities from their discussions. There was strong agreement between Ms Vee's CLES 2(20) for Critical Voice and Student Negotiations and the students' responses. This was supported in the classroom observations. Students sometimes feel safe questioning science and when they do, they feel they learn science better. Ms Vee mentioned that she designed the plant/plant product unit to foster her students' Native American spiritual connection to nature and as a result of the Fun Friday discussions. She exclaimed, "It has to fit their ways of learning!" A large number of Ms Kantor's students are English Language Learners (ELL) and she commented that hands-on activities are appropriate for such students. She presented directions orally, in writing and demonstrated them so that all students understood what was expected of them. She also attempted to ethnically mix her work groups to promote English language development. One of her assessments was pictorial drawings rather than written responses. In contrast, Mr. Goodman's students were primarily off task in the first lesson observed and the second lesson was cancelled because students were unable to focus long enough to conduct the activity. Classroom management became the focus of lessons 1 and 2. A third lesson was observed and students were able to work in small groups to complete a task. Lastly, Mr. Bean used analogies that students were familiar with to help link science understanding of the lesson to students' real lives.

STUDENT'S ROLE IN CLASSROOM & DISCOURSE: All teachers voiced their belief that students should actively participate in group work, asking questions, testing hypotheses, exchanging ideas and formulating conclusions. In addition, teachers talked about students working independently, communicating with each other, offering suggestions, and helping to teach each other. In some cases this was observed by researchers. Mr. Mattr asked students to design an experiment about plant growth. One student suggested that sugar water be used to help the plant grow faster since it provides energy to kids. Another student countered that the energy is short lived and actually has the opposite effect in the long run. After discussion (guided by the teacher), several student groups decided to use the sugar water as the variable to eliminate the 'chance effect' in the results and, therefore, improve the validity of the data. In another case, Ms Kelly used a concept web on the board to determine students' understanding of the science concepts in the science lesson. She explained that this procedure helps recognize misconceptions that need to be challenged and encourages student participation and discussion.

More typically, though, the kinds of student discourse that teachers hoped for was only minimally observed. Ms Christianson stated that her expectations of students were to "learn and ask questions and think a little bit … My goal is to get them to participate as a group, to discuss, to be interested in it (the science lesson), to inquire, to take every opportunity they can to learn something new", this was not observed in the classroom. However, this was not supported in the classroom observations by the researcher. Student questions were ignored or put off to another day. Mr. Goodman expected his students to "challenge themselves" and use tools that he gives them. In the lessons observed students had a difficult time using the equipment for the activity and did not challenge themselves to develop an understanding of the science being taught. Mr. Bean's students worked enthusiastically during the activities but were expected to be seated and were limited in their ability to exchange ideas with each other even though he asked students to explain science ideas frequently.

MANAGEMENT OF SOCIAL ASPECTS AND BEHAVIOR: New teachers in this study were very cognizant of the issue of student social needs and behavior management in hands-on science activities. All teachers used group work in their activities and struggled to find the balance between allowing students freedom to explore and maintain control of the classroom. Ms Brandon earlier discussed the dilemma of redefining classroom control, knowing that when students conduct hands-on explorations, they are inherently noisier than sitting in desks taking notes or listening to the teacher. The question that the teachers raised with their comments was, "At what point does it become too chaotic or noisy and I have then lost control?"" Two teachers cancelled an observed science lesson because the students got "out of hand" and could not focus enough to complete the lesson. The teachers do not feel confident in determining that balance yet. Teachers used techniques such as counting to three, raising a hand, talking quietly, and using wait time to manage student movement, noise or distraction. Two classrooms contained a "time-out" corner for students who did not behave appropriately. Students were asked to raise their hands before sharing their ideas in whole group discussions. Additionally, students were specifically selected for groups based upon, in part, their ability to get along with and work with other students. Most students in the classes observed, were on task, asking questions in their groups and participating in whole class discussions. Ms Kelly explained that she reflects on her lessons in a specific way to determine if the lessons are appropriate for and meet the needs of the students. She asks herself, "Are students using scientific vocabulary when they are working together? Are they challenging each other? Are they really interested in the science? Are they only interested in the toys?" Ms Vee is patient and firm with her special education students. She and her classroom aide are cognizant and alert to changes in students' mood and behaviors. She is also flexible in her lesson design. During one observation she talked to students about responsible behavior. Ms. Cam arranged her ELL students around the room so they could work on their language development with English speaking students. She also expressed her expectation that students help each other. Lastly, teachers moved easily throughout the room to monitor student behavior and small group discussions. This appeared to aid students in their ability to learn from the teacher and their peers.

ESTABLISHING A LEARNING ENVIRONMENT

MANAGING PHYSICAL FACILITIES & RESOURCES: The teachers appeared to arrange the classrooms adequately for teaching the lessons observed, even though each room varied in size and accommodated different numbers of students. All but two classrooms were arranged by grouping desks or providing tables for students to work in groups during activity-based lessons. As mentioned earlier, Ms Vee's classroom was arranged around the periphery of the room so students were less distracted by the activities of the classroom. The students moved their desks to work in groups during science lessons, though. She played soft, Native American music during lessons to create a calm environment and to help students become more aware of cultural music. Posters in the room also linked to their science learning. In addition, she had the students help to sponge-paint the wall as a backdrop for ocean habitat decorations and as part of their ocean unit of study.

Mr. Goodman had difficulty with movement of students for one observed lesson due to inadequate arrangement of materials. After the lesson he remarked that he would arrange materials differently to prevent congestion of students the next time he taught the activity. Several teachers identified “getters” in each group to obtain and return science materials for the activities from a central location. One teacher handed out materials to each group of students so they did not have to move around the room obtaining materials. These decisions made for a safe learning environment for students. Ms. Kelly noted, “I change the desks and everything once a month and I think I’ve had them different each time I’ve changed them. I try to do something different. I like to, when we’re doing science, I really like to work the kids around a group setting – around an area, whether they push desks together to form a surface where everyone can work or if they’re working at a table or if they’re working on the floor – somewhere where there’s an open space for everybody to participate.”

All teachers were observed giving students detailed directions for each activity. Some teachers modeled the process to be followed, the use and handling of equipment, and the consequences for not following safety rules prior to student participation in the activities.

INSURES PHYSICAL SAFETY: During the inquiry lessons observed, teachers clearly indicated to students safety concerns and procedures prior to students conducting the activities. In situations where there was potential safety concerns with equipment or chemicals, the teachers designated specific people (eg: teacher assistant) to dispense the chemical or use the equipment to assist students. Teachers walked around the classrooms to monitor appropriate use of equipment to insure safety during the activities. They also were observed individually dealing with students not on task to reduce safety hazards. Teachers appeared to be well prepared for the hands-on lessons observed.

DEVELOPING AS A TEACHER

SELF-REFLECTION: All teachers displayed reflection of their science teaching but to varying degrees. All teachers but one stated that student responses influenced their decisions about what to do next or when they taught the lesson the next year. Ms Kelly “jotted down notes” and asked herself what she needed to do differently or keep the same for the next lesson. This was typical of the responses during teacher interviews. There was no evidence to suggest that second year teachers reflect on their teaching to a greater or lesser extent than first year teachers. Those teachers who developed their own curricula appeared to reflect on their teaching in greater detail, questioning the effectiveness of each lesson/unit and what they might do to improve the effectiveness of student learning. They also spent a greater amount of time preparing for and researching lessons taught, which may influence their self-reflection. This compares to teachers using FOSS kits that have all materials and content information included.

Several teachers viewed changes in teaching lessons in relation to time constraints. Ms Cam's second observed lesson did not go as well as anticipated. She stated that she will try to conduct the lesson "more slowly" next time. The teachers who appeared to be most reflective viewed changes of lessons in terms of what to do to improve effectiveness of students' learning. For example, Mr. Goodman asks himself questions such as, "Are you presenting in a way (that) you are helping to bridge their understanding to knew understanding? Are you teaching them with methods that are developmentally appropriate?" He noted, "One thing I think I need to work on is how to frame class discussions that kind of reflect on the activities done. Because getting the kids to focus all at once and maintain active listeners is a challenge. I don't do that enough." Another teacher, Ms Brandon, spoke of her need to continue to change her view of classroom control in relation to teaching activity-based science. She remarked, "I still have control even though they are in charge of themselves and they're the ones talking and they're the ones working… I sort of am still in control, but it's a different kind of control." Additionally, she explained that student control in the science classroom is "one of the hardest things for me, to still feel like I'm a good teacher…"

PROFESSIONAL DEVELOPMENT: Most teachers credited their teacher preparation programs, their undergraduate work, and their student teaching for a significant portion of their professional development thus far. However, the % designated ranged from 20% to 50%. Prior work experience such as being a nanny for young children (Ms. Brandon), and working as at a nature center as a naturalist (Mr. Goodman) had a significant impact on their preparation for teaching. Several teachers sited conversations with colleagues as an important experience in their continued growth as a science teacher. Mr. Goodman called this communication "productive conversations" to distinguish the conversations from the typical gripe sessions or classroom management/discipline discussions. The productive conversations dealt with curricular issues and pedagogy.

Teachers also listed district or school inservice programs. But they stated the sessions provided did not include science related materials or resources. Mr. Bean spoke of attending an MnSTA workshop at a science museum, participating in a 3M Wizard's workshop, and using the "science masters" website as sources of his professional development. As time permitted, some teachers used the internet to gather information and search for effective and engaging science lessons for their students. Ms Kelly utilized the district's science center personnel for professional development. Additionally, two teachers found that being on the school's science curriculum committee served as a source for professional development. Three teachers stated that they had not participated in any professional development during the academic year. Some teachers stated they did not know about MnSTA (the state's science teacher organization), but that it might help them in their own professional development in the future.

RESOURCES, SUPPORT COMMUNITIES & LEARNING COMMUNITIES: As in many other areas of this study, the researcher found the amount of support and resources available to new elementary teachers of science varied greatly. Ms Cam listed her school principal and another third grade teacher as her greatest resource for support and growth.

Mr. Bean sites scientist parents and his mentor teacher in his support and learning communities. An experienced middle school science teacher at the school is serving as a mentor teacher for him this year. Mr. Mattr was provided a mentor teacher the first year of teaching, but this support was not continued to the second year. Most teachers did not have mentors specifically assigned to them their first year of teaching. The local library is also a resource mentioned for professional development.

None of the new teachers sited the CFL as a resource for professional development. One teacher who is currently working toward a masters degree listed the graduate course as a resource for professional development. The researchers found no evidence that districts have formal mentoring or other support for their new teachers. The new teachers perceived support from their districts/schools to be less than adequate.

RESEARCHER COMMENTS

Included in this section is a compilation of comments made by the researchers that may be valuable to consider when drawing conclusions from this study. The comments (many of which were voiced by the teachers themselves) influence the ability of new teachers in this study to effectively teach science to students on the elementary level. It is with this in mind that the comments are included.

- One teacher expressed his uncertainty of being rehired the following year (due to budget cuts) as influencing his motivation to participate in or seek out professional development opportunities this year.
- Several teachers voiced frustrations about unexpected outcomes that resulted from conducting FOSS kit activities. They anticipated that, if the directions and procedural steps were followed carefully, the expected outcomes should result. However, they found that to not be the case in several instances. They also found the kits to be quite involved and time consuming.
- Although teachers thought they were encouraging in depth inquiry in the science lesson, there was little evidence of this actually occurring during the observations. The researchers often noticed basic and strictly directed inquiry occurring, and observed that the focus became more of completing the activity rather than determining what science was being learned. Teachers spent a considerable amount of time explaining what the students should do. They also answered mostly “right answer” questions and there was no evidence that they followed up on the open-ended questions students asked during discussions.
- Time management was a pervasive issue for most of the new teachers in this study. The researchers noticed that the lessons were at times, rushed through by the teachers so that the lesson could be completed in the limited time frame. Two researchers questioned whether students understood the science of the lessons even though they appeared to be interested and engaged in the activity.
- One first year teacher found it difficult to teach 30 students, 17 of who are ELL students. She had no experiences in her teacher preparation program to accommodate for the degree of language or cultural diversity she found in her class this year. Ms Kantor remarked, “I feel good (about teaching) because I accomplished something

that is difficult, and you know, I also feel good because I helped a population of students who are usually not given a lot of resources that they need. But I don't, I honestly don't think I could be in urban teaching for my entire teaching career. It takes a lot out of you."

- One teacher suggested that the three special education students in the class greatly influenced her ability to conduct science lessons effectively because she needed to spend a considerable time addressing their behavioral/off task difficulties to the detriment of the other students in the room.
- Two researchers voiced concerns about elementary students completing the CLES 2(20) appropriately so that valuable information can be gleaned from the responses. In one instance, only 7 of 15 students completed the student form and another teacher stated he did not know that his students understood the questions even though he attempted to read the questions to them.

ANALYZER COMMENTS

- There is significant evidence in the profiles presented to suggest that even though teachers believed inquiry science is critical to students' science learning, the observations showed little in-depth inquiry occurring. Teachers most often asked and answered "right answer" questions of students. This was common among teachers using the FOSS kits.
- Only one teacher overtly attempted to integrate science lessons with other subject areas. In this case the teacher developed her own curriculum to accomplish the objective, and taught all subjects in a contained classroom of special education students.
- New teachers generally relied on the importance, accuracy and appropriateness of the FOSS kits for their science teaching. They did not question the reliability of the kits and valued their use because the kits were recommended (and in some cases mandated) by the school district. Yet, most teachers had little or no training in how to effectively use the kits with their students.
- Mr. Mattr, the teacher with 4 previous years of unlicensed teaching, demonstrated more risk taking and appeared to have a greater handle on classroom management. He also seemed to feel more confident letting students design and explore their own experiments. Additionally, he appeared to guide classroom discussions so that student learned to think about problem solving in depth, look at validity of data, and respond to each other's thoughts and ideas.
- Even though Mr. Goodman had significant work experience teaching environmental lessons for children at a nature center, he struggled with classroom management issue in similar ways as other new teachers. He had a clear view of how he wanted to teach but was unsure how to get there.

THOUGHTS OF TWO-YEAR STUDY

EMERGING PATTERNS: It appeared that classroom management wass problematic for new teachers and this created a barrier that influenced the effectiveness of hands-on instruction in science. Teachers referred to management issues in their interviews to varying degrees. New teachers indicated that students with behavioral disabilities cause lessons to be less effective, rather than reflecting on what they can do as teachers to accommodate for the diversity of student behaviors. The new teachers did not address issues of learning style differences other than to explain that they thought hands-on lessons aided kinesthetic learners, or that students could draw their observations rather than write their responses.

New teachers additionally felt less confident in their ability to assess student understanding of the science to be learned. They generally talked about observing them and listening to their responses during group and whole group discussions, but they rarely gave specific examples of what responses indicated student understanding or misunderstanding. This may or may not be a result of the prompts given for the interview or the prompts on the post-observation form. Most teachers did not use traditional testing to determine student understanding of science. However, they were reluctant to make decisions about what to do next if students indicated that they did not understand the concept(s) to be learned in the lessons.

Observations supported the premise that new teachers are still in the “teacher-telling” mode and that the discourse most frequently is the teacher asking questions and the students responding to them. There were few student generated questions being observed or encouraged overtly. Moreover, the kinds of questions most often asked were “right answer” questions. This gave students, over the long term, the idea that science is about right and wrong answers rather than the intended view that science is about identifying patterns in the world around us.

Students rarely had an opportunity to help determine the activities, units, lessons to be studied in science. The most frequent determining factor was the district’s adopted program for science. The programs varied from district to district and from public to private schools.

Few teachers made reference to the MN Science Frameworks or the National Science Education Standards when making decisions about what to teach and how to teach it. Some teachers did not have a clear view of what constructivist teaching is and how it plays out in the classroom.

New teachers frequently voiced concerns about the lack of support for their jobs. They spoke of inadequate budgets for science, the lack of importance to learn science in elementary school, and the lack of mentorship for new teachers. Most teachers had no mentors and second year teachers do not have the benefit of a mentor even if one is assigned for their first year of teaching. There was no evidence to determine the extent to which mentoring programs within districts or schools are effective and help to meet the needs of new teachers in any subject area. New teachers often relied on more experienced teachers for support and growth. But they did not indicate if they use additional criteria other than length of teaching to indicate their ability to mentor them. Those teachers who felt they had significant support were more willing to take risks and try new teaching methods than those who had little perceived support.

Many new teachers' perceptions of inquiry were different than what is observed by researchers. The teachers intended to provide opportunities for students to do in-depth inquiry in their science lessons. Yet the researchers observed students participating in basic, low level inquiry. Large groups discussions also supported this premise.

There wss little evidence that new teachers attempt to integrate science into other subject areas. The science lessons tended to be stand-alone units or lessons. However, new teachers made a noticeable effort to apply the science lessons/units to students' real lives and, frequently to the world outside the classroom. Many teachers voiced their desire to improve upon this aspect of teaching for coming years.

New teachers stated that they are confident in their own science knowledge, and believed they could effectively teach science to elementary students. They were willing to put for a great deal of effort to prepare for hands-on science lessons because they believe students learn more effectively when they are actively involved in the lessons.

Many teachers spent a great deal of time in "survival mode" their first year of teaching. This period of adjustment to teaching seemed to create barriers in their ability to move beyond the prescribed mandates (such as using the FOSS kits) for teaching science. The teachers, though, remarked that they understand their ability to teach in effective ways is a "work in progress" and with reflection and experience they will improve.

EMERGING QUESTIONS: Some questions emerged from analyzing this data. The questions may serve to guide discussion among researchers or provide ideas for further study. Most often teachers have students conduct hand-on activities but do not overtly discuss the depth of thinking that should occur for students to make the connections they anticipate. Are teachers assuming that if students complete the hands-on work, they will make the necessary connections to link the new knowledge to their prior knowledge, or to draw appropriate conclusions? How do teachers learn to recognize students' misconceptions and know that the misconceptions have changed? What kind of support is necessary for new teachers so they can begin to feel confident and willing to move toward the kind of teacher that the state and national science standards describes for our students? What can help teacher become familiar with and confident in assessing student understanding? At what point do teachers move beyond the "survival mode" and begin to ask themselves critical questions that result in more student-centered classrooms? And what helped those teachers with more student-centered classrooms get there?

CONCERNS, ISSUES TO FURTHER ADDRESS:

It would be quite helpful, for the purpose of improving the credibility of the study, for all researchers to include actual quotes from the teachers they observe. This was not consistent in the profiles submitted for analysis. The quotes can come from the pre/posts observation sheets, observations, or the interview. This helps to substantiate the evidence that is presented in the individual profiles and assists the analyzer in recognizing trends and patterns that may be emerging for the long term study.

There is an ever increasing concern that many young children do not understand fully the essence of the questions asked on the CLES 2(20) form. If this is the case, then the information resulting from the responses is weakened and may not be a valid component of data to use in the analysis.

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