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The Impact of Notebooking on Teacher Candidates' Construction of Knowledge

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Abstract

Teacher education preparation programs must adapt to changing science education reform movements that identify notebooking as an effective means to increase children's' science process skills and content knowledge. This study addresses the question, "What are the structures and thinking processes that teacher candidates utilize when writing in notebooks?" Specifically, how do they express their thoughts during an observational-based prompt writing experience in an undergraduate, integrated science and mathematics methods course? Sixteen teacher candidates at a Midwestern university in the United States completed an eight-week assignment during the spring 2012 semester using notebooks. Results indicate the participants could be placed into three distinct categories of processing and formatting the notebooks which are described in detail with supporting examples.

Keywords: Observation, Curriculum, Constructivist, Teacher Candidates

Introduction

The need for something better

Science education continues to be a vital subject for the United States and its citizens. Recent advances in technology mean that emerging careers are strongly linked to education, training, and knowledge in the science, technology, engineering, and mathematics (STEM)

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fields. In addition to career opportunities, science education is critical in helping citizens prepare for incorporating scientific advances into their personal lives. And, of course, the process skills and scientific attitudes developed through science are important to help young and old navigate (Achieve, Inc. 2013; National Research Council 1996; National Science Teachers Association, 2002). But, for many in the United States science education is not meeting the demand for educating students to live and work in a rapidly changing scientifically enhanced world. One of the nation's leading advocates for reform in science teaching or education, the National Science Resource Center (NSRC), expresses its mission as "…to improve the learning and teaching of science for all students in the United States and throughout the world." (NRSC, 2011). This reform is largely based on research that supports inquiry based coursework. Such coursework, and appropriately connected elementary teacher instruction, promotes problem solving and deeper understanding of science content. Such instruction often requires integrated learning connected to solving problems and investigating problems over time.

To help address the need for something better, the NRSC, and other leading reformers, call for a change in the way curricula is taught to elementary students. One such change is the incorporation of inquiry based kits. Inquiry based kits have existed and been used in elementary classrooms for about half a century and have seen an increased emphasis over the last decade. One reason for their use is that the kits often include assessment tools that help teachers monitor and determine students' abilities to master science process skills and the content knowledge upon which a kit is based. These assessment tools often require students to write out their answers as they learn. Researchers have long demonstrated, and still do, that students better learn the science when they write about it (Aschbacher & Alonzo, 2006; Endreny, 2010; Fulton & Campbell, 2004; Matsumura, et al., 2002; Rivard, 1994; Scardamalia & Bereiter, 1985). Rowell's (1997) metanalysis on writing in science implies that students can improve their conceptual understanding of science through notebooking. This is largely due to the cognitive disequilibrium they experience as they attempt to scaffold existing schemata into a new framework to integrate new information, terminology, and linkages. Therefore, notebooking and writing can be used as essential curricular strategies to enhance learning in the elementary classroom.

The role of science notebooks

While students have long used writing in school it has not always been done in a systematic way. Copying class notes from a board, completing worksheets, or writing one word answers to questions on laboratory sheets is not currently viewed as best practices in learning and assessment with inquiry-based methodology. To address this deficiency in elementary science, student notebooks are often incorporated as a pathway for students to better learn through an authentic, inquiry-based method. Science notebooks include the ways scientists (and students) systematically develop research questions, record observations and data, draw inferences and conclusions, and communicate findings as they go about their work. Notebooking and writing practices are critically important and directly called for in Practice 4 (Analyzing and Interpreting Data) and Practice 8 (Obtaining, Evaluating, and Communicating Information) of the Next Generation Science Standards (Achieve, 2013).

To effectively model the process by which adult scientists go about their work, elementary teachers are encouraged to utilize notebooks with their students. In the elementary school, notebooking may defined as "…tools for students to grapple with scientific concepts and make sense of their understandings using recording and organizing strategies that are personally meaningful" (Fulton & Campbell, 2004, p. 26). A key goal for notebooking then is to write for conceptual understanding (Tomkins & Tunnicliffe, 2001).

Variations about what should be included in science notebooks exist, but they all attempt to challenge students to record observations, analyze data/findings, summarize their learning, and ask new questions from the experience. They are then able to take ownership of the notebooks and review them as they integrate their developing knowledge with classroom work. In addition to writing for conceptual understanding students should include drawings and diagrams to help internalize the content being learned (Glynn & Muth, 2008). Shepardson and Britsch (2001) report that this is a bit more intuitive for primary students based on their imaginative play. Primary students contextualize their occurrences in relation to a) imagination, b) previous experiences, and c) the science activity/experiment itself. Intermediate students have become more normalized to the process of schooling and learning and expectations of the teacher.

This begs the question then of how elementary teacher candidates will structure and express their thinking while using notebooks to record observations in nature. Since observing lies at the heart of the basic scientific process skills, it is important that teacher candidates model, understand, and master the creation of exemplary observations when notebooking. Indeed, how they internalize the process as emerging teachers will relate to how they use and teach the process to future elementary students. As such, their notebook recordings will be used to discover how teacher candidates structure and express their thinking while making observations in a nature setting. Specifically, the research question we addressed was what are the structures and thinking processes that teacher candidates utilize when writing in notebooks how do teacher candidates physically structure their notebook observations when recording observations in a nature setting.

Method

To address the research question, researchers analyzed entries from 16 teacher candidate observation notebooks. Notebook entries were collected weekly over an 8-week period following the introduction of the assignment. Following best practices, intermediate notebook entries were not formally assessed and feedback was limited to helping candidates uncover their ideas, asking questions, and making general comments (Fulton & Campbell (2003).

Participants

Participants for this study came from teacher candidates enrolled in two sections of an undergraduate integrated science and mathematics university level course taught by the lead author. The course material covered content and strategies for teaching grades kindergarten through grade three and seeks to emphasize the use of inquiry-based practices with young children. Participants were recruited through an explanation of the project given by the professor (first author) who taught both sections. The final 16 participants represent those who consented.

The participants have been accepted into a Department of Teacher Education program located in a Midwestern United States 4-year public university that is accredited by the National Council for Accreditation of Teacher Education (NCATE). To be accepted into the program candidates must have passed, by meeting minimum state cutoff scores, the Praxis I, ACT, SAT, or GRE examinations; earned a 2.75 GPA; passed a criminal background check; and successfully completed all coursework that applies to the program course requirements with at least a C or better.

The professor desired that teacher candidates (participants of study) spend time outdoors as well as begin to practice recording observations, so she combined these into this assignment. As a classroom teacher, she had found that even young children do not always

observe carefully when in nature. Many of the children did not get up close to trees, leaves, logs, and bugs. They did not handle them or peer at them. This assignment was to provide teacher candidates an opportunity to be introduced to doing observations outside as well as a way to practice asking questions that would lead to data collection and problem solving. She was also interested in how they might connect this series of observations with their future teaching.

Procedures

After IRB approval, the research project was explained to all eligible participants in both sections of the course and informed consent documents were distributed in class during the first week. Those who were willing to participate signed the informed consent document and returned them to the professor. An explanation of the observation notebook assignment (see Figure 1) was provided in class to all participants.

Assignment: Observation Notebook

Goals for this assignment

- ✓ Consider why young children need to observe and spend time outdoors
- ✓ Use several senses
- ✓ Recognize possible use of photographs, drawings in conducting observations
- ✓ Relate observation to other content learning, and the development of children
- ✓ Growing ability to ask higher level questions
- ✓ Increased use of ideas of how to represent knowledge
- ✓ Consider how you might teach the ability to observe to young children

Week #1

**Choose a place outdoors to observe and focus. It needs to be a place you can continue to get to and be still for at least 15 minutes (no texting or talking). Immediately note your observations in the notebook. Make drawings, sketches, or take photographs of objects or areas connected to your observations. Ponder about the relationships between natural elements and/or manmade elements, and any changes that occur over time. Record questions that come to mind as you conduct your observation. These 'questions' may take the form of ponderings, but include at least 3 throughout your notes. These may prompt future observations as well as help you consider what you might help your students in the classroom.

**You are *required* to observe at least once a week for 8 weeks; however, you may go more often and stay for more than 15 minutes – this may lead to further knowledge and understanding!

**Submit on the due dates and it will be returned at the next class period.

Figure 1. *Assignment Guidelines*

All participants were given pseudonyms and the handwritten narratives were transcribed as line by line entries. Transcripts were coded individually by the researchers and then a common list of codes was compiled to utilize for further analysis. Codes that emerged initially included questions, professional connections, and observations. Researchers established a 93% inter-rater reliability of coding (Miles & Huberman, 1994) before continuing analysis of all transcriptions.

Analysis required the researchers to look at the entries not only line by line but also in chunks allowing them to see how individuals approached this assignment with respect to structure and thinking. As analysis continued, it became clear that students were using specific ways of documenting and recording in their notebooks. These findings are detailed in the following section.

Findings

The assignment was designed to be constructivist in nature in an attempt to allow creative freedom. Ultimately, this lead to participants creating their own unique system for organizing the information they were recording during the 15 minutes of observation. In an attempt to organize the content they observed, the participants tended to create a sort of template for each entry. This is exemplified by several of the participants following a self-developed, consistent order such as stating something they observed, asking a question about the observation, posing an explanation about the observation, concluding with an action to further explore an issue about the observation, or making connections to activities they could do in a future classroom.

The results indicated that as participants began to record observations in nature, they made choices about how to record, as well as, what to record. Even though each participant created his/her own format, there were some commonalities within the 16 notebooks. This ultimately led to the identification of three distinct categories (Reflectors, Wonderers, and Planners) of processing and formatting the notebooks. Each is described in the following paragraphs with supporting excerpts from notebook entries.

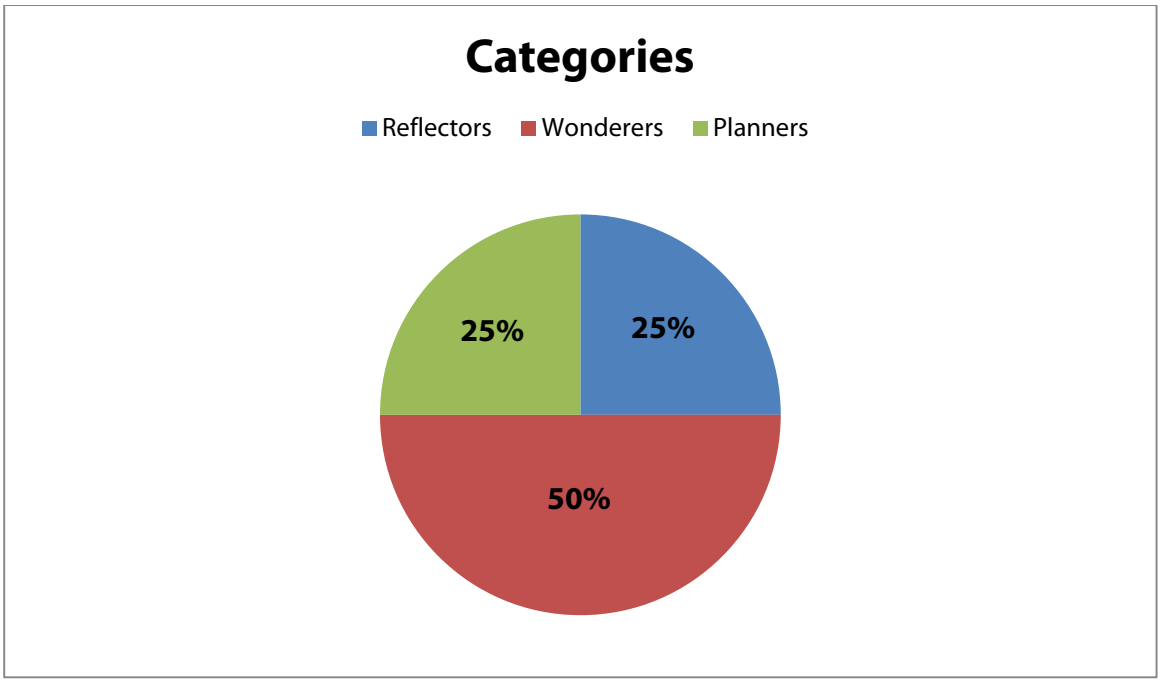


Figure 2. Pie Chart of Categories

Reflectors. "Reflectors" were represented in 25% of the notebooks. These were teacher candidates who observed something in nature and recalled similar or related prior experiences. It was as if memories were engaged allowing the teacher candidate to make sense of what they were currently encountering in nature. For example, *Chelsea* wrote,

> "The children just run past the lake again. One little girl is scared to get close to the water, but follows in the older kids footsteps anyways. Maybe to prove a point? She's courageous. Being out here and seeing these kids, makes me think of when I was little. My siblings and I would always play outside with the neighborhood kids. To prove myself to my older brother and the boys I would do stuff that I was secretly afraid of. It's funny how being out here would make me think of all this. It's not like déjà vu, we never had a lake near, but the smell of grass, the sound of the fountain (like a sprinkler). The neighborhood kids out playing, I swear I can just close my eyes and be instantly transported back to the late 1990s."

Liz wrote,

> "The water in the river is not very clear or clean. I describe it as a dark greenish brown color. Why are some rivers cleaner and clearer than others? As I continue to study the color of the water, I recall trips to the mountains where those rivers were beautiful. I am sure there are many causes to this. Could it be that those rivers in the mountains have rock on the bottoms versus ours that consist of a muddy, clay, and sandy type of bottom? As I continued to observe the environment around me, I noticed that the current of the water (which is moving pretty slow) is running from what looks like South to North. I couldn't help to think this was strange. I recall my dad discussing this topic with me in the past. Learning that the Ohio River starts in Pittsburgh and ends in Cairo where it runs into the Mississippi River, the overall flow of the water is moving east to southwest. Knowing rivers do not flow in straight lines, but with many turns and bends, including what I've heard to be called 'horseshoe' Bend in Evansville, I believe is a part of the current I am currently seeing. This is a topic I would like to further learn about."

Wonderers. "Wonderers" were represented in 50% of the notebooks. These were teacher candidates who observed something in nature and then posed a string of questions. It was as if their observations inspired question after question. For example, *Faith* wrote,

> "It makes me wonder if squirrels have families. I never see more than 2 or 3 of them together at the same time. It makes me curious about where they live.
>
> Do they choose certain trees? Can the squirrels burrow underground?
>
> We see squirrels almost every day but I never have really learned too much about them."

Robert wrote,

> "I do wonder what will happen to the trees who start budding right now? Will their life cycles end much sooner this year? Will the leaves fall off the trees in July rather than September or October? What will the weather be like if there are no leaves on any of the trees to provide shade in really hot weather?"

Planners. "Planners" were represented in 25% of the notebooks. These were teacher candidates who observed something in nature and would create a sort of "to-do" list of potential future classroom connections. It was as if these teacher candidates were in teacher mode throughout the entire 15 minutes of observing. For example, *Debbie* wrote,

> "While looking at my backyard I am feeling goose bumps creep up all over my arms.
>
> I wonder why they are called goose bumps? Maybe it is an illness that geese get. I think goose bumps happen because the nerve endings under your skin get agitated because of the cold and they pop up a little bit above the skin to show they are under

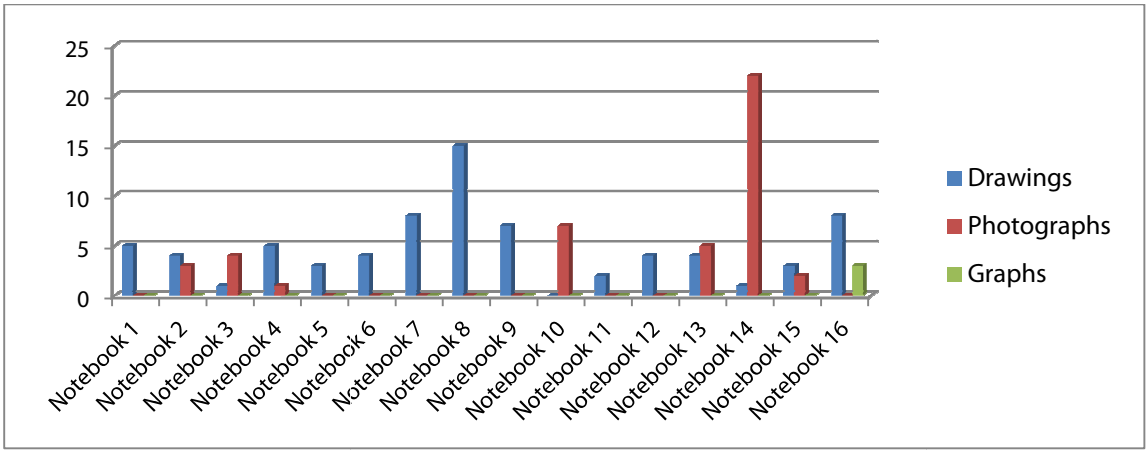
some stress. I fun activity to do with students would be to see at what temperature outside do we get goose bumps. Depending on the temperature of each student's goose bumps we could make a graph & analyze the data to see at what temperature the majority of the students started getting goose bumps. Then the students could hypothesis how they think goose bumps form. We could also analyze what qualifies a goose bump? The start of the goose bump, or the point at which the goose bump is fully inflamed above the skin. If the students don't verify these possibilities then the student's data [will] be incorrect."

Chloe wrote,

"I decided to walk down the trail a little ways to try and find the birds. I never did see them, but I did see this beautiful yellow flower instead. It was the only one like it in the area. I walked a little bit farther along the trail and found a beautiful purple flower. It too was the only one of its kind in the area. What are these particular flowers doing in the middle of a forest? How did they get here? Where are the other flowers like these two? Did they die off or were they never here to begin with? Since it is so dark on the mediation trail and not a very good place for plants to grow (the dirt has many rocks in it and the only other living plants in the area are mainly moss and big tall trees), I would infer that these plants were not meant to be grown in this area. Perhaps people brought the seeds of these flowers over to the meditation trail and planted them here. Or maybe the wind picked up the seeds and carried them here. Or maybe an animal accidently brought the seeds to this area. This would be a great science activity to do with my students. They could plant seeds in different environments (rocky soil, dark atmosphere, sunlight, soil near a body of water, etc.), and then observe the plants to determine the environment that is most suitable for plant growth. I think it would also be a good idea to teach my students that plants are not always put into an area by people. We could visit several different environments that have plants in them. The students could observe the type and number of plants in each environment. They could then infer or draw their own conclusions about why those plants may be growing in that environment."

Again, ideas were posed but only one participant expanded upon these ideas by creating fictitious graphs (see Table 1) that future elementary students might create based upon the participant's observation.

Table 1. *Creative Content Per Notebook*



Focusing on the research question, "What are the structures and thinking processes that teacher candidates utilize when writing in notebooks?" Specifically, how do they express their thoughts during an observational-based prompt writing experience in an undergraduate, integrated science and mathematics methods course? When given the choice, students chose differing ways to record their observations and their thinking; they created their own unique system for organizing the information. The results indicated that three distinct categories of notebooks, that of reflector, planner, or wonderer could be established based on the structure and thinking processes from the teacher candidate's notebooks.

Discussion

Findings of this study indicate that participants made choices about how to place their observation documentation within each notebook entry. Each participant made a decision about how to format the words on the page and how the space would be used. Some inserted drawings as borders or in the margins, some placed photos following the written descriptions, and others put all photos or drawings at the end of each entry. Participants did not make changes in their self-developed formats once they began. It's as though they found something that made sense for each of them and continued with the chosen formatting pattern. Several questions emerge with this finding. One set of questions revolves around candidates' learning. Why were specific formats chosen? What connections to learning does their format bridge for them as compared to other formats with different candidates? Will candidates view their format better than others? And, importantly, to what extent are other types of categories/writers can be uncovered by extending the study to larger populations and different audiences?

Another set of questions revolves around future implications. Will this format be the one that they ultimately utilize with students? Are they cognizant of other formats and therefore ready to encourage and recognize the other formats with future elementary students?

The authors plan to research several of these questions with upcoming students. We encourage others to consider them as well and add to a growing body of research around the infusion of student notebooking with teacher candidates and elementary students.

Ultimately, this assignment and study led the professor to reexamine the assignment and its goals. Using a constructivist approach in assignments allowed for variability in recording observations in nature; however, the findings of this research indicate that the instructor should consider discussing with students the reasoning behind their choices. Fulton and Campbell (2004) explain that it is key for teachers of elementary children to help elementary students question and analyze the organizational strategies they choose to use in notebooks. One conclusion from this study suggests that this should also be done with those who would be teachers of those elementary students.

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