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Learning to Use Digital Science Notebooks: A Teacher's Perceptions and Classroom Use

Abstract

Note taking applications for tablet devices offer the potential for meaningful integration of science and technology through the use of digital notebooks. This case study examined one pre-service teacher candidate's thoughts on using a digital notebook during a STEM methods course and how she transferred this knowledge and practice to a summer STEM camp. Data included artifacts from the STEM course, video of a lesson, a follow-up questionnaire, and students' notebooks. Analysis indicated that the candidate had a positive view of a digital notebook based on her use in the STEM course, and that she successfully incorporated a digital notebook into her summer STEM camp. Students' notebook entries incorporated photos, drawings, and explanations that extended beyond what they were doing in science to what they were learning. While this study shows potential for meaningful integration of science and technology through the use of a digital notebook, additional research is needed to further understand the impact a move to digital notebooks could have on the teaching and learning of science.

Keywords: Elementary, Pre-Service, STEM

Introduction

For more than a decade science notebooks have been used in elementary science classrooms as a means to document students' work and thinking processes (Baxter, Bass, & Glasser, 2001; Fulton & Campbell, 2014; Fulwiler, 2007). These notebooks are typically composition books, in which students make drawings, record data, and make sense of their findings through the development of explanations. The notebook is ever present during science investigations, as well as science talks, so that students can refer to data as they discuss their ideas and viewpoints with others.

Although the composition book serves this purpose well, digital technologies could offer new opportunities for science notebook use. A digital science notebook offers opportunities for students to document their learning using more traditional methods, such as drawing and writing, while it also allows students to add photos and audio recording to their entries. Such elements could enhance notebook entries, especially for emerging writers who might struggle to get their ideas down on paper. With more and more schools incorporating tablet based devices into classrooms (Hill, 2012; Leonard, 2013; Quillen, 2011) the time has come to explore how teachers and students use a digital version of the science notebook to promote learning in science.

To promote such learning, teachers must have personal experience using the science notebook as their students would (Morrison, 2008). While science methods courses have incorporated traditional paper based science notebooks with success (Morrison, 2008), little has been reported on the use of digital science notebooks with pre-service teacher candidates or the elementary students they teach. This study set out to examine the impact incorporation of a digital science notebook in a STEM Methods course would have on the pre-service teacher candidate's perceptions and eventual practices in the classroom. The research questions posed were (a) How does use of a digital notebook in a STEM methods course impact a pre-service teacher candidate's perceptions of a digital notebook? and (b) How does this perception translate into classroom practice and student outcomes?

Literature Review

Writing in Science

Educators should consider language and writing integral components of doing and learning inquiry-based science (Baker et al., 2008; Yore, Florence, Pearson, & Weaver, 2006). *A Framework for K–12 Science Education* (NRC, 2012) asserts that inquiry-based science "requires … students [to] combine processes and scientific knowledge as they use scientific reasoning and critical thinking to develop their understanding of science" (p. 105), and that

> from the very start of their education, students should be asked to engage in the communication of science … [and] should write accounts of their work, using journals to record observations, thoughts, ideas, and models. They should be encouraged to create diagrams and to represent data and observations with plots and tables, as well as with written text (pp. 76–77).

Writing in science helps clarify thinking and build understanding (Keys, 1999; Rivard, 1994) and has been described as the "minds-on complement to hands-on inquiry" (Yore, Bisanz, & Hand, 2003, p. 712). However, in order to develop these types of understandings, teachers need to provide explicit instruction that scaffolds students' thinking and writing (Yore et al., 2003). Science notebooks have the potential to incorporate this type of writing and serve as powerful learning tools for students (Fulton, 2012; Pearson, Moje, & Greenleaf, 2010; Ruiz-Primo, Li, Tsai, & Schneider, 2010).

In recent years, educators have looked to technology as a means of promoting writing. In terms of science education, it is our position that *digital* science notebooks are a way to build upon the well-documented effectiveness of traditional paper-based notebooks by supporting students and instructors. For example, one of the many benefits of digital science notebooks is increased functionality. With digital science notebooks students can type their notes, insert tables, take photographs of specimens, and record audio and video. In addition, their notebooks can easily be shared with the teacher via file storage services. Another compelling set of arguments in favor of digital science notebooks can be found in the literature on Information and Communication Technology (ICT) literacy.

Information and Communication Technology (ICT) Literacy

The *National Educational Technology Standards* (NETS) (ISTE, 2007) state students should, "demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology," and "use digital media and environments to communicate and work collaboratively." Along with an emphasis on ICT literacy, studies have also demonstrated the potential benefits of ICT on science learning. These benefits include the encouragement of science-related communication, collaboration in science research activities, collection of scientific information, and interaction with multimedia resources (see Bingimlas, 2009).

For decades, the field of science has been "inextricably linked" to technology (Narin & Olivastro, 1992)—a link that has only grown stronger in the early part of the 21st Century. For example, scientists' paper-based lab books, "the de facto standard for recording experiments" (Schraefel, Hughes, Mills, Smith, Payne, & Frey, 2004, p. 1), have been "replaced or enhanced …with desktop computers" (Szalay & Gray, 2006, p. 413). Furthermore, it has been argued that digital notebooks will someday completely replace scientists' paper notebooks (Nussbeck et al., 2014). Based on the above ideas and the need to promote 21st Century skills such as using "multiple media and technologies" (Greenhill, 2009, p. 4), and using "technology as a tool to research, organize, evaluate and communicate" (Greenhill, 2009, p. 5), research to investigate the modern equivalent of the traditional science notebook is needed.

For various reasons, the existing research on digital science notebooks is quite limited. To the best of our knowledge, there is only one project—the Leonardo Project, which designed the CyberPad—focusing on this area. The CyberPad is an "intelligent virtual science notebook" (Lester, Carter, Mott, & Wiebe, n.d.) that guides students through classroom activities (Wiebe, Shelton, Patterson, Hardy, Carter, & Sheffield, 2013). However, this digital science notebook is geared toward a particular set of curriculum materials and is not open-ended, making it more limiting than a traditional paper science notebook. Therefore, research is needed on digital notebooks that are open-ended and similar to the conventional composition book.

Writing and the Impact on Student Achievement

Writing in science and the use of science notebooks have the potential for increasing the critical thinking skills students need to achieve in science as well as other academic areas (Pearson et al., 2010; Ruiz-Primo et al., 2010). There are a number of studies that link writing in science to positive impacts in student achievement. Mason and Boscolo (2000) found that fourth graders who were asked to write about what they were doing and learning in science, had a better understanding of the science concept on post-instruction questions related to transfer of information, and metaconceptual awareness. Lee, Mahotiere, Salinas, Penfield, and Maerten-Rivera (2009) found that third-graders showed gains on posttests when engaged in learning activities that focused on inquiry-based, hands-on science that integrated writing strategies as well as linguistic scaffolding for English Language Learners.

There is also a great deal of research on use of the Science Writing Heuristic (SWH) Framework. The SWH Framework focuses on inquiry-based instruction in which students construct and test questions, justify claims based on evidence, compare what they found to the findings of others, consider how their ideas have changed, and present this information through some sort of written task (Akkus, Gunel, & Hand, 2007). Hand, Wallace, and Yang (2004) found that the SWH approach improved seventh graders' understandings of cells, based on conceptual questions. Choi, Notebaert, Diaz, and Hand (2010) determined that the SWH Framework was helpful in assisting students in developing a written argument, or conclusion, in science, and that students' arguments improved over time. An interesting finding of this particular study was that year 5 students produced the strongest arguments, in comparison to year 7 and year 10 students, providing disconfirming evidence for the idea that maturation is an important component of the development of arguments. Nam, Choi, and Hand (2011) found significant differences between a group of eighth graders in Korea who used the SWH approach and those who did not in the development of big ideas related to the science concept of electricity.

It is through writing that students transform their initial ideas into coherent understandings. The digital science notebook can offer students alternative means, as stated earlier, by which to write about their understanding of science concepts.

Methodology

This qualitative case study (Creswell, 2007) examines the ideas and practices related to the use of digital notebooks of one pre-service teacher candidate who agreed to participate after accepting a position to teach during a summer camp session. This pre-service teacher candidate, Tami, used digital notebooks as part of her STEM summer camp for fourth and fifth grade students.

Context

The pre-service teacher candidate was enrolled in an elementary STEM methods course during the first semester of her senior year. The course incorporated a digital notebook that candidates used

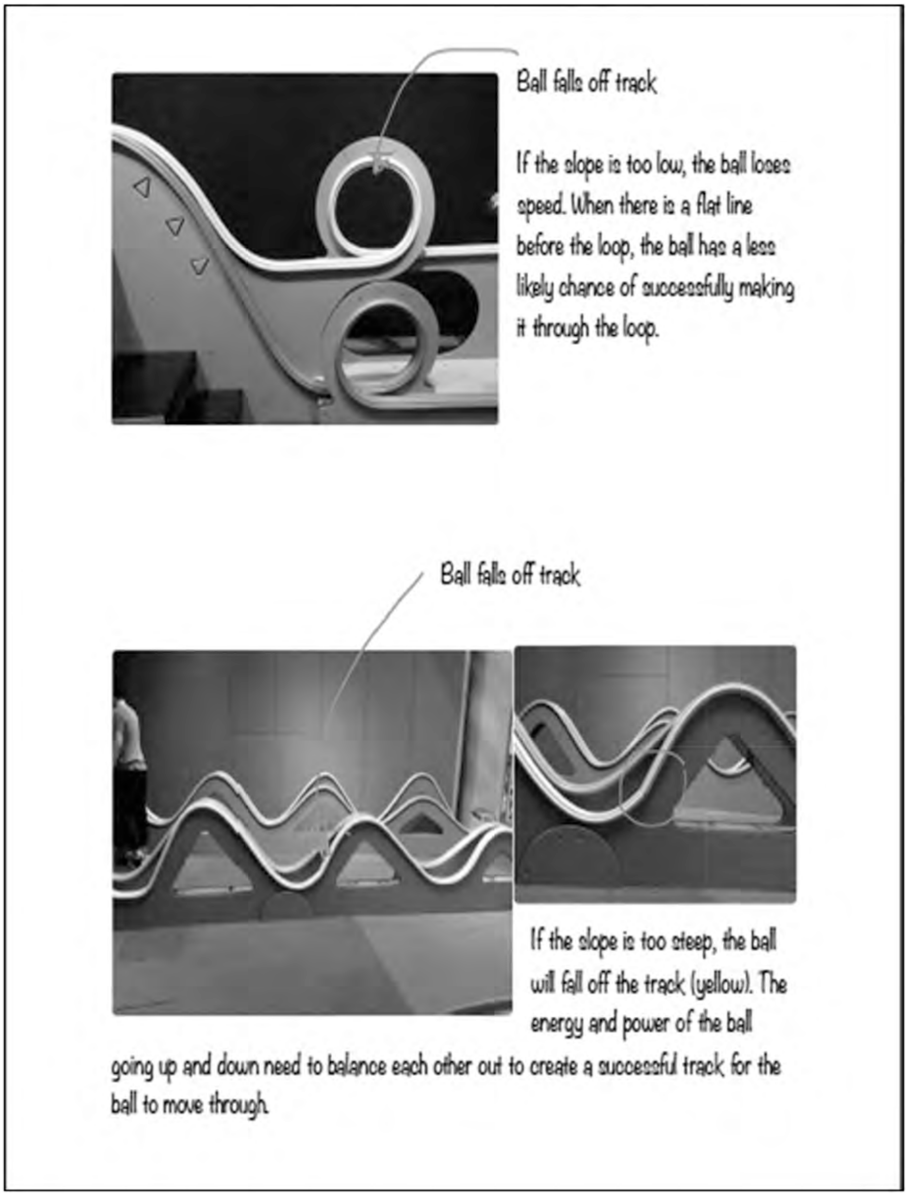

Figure 1. Use of photos within a notebook entry.

on a regular basis to record and organize data related to the STEM activities (i.e., catapults, roller coasters, gears, etc.), as well as to reflect on the concepts behind those activities. The candidate maintained the notebook throughout the semester and submitted a reflection on her use of the notebook, how it impacted her learning, and her thoughts on using a notebook with elementary aged students. For the purposes of this study, *Notability*, an application developed by Ginger Lab, was selected to serve as the digital science notebook. After reviewing ten popular but affordable note taking applications, the authors chose *Notability* based on the fact that it allowed users to type, write, and draw using a finger or stylus, record audio, take and insert pictures, and share notes using file storage services such as Google Drive, Dropbox, iCloud, etc.

Teacher candidates in this course were invited to apply to teach in a summer camp program run by a different division of the College of Education. Tami was selected to teach a grades 4-5 STEM course with 25 students, in which she would have access to 12 iPads with the *Notability* application. The summer camp was five weeks long, meeting for 3.5 hours each day, with the goal of students discovering, through inquiry-based, hands-on learning, what it takes to be an engineer. Demographic information on the students enrolled in the summer camp was not collected due to privacy issues; however, the students in this class came from many different schools throughout the area and represented a variety of cultures and backgrounds.

Data Sources

Data consisted of artifacts collected from the STEM methods course and the summer camp, which included a survey on the note-taking application and a notebook reflection assignment; video of a self-identified lesson from the summer camp session; a follow-up questionnaire completed after the summer camp session; and the students' notebooks from the summer session.

The survey consisted of 10 questions that addressed tools used within the note-taking application and preference of tools and type of notebook (paper vs. digital). The reflection was based on the candidate's use of the notebook over the semester and how this applied to the elementary science classroom. Tami completed this survey at the end of the semester as part of the STEM methods course. The open-ended questionnaire consisted of 20 questions, and was completed by Tami upon completion of the summer camp. The questionnaire addressed notebooks in the science curriculum, use of digital notebooks, and technology use and impact. The survey, reflection, and questionnaire allowed us to determine the candidate's views of the digital notebook and how she thought it impacted learning in science. We also collected Tami's notebook at the end of the course. It consisted of 24 entries and allowed us to see how she used the digital notebook herself, although a thorough analysis of her notebook is not the focus of this study.

Table 1. Anchor Chart of What to Include in a STEM Notebook

diagram, labels	ideas, brainstorm	picture
page #s	research	strategies
questions	constraints, problem	date, name
instructions	opinions	improvements
title	drawbacks	bullets
journal entries	observations	
conclusions, predictions, estimates	charts, graphic organizers (drew web, t-chart, venn and flow map)	

The video of the classroom lesson was 51:03 long and allowed us to determine if Tami's espoused ideas about digital notebooks were put into practice in the classroom, as this would influence her students' use of the notebook. However, it should be noted that she turned the video off as students worked on various tasks, so it is not clear exactly how long the lesson went. Finally, 12 digital notebooks were collected in PDF and note format via Google Drive. Due to the limited number of iPads, students worked in pairs to develop a notebook. The students' notebooks allowed us to determine what took place throughout the camp and how students used the digital science notebook.

Data Analysis

The reflection, questionnaire, and classroom lesson were analyzed using a constant comparative method (Strauss & Corbin, 1998), looking for emergent themes. The two authors identified themes, which included the candidate's beliefs about the digital notebook, instruction, student responsibility, and technology related aspects. The survey data were summarized using descriptive analysis (Hinkle, Wiersma, & Jurs, 2003). This allowed for a simple description of the types of tools used and preferences related to those tools. Students' notebook entries were uploaded to a cloud based network as "notes" and analyzed using content analysis (Berg, 2001) to determine the elements students included, based on elements identified within the literature on science notebooks (Aschbacher & Alonzo, 2006; Fulton & Campbell, 2014; Ruiz-Primo, Li, Ayala, & Shavelson, 2004).

Table 2. Percent of Entries Containing Elements

Notebook Elements	Complete Notebook (n=24 entries)	Catapult Entries (n=12 notebooks)
Basic Elements		
Date	80	58
Title	64	100
Focus Question/Problem	32	8
Drawings / Diagrams	60	83
Labels	52	75
Photos	84	100
Written Explanation	64	92
Graphic Organizer	16	58
Content of Entries		
Addresses Science Content	72	92
Describes Science Activity	12	8
Describes Feelings	4	0
Contains a Claim	56	92
Contains Evidence	24	42
Contains Reasoning	48	50
Uses "because"	44	58

Findings

The Methods Course

Tami was introduced to the notebook as a means to document and reflect on her thinking as both a learner and teacher in the STEM methods course. She used the notebook on a regular basis, and, while given basic direction on how to use it, she made decisions about what and how to record. Focusing questions were posed at the end of investigations to encourage the candidates to move beyond simply recording their work to thinking about and reflecting on the concepts related to the task. Tami's notebook had 24 entries, or "notes" within one "STEM" folder. Each note was named with the date and a title relevant to the activity. She used a variety of tools within the application to record, including typing, handwriting, photos, importing documents, and sharing to a cloud based server.

On the survey, Tami indicated that she was comfortable using the digital notebook and actually preferred it over a paper notebook, stating that she liked "the photo aspect of it." She also found the photo to be the most helpful tool when recording data, saying that it was, "quick and efficient" and allowed her to "see something visually and watch the steps of an experiment in progress." She disliked inserting documents, as "it turned it into a PDF and there was limited space to write answers to questions." She also found the handwriting tool to be difficult, saying that "sometimes [she] couldn't read [her] writing and would have to erase and write again." In her reflection, she stated that using the digital notebook was "really difficult … in the beginning" and that she struggled to find a way to organize her information within it in a way that she could understand. However, she also stated, "throughout all the trouble, I have to admit that I enjoyed using my iPad as a STEM notebook" and she chose it as her preferred material for note taking. Tami's digital notebook demonstrates her preference for the photo tool as well. Thirteen of her 24 entries have photos in them, with a total of 89 photos overall. She often used the photo

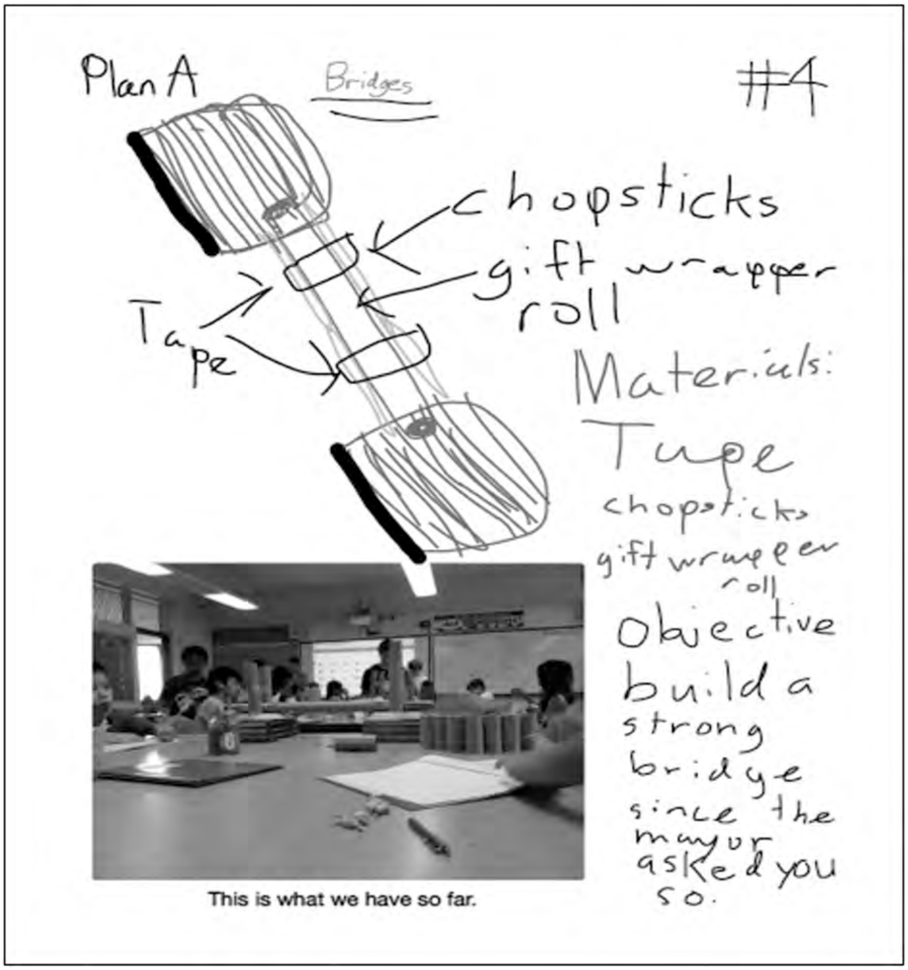

Figure 2. Description of work with drawing and photo.

as a means of evidence to support a claim she had made, as can be seen in Figure 1.

In using her own digital notebook throughout the course, Tami gained insight about the purpose of the notebook and how she would use it in her own teaching. In her reflection, she stated that “the notebook gives students the responsibility and power to create their own special journal when doing science experiments” as well as that it provides students with a way “to understand what they are learning.” She came to realize and regret that in the beginning she spent a great deal of time “trying to make [the notebook] look ‘pretty’” and focused on “looks rather than the information.” In thinking about using a notebook for her own class she emphasized that it should be a way for students “to make sense of something” but that the teacher can provide questions to keep the students “grounded and heading in a forward direction.”

The Classroom

To help ground and guide her students, Tami started the 5-week camp by introducing her students to the digital notebook. Since she had 25 students and access to only 12 iPads, she had students work with a partner, or in one case two other students, generating one notebook between them. Her idea about responsibility came through as she had students work in small teams to generate the types of information they might include in their STEM notebook rather than giving them a list of what to include. Their ideas were then compiled into one anchor chart for the class (see Table 1). She then modeled what a notebook entry might look like using an activity students had done earlier in the day.

Before passing out the iPads, Tami had the class come up with ground rules for using them, which included such things as “handle with care, do not use an app you are not authorized to use, no looking up the latest game.” It was made clear to students that if they chose to use the iPad inappropriately that they would lose the privilege to use it. Once rules had been established, the iPads were handed out and Tami modeled how to access the application and how to create a new document and name it. She then provided the students with approximately five minutes to explore the application to learn about the various icons. At the end, students shared out some of the things they found, such as the drawing and erasing tools, scissors, photo, and typing. She revisited the features the next day by having the students create a web of the different tools available on the application. This matched her ideas about instruction, as she stated in the questionnaire, “I think students need time to explore the science notebook and find out what they can do with it rather than the teacher giving a set way of how to use things. … [after, I would] go back and teach students about certain parts of the application that they might have missed.”

On the questionnaire, Tami noted that she specifically taught the features of typing (keyboard), drawing/coloring, writing, highlighting, taking a photo, and erasing. However, she also noted that her “students caught on fast with the Notability app. They were able to find features that I was not aware of and found creative ways to use the notebook.” In addition, she thought that using the iPad as a digital science notebook was easy for students, due to their experiences with technology in general. The only problem students encountered was “not being able to type as fast as their thoughts came.” Similar to her own experience, she thought students “enjoyed documenting their learning through pictures.” However, she also noted a concern that students would sometimes not follow the established ground rules for

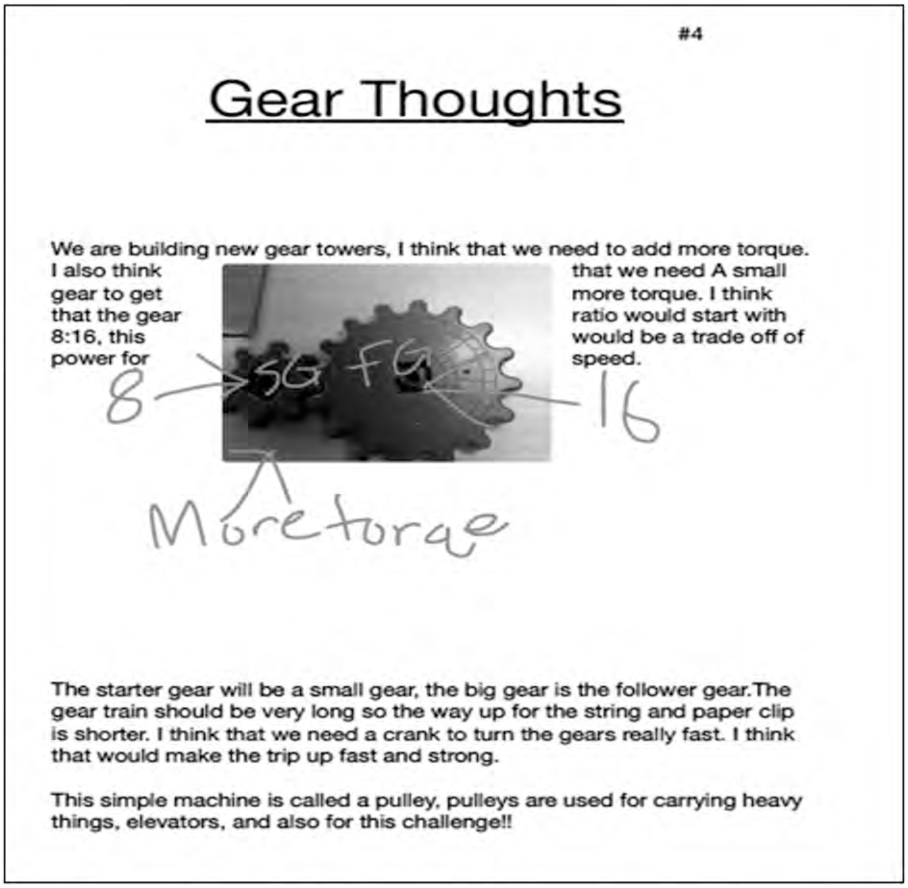

Figure 3. Entry with a written explanation supported by a photo.

the iPad, as she observed them "taking 'selfies' or using the internet inappropriately during class time." Overall though, she felt that "using a digital-based notebook [got] students more involved in their learning."

Student Notebooks

An important component of notebook use is to document the learning that is taking place. Entries need to go beyond simply documenting observations and what was done, or mechanical use, to include reflection and development of explanations (Ruiz-Primo et al., 2010). To determine how students used their notebooks, we conducted a content analysis of one complete notebook (iPad 1) identified by the teacher as a group she thought was representative of what students did with the digital notebook. Based on the analysis of the representative group's notebook, we then analyzed one entry, catapults, from all of the remaining 11 notebooks (see Table 2). We found that the majority of entries contained some sort of written explanation and focused on the content being learned. The entry examined within the 12 notebooks had a higher incidence of claims supported by reasoning than did the full notebook we examined. This does not come as a surprise though, as the entry was selected based on the fact that iPad 1 contained a claim supported by evidence and reasoning. In addition, this entry focused on a catapult activity, which was similar to an experience Tami had in the STEM methods course.

Based on this analysis, it was evident that students were incorporating many of the basic elements of a notebook, including the use of photos, which was one of Tami's preferred features. It was also encouraging to note that there was a high percentage of written explanations containing some sort of claim, evidence, and/or reasoning within the notebooks, 64% of students provided written explanations over multiple entries, and 92% of students provided a written explanation for one particular entry. The fact that the majority of notebook entries on this particular day contained a written explanation implies that Tami might have provided a focus question and or time for students to write about the topic. In addition, these explanations contained claims, with some supported by evidence and reasoning. It is not surprising that the percent of entries containing evidence and reasoning present was not as high as the percent containing claims, as students often struggle with these components of an explanation (Zembal-Saul, McNeill, Hershberger, 2013). However, it is encouraging to see these elements in notebooks facilitated by a pre-service teacher candidate, as many in-service teachers struggle to include these elements (Ruiz-Primo et al., 2010).

Complete notebook. In looking through iPad 1, it was evident that Tami had done some of the same STEM challenges with her students that she had done in the course. There were notebook entries on gears, roller coasters, towers, and catapults. In addition, she added new challenges, which included bridge building, making a sturdy house for the three pigs, and a Lego design challenge. The notebook on iPad 1 had 24 entries, organized into 11 folders, with the majority of entries clearly dated (80%) and titled (64%) either on the entry itself or in the title of the "note." Photographs were used in a high percentage of entries (84%), and were used by the students to support the description of their work (see Figure 2) or to support their written explanation (see Figure 3).

In addition, in Figure 2, the students included a drawing of the plan for their bridge along with a written list of materials and the objective. Drawing and writing is a natural mode of data entry for students and drawing can be a helpful communication mode for elementary aged students (Shepardson & Britsch, 2001). The majority of entries included typed text however (see Figure 3), which

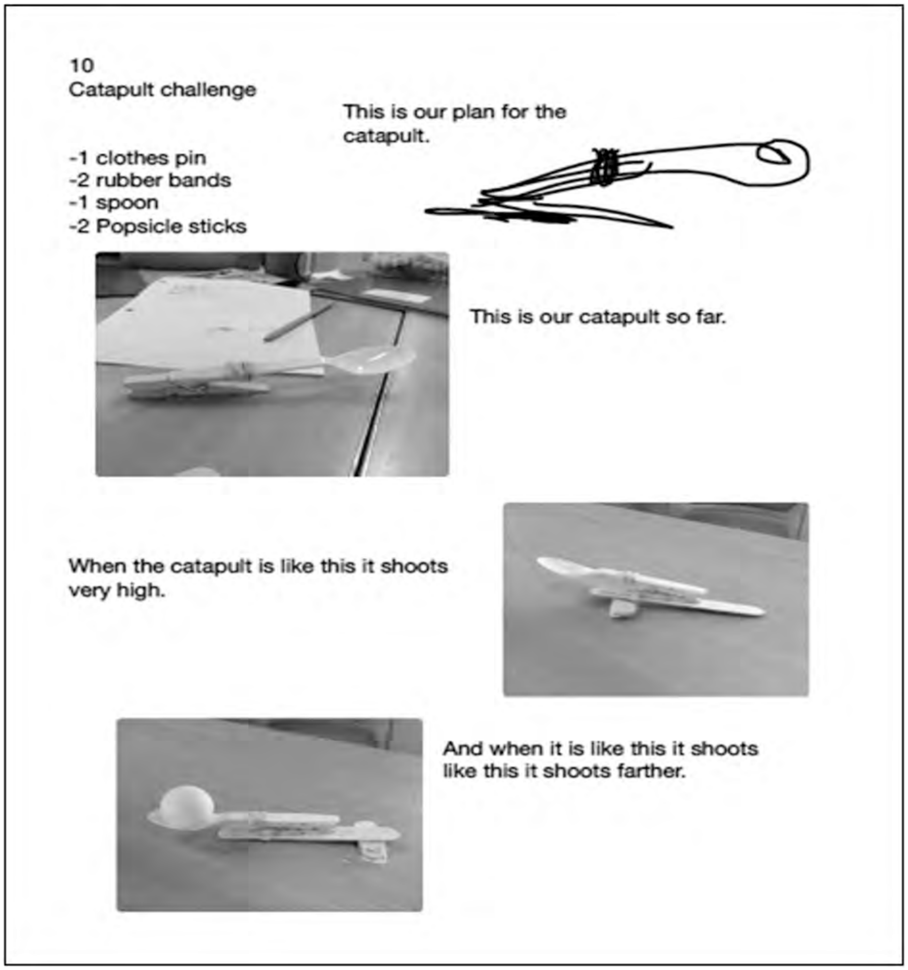

Figure 4. This entry from iPad 9 uses photos as part of the explanation.

Longcamp, Zerbato-Poudou and Velay (2005) found to be the least efficient entry mode for children. Also, in Figure 3, students included an explanation of how they should assemble their gears to lift a paperclip tied to string to the top of the tower. In this explanation, they included claims, such as, "we need a small gear to get more torque" and "the gear train should be very long." They also included reasoning, such as "this would be a trade off of power for speed" and "the way up for the string and paper clip is shorter." There does appear to be some disconnect between their claims and reasons, as it is not evident how a long gear train will create a shorter distance. Still, it is encouraging to see students including these types of ideas rather than simply writing about what it is they are doing.

Catapult entries. Students' entries for the catapult were organized in different manners, making it clear that the students had choice in the way they organized their notebooks. From the titles and dates on students' entries, it was evident that the catapult activity took place over a 3-day period. Some students generated new "notes" for each day while others combined the days in one "note," due to this the entries ranged in length from one page to six pages. When different notes were generated for each day, we looked at the third day's note, as this is where it appears that students were asked to reflect on the catapult challenge, which was similar to the entry on iPad 1. All of the entries contained a photo and 92% contained a written explanation. Figure 4 is an example of an entry that used photos as part of their claim, in saying, "When the catapult is like this it shoots very high." While it could be interpreted that the students are referring to the angle of the arm, it is not clear. Their explanation could have been extended by having them support their idea with evidence of how high or far the catapult shot the object and/or reasoning about what component of the design they thought influenced the outcome.

In Figure 5 the students drew a model of their catapult but also used photos to demonstrate what their old and new catapults looked like. They claimed that the load was too heavy, which resulted in their catapult breaking. Their reasoning was that it was not stable enough and that they could improve their design by using more effort and adding more rubber bands to make it more stable. While the students provided some evidence of the launches to support their ideas about the best design, it was not clear which design resulted in the catapult launching the object up but not toward the target.

The majority of the catapult entries went beyond simply describing the task and collecting and organizing data to including some sort of reflection or explanation about how the design of the catapult affected the launch results. Many of the entries used photos as a component of their reflection and/or explanation as well, something made easier with the digital notebook. This is important to note, since the development of reflections and explanations are connected to higher student learning outcomes (Ruiz-Primo et al., 2010).

Discussion and Implications

In this study a teacher candidate successfully used a digital notebook in her STEM methods course and then implemented a digital notebook with her grade four and five students enrolled in a summer camp. The students were able to use the digital notebook with success, incorporating reflections and explanations, which research has shown is associated with higher student achievement (Ruiz-Primo et al., 2010).

Since teachers' practices are often a result of their own experiences (Bandura, Day 1 and day 2

Materials: tape, spoon, big popsicle sticks and small Popsicle stick, and a marshmallow.

Problem: we can't tape the catapult to the ground, we only have $150, the Bulls eye is small, and the catapult is not stable enough. The Bulls eye is 2 yardsticks away.

Plan: we will use effort to push the spoon with so the spoon launches the marshmallow .

Objective: to launch the marshmallows into a certain direction. We have to try launch the marshmallow into the bulls eye.

Old lever

Test: 1st try: O
2nd try: O
3rd try: O
4th try: O
5th try: O
6th try: O
7th try: O
8th try: O
9th try: O
10th try: O

The load is too heavy so it damages the catapult and when it damages the catapult it breaks.

Improvements: We can use more effort and make it more stable because the load is too heavy for the catapult.

We can improve by adding more rubber bands so it is more stabled.

What worked: The catapult launched it up.

What didn't work: It did not even touch the paper . It almost broke.

We are destroying the old lever and we are building a new lever because the old one always collapse it was not stable.

We also changed the old lever because it can't hold the load. We made a new lever because the old one would always damage the catapult when you try to launch it. The changes that we made to the old lever is we broke it down so then when we remade it looks a little like this.

New lever

We remade it because it would always brake when we try to launch the marshmallow because it is like so.

We had all Os because

The chart

Figure 5. This entry from iPad 7 contains a claim supported by evidence and reasoning.

1977; Lortie, 1975) it was no surprise to find that Tami incorporated some of the same STEM activities she did in the STEM course into her summer STEM camp (i.e., gears, catapults, roller coasters). She also structured her students' experiences with the digital notebook in a manner similar to that used in the course, as she (a) provided time for students to first explore the notebook and the tools within it, (b) allowed students to make decisions about what and how to record, and (c) had students write about what they were learning versus simply recording what was done. Incorporating the digital notebook into the STEM course and having her use it just as her students would allowed Tami to develop a positive attitude toward the digital notebook, even though in the beginning she found it difficult to use and had trouble focusing on the substance versus the aesthetics of her entries. This supports Morrison's (2008) findings that it is essential to have candidates use a notebook just as their students would use it.

With tablets becoming more prevalent in schools (Hill, 2012; Leonard, 2013; Quillen, 2011) and technology changing the way in which science is practiced (Szalay & Gray, 2006) it is imperative that the science education community fully understands the influence digital science notebooks might have on student learning in the 21st Century. This study suggests that the impact was positive for the students involved in this study. Within many entries, students used photos as a means to add to or support their written explanations; something that is easier to do in a digital notebook compared to a traditional paper notebook. Tami also reported that her students were highly engaged with recording information in the digital notebook and that she believed they were more involved in their own learning. However, Tami reported that her students struggled to record their ideas, as they could not type fast enough, and it was evident that most chose not to use the handwriting tool as an option to record their ideas. Further research is needed to compare the use of traditional and digital notebooks to determine if the positive outcomes outweigh the struggles encountered and whether it adds to student learning or not.

Technology is rapidly changing the classroom environment and it is essential that science education and science teacher education change with it. The movement to include tablet devices in elementary classrooms provides an opportunity for students to document their science work and learning in new ways; however, it also brings with it the need to educate pre- and in-service teachers on meaningful ways to use these devices. Therefore, it is essential that the science education community understand the impact technology could have on well-established, research-based practices, such as the use of science notebooks. This research begins to fill that gap by examining the way in which one teacher candidate thought about and used an open-ended note-taking application for her own use and then in her classroom. While the size of this study brings with it inherent limitations, we believe the findings provide insight into and questions about the use of digital notebooks.

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