THE EFFICACY OF DIGITAL SCIENCE NOTEBOOKS ON STUDENT LEARNING AND SELF- EXPRESSION

by

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DEDICATION

This Action Research study is dedicated to my 5th grade students at JGW Middle School in the 2020- 2021 school year. You will always be a special group of students as we made it through a global pandemic together, fully remote, for the entirety of the year. You are a remarkable group of young adults.

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ABSTRACT

Due to the Covid-19 pandemic, many schools have been required to move to a fully remote learning model, relying completely on technology. Science notebooks, which have been proven to be an effective teaching method, must be implemented in a digital format. Students in a 5th grade remote classroom used Google Drive to create science notebooks during one unit, while not using digital notebooks during another unit. Pre- and post- assessments were completed during each unit to measure growth. Students also participated in attitude surveys before, during, and after treatment. The teacher kept a self- assessment, including a journal. Students showed more growth during their post-assessment after using their digital science notebook, however, students didn't use their notebooks to their full potential throughout the unit. Students also were not able to show self-expression through their digital science notebooks. It is possible that digital science notebooks can be just as effective as physical science notebooks, but more research needs to be completed to find the best format for a digital science notebook.

INTRODUCTION AND BACKGROUND

In September 2020, the district I teach in decided on a hybrid learning model where half the students attend school on Monday and Tuesday, while the remainder attend school on Thursday and Friday. Wednesday is a day for remote learning, small group work, and planning. Families also had the option to sign up for our Remote Learning Academy, in which I had been chosen to teach. This means that I teach approximately 90 students remotely, split up into three classes. I teach both science and social studies to these groups. Students are expected to follow their schedule like a regular school day and attend their Google Meets for the duration of our 90 minute blocks, while also completing their assignments through Google Classroom and other curriculum resources.

This year has proven that technology is of the utmost importance right now. Teachers and students need to rely heavily on the available technology that our district provides to make the most of their learning. Now is a time to investigate how successful technology can be in the classroom, especially when it is our only option for learning.

In previous years, my students have used physical interactive science notebooks in the classroom. These are provided by the teacher and students include a table of contents, vocabulary, observations, data tables, drawings, and Claim/Evidence/Reasoning writings among other things. Students are encouraged to personalize their notebooks to reflect what they know in their own way, while also following assignment rubrics and expectations. This year, I was unable to use physical notebooks due to the remote nature of our learning. Instead, I took a digital approach and had students create their own digital science notebooks. These science notebooks were set up by the students using

their Google Drive. Students created a digital science notebook folder and included a sub-folder with the current unit name. The work that students completed in class was then added into their science notebook folders so that students would have one space to keep all of their work.

When considering possible research for implementing digital science notebooks, I needed to consider the following question, "How can I achieve proficient student performance, while giving students the ability to express their learning in different ways, with the use of digital science notebooks in place of physical science notebooks?" In an environment where teachers need to establish new lesson plans, routines, and norms, it was the right time to consider whether or not digital notebooks offered the same success to student learning as physical science notebooks have been proven to do. The idea was simple; create a digital space where students can keep their work organized and make choices on how they present their work, while also showing proficiency on state standards.

Focus Questions

The focus question for this study was, What is the impact of digital science notebooks on student learning in a 5th grade science classroom?

My sub-questions included the following:

1. What is the effect on student attitudes towards learning science?
2. What is the effect on student attitudes towards online learning?
3. What is the effect on teacher attitude towards providing feedback and grading?
4. To what degree are students taking responsibility for their learning? Can they

express themselves and their learning virtually?

These research questions were designed to guide this study in finding out the efficacy of digital science notebooks and their effect on the student and the teacher.

To assist in my research, I put together a support team that will help me to stay motivated, while also contributing expertise in editing and research. The first member of my AR support team is Dr. Nicole Glen. She is a Professor and Department Chair at Bridgewater State University in Bridgewater, Ma. Dr. Glen teaches Science Education Methods courses at BSU. Not only has Dr. Glen been my professor during my undergraduate degree but she was also a Co-PI for the NSF Robert Noyce Teacher Scholarship Program, which I received, and through this scholarship, she has offered countless resources to me including trainings, action research, and funding for conferences. Dr. Glen was also the advisor on my undergraduate thesis. She guided me through my research and writing. Dr. Glen is a professor whose opinion I value very much. She has high standards for science education and science writing and because of this, I hold myself and my work to those same standards. Having Dr. Glen on my AR support team will help me hold myself accountable, and I trust her opinions and suggestions.

The next member of my AR support team is a colleague of mine, Krista DiGloria. Krista is a grade 7 humanities teacher. I have gotten to know Krista in my time working at JGW Middle School. She is a very intelligent person who really enjoys reading. One of the qualities I admire in Krista is that she asks questions and is not afraid to offer her opinions. I will primarily turn to Krista for proof-reading. I trust her ability to correct my

writing grammatically, and I know that if there is something she does not understand, she will ask and provide feedback. Krista will play an integral role on my support team as far as editing.

The third person on my AR support team is my boyfriend, Taylor Reslow. Taylor is in school himself for nursing. His job was to offer me moral support because he knows so much about my work and my goals, that he can step back and provide more personal support. Taylor understands my overall goals of what I am trying to accomplish with my AR topic and in education in general as I often talk about it candidly. He knows where my passion lies in education and constantly pushes me to stay on track and reminds me of this passion when I get lost in the work. I also trust his opinion in regards to my writing, but I also believe he will be a point person when it comes to organizing my thoughts and ideas and getting them into writing.

When thinking about my AR support team, I knew I needed well balanced team. Dr. Glen will be extremely valuable in understanding the content. She is a big believer in science notebooks and teaches science education herself. Krista has a strong knowledge of grammar and formatting. She is an avid reader and her comprehension is remarkable. She will provide honest feedback, as well. Taylor will provide moral support when I need it most. He understands my drive and my goals and will help me stay on track. I believe this team can offer me support in several ways that play off of their own strengths and I feel honored that they are willing to assist me in my research.

CONCEPTUAL FRAMEWORK

Benefit of Science Notebooks

Interactive Science Notebooks have been a topic of study in science education for many years now. Students in science classrooms are using inquiry skills to guide their learning and they have taken on the role as young scientists in the classroom. When students write in science notebooks, they discover what they think and come to a better understanding of what they know and what gaps remain in their knowledge. The metacognitive awareness produced by writing can serve as a catalyst for further learning (Butler & Nesbit, 2008). To build on this learning method, teachers of science have been implementing interactive notebooks as a way to express understanding of the material, while giving the students the responsibility of their own learning. Science notebooks have become a way to engage students with actual scientific practices and allow students to understand the language of science because they are used for recording observations, collecting data, and summarizing investigations. For science notebooks to be successful, students need to be using them as scientists would (Fulton, 2017). Part of this comes from the ability to build on students' literacy skills. In a study conducted by Huerta et al. (2016) science notebooks from 5th grade economically disadvantaged English language learners were monitored and compared to native English speakers. The study showed that English language learners made statistically significant growth over time in their academic language in their science notebooks. Writing in science notebooks causes students to make sense of investigations because they are in the process of constructing

knowledge. Instead of using memory, students are using their conceptual understanding of the science topic (Butler & Nesbit, 2008).

Interactive science notebooks are also a means of assessment. A science notebook can be used to assess growth in the students' conceptual understanding as well as their ability to use their notebook as a scientist. Growth in writing can also be assessed through their science notebook (Young, 2003). Science notebooks work as a snapshot of student work throughout the whole year. Improvement or lack thereof can be compared throughout the life of the notebook by comparing things like scientific writing, observations, data tables and graphs, along with conceptual understanding.

Implementation of Science Notebooks

While science notebooks can be a helpful learning tool for students in the classroom, they may not always be implemented correctly. When using notebooks as an assessment tool, Alonzo (2008) stresses the importance of asking yourself these questions when implementing science notebooks in the classroom: "Why am I having students write in science notebooks?"and "When I look at students' science notebooks, what do I want to learn?" Science notebooks need to serve a purpose that both the student and the teacher understand. Most of the time, a notebook serves as a blank slate to record new ideas, notes, observations, data, and scientific writing. Nesbit et al. (2004) observed many strategies that teachers use to help their students become comfortable using a notebook and familiar with the routine. For example, teachers might introduce the idea of science notebooks by using a book or a video. Students should understand how real scientists use their notebooks. Students should get in the habit of writing the

date and time every time they work on something new in their notebooks. For students in younger grades, abbreviations can be used to reduce the amount of time it takes some students to write. For example, students might use a P in place of the word “prediction” (Nesbit et al., 2004).

When implementing science notebooks, it is important to develop rubrics for students. Rubrics give students clear guidance on what is expected of them in their notebook. Rubrics also give the opportunity for students to work beyond what is expected by giving students a baseline and allowing them to express their learning in their own way as long as the rubric is followed. Rubrics also provide a means of measurement. Rubrics that are intended to analyze student work should yield valid and reliable data. It can be difficult to measure student growth without measurable data (developing a science notebook rubric) (Huerta et al., 2016).

Digital Science Notebooks

The idea for interactive science notebooks to take a digital approach is based on the fact that we are in a digital era. Upcoming students have the capability of mastering digital platforms quite easily. Digital science notebooks allow students to learn with technology as it develops instead of just learning from technological platforms. In a study by Fulton, Paek, and Toaka (2017), students using digital science notebooks developed on iPads showed that students used their notebooks similarly to a physical science notebook by including written explanations, drawings, and observations. One challenge that students had was including pictures but because they were using iPads, students were able to take pictures right on their device. The study found that with new technology, it is

important to spend time teaching students how to use the technology before they learned any new science information.

Many times, digital notebooks can be put together using various Google platforms. Sometimes a digital notebook might be a Google Slide that includes templates and allows the student to build new slides as they progress through the school year. Students can also share Google Slides, Docs, or Sheets with one another so that students can collaborate on their work. In a study by Robinson (2018), focused specifically on digital science notebooks in the classroom, it was found that one area of concern when using science notebooks is that new information is better retained when hand-writing information. When using a digital format, it is important to make sure that students are not copying and pasting their work into their digital science notebook. Students should be typing out their own thoughts and ideas to help them better retain the new information (Robinson, 2018).

One challenge that will come with the implementation of science notebooks is offering students a Universal Design for Learning (UDL) approach in which students are able to express their learning using multiple means of action and expression. This strategic approach to learning allows students to express what they know in their own way. (CAST, Inc, 2021) Rappolt-Schlichtmann et al. (2013) mentions that digital technology along with strong teaching strategies does offer opportunities to support developing science learning skills through different means of expression, the technology based format does not improve on the print format. This means that there is no significant difference between physical notebooks and digital notebooks. It is important to note that

the aim of my study is to see if digital notebooks are as effective as physical notebooks, and not necessarily *more* effective than physical science notebooks.

METHODOLOGY

Demographics

The treatment group for this research includes approximately 17 fifth grade students from my homeroom class at the grade 5-8 middle school where I teach. I teach science and social studies to this group of students, along with two other groups of students. The general age for this group is between 9-11 years of age. Students go to one of six middle schools in a small city in Massachusetts with a population of 64,000. The demographics here are quite diverse. At our middle school, 44% of the students are economically disadvantaged and 59% are high needs. While many students chose our hybrid learning model, some students opted to join the Remote Learning Academy, a completely remote learning model with specific remote teachers, including myself. Most of the students in this Remote Learning group are self- motivated. There are approximately 3 - 5 students in this group who prefer not to complete work or need a stronger push than others to do so. However, most students, when given an assignment, complete their work. Most students also follow along with classroom instruction.

Treatment

To begin treatment, fifth grade students in the Remote Learning Academy were given Chromebooks for use at home. These Chromebooks support a Google platform. Students used their Google Drive to create a digital “Science Notebook” folder. Then, students were instructed to create a sub-folder for the unit we were working on, physical science. Students were required to transfer all of their assignments into their digital

notebook unit folder. Assignments varied between Google Docs, Google Slides, Google Sheets, and Peardeck presentations. Treatment began in September 2020 and ended April 2021. During treatment, students were expected to join our afternoon check-in on Mondays to put their weekly assignments into their Google Drive. Students began by learning how to make their digital science notebook, share it with me, and then add files to it. Each Monday, students would join our Google Meet and add any assignments from the previous week. Students were then encouraged to use these assignments to complete further assignments or assessments.

Instrumentation

Table 1 below shows the original AR question and sub-questions, along with data collection methods that were implemented throughout each unit. Some of these methods provided qualitative data, while others provided quantitative data. Data was collected in four ways.

Table 1. Treatment and Instrument Methods.

Question	Pre- and Post-Assessment Data	Student Attitude Surveys	Teacher Attitude Survey and Journal
What is the impact of digital science notebooks on student learning in a 5th grade science classroom?	X	X	X
What is the effect on student attitudes towards learning science?		X	X
What is the effect on student attitudes towards technology?		X	X
What is the effect on teacher attitudes towards providing feedback and grading?			X
Are students taking responsibility for their learning? Can they express themselves and their learning virtually?		X	X

Treatment began by generating pre- and post- assessments without the use of digital science notebooks. These assessments are created by the teacher to be used as a science benchmark. At the end of September, students started their life science unit with a pre-assessment. Students were given assignments in Google Classroom that were generated by me. These assignments often included worksheets or Claim, Evidence, Reasoning (CER) writing in Google Docs, activities and presentations created in Google Slides, observations using Google Draw, questions in Google Forms, and various other types of

assignments. Students were expected to follow a basic classwork rubric. Our life science unit ended in December with a post assessment. Beginning in January, the second phase of treatment began with our physical science unit. Students took a pre-assessment at the beginning of January, before they began using their digital science notebooks. Students took a post- assessment at the end of this unit in April.

In addition to pre- and post- assessment data, students completed a teacher developed attitude survey that was conducted three times during treatment. The first survey was given to students on December 17th right before the second phase of treatment began, the second survey was given February 21st, which was halfway into treatment, and the third survey was given at the end of treatment, on April 4th. The survey uses a Likert scale to learn about student attitudes towards using a science notebook in general and using technology. The survey also includes some open response questions to gauge further understanding into why students chose the response that they did. Data analysis for open-response questions offers a more qualitative approach. All students in the treatment group were given the first survey after having already set up their science notebooks at the beginning of the year.

During the treatment phase I also completed a weekly teacher- created attitude survey. This survey is made up of questions including Likert scales, multiple choice, and open response. Included in the survey was also a section for journaling. This survey was completed on a weekly bases to identify how my attitude might have changed in regards to students using their notebooks, showing proficiency of standards, and providing feedback to students.

The data collected in this study is both valid and reliable. I know this because the instruments were developed based on a triangulated approach. Instruments were cross referenced with other vetted instruments, as well as, peer and professor reviewed. Pre- and post- assessment provides, quantitative data to demonstrate measured student growth throughout each unit, with and without the use of digital science notebooks. It is important to note that all pre- and post- assessments included the same students each time. Students who missed an assessment were removed from the study, thus contributing to the reliability of the study. Student and teacher attitude surveys were developed for both reliability and validity. Both surveys included thorough and detailed questions that were in the form of Likert scale questions, with opportunities to provide personal reflections on some questions.

The research methodology received an exemption from Montana State University's Institutional Review Board (Appendix A).

DATA AND ANALYSIS

Pre- and Post-Assessments

Students took a pre-assessment before their life science unit and a post-assessment after this unit finished. Students also took a pre-assessment before their physical science unit began, as well as a post- assessment at the end of this unit. Each assessment had a possible score of 100 points that could be earned. Assessments consisted of twenty multiple choice questions. The pre- and post- assessments for both the life science unit and the physical science unit were identical.

When looking at student performance, without taking the use of digital science notebooks into consideration, students demonstrated significant growth from pre- and post- assessments. Table 2 shows the score for each of the seventeen students included in this treatment, in each of their assessments. Numbers were given to students to maintain anonymity. The scores each student earned are listed in the columns next to their student number. The assessments are identified with the abbreviation DSNB (Digital Science Notebook).

Table 2. Pre- and post-assessment scores, (*N*=16).

Student #	No DSNB Pre-test	No DSNB post-test	DSNB Pre-test	DSNB post-test
1	20	85	45	98
2	35	60	40	90
3	30	85	70	98
4	30	65	45	60
5	45	100	65	90
6	30	85	25	85
7	50	80	50	80
8	55	75	70	95
9	25	85	45	75
10	75	100	75	95
11	65	90	70	75
12	60	75	35	80
13	25	70	15	58
14	35	60	45	45
15	25	75	45	40
16	65	85	40	73
Avg. Score	41.87	79.68	48.75	77.31

Average scores were generated for each assessment. The life science assessments, identified as “No DSNB”, show an average pre- assessment score of 41.87 and an average post-assessment score of 79.68. The physical science assessments, identified as, “DSNB”, show an average pre-assessment score of 48.75 and an average post-assessment score of 77.31. The No DSNB category shows an average growth of 37.81 points. The DSNB category shows an average growth of 28.56 points. Overall, students showed less growth when using digital science notebooks. It is also important to note that student 14 and student 15 are both students who do not put their best effort forth when test taking.

Specifically, student 14, who showed zero growth in their DSNB Post- assessment, did not add any assignments to their digital science notebook during the treatment phase.

Scores from Table 2 were also graphed to visualize growth and compare assessments from each unit. This graph can be found in Figure 1. When comparing the growth from each pre-assessment compared to each post- assessment, there is not a significant growth difference between each unit. On the contrary, students demonstrated slightly more growth in their No DSNB pre- and post- assessments, than in their DSNB pre- and post- assessments.

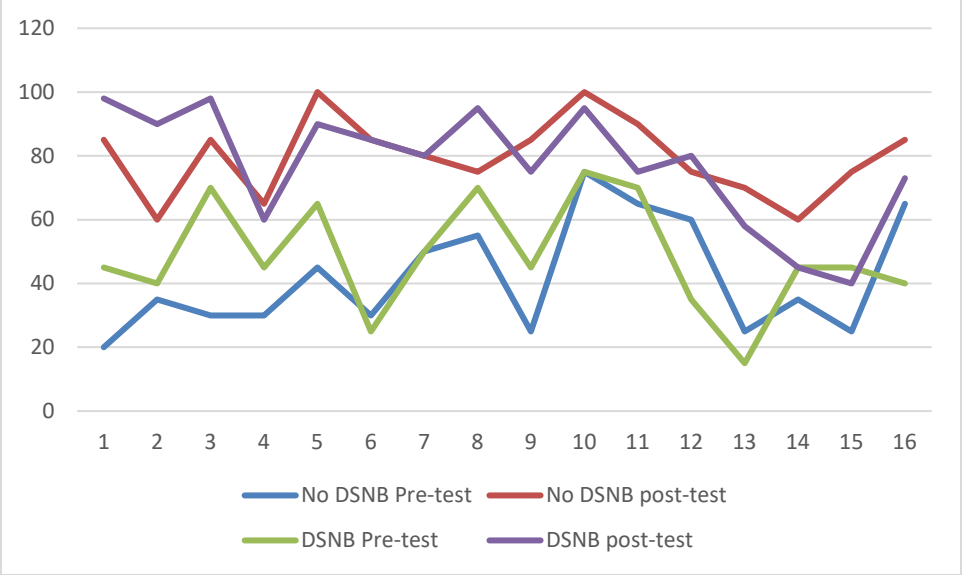


Figure 1. Individual pre and post assessment data with and without digital science notebooks, (*N*=16).

Data from pre- and post- assessments were also graphed in a box and whisker graph to summarize how assessment scores are distributed among the whole class.

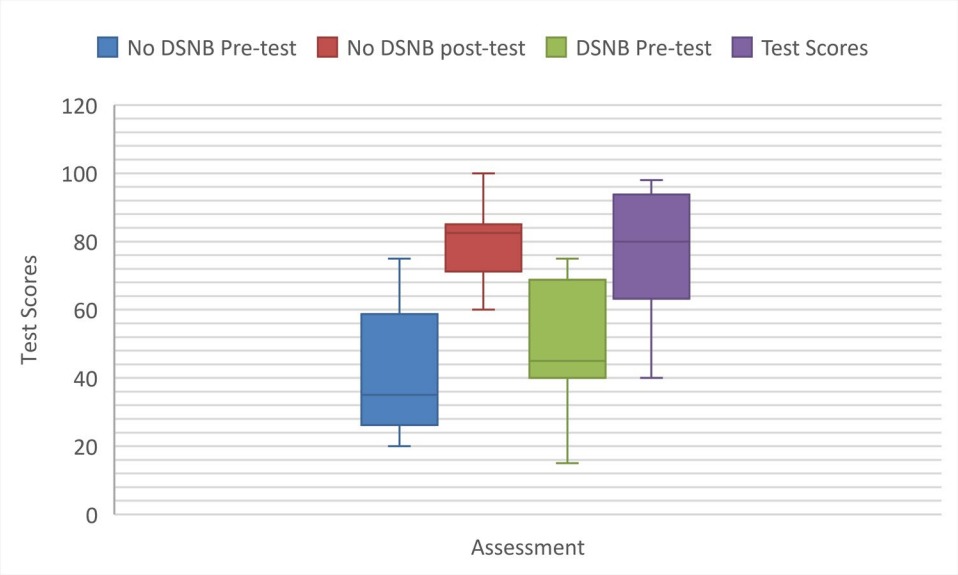


Figure 2. Whole class pre and post assessment data with and without digital science notebooks, (*N*=16).

Students generally scored lower on their No DSNB pre-assessment, compared to their DSNB pre-assessment. It should be noted that students would have taken their DSNB pre-assessment not having yet used their digital science notebook, as this assessment was implemented at the very beginning of the unit. The significant data to look at in Figure 2 is the post- assessment data. While the data range for the No DSNB is higher, the majority of students scored lower on this assessment than they did on their DSNB assessment. The majority of students scored in the ranges between 71.25 and 85 on their No DSNB post-assessment, while students scored between the ranges of 63.25 and 93.75 on their DSNB post-assessment. More students scored higher on their DSNB post- assessment than their No DSNB post- assessment. This could be because of the content of the unit. The first unit taught without the use of digital science notebooks was life science. Students might have a stronger understanding of life science based on real

life connections, which would in turn, cause them to score higher on their pre-assessment, leaving room for less growth. The unit in which students used digital science notebooks was their physical science unit. Students don't have as many known real life applications which would cause them to score lower on their pre-assessment, leaving more room for growth. Students also tend to be more engaged in the physical science unit based on the content of the experiments.

Student Surveys

Student surveys consisted of twenty- three Likert scale questions that used a 5-point Likert Scale. Each point on the Likert scale is identified in table 3. While a seven-point Likert scale would provide more reliable data, the choice was made to use a five-point Likert scale to lessen the confusion for ten and eleven year old students. They are not very familiar with a Likert scale style survey, therefore, a five- point Likert scale was considered to be less overwhelming for the students.

Table 3. Likert Scale Identification, (*N*=16).

Number	Likert Scale Identification
1	Strongly agree
2	Agree
3	Neither agree or disagree
4	Disagree
5	Strongly disagree

Likert scale data was collected from each survey. Students took a pre- survey, mid-survey, and post- survey during the second phase of treatment. The data from each question was calculated by identifying how many students chose each scale number for a question and then converted to percentages. For example, if 100 students answered a question and 50 students chose 1- Strongly agree, while the other 50 students chose 5- Strongly Disagree, the conversion would identify 50% of students as choosing 1- Strongly agree and 50% of students choosing 5- Strongly disagree. The average amount of students choosing each Likert scale was then visualized using a pie chart. Each multiple choice question was put into a question category based on what the question stated. These categories are “Use of Technology”, “Student Performance”, “Self-expression”, and “Overall use”. Table 4 identifies each category and its accompanying questions. The survey also included six open- response questions that acted as further explanation for some multiple choice questions. These can be found in the appendix in the full survey. The open- response questions were used to further identify student generated trends when responding to these multiple choice questions. Data from these open- response questions support the reasoning for the quantitative data and will be further identified in the Claim, Evidence, and Reasoning section of this study.

Table 4. Student survey multiple choice categories and questions, (*N*=16).

Question Category	**Questions Included**
Use of Technology	I would rather use a physical science notebook for science
	Using a digital science notebook is easy for me because I understand technology
	Using a digital science notebook is confusing for me because I have a hard time with technology.
	I have a hard time including pictures and drawings into my digital science notebook.
Student Performance	Having all my assignments and notes on the computer helps me learn
	I would learn better if I had worksheets and a physical science notebook
	I look back at my digital notebook folders to help me with assignments and studying.
	I know it is my responsibility to organize my work in my digital science notebook
	I want to receive high grades in science
	My digital science notebook helps me understand what I am learning
Self- Expression	I like to choose the way I show what I learned in science
	I have a hard time making choices to show what I learned in my digital science notebook
Overall Use	A digital science notebook helps me organize my science notebook into labeled folders
	I enjoy using my digital science notebook during science.
	I use my digital science notebook for all of my science assignments
	I have a hard time finding my work in my digital science notebook
	Before 5th grade, I have never used a digital science notebook
	It is easy to do assignments in a digital science notebook
	I use my digital science notebook when I am working independently
	I can easily record my observations in my digital science notebook
	I only use my digital science notebook when the teacher tells me to

Each multiple-choice question in this survey has a general expected response. When researching the efficacy of digital science notebooks, the goal is to see responses

that are on trend with the expected response. If the expected response is a 1 or 2 on the Likert scale, the actual responses should coincide with this expected response. Instead of analyzing each question, I will discuss the overall trends identified in the results.

The category, “Use of Technology” included four questions. The expected trend for these questions should show that students found ease in using technology to maintain their science notebooks, and chose digital science notebooks as preference over physical science notebooks. The overall responses for this category were both on trend and off trend. For example, responses from the question, “Using a digital science notebook is easy for me because I understand technology” should trend towards agree. After using a digital science notebook, it is expected that students feel comfortable using technology. Figure 3 shows a bar graph indicating that more than 30% of students agreed with this statement, and more than 20% of students strongly agreed with this statement in the pre-survey, mid- survey, and post- survey.

On the other hand, an example of a question that did not follow the expected trend is, “I would rather use a physical science notebook for science”. The expected response for this question would be “disagree”, as students should prefer digital science notebooks to physical science notebooks. The responses for this question are also shown in Figure 3. More than 40% of students disagreed during their pre-survey that they would rather use a physical science notebook. This changed significantly in their post-survey. Data from the post survey for this question shows that the majority of students neither disagreed or agreed or strongly agreed with this statement. Results from this category demonstrate a

strong ability to use technology but preferred to use a physical notebook after having used the digital science notebook.

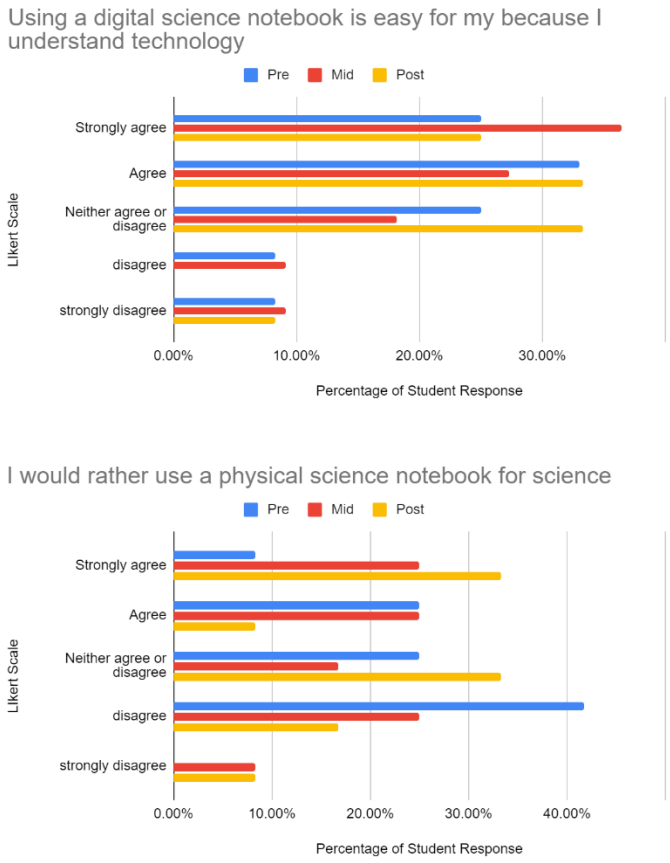


Figure 3. Student survey bar graph data (1) (2), (*N*=16).

Students were asked to explain why they would rather use a physical science notebook if they chose “agree” or “strongly agree”. The qualitative data from this question did not identify any meaningful responses. Many responses included, “I don’t know” or “Because I want to”. It is likely that students did not understand the question.

Responses from the “student performance” section showed varying trends. Student responses to the statement, “I want to receive high grades in science”, were

overwhelmingly trending towards agree and strongly agree in each survey. More than half of the responded “strongly agree” in the pre-survey, while 75% of students responded “strongly agree” in the mid and post- survey. Another question in this category asked, “I look back at my digital notebook folders to help me with assignments and studying”. The expected trend for this question is “agree”, as students should be using their digital science notebooks as a resource for studying. Responses for this question were not on trend. Shown in Figure 4, it is evident that many students believed they would look back on their assignments when they took their pre-survey. By the time students took their post- survey, more than 30% of students neither agreed nor disagreed. There is a larger percentage in the post- survey of students choosing, “strongly agree”, however, this isn’t a significant trend because students also chose “disagree” and “strongly disagree”, with very few, less than 10%, choosing “agree”.

One question in this category did show on- trend results. This question is, “My digital science notebook helps me understand what I am learning”. The lower graph in figure 4 shows that 50% of students agreed with this statement in their post- survey. Only 16% of students disagreed with this statement, with zero students choosing a “strongly disagree” response.

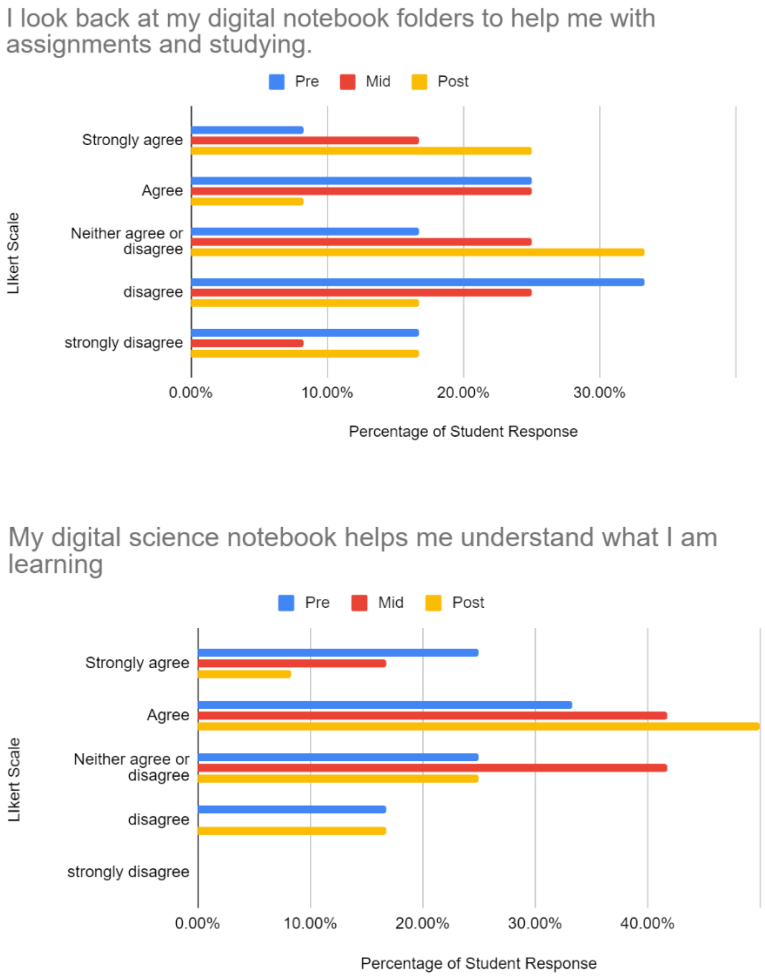


Figure 4. Student survey bar graph data (3) (4), (*N*=16).

There is another question in this category that generated open- responses that further explain the results. The question is, “I would learn better if I had worksheets and a physical science notebook.” More than 30% of students strongly agreed with this statement, and 16% of students agreed with this statement. The expected trend for this question is “disagree” as it would be expected that students feel comfortable with digital assignments and a digital notebook. However, it seems students prefer to have physical worksheets and notebooks. When asked why, one student response states, “I learn better

in paper notebooks because I get to draw on it or write with a piece of paper instead of typing and making typos." Some students may find physical notebooks easier for drawing.

There were only two questions in the "self-expression" category and these questions exhibited mixed results. The question, "I like to choose the way I show what I learned in science" demonstrated that while most students chose "neither agree nor disagree", there were no students who chose, "strongly disagree", indicating that most students answered more positively towards this question The other question, "I have a hard time making choices to show what I learned in my digital science notebook," trended more negatively. Fifty percent of students chose "neither agree nor disagree" for their response, however there were no students who agreed or strongly agreed with this statement towards the end of treatment. The data from these questions is shown as bar graphs in Figure 5 below.

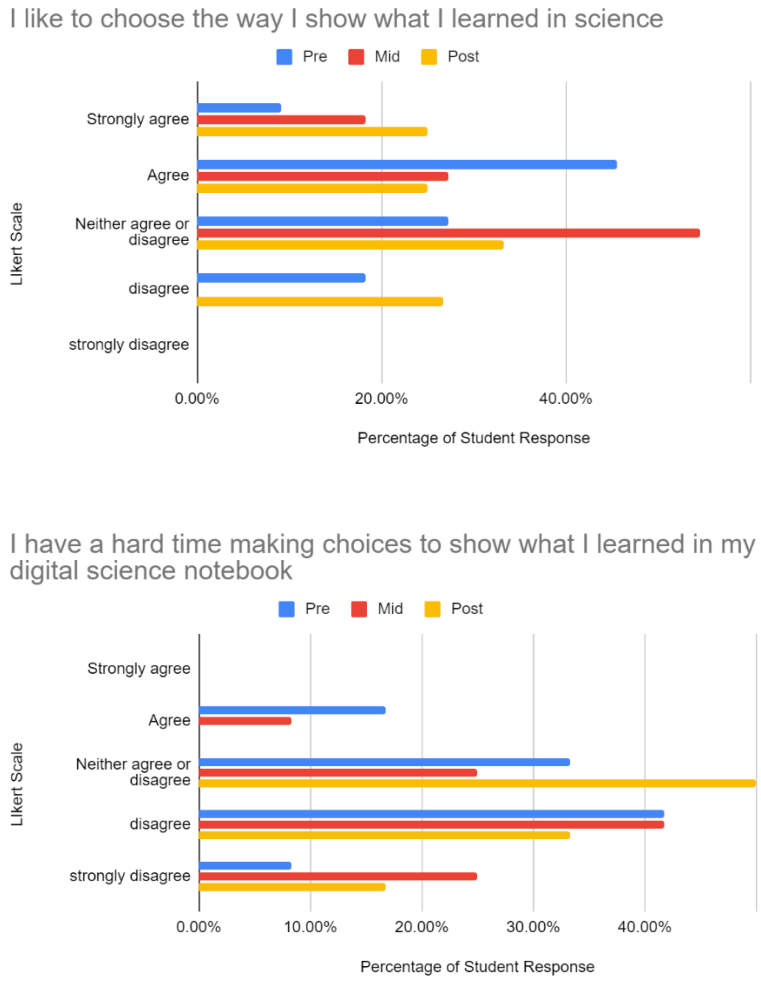
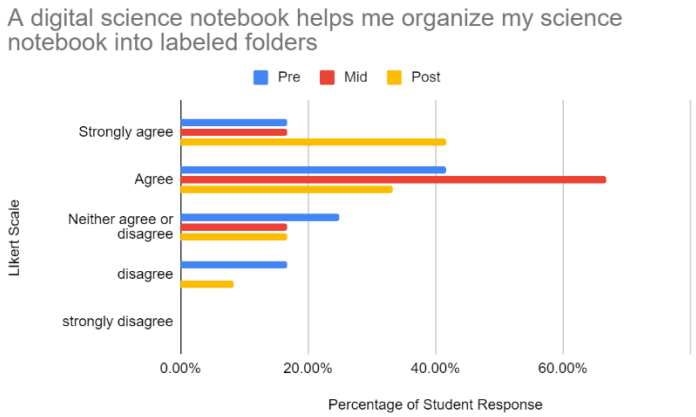


Figure 5. Student survey bar graph data (5) (6), (*N*=16).

The last category, “overall use”, had a total of nine questions. I have chosen to identify the questions that resulted in significant data. This category focuses on the ease and organization of a digital science notebook. These questions have less to do with the ability to use technology, and more to do with the ability to keep assignments organized and easy to find, as well as how often or when their notebooks are used.

Response trends found that digital science notebooks did help students stay organized. Figure 6 shows data from two questions pertaining to organization. Likert data from the question, “A digital science notebook helps me organize my science notebook into labeled folders”, identifies a clear trend. Only 8% of students disagreed with this statement, while more than 40% of students strongly agreed. Zero students chose “strongly disagree”. A similar trend can be seen in the responses from the question, “I have a hard time finding my work in my digital science notebook”. Results from the pre-assessment demonstrate balanced responses among the Likert scale. Mid- survey results trend more towards agree, and post- survey responses trend more heavily towards agree. A large number of students chose “neither agree nor disagree”, while the rest of students chose either “agree” or “strongly agree”. No students chose “disagree” or “strongly disagree” in their responses to this question. Students didn’t seem to express difficulty in finding their work or keeping it organized. Students also found it quite easy to complete assignments in their digital notebook. In the question, “It is easy to do assignments in a digital science notebook”, 41% of students chose “agree” in both the mid- and post-survey responses. Sixteen percent chose “strongly agree”.



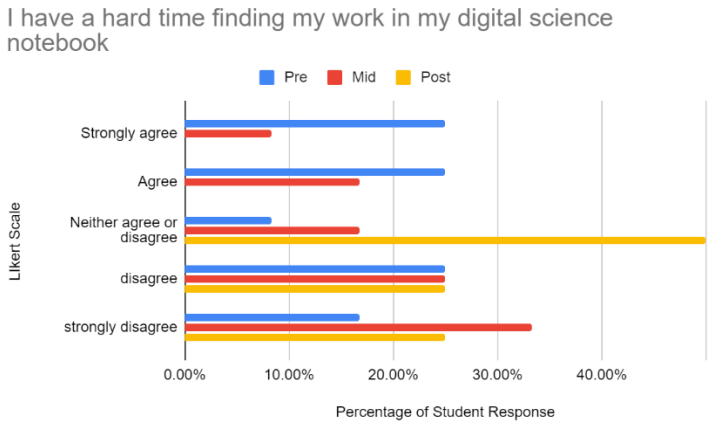


Figure 6. Student survey bar graph data (7) (8), (*N*=16).

Two questions in this category that have obvious trends are, “I use my digital science notebook when I am working independently.” and “I only use my digital science notebook when the teacher tells me to.” Figure 7 includes two bar graphs that identify these trends. Half of students, 50%, disagreed that they use their notebooks when they are working independently, and more than 20% of students strongly disagreed with this. Very few students chose “agree,” while zero students chose “strongly disagree”. This question has an expected response trend of “agree” with the expectation that students are using their notebooks outside of guided instruction. Student responses are far off from the expected trend.

This is also very clear when looking at the question, “I only use my digital science notebook when the teacher tells me to”. This question should have an expected trend of “disagree”, indicating that students use their notebooks on their own, without instructions from the teacher to do so. More than 70% of students chose “disagree” or “strongly

disagree” in their response, with zero students choosing, “strongly agree”, and only 25% of students chose “agree”.

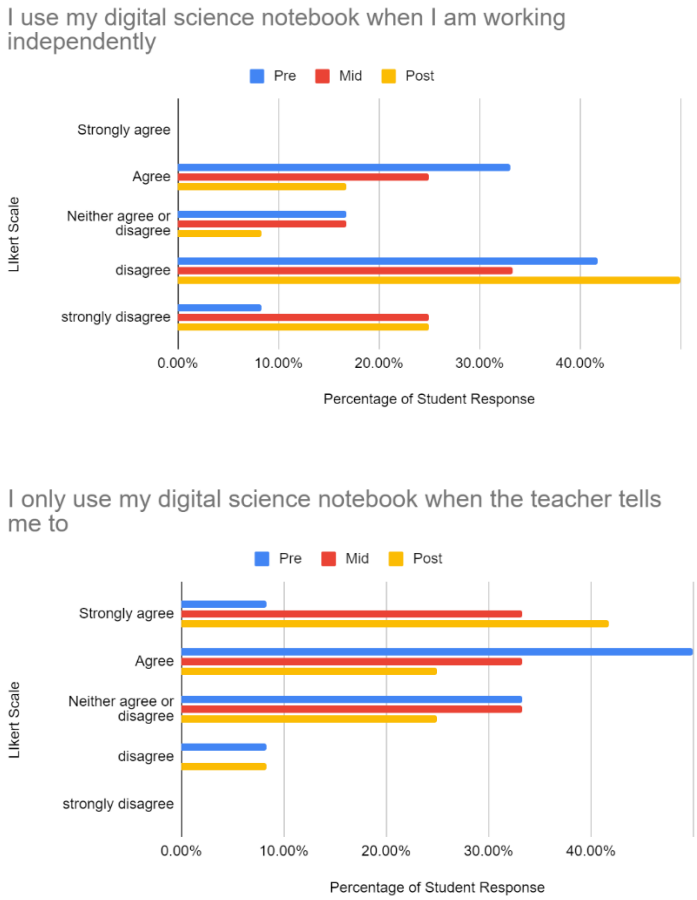


Figure 7. Student bar graph data (9) (10), (*N*=16).

Self- Assessment Survey

Over the course of treatment, 7 self- assessment survey responses were generated. This consisted of 10 questions and a journal response. However, some questions from the survey were not used because they were irrelevant. These questions had to do with notebooks checks. Notebook checks did not occur as expected during treatment. Student notebooks were only checked to be sure their assignments were in their notebooks,

however, no rubric was used to score their notebooks. Questions that were not used are listed below:

- How many times were notebooks checked this week?
- How much time was spent conducting notebook checks this week?
- If notebook checks were conducted this week, how many students needed to re-submit assignments?

The rest of the questions, much like the student survey questions, have been placed into categories. These categories include student feedback, student performance, and self-expression. Table 5 identifies each category and the questions that have been grouped into that category.

Table 5. Self- assessment categories and questions.

Category	**Survey Question**
Student Feedback	How much time was spent providing feedback to students on specific assignments?
	How do I feel about my time spent on student notebook checks and feedback?
	It has been easier to provide feedback digitally.
Student Performance	How do you feel about students utilizing their digital science notebooks? (Using means adding their assignments into their digital science notebook drive under the appropriate folders)
	How do you feel about student learning as evidenced by their science notebooks?
Self- expression	I feel that my teaching methods have helped students show self-expression through the use of their digital science notebook.

Each question used a Likert scale or multiple choice response depending on the question. The response data was put into a pie chart to identify the frequency that each response was chosen. For example, one question asks, “How much time was spent providing feedback to students on specific assignments?” This question was a multiple choice response with “0”, “1”, and “2” as response options. A pie chart would identify how often each response was chosen. Diary responses were analyzed by identifying frequent and consistent ideas or words and quotes will be provided as further evidence to support response results.

The first question results that centered on feedback had to do with the amount of time spent providing feedback on specific assignments. The choice options were “less than 1 hour”, “1 -2 hours”, and “more than 2 hours”. Seventy- four percent of responses were “1-2” hours, while the remaining responses were “less than 1 hour”. No more than 2 hours were spent providing feedback. Figure 8 identifies responses to the question, “How do I feel about my time spent on student notebook checks and feedback?” This was a 5-point Likert scale question with one side of the scale stating, “1- overwhelmed”, referenced in Figure 8 with the color blue, and the other stating, “5- effective and efficient”. The results identify a mostly “overwhelmed” response with 70% of responses in the 1-2 range. A diary response states, “There has been little time to provide feedback to students on their notebooks and assignments”.

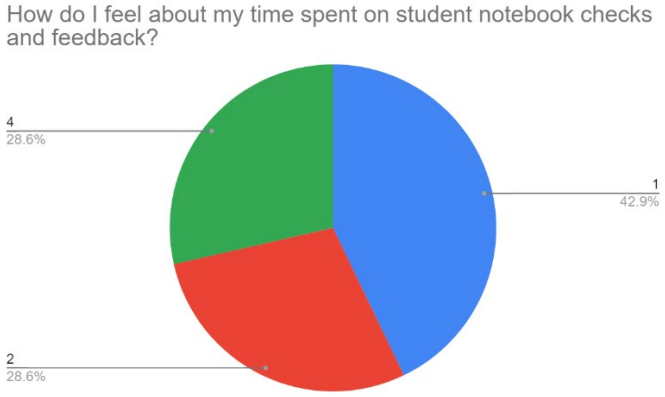


Figure 8. Self- assessment survey data (1) Blue = 1; Green = 4; Red = 2.

Despite the "overwhelmed" response to the question about how I feel about my time spent on feedback, the question, "It has been easier to provide feedback digitally", is shown in figure 9. The Likert scale for this question is, "1- strongly agree" and 5- "strongly disagree". More than 75% of my responses indicate that it is easier to provide feedback digitally, than in physical science notebooks.

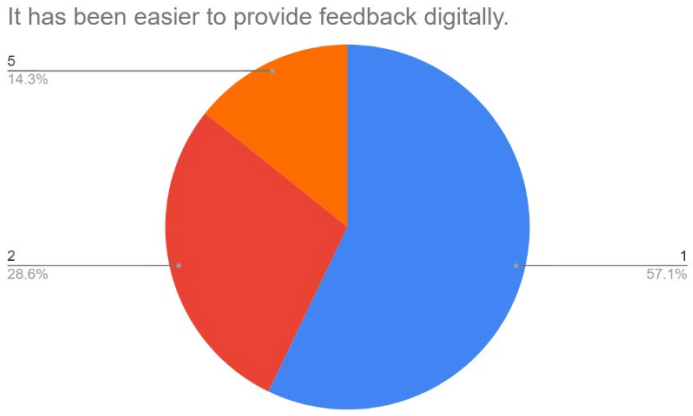


Figure 9. Self- assessment survey data (2) Blue = 1; Orange = 5; Red = 2.

The category of "student performance" consisted of two questions.

Figure 10 includes two graphs representing the results of these questions. The first question, “How do you feel about students utilizing their digital science notebooks? (Using means adding their assignments into their digital science notebook drive under the appropriate folders)” uses a five- point Likert scale that consists of “1- students are using notebooks for most assignments” through “5- students are not using their notebooks for most assignments”. The results from this question centered mostly around 4-5 on the Likert scale. Only 14% of responses were 1. The expected response for this question was 1 or 2. It was expected that students would use their notebooks to complete assignments. The second question, “How do you feel about student learning as evidenced by their science notebooks?” also uses a 5-point Likert scale ranging from “1- students are showing evidence of their learning in their notebooks” through “5- students are not showing evidence of their learning in their notebooks”. The results from this question do align with the expected response, which should be a 1 or 2. Student notebooks did show evidence of student learning. One quote from the teacher diary states, “One concern is that the kids are putting their assignments in but are not using them to help with their new assignments.”

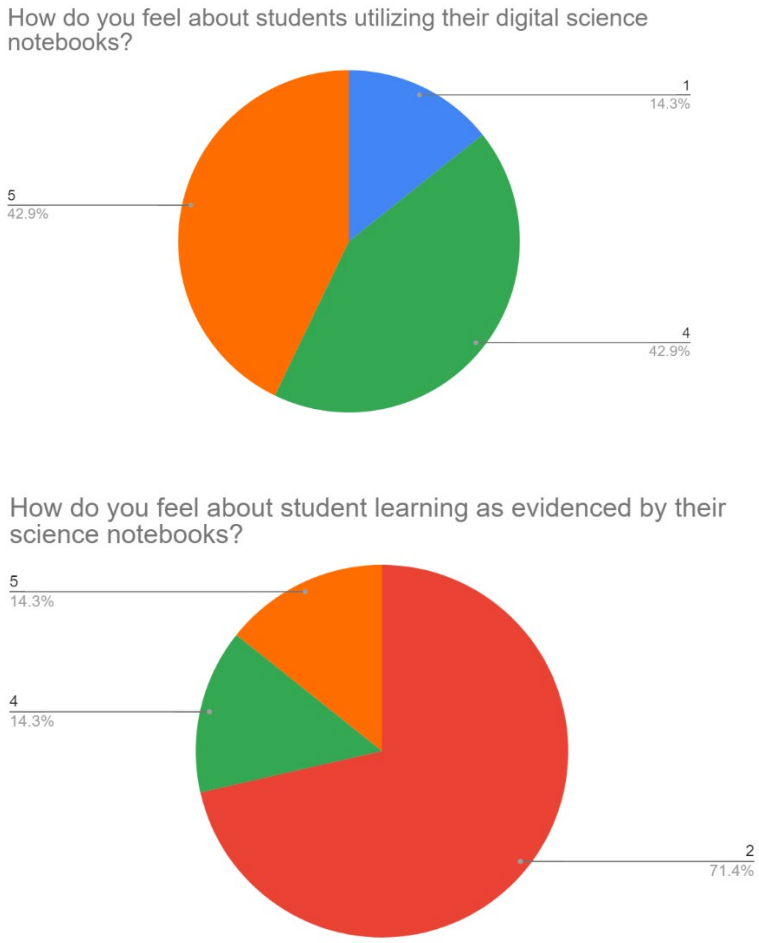


Figure 10. Self- assessment survey data (3) (4) Blue = 1; Red = 2; Green = 4; Orange = 5.

The last category, “self- expression” did not result in trending responses. Results from the question, “I feel that my teaching methods have helped students show self-expression through the use of their digital science notebook,” identifies that little self-expression was evident in student’s digital science notebooks. The Likert scale on this question was 5 points and ranged from “1- strongly agree” to “5- strongly disagree.” The “strongly agree” response was chosen 57% of the time, while “strongly disagree” was not chosen at all, while “agree” was chosen 28% of the time. The teacher diary provides

some data to identify these results. One quote says, “Students are unable to show self-expression in their learning. I have realized that it is quite difficult to create assignments that are not all the same in the remote environment. It is hard to create assignments that are different as everything is being re-created and I am planning for two subjects, and 6 classes.” Another quote states, “Students are putting their work into their science notebooks but they are not using self- expression in their assignments- this is in part, due to myself not creating lessons in which they can do so.” These quote focus on the inability to provide opportunities for self- expression. On the contrary, one response states, “Students were finally able to show some self- expression in their notebooks with a project assignment. Students could create a Google Doc (poster), slideshow, or video to show the difference between a chemical reaction and a physical change. Students did really well on this assignment.” This quote indicates the use of self- expression and can be correlated back to the “agree” response in the Likert scale. It should be noted, however, that most of the time, self- expression through digital science notebooks was not possible for students.

CLAIMS, EVIDENCE, AND REASONING

Claims From the Study

In response to my question, "What is the impact of digital science notebooks on student learning in a 5th grade science classroom", digital notebooks showed no significant impact on student learning. This is evident in the pre- and post- assessment and the student survey. Data from the pre- and post- assessment indicated that more students earned higher scores on their unit test after using their notebooks, than when their unit test that didn't utilize digital science notebooks. However, students showed more average growth in their unit post- assessment without using science notebooks. There is no strong evidence that shows students earned higher scores because of their notebooks. The student survey also shows minor evidence of student learning. Students responded to the question, "My digital science notebooks helps me understand what I am learning" and more than half of their responses agreed or strongly agreed with this statement. On the other hand, students also suggested that they only used their notebooks when instructed by the teacher. The self- assessment survey does not provide enough evidence to support this claim. During the treatment of this study, students did show growth in their learning, however, students were not using their digital science notebooks as expected. Had students spent more time using their notebook as a resource, it is possible there could have been more growth evident in their learning.

In response to my question, ". What is the effect on student attitudes towards learning science?" digital science notebooks did not have an impact on student attitude towards learning science. While students did show small growth in their learning, some

students still prefer physical science notebooks to digital science notebooks when learning science. Evidence from the student survey indicates that more than 30% of students prefer a physical science notebook to a digital science notebook. One student stated, ""I learn better in paper notebooks because I get to draw on it or write with a piece of paper instead of typing and making typos." While digital science notebooks kept students' assignments in one place, some students still prefer a physical science notebook when learning science so that they could draw and write more freely. Students also might have felt more comfortable using them if they used them more often, not just when the teacher instructed them to.

In response to my question, "what is the effect on student attitudes towards online learning?" digital science notebooks did have a great impact on students' online learning. Evidence from the student survey shows that more than 50% of students strongly agreed or agreed in their pre-, mid- and post- survey that using a digital notebook is easy because they understand technology. Students had no issue using technology and felt quite comfortable finding and accessing their digital science notebook. Another piece of evidence from the student survey indicates that zero students chose "agree" or "strongly" agree when asked if they had a hard time finding their assignments in their digital notebooks. Students this year have had the opportunity to spend time using various types of technology. Many students became proficient in adding assignments to their digital science notebook. As ten and eleven year olds, many were already proficient in using technology before they were introduced to their digital science notebooks.

In response to my question, “what is the effect on teacher attitudes towards providing feedback and grading” digital science notebooks had a large impact on my own attitude towards providing feedback and grading. When looking at the self- assessment survey data, there were no indications that more than 2 hours had been spent on providing feedback. Another self- assessment survey question provides evidence that it is easier to provide feedback digitally. Seventy- six percent of the time, “agree” or “strongly agree” was the chosen response when asked the prior question. Because of the nature of technology and typing, it is a faster process to type feedback on assignments. When using physical science notebooks, feedback would typically be provided by writing it in the notebook. This can be very time consuming, and therefore, providing feedback in digital science notebooks can take less time, allowing the teacher to provide more valuable feedback to the student.

Finally, in response to my questions, “to what degree are students taking responsibility for their learning?” and “can they express themselves and their learning virtually?” the use of digital science notebooks does not allow students to take responsibility for their learning or show self- expression. Evidence from the student survey indicates that zero students agreed or strongly agreed that they have a hard time making choices to show what they learned in their science notebooks, and little opportunity was provided to students to do so. The teacher journal states, “Students are unable to show self- expression in their learning. I have realized that it is quite difficult to create assignments that are not all the same. It is hard to create assignments that are different as everything is being re-created and I am planning for two subjects, and 6

classes". Another quote further explains, "Students are putting their work into their science notebooks but they are not using self-expression in their assignments- this is in part, due to myself not creating lessons in which they can do so". Students also responded to the question, "I like to choose the way I show what I learned in science" with varied answers on the Likert scale, providing no further evidence that students prefer to choose their assignments. The reason digital science notebooks did not indicate any use of self-expression is due to the nature of assignments. Students were not provided much opportunity to show what they learned in their own way. This was mostly due to the fact that assignments were not created that allowed self- expression. It is unclear if self-expression could be impacted if the students had more opportunities to show their knowledge in different ways in their assignments

Implications and Value

This study has a few implications that are important to note. The first implication is the sample size. Only 16 students participated in this study which does not give a large enough overview of the impacts from this study. Due to the Covid- 19 pandemic, students were often being moved in and out of remote learning to in- person learning. Should this study be conducted again, a larger sample size would provide more data.

Also, due to the pandemic, all teachers were strongly encouraged to use curriculum materials, instead of creating new lessons from scratch. This made it very challenging to provide students with assignments that would allow for them to show their knowledge of science content in different ways.

The nature of teaching in the pandemic forced me to limit certain aspects of the study due to overwhelming tasks in other areas of teaching, such as parent communication and student engagement. The study originally had a notebook check rubric that would have provided more qualitative data but it was not possible to keep up with rubric checks. Student notebooks were checked weekly to make sure students had what they were supposed to in their digital science notebooks, however, this was identified with a check mark on my roster.

Should this study be duplicated when there is not a global pandemic, and students are in the classroom learning, it would be ideal to have a comparison group. One class of students would use only physical science notebooks and the other class would use only digital science notebooks. This would allow for clear differences between both learning methods. A regular school year would also provide more time in class to make sure students are using their notebooks properly, as well as allow students to include more in their digital science notebooks, like drawings on paper that they could upload or pictures of experiments that could also be uploaded.

Careful consideration would also be made when deciding what format of a digital science notebook would be most useful for students. The choice was made to use Google Drive as a platform for their notebooks. It is possible to use another platform, such as a long running Google slide. This may be more effective for students if they are able to easily scroll through and see their work. Using Google Drive provides students with important technology skills that they will need as they progress through school, as cloud

based storage has moved into the most common way to store digital files, however, it may not be the best platform for a digital notebook.

This study was very difficult to conduct during the Covid- 19 pandemic, however, it is extremely valuable research at this time. The Covid-19 pandemic proved that technology is not just a helpful resource, but it is a necessary resource. Teachers have had to adapt years of physical lessons to a digital platform, where we now have to rely heavily on the technology just to bring lessons to our students. With so much research on the success of physical science notebooks, it is imperative to find an equally effective way to use digital science notebooks in the classroom, as an alternative. This study should provide a jumping off point for further research on the efficacy of digital science notebooks.

Impact of Action Research on the Author

I have always used physical science notebooks in my science classroom. Science notebooks provide an outlet for students to make their work their own. This study has provided enough evidence around the effective use of digital science notebooks to continue this research, in order to find a more effective digital notebook strategy. This is only a preliminary study into what is an extremely necessary need.

At the level of classroom teaching, this study can be used to develop teachers' understanding of the best format for a digital science notebook. Students did show growth, but I believe this can be more significant when introduced in a different way. I will likely use a long- standing Google slide as a digital science notebook, as I believe

this would provide better opportunities for students to look back at their work and show their work in different ways.

At the building level, digital science notebooks can be promoted and encouraged to be used by the other science teachers. There are still teachers that don't use science notebooks for various reasons, one being that not all students have their own physical notebook. Working in an economically disadvantaged area, students can't always afford to purchase notebooks. I have always purchased them myself. Digital science notebooks offer an opportunity for every student to have a personal notebook without worrying if they can afford to buy one, provided that schools will still have the ability to arrange for each student to have their own electronic device.

Lastly, at the district level, this study can provide evidence that technology is of the utmost importance in this district. This year, due to the Covid- 19 pandemic, students were all provided a personal device. This is a norm that should have already been in every middle school in the district. Digital science notebooks give students the ability to access their work from home. Implementing more technologically based curriculum materials allows for more flexibility in learning. Students can continue to keep up with their work, even if they are going to be out. Accessible digital learning tools can prevent students from falling behind. Using digital science notebooks is one way that educators can take a researched best practice and adapt it to their students.

REFERENCES CITED

Butler, M. B., & Nesbit, C. (2008). Using science notebooks to improve writing skills and conceptual understanding. *Science Activities: Classroom Projects and Curriculum Ideas, 44*(4), 137-146. doi:10.3200/sats.44.4.137-146

CAST, Inc. (2021, April 20). *About Universal Design for Learning*. CAST. https://www.cast.org/impact/universal-design-for-learning-udl. doi May 30, 2021

Dickenson, G., & Summers, E. J. (2011). Science notebooks as a teacher training tool [abstract]. *The International Journal of Science in Society, 2*(2).

Fulton, L. (2017). Methods and strategies: Science notebooks as learning tools. *Science and Children, 054*(06), 80-85. doi:10.2505/4/sc17_054_06_80

Fulton, L., Paek, S., & Taoka, M. (2017). Science notebooks for the 21st century. *Science and Children, 054*(05). doi:10.2505/4/sc17_054_05_54

Huerta, M., Lara-Alecio, R., Tong, F., & Irby, B. J. (2014). Developing and validating a science notebook rubric for fifth-grade non-mainstream students. *International Journal of Science Education, 36*(11), 1849-1870. doi:10.1080/09500693.2013.879623

Huerta, M., Tong, F., Irby, B. J., & Lara-Alecio, R. (2016). Measuring and comparing academic language development and conceptual understanding via science notebooks. *The Journal of Educational Research, 109*(5), 503-517.

Nesbit, C. R., Hargrove, T. Y., Harrelson, L., & Maxey, B. (2004). Implementing science notebooks primary grades. *Science Activities: Classroom Projects and Curriculum Ideas, 40*(4), 21-29. doi:10.3200/sats.40.4.21-29

Rappolt-Schlichtmann, G., Daley, S. G., Lim, S., Lapinski, S., Robinson, K. H., & Johnson, M. (2013). Universal Design for Learning and elementary school science: Exploring the efficacy, use, and perceptions of a web-based science notebook. *Journal of Educational Psychology*, *105*(4), 1210–1225. https://doi.org/10.1037/a0033217

Robinson, C. (2018). Listserv roundup: Interactive and digital notebooks in the science classroom. *Science Scope, 041*(07). doi:10.2505/4/ss18_041_07_20

Young, J. (2003). Science interactive notebooks in the classroom. *Science Scope,* 44-47.

APPENDICES

APPENDIX A

IRB EXEMPTION

INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

MONTANA STATE UNIVERSITY

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Telephone: 406-994-4706
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Chair: Mark Quinn
406-994-4707
mquinn@montana.edu
Administrator:
Cheryl Johnson
406-994-4705
cheryl@montana.edu

MEMORANDUM

TO: Jamie Lee MacDonald and Walter Woolbaugh

FROM: Mark Quinn
Chair, Institutional Review Board for the Protection of Human Subjects

DATE: November 4, 2020

RE: *"Efficacy of Learning and Self-expression through the Use of Digital Science Notebooks in a 5th Grade Science Classroom" (IRB-FY2021-0426-EXT)*

The above research, described in your submission of November 4, 2020, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal Regulations, Part 46, section 101. The specific paragraph which applies to your research is:

_X_ b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

_X_ b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation; and (iii) the information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and (iv) IRB conducts a limited IRB review to make the determination required by section 111(a)(7).

___ b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

___ b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

___ b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

___ b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and Committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX B

NO DSNB PRE- AND POST- ASSESSMENTS

Life Science Pre-Assessment

Please do your best at answering the questions below.

The respondent's email (null) was recorded on submission of this form.

1. Email *

2. First and Last Name

3. Plants get the food they use for energy and growth by— 5 points

Mark only one oval.

- ( ) Making it from sunlight
- ( ) absorbing it from other living things.
- ( ) eating small insects.
- ( ) breaking down bacteria.

APPENDIX C

DSNB PRE- AND POST- ASSESSMENTS

Physical Science Unit Test

The respondent's email (null) was recorded on submission of this form.

1. Email *

2. 1. Which of the following provides the best evidence that a chemical reaction has taken place? 3 points

Mark only one oval.

- Water, when boiled, evaporates and turns into vapor
- Sugar dissolves completely when added to water
- A liquid becomes a solid when heat is removed
- Two liquids are mixed and a solid substance forms

APPENDIX D

STUDENT SURVEY

A digital science notebook helps me organize my science notebook intro labeled sections.
My digital science notebook is organized and I know where to find my work.
I enjoy using my digital science notebook during science.
If you enjoy using your digital science notebook, explain why. If you don't enjoy using your digital science notebook, explain why.
I would rather use a physical science notebook for science.
If you would rather use a physical science notebook, explain why.
I use my digital science notebook for all of my science assignments.
I like to choose the way I show what I learned in science.
I have a hard time finding my work in my digital science notebook.
Before 5th grade, I have never used a digital science notebook.
Using a digital science notebook is easy for me because I understand technology.
Using a digital science notebook is confusing for me because I have a hard time with technology.
Having all my assignments and notes on the computer helps me learn.
I would learn better if I had worksheets and a physical science notebook.
If you answered towards "agree" in the question above, why do you learn better with worksheets and physical science notebooks?
I have a hard time making choices to show what I learned in my digital science notebook.
It is easy to do assignments in a digital science notebook.
I look back at my digital notebook folders to help me with assignments and studying.
I use my digital science notebook when I am working independently.
I can easily record observations in my digital science notebook.
What is your favorite way to record science observations?

I have a hard time including pictures and drawings into my digital science notebook.
If you answered towards “agree” in the question above, what do you find difficult about including pictures and drawings in your digital science notebook?
I know it is my responsibility to organize my work in my digital science notebook.
I only use my digital science notebook when the teacher tells me to.
I want to receive high grades in science.
I follow the notebook rubric when working in my digital notebook.
My digital science notebook helps me understand what I am learning.
What suggestions do you have for Ms. MacDonald that would make working in your digital notebook easier?

APPENDIX E

SELF- ASSESSMENT SURVEY

How many times were notebooks checked this week?	0 1 2
How much time was spent conducting notebook checks this week?	Less than an hour One to two hours More than two hours
How much time was spent providing feedback to students on specific assignments?	Less than an hour One to two hours More than two hours
How do I feel about my time spent on student notebook checks and feedback?	1= Overwhelmed 2= Efficient and effective
If notebook checks were conducted this week, how many students needed to re-submit assignments?	Open response
How do you feel about students utilizing their digital science notebooks? (Utilizing means adding their assignments into their digital science notebook drive under the appropriate folders)	1= Students are using their notebooks for most assignments. 5= Students are not using their notebooks for most assignments.
How do you feel about student learning as evidenced by their science notebooks?	1= Students are showing evidence of learning in their notebooks. 5= Students are not using their notebooks for their assignments.
I feel that my teaching methods have helped students show self-expression through the use of their digital science notebooks.	1= Strongly Agree 5= Strongly disagree
It has been easier to provide feedback digitally.	1= Strongly agree 5= Strongly Disagree
Teacher Journal	Open response