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Discovery Education Techbook Use as a Montessori Science Resource

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Abstract

This study analyzed whether adding *Discovery Education Techbook*, as a resource for science research, would enhance students' depth of exploration and increase their level of understanding of research topics. The study took place in a fourth and fifth grade Montessori classroom, part of a school within a school program, serving 13 fourth graders and 7 fifth graders. Data collection tools included a discussion accountability form and a science journal rubric. These displayed students' research work and discussion participation. A student attitude scale and parent informational tool were used to record students' feelings about science research and collect data on how often they discussed science research with their families. Evidence showed that the use of *Discovery Education* as an additional resource for science research did increase students' ability to locate resources and boosted understanding of topics. Student attitude forms and parent informational tools showed more satisfied learners and better-informed families. The study verified *Discovery Education* as a valuable research tool that should be adapted for use in the Montessori classroom.

Key Words: tech book, *Discovery Education*, science research

Wandering into our fourth and fifth grade Montessori classroom to observe children at work can be an awe-inspiring experience. Visitors will witness students working together, collaborating on projects, working independently, engaged in their work and excited about learning. We have worked hard to create a well-organized, inspiring, learning environment that meets the developmental needs of the students. They learn and grow together in a community of curious learners that brings out the best qualities in each another.

Digital technologies have become a beneficial part of this learning environment. Our public-school district empowered students by placing iPads or MacBooks into the hands of every child. The district has hired and trained specialists to seek out quality resources for students. However, it has become the job of teachers to find purposeful and meaningful ways to use these tools with students.

As a part of the cultural area of our classroom, students receive impressionistic lessons; these lessons are intended to get the creative juices flowing and thus stimulate curiosity and a desire to learn more. Students use Montessori materials, books, and teacher created shelf activities to follow these interests, answer their questions, and learn more. We have begun to use DISCUS (the South Carolina virtual library) for some of this research and occasionally use the internet, carefully "Googling" our questions. The difficulties we have encountered are that the information they find is not presented at their level for understanding, the sources are not always valid, and there are dangers of their bumping into inappropriate material while surfing the net. For these reasons, online research is not always the best option.

The district recently adopted an enhanced online tech book for science called *Discovery Education*. I had the opportunity to attend several workshops given by teachers currently using *Discovery Education* in their traditional classrooms and learned that this tech book contained a wide variety of resources, which could benefit our Montessori students. The resources included: leveled reading passages on topics my students are researching, read aloud capabilities, an online dictionary, highlighting and note taking capabilities, video clips and full-length videos, links to further information, interactive games, and collaborative activities to engage the students.

Although my co-teacher and I had never used textbooks with Montessori students because we did not want to follow a prescribed curriculum, we did feel this tech book had excellent resources that would be of value to our students in their cultural studies. Therefore, we decided to delve more deeply into the tools and offerings of *Discovery Education*. After more experiences with it, we implemented the use of this tech book as an additional resource for our students as they completed follow up work or research after Montessori lessons. The purpose of this study was to discover whether the use of this tech book enhanced the depth of students' exploration and increased the level of understanding for research topics.

Review of Literature

Learning, in a Montessori elementary classroom, involves the use of impressionistic lessons to inspire questions. Children research and begin to discover answers and understand new ideas. Next, students process their new information, analyzing what they have learned. They create projects or posters to display their knowledge. The environment provides concrete materials to ensure learning is active, thoughtful, and self-directed. For today's student, the internet is becoming a significant part of the learning process for research work. Teachers find themselves faced with the increasingly hard task of compiling collections of the most relevant, realistic, and real-world online resources from a broad range of internet sources. The quest for relevant online resources can be difficult. Finding information at a suitable level for student understanding, proving the validity of the material discovered, and facing the dangers of inappropriate material while surfing the net sometimes proves challenging (Totter, 2001).

Digital tech books seem to provide an answer to the online resource challenges. They offer new opportunities for teachers and learners in a continuously evolving educational landscape. (Throughout this literature review, tech books and e-textbooks are interchangeable terms for an enhanced online textbook.) Most e-textbooks contain more than just online versions of printed text. E-textbooks encourage a wide range of learning activities and strategies by providing a system of learning that supports students' use of tools for interaction and multimedia resources. Adding these personalized and interactive components should ultimately result in a more individualized, efficient, and resourceful education (Oliveira, Camacho, & Tarragona, 2014).

Dobler (2015) revealed that digital tech books could transform the way students read, research, and understand information. The purpose of this literature review is to learn the pros and cons of using digital tech books in classroom settings from the findings of current research studies. The goal is to analyze what these studies revealed regarding how e-textbooks affected students' reading comprehension, whether they targeted a wide variety of learning styles, and whether they increased students' curiosity for learning and thus led to deeper exploration of concepts.

Herther (2014) demonstrated in his research that a significant percentage of students who had never experienced reading with online tech books predicted that they would prefer print textbooks to digital text. After the experience, however, fewer than 20% of those students said they would choose to go back to using print only. Dobler (2015) also discovered that tech books have been shown to promote active, self-regulated learning by providing students a variety of formats for accessing information; they could choose the activity that best suited their individual needs.

McFall (2005) found that digital tech books could change the way students read, transforming them from passive readers to active readers. McFall defined passive readers as readers who show little to no engagement with their reading. They simply read to finish the text. Passive readers may highlight and occasionally take notes as they read. However, they are not likely to achieve an adequate understanding of what they are reading. McFall stated that active reading included completing extension lessons such as rewriting key concepts in their own words and identifying main points within the passage in addition to the highlighting and note taking. Active readers reflected on the most valuable portions of the text and constructed their own mental model of the text. Active reading ensured that students completed a reading passage with full comprehension of what they have read (McFall, 2005). Dobler found that the addition of these digital tools added “layers of complexity” to the reading process. These resources enabled students to be actively involved in their reading. Training students to “remain in the reading moment…is especially critical when a reader toggles between media, web links, and text” (Dobler, 2015, p.487).

The read aloud capabilities available in the digital versions of books have been found to be particularly beneficial for struggling readers. Dobler noted that even proficient readers used this tool. Readers at all levels displayed an increased capability to focus on understanding the text rather than concentrating on the decoding and pronunciation of difficult vocabulary terms (Dobler, 2015). Some tech books additionally included features that enabled educators to upload and integrate resources into the reading passage notes. This feature, designed to assist students in making connections to the reading, increased students' ability to relate to and understand the text (McFall, 2005).

One significant apprehension that Lee, Messom, and Yau found was the visual fatigue students displayed from reading on screens rather than paper and that optical fatigue could be a side effect of long term usage of e-textbooks. In their study, they quoted two separate students as saying, "It's exhausting to read a lot of content off the screen" and "Personally, I do not understand why people want to read from a backlit screen for hours. Reading should be done without torturing themselves" (2013, p. 36). Dobler suggested that these issues have been lessened with the creation of updated options for screen quality and backlighting choices in newer devices (2015, p.483).

Comprehension studies seem somewhat contradictory. Korat's study (2010) found that for elementary aged children, understanding increased with an e-book over traditional books. Herther's study showed slightly higher reading comprehension with print text, but greater satisfaction and curiosity with e-books (2014). Dobler found that 65% of students indicated that the digital tools in the online textbook enhanced their learning experience (2015). She noted that some students enjoyed the ease of note taking, the text highlighter, the linked definitions, and the quick access to additional resources when using e-books. Other students found themselves easily distracted, not being able to enter the study mentality associated with textbook learning. Students discovered that the physical movement involved in note-taking improved their ability to remember. One student using e-textbooks stated, "I am used to skimming on the computer. I carried this same habit to the e-textbook. It was harder to get absorbed in the reading" (Dobler, 2015, p.487).

Tech books, by providing a more learner-centered approach, reach children of different learning styles, thus leading to greater comprehension of content. Students interact with a multitude of learning tools. Some resources include articles with read aloud capability, audio and video clips, full-length videos, flash tutorials, interactive maps, and collaborative media experiences. Other research tools include links to a glossary, search bars, note-taking tools, and report writer's assistant (to help with citations and footnotes). Tech books also provide follow-up work, virtual labs, and virtual field trips. By integrating each of these different activities into a unified learning environment, we can save students time and improve the discoverability of information (Rivero, 2010; Sigarchian, et al., 2015; Grensing-Pophal, 2010; Totter, 2001).

Lee, Messom, and Yau (2013) found it helpful to include a chat room or blog area for each class and teacher. This cooperative tool granted students the ability to express their thoughts or ideas and to ask or answer questions both individually and anonymously (if desired). The chat rooms encouraged a stronger sense of community as both peers and teachers responded, commented, and discussed posts. Students learned collaboratively from the thoughts, questions, and mistakes of other students within their class (McFall, 2005; Lee, Messom, & Yau, 2013).

While some students still prefer to access textbooks in the traditional way, this group is likely to diminish over time. Oliveira, Comacho, and Terragona suggested introducing elementary school students to e-textbooks would have lasting effects "since young people typically have more malleable study habits and academic reading practices" (2014, p. 90). Preschool children today are already becoming comfortable with accessing and using online content, and as they grow up, this is going to be their norm. E-textbooks better match the learners of today. Today's students are comfortable with multitasking; they have little tolerance for delays, and prefer to learn through the trial and error approach found in games and simulations. Technology is a huge part of their lives, and tech books make learning a complete educational experience for these learners. Ninety-seven percent of students felt the online resources were easy to use and 88% said it improved their understanding (Grensing-Pophal, 2010).

Oliveira, Camacho, and Terragona (2014), have overwhelmingly found student perceptions of e-textbooks as being greatly dependent upon the schools' values and the teacher's attitudes towards using the tech books. Herther uncovered some concerns about teachers and faculty resisting adoption of digital texts (2014). Findings showed younger faculty handled the change more readily because they were more comfortable with technology (Grensing-Pophal, 2010). Many textbook companies, realizing the importance of teachers' comfort levels with the use of the tech book, are now cooperating with school districts to provide a variety of professional development opportunities to support teachers as they begin making this enormous change (Rivero, 2010).

Tech books include helpful data collection resources for teachers. These tools keep detailed records for each student. They track the amount of time students spend reading or working and notify teachers when students are idle or not engaged in their work. Data collection records also track which tools or resources the students used while they were working and then provided reports of online work, vocabulary, or quizzes. This information creates an accurate description for teachers of each child's unique learning experience (McFall, 2005).

Discovery Education, a trailblazer in standards-based digital content, is one of the tech books available for adoption in South Carolina schools. It uses an "inquiry-based instructional approach that emphasizes informational text, analytical writing, and problem-solving skills that students will apply in the classroom and beyond" (Discovery Communications, LLC, 2016, par.

4). In a search for a digital science tech book, South Carolina school district seven decided that *Discovery Education* proved itself to be the tool that best met today's students' needs. Recent studies have shown the use of this resource being "associated with higher science achievement scores in elementary school students" (Piehler, 2014, par. 1). The recipient of numerous awards, *Discovery Education* was recently rated "top digital resource available to K-12 classrooms" by SpotOn (Discovery Communications, LLC, 2016; PR Newswire, 2011).

Technologies are growing rapidly; the use of online tech books is gaining effectiveness and popularity. The pace of technological change in this generation is causing textbooks to become less essential in the educational process (McFall, 2005). However, the change from print to online text will likely take years to evolve; the two will probably live side by side for an extended time. Cutting edge schools will begin transitioning more quickly, and their students may have an advantage in the job marketplace due to their comfort level with technology (Herther, 2014; Rapp, 2008; and Grensing-Pophal, 2010).

This research was conducted to discover whether the use of tech books as a resource would deepen the student's research experience as well as inspiring them to more curiosity. My classroom action research project focused on this question: Will the addition of the tech book *Discovery Education*, as an additional resource to our science program, enhance the depth of exploration and increase the level of understanding of research topics for students in our 4th and 5th grade Montessori classroom?

Methodology

My quest to find out whether *Discovery Education* would enhance the depth of exploration and increase the level of understanding of research topics began by sending assent forms to parents, which would allow me to use the information I collected from their children.

At the same time, I also sent the parent consent forms that would enable me to gather data from them. Within a week, I had received permission from each family to use all data that I collected in my study. I had my co-teacher sign a consent form to participate in this project.

A week later, I sent home a parent informational tool for completion (see Appendix A). This tool was used before my research began, to determine to what extent children discussed science research topics with their families. All forms were returned. Students completed an attitude scale that gave me baseline information, illustrating how they felt about resources available to them for research (see Appendix B).

I then spent two weeks collecting baseline data using the discussion accountability checklist during weekly science meetings (see Appendix C). On this form, I could keep track of students' participation, accurate information shared by the students, and whether they demonstrated rigorous thinking. Listening to and taking notes on students' discussion of essential questions before using the *Discovery Education* tech book provided evidence as to how much research was completed and the level of understanding gained from this research on science topics.

At the same time, I began completing the science notebook rubric with students during our weekly conferences (see Appendix D). Using this rubric, each student and I analyzed the completed science journals for neat organization, content accuracy, and use of illustrations and diagrams before using *Discovery Education*. This rubric produced evidence of the quality and quantity of research students conducted. It also exemplified how well they understood assigned science topics.

Over winter break, I spent time outlining science study topics for the six-week action research project. I narrowed down specifics for each week and explored available resources in

Discovery Education Techbook. The fourth-grade would focus on light and sound. The topics for light were: Light Energy, Color, Reflection, and Refraction. Sound included: Sound Waves, Pitch, and Volume (Volume concluded after the six-week data collection was complete). Fifth grade would work on force/motion and engineering technologies. Their research topics were: About Force, Describing Motion, Friction, Making it Work (simple machines within complex systems), Information Transfer (analog vs. digital), and Materials for a Purpose (natural vs. human made materials).

After Winter Break, I was ready to begin using *Discovery Education* as a science resource. I invited our school's technology specialist to instruct us. She assisted each student as they logged into *Discovery Education* and gave navigation directions for using the tech book. After she left the classroom, I gave students extra time to explore independently. I practiced with them until they demonstrated proficiency using the tech book and could browse available resources independently.

The next day, students received introductory science lessons for the new semester. After small group lessons, my co-teacher and I assigned essential questions for the week's research. We introduced students to available classroom materials, books, shelf-work experiences, and instructed them to use *Discovery Education* resources rather than SC Discus or the internet, as they had in the past, for online research.

My co-teacher and I continued to assess science journals with students using the rubric during individual weekly conferences (see Appendix D). We were attentive to organization, content, and diagrams/illustrations. We charted findings in a data notebook. We continued to record participation activity throughout discussions during weekly science meetings using the discussion accountability sheet (see Appendix C). The use of this sheet helped us keep track of students' participation, accurate knowledge shared, and rigorous thinking. We took anecdotal notes and stapled them to the data report. We conducted the study for six weeks.

When the study concluded, I asked students to complete the student's attitude scale again after using *Discovery Education* as an added science resource for six-weeks (see Appendix B). I sent home the parent information tool again at the end of the project (see Appendix A). This data was used to observe any changes in students' attitudes and to determine if science discussions with parents changed throughout the study.

Analysis of Data

My research was conducted to determine whether the addition of the tech book *Discovery Education,* as a resource to our science program, enhanced the depth of exploration and increased the level of understanding of research topics for students in our fourth and fifth grade Montessori classroom. Results from my study showed that the addition of *Discovery Education* had a positive impact on the depth of students' research and level of students' understanding in our Upper Elementary Montessori classroom.

Science Journal Rubric

After two weeks of baseline data collection, we began implementation of *Discovery Education* as an added science resource. During the first week, my co-teacher and I noticed a positive shift in the notes and illustrations students documented in science journals. We used the science journal rubric (Appendix D) when conferencing with students, to evaluate aspects of their journal work. The additional clarity of students' vocabulary notes gave evidence that they obtained an improved understanding of vocabulary terms when they used *Discovery Education's* interactive glossary animations and images rather than classroom dictionaries, glossaries from book sources, or online dictionaries.

The scientific language *Discovery Education* used was appropriate and understandable. Students easily experimented with variables and could document their findings more concisely using *Discovery Education's* exploration worksheets than they had been with previous exploration tools. The clear, simple to use format was evident while analyzing students' journals with this Science Journal Rubric. We noticed a striking difference in the quality of students' illustrations, diagrams, and the notes they took while working on explorations from the tech book.

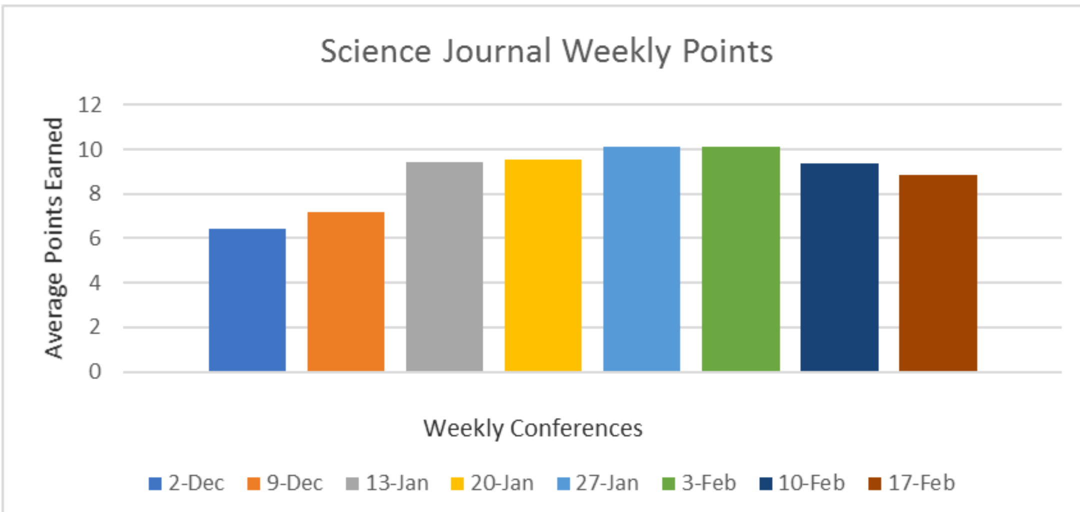

Figure 1. Average of Science Journal Points Earned

As we conferenced with students regarding science journals, one negative issue we encountered was that several children did not feel they had adequate time to finish research or investigations within the timeframe allotted. Time had rarely been an issue in the past. As we spoke with students concerning this matter, we uncovered two main themes causing this dilemma. Students often encountered issues finishing research or investigations because there were times when the internet was down and students could not access the tech book, or students found inactive links. Many of them also located a larger amount of relevant materials than they had time to read and investigate. One student noted, "I have trouble getting through all of it."

Numerous students looked for teacher guidance in deciding how to pick and choose “the best” from the large quantities of materials found available for use.

During the final two weeks of the action research my co-teacher and I noticed a slight decrease in the quality of students’ work. This data was apparent in Figures 1-4. One possibility for the subpar quality of work was that our class hosted a Valentine’s dance for kindergarten to fifth grade students at our school. Upper Elementary Montessori students took the lead in supporting the American Heart Association by making decorations, planning concessions, hiring a DJ, and hosting the event that took place on Valentine’s Day. The enthusiasm students demonstrated for such a worthy cause provided an excellent learning experience. However, it was a distraction from science research. The data results showed a small decline during those two weeks, but even then, the data collected showed an increase from the baseline data we collected.

Science Discussion Accountability

During weekly meetings, my co-teacher took anecdotal notes while I led the student discussion. Together, we used these notes to complete the science discussion accountability form (Appendix C). With this tool, my co-teacher and I saw an increase in the number of students actively participating in our weekly small group discussions. Our science discussion accountability sheet exhibited the fact that a higher number of students elaborated, clarified, and built upon one another’s contributions. We observed and noted more attentive students engaged with each other and an increased desire to add knowledge to the conversation.

Figure 2. Discussion Participation Averages

One of the language and science standards we strive to foster is the students' ability to provide evidence from the text for their claims and arguments. Anecdotal notes from our small group meetings and the discussion accountability form showed students did demonstrate a gradual increase in their ability to use precise and accurate knowledge. However, during meetings, we observed only a slight increase in students' ability to support what they were saying with quotes from the text. We anecdotally noted that when students brought books and materials from the shelf to meetings, it was easier for students to refer to them during discussions. Students do not bring digital devices to small group meetings. Therefore, our anecdotal notes showed that unless children had taken extensive notes when using the digital textbook, it was more difficult for them to provide evidence from text, video, or explanation for facts they were contributing.

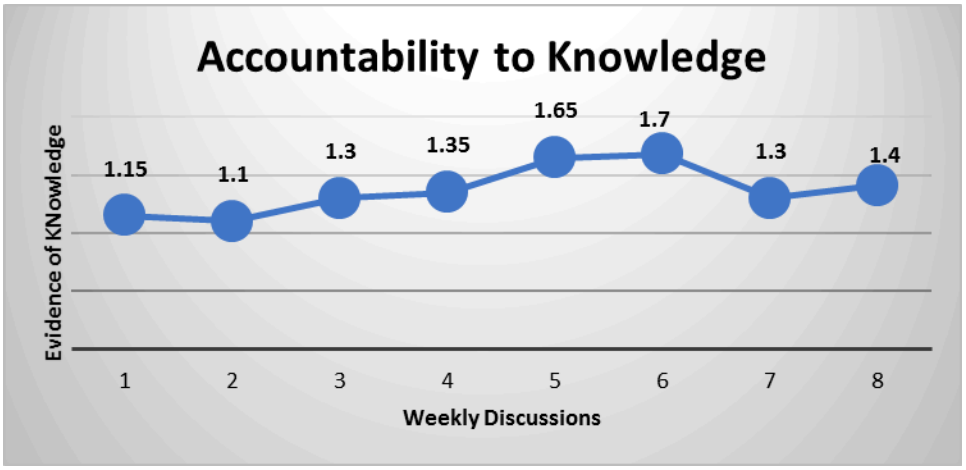

Figure 3: Evidence of Specific and Accurate Knowledge

The area in which my co-teacher and I observed the greatest increase and continual growth throughout this study was in students' ability to construct explanations, and analytically consider what they learned. Students were no longer reading the exact same materials before coming to weekly science meetings. *Discovery Education* provided them with a plethora of informational tools related to their topic and essential questions. Therefore, during discussions students began to raise questions about one another's responses. Students began to synthesize what they had learned from several different sources of information and from each other. Our anecdotal notes showed this increase in students' discussion abilities was undoubtedly due to a more complete understanding of the topic.

An example of this discussion and synthesis of information took place in our 4th-grade pitch discussion (Appendix E). Students were discussing how the amplitude and wavelength of the sound waves affect the pitch of a sound. One student began the conversation by talking about a video he watched. In the video, he "listened to the sound of water going into a glass." Another student described how the pitch of the sound "changed as the glass became more and more full." Additional children chimed in about a recorder, one saying, "the vibration is caused by the reed, and the pitch is determined by the distance the air travels before it comes out of the instrument." Someone else brought up the 25-ft. Tuba and how "the brass pipe is shaped and bent, the air has to travel longer distance before a sound can be made, this results in a lower pitch." Next, a child brought up guitar strings and how the strings vibrate over the hole. Still another student brought up dolphins in the water and that "their clicks and whistles echo through the water so they can communicate." Dolphin communication led to a discussion about dogs and how dogs "hear higher pitches than humans can hear." Students discussed the concept of a dog whistle that humans are unable to hear. Questions were asked about whether this "had to do with the placement (of the ears) on their (the dog's) head," and observations about how "their ears perked up when they were listening." Students knew that this meant dogs could "hear at a higher vibration rate." Then, students wanted to compare the frequency numbers and sounds that had different vibration rates. Lastly, the discussion moved to ultrasound and infrasound. They looked at the prefixes and discovered that" infra is low pitches we can't hear." They stated, "earthquakes make infrasound, we can feel the vibrations, they move the earth, but we don't always hear them."

Discussions like the one described took place on a weekly basis throughout this study. My role in these discussions was minimal. I started them off with a sentence or two about our topic and the students took over from there. My co-teacher's anecdotal notes conveyed how students took over, conversing about the topic and learning through their discussions. As children became more and more practiced at these conversations, my co-teacher and I noted students' rigorous thinking improved; and we observed growth in their ability to put ideas into words. According to our observations the level of student comprehension of assigned topics increased.

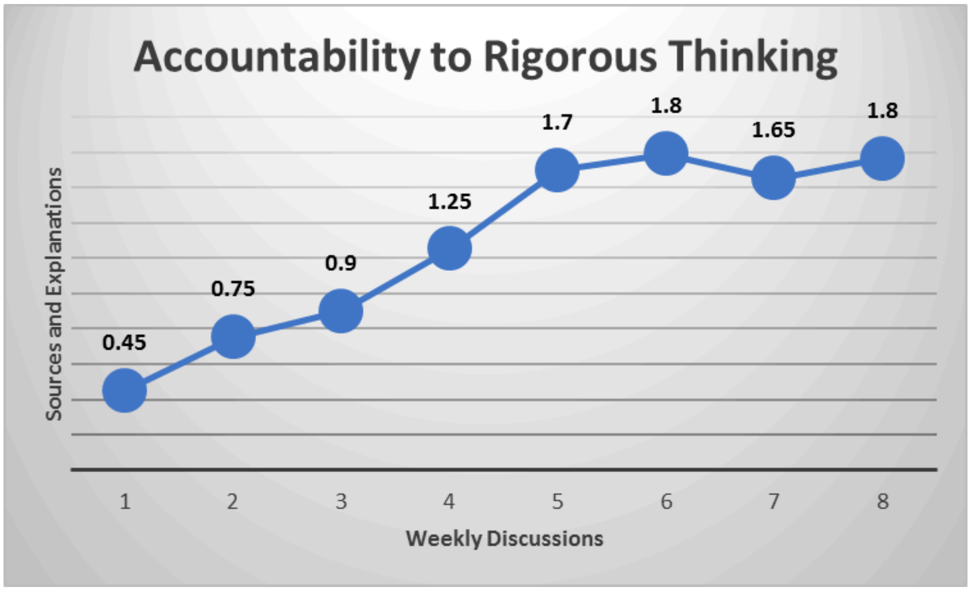

Figure 4: Depth of Sources and Level of Understanding Demonstrated

Student Attitude Scale

The student attitude scale (Appendix B) data suggested an improvement in the way students were feeling about science work and research in the classroom. On the baseline survey before the action research, one student commented, “I am excited to try something new with science.” Another suggested nervousness about adjusting our science research techniques saying, “I like it just the way it is, why change?” The final survey, after six weeks using the tech book, included students’ comments saying, “I like *Discovery Education*. It is an improvement…I enjoy writing my answers to the essential questions.” “It is a little challenging, but it’s fun at the same time” and “*Discovery Education* is interesting and fun. I enjoy the variety of things to do.”

The highest rate of change was reflected in how students felt about their ability to find the resources needed for science topics. This area grew by 15% clearly showing students felt more successful locating resources using the tech book. On the low end of the scale, students felt about the same (a 1% increase) in their ability to complete science research in the allotted time.

The Student Attitude survey data presented clear evidence of behaviors we were observing during journal analysis conferences and small group meeting discussions.

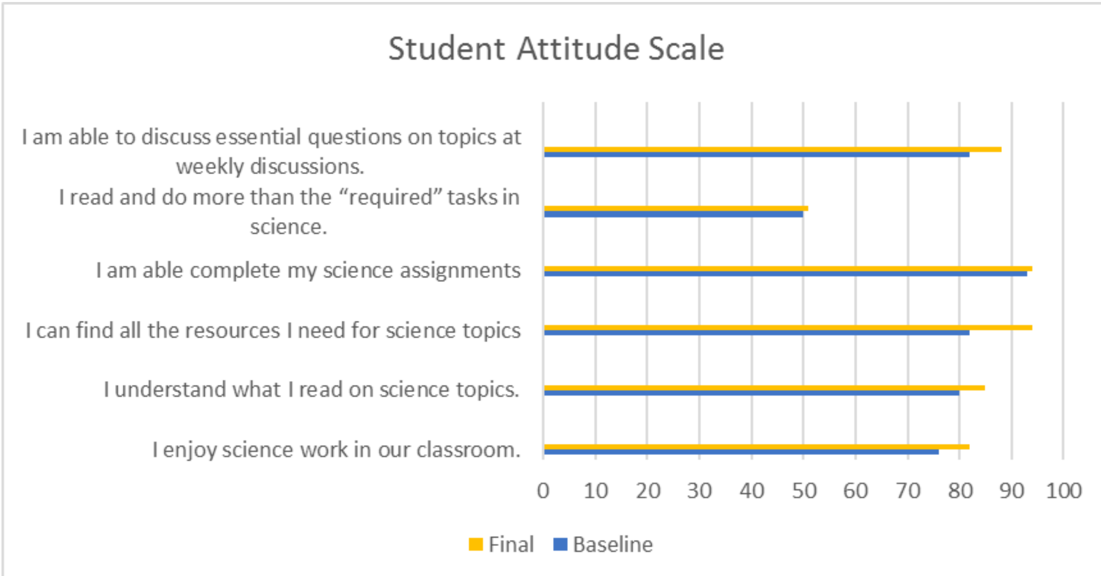

Figure 5: Student Attitude Scale

Parent Informational Tool

The parent informational tool (Appendix A) data was also consistent with classroom findings. Figure 6 showed that students talked to their parents more regularly. Figure 7 supplied evidence that the level of understanding and depth of knowledge students shared with their families improved with use of *Discovery Education* as an added science resource.

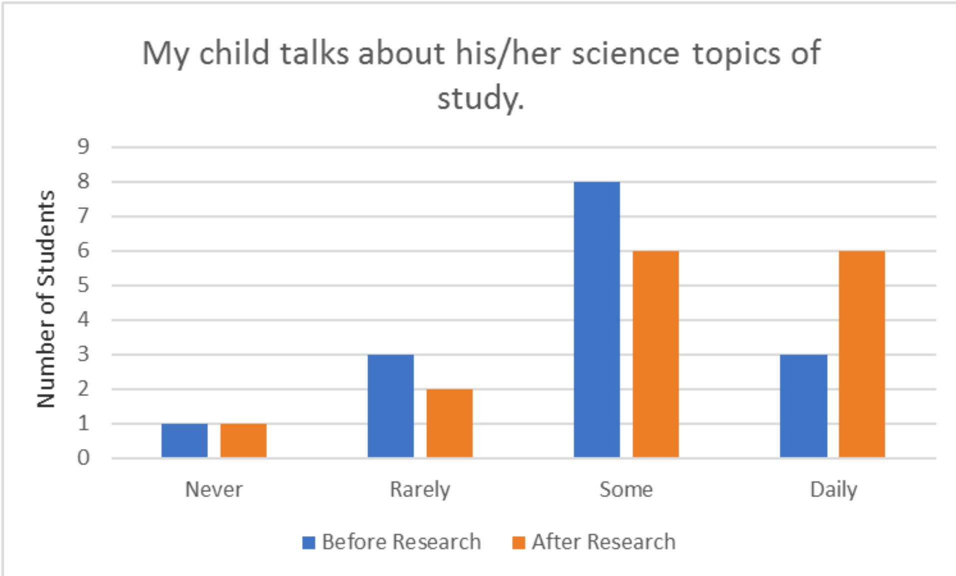

Figure 6: Family Talks About Science Research

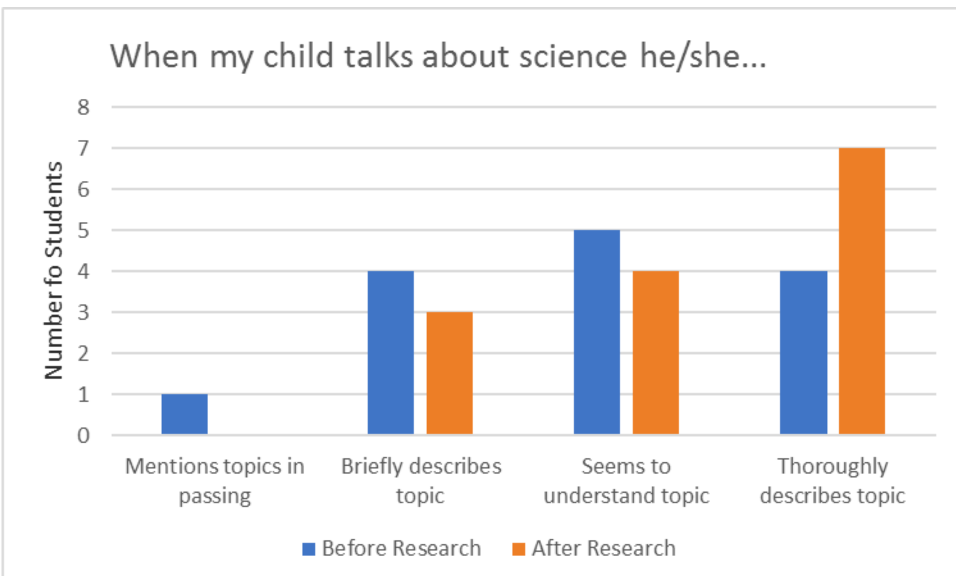

Figure 7: Level of Knowledge Demonstrated

Parent comments on the baseline tool included:

- "He is bored with science this year at school, but he pursues science topics at home on his own time."

- "She talks about it, but does not seem engaged. She only does what is required it seems. She needs to be pushed into more topics."
- "He often feels there is not enough detail or it is a restatement of information he already knows…"

Parent comments on the final informational tool included:

- "___ really enjoys the topics and tries to learn more about them at home."
- "He seems more interested and likes to explain what he has learned."
- "He likes it much better with *Discovery Education*. I would like him to continue with this product if possible."
- "She continues to investigate topics learned when she gets home from school."
- "She really enjoys this science work, it makes her question more."

From the data collected through the course of this action research study, it is evident that the use of *Discovery Education* as an added resource for science research did in fact increase students' ability to locate relevant resources and it boosted understanding of assigned topics. Student attitude forms and parent informational tools displayed additional benefits showing more satisfied learners and better-informed families. The study has proven that *Discovery Education* is a beneficial tool for research and learning in our upper elementary Montessori classroom.

Action Plan

As I conclude my study using *Discovery Education* as an added science resource, I am enthusiastic about the continued expansion of research capabilities in our classroom as we strive to stay current with the ever-evolving educational landscape today. In just six weeks, I have observed gains in students' ability to find relevant, appropriate material. Their journals demonstrate accurate, concise notes, illustrations, and diagrams of their findings. Use of the tech book has also strengthened students' capacity to discuss assigned topics with their peers. The result of this growth is deeper, more solidified student learning. I am confident that student progress will continue with further use of *Discovery Education*.

Since starting this study, my co-teacher and I have become less concerned about children as they research online. Using *Discovery Education* for research, the information they locate is presented at an appropriate level for comprehension, the sources are always valid, and there are no longer dangers of students accidentally coming across inappropriate material. My co-teacher and I have found our teaching role has changed from informing students about safe methods to locate information on the internet to instructing students on how to narrow searches and choose "the best" materials from the vast array of relevant findings.

The availability of informative articles, videos, and virtual labs has also led to a desire from students for increased time to conduct research. My co-teacher and I have begun to closely examine our long-range plans to determine how much time we can offer them and still retain the ability to cover required standards. The goal for us as Montessori teachers is to follow the interest and desires of students. However, being a part of a public school brings accountability to state standards as well. We strive to find the appropriate balance for each.

My co-teacher and I have never allowed students to bring iPads to small group discussions. We thought electronic devices would distract students' attention during meetings. After this study, we have decided students could benefit from having the ability to refer to specific articles while they are conversing. Having the materials available will make it easier for them to quote the author's words or provide evidence from the text to support their scientific claims. For these reasons, my co-teacher and I decided to experiment with having students bring iPads to weekly discussions as a reference tool.

In our Montessori classroom, children are encouraged to follow their inspirations in science research studies. My co-teacher and I serve as guides to stimulate student learning. We normally assign work rubrics defining requirements with broad subject suggestions. Students narrow topics down based on their unique interests. This results in smaller group discussions which my co-teacher and I take turns leading. Groups are established based upon the similarity of topics students choose. She and I do not usually each attend every small group discussion. However, due to the time constraints of this study, my co-teacher and I planned students' themes of study ahead of time. We chose topics and assigned essential research questions to students weekly, rather than eliciting topics from students. Therefore, for this research period, we were less flexible than normal in following our students' interests and desires. Our hope is that now that data collection is complete, we will observe the same increases in comprehension as we allow students to follow their individual interests more spontaneously.

During this research project, my co-teacher and I did not ask students to create projects to display their learning as we occasionally do. These more in-depth independent projects are usually four to six week ventures for students to complete and present to their classmates. After finishing this study, we will begin to encourage students to use *Discovery Education* as a beneficial tool as they complete these larger projects as well.

Throughout this school year, our district has offered monthly professional development opportunities to all science teachers to familiarize themselves with the materials that *Discovery Education* has available for student use. Since using *Discovery Education,* traditional teachers discontinued use of other curriculum materials. The difficulty they have encountered is that their students no longer completed any hands- on labs or experiments. These teachers saw this as a weakness of *Discovery Education.* They have begun working together to create science kits for each grade level containing the materials needed for relevant lab work. My co-teacher and I have not faced this dilemma in our Montessori classroom because we have used *Discovery Education* as an additional resource to what we already use with the science studies, and therefore we have not removed other materials or lessons from the classroom environment. It will be insightful to watch as traditional teachers find the most beneficial ways to use this digital tool. Perhaps for them as with us, it will become an added resource rather than the entire curriculum.

Next year our school district has plans to adopt the social studies portion of the *Discovery Education* curriculum as well. It will be interesting to observe if and how this tool may also benefit our Montessori students. My co-teacher and I will carefully analyze our classroom work time to establish a healthy balance of Montessori lessons, hands-on shelf materials, books, and technology to enable students to be best prepared for their futures.

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Appendix A
Parent information Tool

Parent Information Tool **Date________**

Completion of this tool is voluntary and confidential.

	Never	Rarely	Sometimes	Everyday
My child talks about his/her science topics of study and research at home and seems excited about what he/she is learning in science.				

	Mentions the topic in passing	Briefly describes the topic	Seems to understand the topic	Thoroughly tells me more than I ever knew about the topic
When my child talks about his/her science he/she				

Is there anything you would like for us to know about your child and their science work?
____
____
____

☐ I am comfortable allowing my responses to be included anonymously in the study.

☐ I prefer not to have my responses included in the study.

Appendix B
Student Attitude Scale

Name________________________ Date__________

Please take a moment to think about your science work in our classroom and answer the questions below.

Question	Never	Rarely	Some	Mostly	Always
I enjoy science work in our classroom.					
I understand what I read on science topics.					
I can find all the resources I need for science topics.					
I am able complete my science assignments.					
I read and do more than the “required” tasks in science.					
I am able to discuss essential questions on topics at weekly discussions.					

Is there anything you would like us to know about your science work?

____

____

____

Thank you.☺

Appendix C
Discussion Accountability

Discussion Accountability **Date______________**

Topic of Discussion___________________

Students involved in discussion														
Accountability to Peers														
Student actively participates in discussion.														
Student elaborates and builds upon ideas and each other's contributions.														
Student works to clarify or explain the contributions of others if there is misunderstanding.														
Accountability to Knowledge														
Student makes use of specific and accurate knowledge.														
Student provides evidence from the text for claims and arguments.														
Accountability to Rigorous Thinking														
Student synthesizes several sources of information.														
Student constructs explanations.														
Student challenges the quality of each other's evidence and reasoning.														

- Influenced by Acct. Talk &Honor Code.
- This chart will be for teacher use only to acquire data from discussions.

Appendix D
Science Journal Rubric

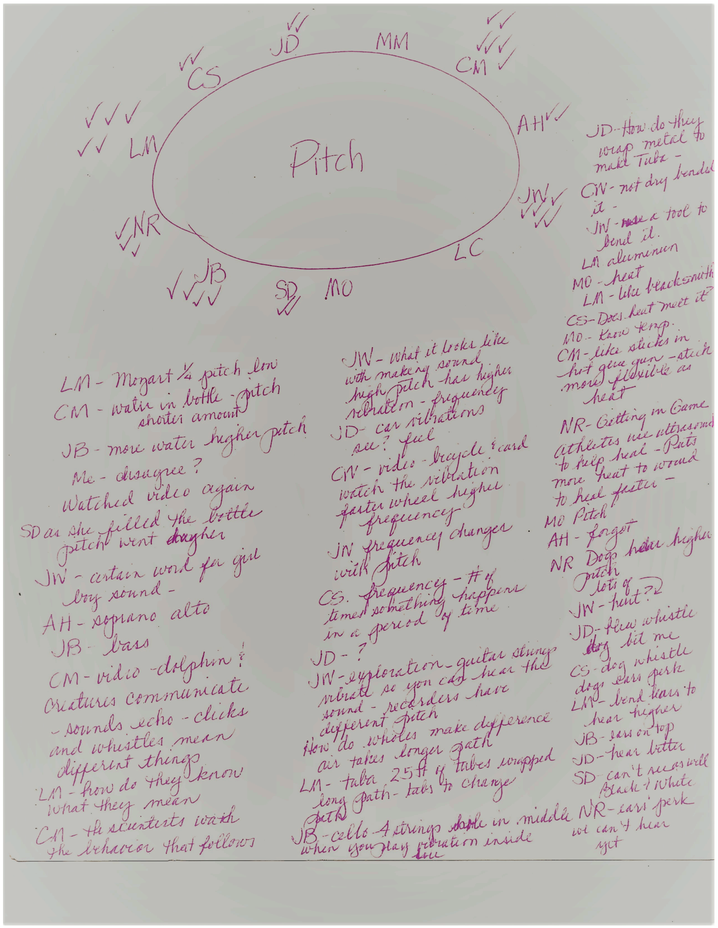
Student: ______________________ Date_________

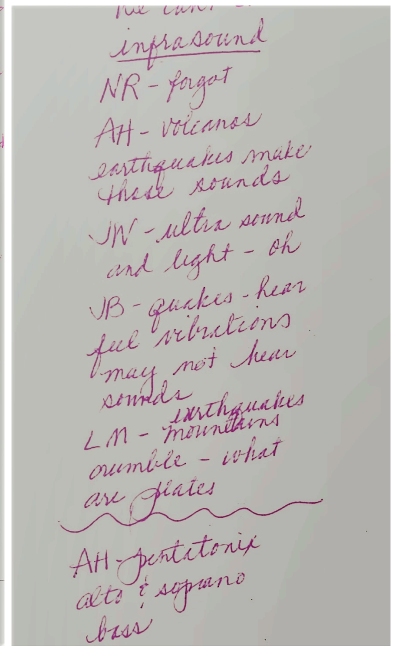
Category	Wow (4)	Good (3)	Almost (2)	Poor (1)	Score
Neat and Organized	Handwriting is neat and information is organized in an easy to understand format.	Handwriting is usually neat and information is organized in an easy to understand format.	Handwriting is not very neat and journal is not well organized or easy to understand.	Handwriting is sloppy and hard to read and journal organization is difficult to follow.	
Content Accuracy	Written responses demonstrate an understanding of science concepts and proper vocabulary use.	Written responses demonstrate an understanding of some science concepts and proper vocabulary use.	Written responses demonstrate a limited understanding of science concepts and proper vocabulary use.	Written responses demonstrate an inaccurate understanding of science concepts and proper vocabulary use.	
Illustrations and Diagrams	Illustrations and diagrams are clear, accurate and labeled.	Illustrations and diagrams are usually clear, accurate and labeled.	Some illustrations and diagrams are clear, accurate and labeled, but some are missing.	Illustrations and diagrams are sloppy, unclear or missing.	

Total score: ____/12

*Influenced by Teacher's Notebook.

Appendix E
Annecdotal Notes from Class Discussion


Pitch
JD MM CM AH JW LC MO SD JB NR LM CS
LM - Mozart ½ pitch low
CM - water in bottle - pitch shorter amount
JB - more water higher pitch
Me - disagree?
Watched video again
SD as she filled the bottle pitch went higher
JW - certain word for give big sound -
AH - soprano alto
JB - bass
CM - video - dolphin! Creatures communicate - sounds echo - clicks and whistles mean different things
LM - how do they know what they mean
CM - the scientists watch the behavior that follows
JW - what it looks like with making sound high pitch - has higher vibration - frequency
JD - can vibrations see? feel
CW - video - bicycle & card watch the vibration faster wheel higher frequency
JW frequency changes with pitch
CS. frequency - # of times something happens in a period of time
JD - ?
JW - exploration - guitar strings vibrate so you can hear the sound - recorders have different pitch
How do whistles make difference air takes longer path
LM - tuba 25 ft of tubes wrapped long path - tubes to change path
JB - cello 4 strings middle in middle when you play vibration inside
JD - How do they wrap metal to make Tube -
CW - not dry bend it -
JW - make a tool to bend it.
LM aluminum
MO - heat
LM - like blacksmith
CS - Does heat melt it?
MO - Low temp.
CM - like sticks in hot glue gun - stick more flexible as heat
NR - Getting in Game athletes use ultrasound to help heal - Puts more heat to wound to heal faster -
MO Pitch
AH - forgot
NR Dogs hear higher pitch lots of
JW - hurt?
JD - Hear whistle dog bit me
CS - dog whistle dogs ears perk
LM - bend ears to hear higher
JB - ears on top
JD - hear better
SD can't see as well Black & White
NR - ears perk we can't hear yet


infrasound
NR - forgot
AH - volcanos earthquakes make these sounds
JW - ultra sound and light - oh
JB - quakes - hear feel vibrations may not hear sounds
LM - earthquakes mountains crumble - what are plates
AH - pentatonix alto & soprano bass