

Student-Generated Photography as a Tool for Teaching Science

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Abstract

This paper describes the experiences of three science educators who used student-generated photographs in their methods classes. The paper explains the impetus for the idea and includes a summary of the literature that supports the use of photographs to teach science. The authors explain the process that they used in their classes and share examples of student-generated photographs. The paper concludes with a summary of the benefits that the authors felt occurred through the use of the photographs including the building of community within the classes and the encouragement of the preservice teachers' identity as science learners and future science teachers.

Introduction

"When words become unclear, I shall focus with photographs." Ansel Adams

As instructors of preservice teachers, we are always looking for ways to ensure that our students find our classes relevant to their futures. We are most excited when a student says, "I can't wait to use this in my classroom!" One of the techniques we have implemented in our courses that is powerful and simple is the use of student-generated photography in the science classroom to build community, model constructivist practices, and build students' sense of themselves as scientists and thinkers. In this article we will share ideas for how we use student-generated photographs in our own classes to help connect science content to our students' lives and to enhance both their science content and science pedagogical understanding. Having explored these techniques at all levels from primary grades through graduate school, we believe the ideas that we present can enhance preservice and in-service science teaching at all grade levels.

Building on Teachers' Experiences

The first literature-based mention that we could find for using photographs as a tool in science teaching was McConnell (1952). In that paper, he encouraged science teachers to use their own collections of science-related photographs as a way to show students a personal connection with a variety of science topics. McConnell (1952) showed that even more than half a century ago there were many ways to share the photographs with students during class time including Kodachromes, lantern slide plates, and 35mm film strip

projectors. As photographic technology has become ubiquitous in the time since this publication, the potential to use photographs to connect students to science has increased exponentially. In the intervening years since McConnell's article, teachers of pre-kindergartners through college have used photographs as a teaching tool in a variety of ways. For example, a number of authors have documented the use of photographs with students to support the development of academic language (Byrnes & Wasik, 2009; Cappello & Lafferty, 2015), particularly for English Language Learners (Jones, 2010). Hoisington (2002) described how photographs were used in a preschool context to help children document their experiences in science investigations, and Good (2005) explained how photographs could be used to build community with young children. In high school science lessons on Newton's Laws of Motion, student-generated photographs were used as an assessment tool (Eschach, 2010). At the college level, Krauss, Salame, & Goodwyn (2010) advocated for the use of photographs to inspire college students to be more engaged and connected to the science content of their classes, while Cook and Quigley (2013) used photographs as a way to help their non-major students in science classes to have a connection to the science of their surroundings.

Although most of the articles that we found focused on teaching strategies, a few also included a research component to document the impact of using photography in science classroom settings. In a preschool setting, Britsch (2019) investigated two students' use of cameras to document their experiences in a science inquiry. She found that the student-generated photographs provided a tool that contributed to the teacher's understanding of students' relationships to science and the meaning that they developed from investigations. Capello and Lafferty (2015) investigated the use of the Visual Thinking Strategy in a fourth grade unit on minerals. With this approach, students take their own photographs and then use the photographs to make close observations and answer questions about the photographs. Capello and Lafferty (2015) found that with this strategy, the images became an opportunity for the teacher to support the correct use of academic language and to help the students reflect on their own understanding of the science content. In interviews about the process, the students in Cappello & Lafferty's study indicated that the visuals helped them to remember information and make connections to what they were learning. Lee and Feldman (2015) explored the use of photographs combined with Technology-Enhanced Formative Assessment (in this case, clickers) in a 6th grade unit on the causes of day and night and the seasons. When compared to students taught in a traditional manner, the students in the classes where photographs were used demonstrated fewer misconceptions and developed a larger number of correct explanations about the topic. Additionally, the students in the intervention class with the photographs reported that their use helped them enjoy their experiences in science class. In Eschach's (2010) study of high school physics students and preservice teachers, he found that when students created and verbally interpreted their own photographs, the teacher was better able to assess whether students could apply conceptual ideas about Newton's Third Law to everyday contexts.

Photographing to Bridge the Gap

All three of the authors, Jeff, Leslie, and Rachel, are elementary science teacher educators who work together and collaborate frequently with teachers in the field. Our own experiences and reading of the literature led us to reflect on ways that we could use student-generated photography with the preservice elementary teachers in our classes. We were inspired by Jeff's interest in the intersection of science and photography. As both a middle school and high school teacher, Jeff found that there was great power in he and his students making original photographs to show science disciplinary core ideas in the school environment as well as to document science explorations in the classroom for later review. More recently, he has been using student-generated photography with groups of fifth grade students in a concerted effort to bridge the gap between their hands-on work in science and the ways that same content is covered in a high-stakes end of grade test in science. The process involves shooting images of all student explorations and then using these images to review concepts developed in the lessons and to reinforce vocabulary. In addition to students' obvious delight at seeing themselves in the images and reconnecting to the pleasure of their direct experiences, the images provided an important connection between the concrete and the abstract and significantly improved students' comprehension and retention of ideas. This initial work in K-12 contexts guided our implementation at the college level for similar reasons: helping bridge the gap between concrete and abstract conceptions and preparing our students for a high-stakes content-based licensing exam.

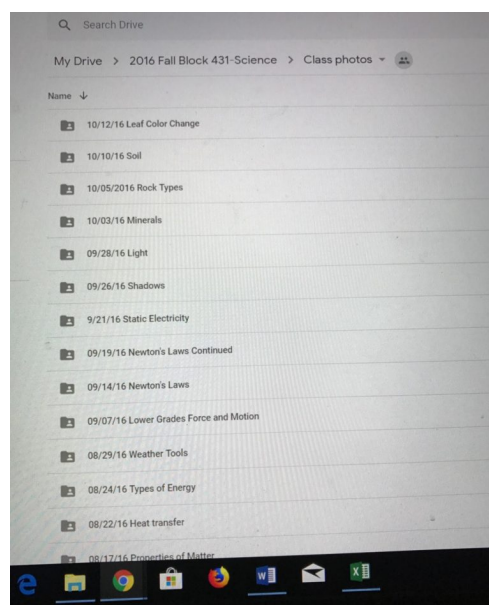
The integration of student-generated photography into our work in college classes initially came about in response to our teacher education students' struggles as they work to strengthen their understanding of the science content they will soon be teaching. Our twice weekly, two-and-a-half hour elementary science methods classes meld the teaching of science disciplinary core ideas with the modeling of teaching strategies. During each class, preservice teachers participate in investigations where they collect and analyze data and connect those direct experiences with accepted scientific understandings. A typical day might involve a 5E lesson on sound in which preservice teachers participate in the Engage phase by trying to identify what object is inside of a closed egg by listening to the sound. In the Explore phase, they might then investigate how a variety of children's instruments produce sound; and using the data from the Exploration, they would then build conceptual knowledge in the Explain phase, discussing the patterns that the students noticed and observing demonstrations to support the idea that sound is produced by vibrations. Finally, students might Expand on their knowledge, using what they have learned to design their own instruments. Throughout the lesson the instructor would Evaluate students' understanding through questioning. In each class session, our preservice teachers have multiple opportunities to engage with science practices advocated for in the Next Generation Science Standards such as analyzing and interpreting data, and engaging in argument from evidence (NGSS Lead States, 2013).

One concern that Leslie had was that students seemed to view the elementary science methods class as fun and engaging, but struggled to connect conceptual science understanding to those direct experiences. That is, their experience of the 5E process gave them a meaningful connection to the subject at hand, but it was less successful at giving them true confidence with the disciplinary core ideas. Leslie was interested in the approach that Jeff had taken in other contexts and began to experiment with using photographs in her class as a way to review science content and to connect it to the investigations her students were doing. Thus, she began to start each class with a photographic review of the science content from the previous session. The first step in the process was to make sure that there were photographs from each class that she could use.

On the first day of class, Leslie was the photographer herself. After explaining the process and allowing students to opt out of having their image taken and shared, she used her phone to take pictures of the investigations in which the students participated. She made sure to include the students themselves in the images that she collected, focusing on both the science content and the social interactions. Each subsequent day in her class, she would assign a student photographer who was responsible for documenting fellow students participating in the day's activities and posting those photographs to a web-based, shared class folder. Not only did this process solve logistical issues, but it created a significant social dimension to the work with images. Leslie created a folder for each of her science methods classes and shared the folder with students using Google Drive. Within that shared class folder was a separate folder labeled "Class Photos." Embedded in the "Class Photos" folder was a folder labeled with the date and topic for each class session. See Figure 1.

Figure 1 (Click on image to enlarge)

Shared Class Google Folder for Storing Images



Once photographs were uploaded into the class site, Leslie went back and chose a couple from each day and developed review questions around the photographs. At the beginning of the next class, she projected these photographs and questions onto the board so that everyone in class could see them. Depending on the photo, there was much laughter when students saw themselves on the “big screen.” Figures 2, 3, and 4 include sample images and questions from a set of lessons on forces and motion (Figures 2 and 3), as well as others from a lesson on identifying minerals (Figure 4). In Figure 2, the student is holding two shoes of different masses to investigate the idea that one of the factors impacting gravitational pull is the mass of the object. In Figure 3, the students are constructing a tool for launching projectiles such as marshmallows or marbles and then collecting data related to what happened when you changed the mass of the projectile or the amount of force that was applied. When students saw the photo of the marshmallow launcher, they immediately began to call out comments such as, “Who were you aiming at Becca?” and “Look at her form, have you been working out?” After the initial excitement receded, the students began to discuss their responses to the questions. In some cases, students discussed their ideas with their small table groups before sharing with the larger class. On some days, rather than developing the questions herself, Leslie projected the photographs, and asked the students to create questions to go along with the images.

Figure 2 (Click on image to enlarge)

Student with Shoes



Explain what Ben is trying to measure with the rubber bands. Why does the rubber band stretch more with the larger adult shoe rather than the smaller kid sandal? Would he get the same results on the moon? Why or why not?

Figure 3 (Click on image to enlarge)

Student Launching Marshmallow



What happened when Becca pulled her balloon back a small amount and launched her marshmallow? What about when she pulled it back a large amount? Why do you think the results were different?

Figure 4 (Click on image to enlarge)

Student Testing Minerals



Explain what Shannon is doing in this picture. What other tests could she do to help her determine which mineral she is holding?

Serving Multiple Purposes

Based on Leslie's success, Rachel began using a similar technique and noticed that in the context of the teacher education environment, the photographs and questions were serving multiple purposes. Certainly, they were functioning as a tool to help preservice teachers think about the investigations that they had participated in and how those activities linked specifically to the science disciplinary core ideas they addressed. Additionally, these verbal discussions were providing an opportunity for students to revisit and check their own understanding in a supportive environment. If a student was still uncertain about an idea, the discussion could provide a space for further clarification. In some cases, students even went back and redid a portion of the activity as they recognized their own incomplete understanding. Both Leslie and Rachel have found that properties of matter and phase change are topics that require revisiting, and the photographs of these experiences prompt students to see the limitations of their understanding. For example, as a follow-up to our photo-based questions, we frequently redo the cloud-in-a-bottle demonstration and connect our photographs of other explorations such as the air pressure can crush to help students build a more robust understanding of a range of related content.

In addition to the opportunity to clarify content, there were multiple affective benefits of the photographs that were no less significant. For example, the photographs enabled the students to see themselves as successful and engaged scientists, and the images of the Explore phase of the 5E reinforced the importance of beginning all science learning with experiences in the physical world. Additionally, students connected these images of themselves doing science to the social pleasure they experienced in the classroom, thus building a positive emotional context for science in their own lives. It is our strong hope and belief that these upbeat emotions will lead to more and better science teaching in their future classrooms.

As the final exam approaches, we use part of one class to go back through the photographs from across the semester to have students review what we were doing in each photo and what science content is connected to the images. The students then create review questions that are connected to the images that they share in the class Google Drive Folder. When Jeff does this review with his students, he also prints some photographs in hard copy to give students a tactile connection to the most representative images of each core scientific process studied. He feels that in the age of omni-present digital imagery, making physical copies of certain photographs helps highlight these images as especially valuable. The students commented that the review sessions helped to relieve their anxiety because they

realized that, having hung information on mental images, they could remember much of the content. From our perspective as teachers, this form of exam review serves the dual purpose of helping our students reexamine the content and modeling an approach to content review that does not resort to worksheets as the only option.

Hearing Student Perspectives

In an interview after the semester when she was asked about the daily review questions, one elementary preservice teacher commented that she liked the process, “because it helped us really prioritize things from the lesson that [the teacher] really wanted us to get out of it.” Another student discussed the idea that viewing the photographs at the beginning of class helped to “refresh our minds of the experiments and of the 5E.” A different student reflected on the difficulty for students because of the number of classes that they took and the amount of material addressed in each. She stated, “with all of our other classes and all of our other work, it was kind of hard to remember specific details of things in any class, and having the pictures really helped us be like, ‘okay, yeah, I really remember this, that was so much fun.’”

As we have reflected on the success of using photography in our courses, we have been intrigued by the connection between students’ experience of community and their acquisition of content. For example, as she described what it was like to go around the room to take the photographs, one student stated, “We had to intersperse to get pictures of everybody...and that is how we really got to talk to people and get to know them.” In our classes, photographs became a mechanism for creating a community of friends — and a community of science explorers. For example, one student stated:

when you’re going back and looking at the pictures of us doing silly experiments, I did kinda laugh a little bit. Like at the one where you have to blow a feather out of a straw, that’s a funny picture.

For students, it was fun to take the pictures and then to refer back to them later, as the daily review photographs helped us share laughter and understanding when we looked at them as a class.

Creating Resources for Teaching

One of the other courses that Jeff teaches is a course on Elementary STEM Education called *Build It!* In this course, he uses photographs in a similar way to the science methods course, though he focuses less on content review and more on helping students build a personal resource using images of themselves and their classmates engaged in a variety of STEM challenges. Each student in this class is responsible for creating a website detailing materials, processes, and underlying scientific principles that animate the many artifacts they create in the course, such as self-propelled vehicles and musical instruments. These websites contain original images of their work in class and thus will serve not only their

developing science understanding now, but also as a reference in their future classrooms. For example, their webpages on building “slow-coasters” include materials, close-up photographs of construction techniques, and explanations of related force and motion content — everything they will need to lead their own future students in this activity.

Both in the case of the *Build It!* students’ web pages and the photo resources developed in our science methods classes, student buy-in is high, as they see the work with photography as beneficial to their development as professionals. In particular, our preservice teachers come to us with a great deal of anxiety about both their content knowledge in science and their ability to lead engaging lessons in a science classroom. The photographs they create and use in Leslie and Rachel’s classes provide them with mental images of concepts and classroom experiences rich in the use of science practices to which they can refer in the years ahead. Additionally, the teaching with photography techniques we are modeling give them new tools to use with their future students. The examples we share from the impetus of the project — the successful use of this approach in K-12 classrooms — serve as an inspiration for their own teaching and lifelong learning. The *Build It!* class website in particular has served as a valuable resource for teacher candidates as they apply for their first teaching positions. A number of students have commented that they used the website they developed in *Build It!* to support their presentations and conversations about their potential teaching strengths as they interview for positions.

Facilitating the Use of Photographs in a Science Methods Class

As we reflected on our experiences over several years, we have generated a list of tips that we feel may be beneficial to others who may want to try ideas we have mentioned here:

- Have a shared electronic space for files. It is useful to have a shared space, such as Google Drive where class photographs are stored and shared. Students and the instructor can be producers and consumers of images if the photographs are uploaded to a shared space.
- Let students know at the beginning of the course that instructors and peers will take photographs of class activities. Students should be allowed to opt out if they are not comfortable with the use of their images.
- Involve students in taking the photographs. This step is important both because it increases the sense of connection and ownership that the students feel to their class experiences and because it gives them practice working with photographs as they will as teachers.
- Encourage students to take photographs from multiple perspectives. It is helpful to have shots that show what is happening from a variety of views, including extreme close ups and wider angle shots showing the whole scene. For example, when students photograph an investigation in which they explore the idea of convection using tanks of water and food coloring in baby food jars, it is beneficial to show a picture of the whole tank, as well as a close up image of each baby food jar. See Figure 5.

- Include people in most of the images. The community benefits of using images are enhanced if images of the explorations include people's faces.
- Finally, if you are planning to use the photographs primarily as a content review, it is helpful if you can print them in some format, whether on photo stock, or simply as images on printer paper. This step allows for the tactile connection to images as well as the ability to have students easily quiz one another about the content of photographs.

Figure 5 (Click on image to enlarge)

Students Observing a Model of Convection



Reflecting on Photographs as a Teaching Tool

In his essay on the importance of visual thinking, Arnheim (1980) laments what he sees as a false dichotomy that has been created between visual perception and thinking. He points to the importance of the interaction between the two. In our experience, photographs are a tool that can help students document and make sense of their experiences in the context of a science classroom and can support them as they develop a richer understanding of the content. Specifically, the photographs allow students to manifest their thinking visually and then to use the photograph as a bridge between the concrete experience and the abstractions of conceptual understanding.

As mentioned in Hoisington (2002), our students found that taking and reviewing the photographs helped them to remember the science investigations in which they participated. Additionally, the photographs cemented memories so that they could become tools in future thinking activities. Similar to Cappello and Lafferty's (2015) experience in a fourth grade unit on minerals, in our classes, the student-generated photographs served the function of enabling students to step back and reflect on the experience and helped them to see where they might have incomplete understandings. Thus, the photographs prompted students to engage in metacognitive thinking related to each experience.

When used intentionally, the photographs also served as a tool for assessment (Capello & Lafferty, 2015; Eschach, 2010) because they enabled both us and our students to check for understanding of science content on a regular basis. Because the brief review sessions happened daily, we could determine whether we needed additional discussion or modeling on a topic before moving on to something else. In one example, Jeff discussed that when students could not explain what was happening in an incident where a car on the tallest ramp did not go the farthest even though it had the largest amount of potential energy (the car had crashed rather than rolling), he and his students realized he needed to “do more teaching.” Indeed, viewing that particular photograph elicited students calling out, “Wait. What? Can we go over that again?”

While our use of photographs was largely to document investigations and not as tools of direct observation, we agree with Lee and Feldman (2015) that photographs can be used as a valuable tool for supporting focused student examination of specific scientific phenomena. Thus, an ancillary benefit of our photographs was that we could re-observe specific incidents or moments in time. Like the preschool students in Britsch’s (2019) study, our preservice teachers used the cameras to focus their attention on aspects of the investigations that resonated with them. We were able to use these images later to focus the whole class’ attention on particularly relevant incidents within the investigations.

Since the invention of photography, photographic imagery has been used as documentary evidence that an event happened. Katz (2011) noted the possibility that having a child review a photograph in which he was depicted “as capable explorer” may help him to internalize that characteristic and support the development of an identity as a scientist. One notable similarity between our experience in our classes and other research published on the topic is the potential for photographs of students engaging in scientific work to serve as a scaffold for developing an identity as a successful science learner. Because our students were engaged in investigations in the photographs, they had images that supported their sense of themselves as scientists.

Lee and Feldman (2015) note that the use of photographs encourages wide participation and a sense of community in the classroom. Our work builds on this idea of science as a social endeavor, as students build community around images of classmates and their instructor doing science. It is significant that we are not relying on images created by others. Viewing oneself and one’s peers in the images elicits laughter and extends the sense of fun that was present in the original investigations. We trust that this experience will translate into our students leading joyful science classrooms in the years to come.

Conclusion

As we reflected on the use of student-generated photographs in our science teaching, we were excited to recognize the many benefits. In addition to the valuable learning opportunities provided by using photographs for science teaching, four words came

to mind: easy, cheap, enjoyable, and transferable. Using photographs in the ways that we have described requires no equipment beyond a cell phone, does not require advanced technical skills, leads to student engagement, and allows preservice teachers to imagine themselves using the strategy in their own future classrooms. This approach is not radical, but it is finally easy to implement this strategy due to the ubiquity of cloud storage and cell phone cameras as a part of students' everyday practices. In essence, we are transferring our students' habitual documentation of their lives with their phones to a learning purpose and leveraging their enthusiasm for photography towards greater attention to science experiences. Our approach is supported by a research base that the use of photographs helps students learn, and we have tested it in our own preservice and K-12 classrooms. What are you waiting for?

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