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*The Impact of Hands-on Environmental Science Lessons on Middle School Students Learning*

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Spring 2023  
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## *Abstract*

This capstone research focuses on the impact of hands-on environmental science lessons on middle school students learning. In this research project, besides conducting an extensive literature review, I collaborated with five middle school educators in a local school district to understand how student engagement and retention are affected by hands-on science material and surveyed 151 7th-grade students. This senior capstone explores the individual experiences of middle school students, their relationship to science education, and possible future implications of their learning. Many aspects of a student's personal and educational life can positively or negatively impact their relationship with science and their interaction with the natural world. The result findings indicate that providing meaningful hands-on environmental science lessons with relevant content and instructions could make a long-lasting impact on middle school students.

## *Introduction and Background*

The modern world is experiencing a time of uncertainty and unprecedented change that the human species has never lived through before. This era of history is critical in defining the fate of our planet as we know it and all of humanity. As we try to navigate and mitigate the damages caused by our self-induced changing climate, the younger generations are inheriting an unpredictable environment and planet. There is a growing and consistent need for the world's youth to be conscious and acutely aware of how human activity affects the world's environment.

Middle school students are at an especially impressionable age. Exposure to environmental science can help them develop a sense of stewardship for the environment by providing the knowledge and skills that enable them to understand the natural world and their role in it. Environmental science education can foster a sense of connection to the environment as students learn about the intricate relationships between humans and the natural world. Exposure to environmental science can also encourage students to engage in hands-on, experiential learning opportunities, such as outdoor activities and environmental projects. By working on such projects, students develop a deeper understanding of environmental issues and gain practical skills to apply to real-world challenges. They can also create a sense of ownership and responsibility for their local environment, leading to a desire to protect and preserve it. One example of an organization working on hands-on outdoor activities and environmental projects is LifeLab.

LifeLab is an organization founded in Santa Cruz, California, that works to “cultivate children’s love of learning, nourishing food, and nature through garden-based education” ([lifelab.org](http://lifelab.org)). The institution collaborates with school districts that develop their own gardens, which they use as a center for outdoor, culinary, and nutrition education. LifeLab also works to

provide workshops and consultations to educators across the country, to bring the essence of the program to their local schools and communities. These outdoor education programs can positively impact students' environmental understanding and awareness.

According to a study from the International Journal of Environmental and Science Education, outdoor education can improve students' knowledge and attitudes toward the environment (Liu & Chen, 2017). The study found that outdoor education programs increased students' understanding of environmental issues and the interconnectedness of natural systems. Additionally, students who participated in outdoor education had more positive attitudes toward the environment and a greater sense of personal responsibility for its protection. These findings suggest that outdoor education can effectively promote environmental literacy and foster a sense of stewardship for the natural world.

To better understand how students engage and respond to learning about the environment and human impacts on it, my primary research question is: How do hands-on environmental science lessons impact middle school students learning? My related secondary questions include: What is environmental science, and what does it entail? How has it evolved over time? What do the state standards and/or the common core standards say about teaching environmental science to middle school students? What does the research say about the impact of hands-on environmental science lessons on middle students? How do teachers implement hands-on environmental science lessons for middle school students in the classrooms? To what extent do they engage students' learning? According to teachers, how do hands-on environmental science lessons impact students' learning inside and outside of the classrooms? Lastly, are there resources available for teachers should they want to implement more hands-on environmental science lessons for their middle school students? If there are, what are they?

### *Literature Review*

Environmental education in middle school is crucial as it helps students to understand the complex relationships between humans and the natural world. It gives them the knowledge and skills to become environmentally literate citizens who can make informed decisions about the environment and its resources. Moreover, environmental education creates opportunities for students to engage in hands-on learning, which promotes critical thinking and problem-solving skills that can be applied to real-world environmental challenges.

In addition to educational benefits, environmental education in middle school has significant social and personal benefits. It promotes civic engagement and encourages students to protect the environment in their communities and globally. Furthermore, environmental education fosters a sense of responsibility and stewardship for the environment, which can contribute to personal growth and well-being. Educators can help create a generation of environmentally conscious and responsible citizens equipped to address environmental challenges and work towards a sustainable future by instilling environmental values in students at a young age.

### *The Essence of Environmental Science*

Environmental science is a multidisciplinary subject that studies the environment and its various elements, including biological, physical, and chemical factors. This branch of science is concerned with understanding the natural world, how it functions, and how human activities affect it. Environmental science draws from various fields, including biology, chemistry, physics, geology, and ecology. Environmental education is the process of educating individuals about the natural world and how it works, including how human activities can impact the environment. It seeks to promote environmental awareness and encourage individuals to take actions that will

reduce their impact on the environment. Environmental education can take many forms, including traditional formal classroom instruction, experiential learning, and community outreach.

The importance of environmental science and environmental education cannot be overstated. Today, the world faces numerous environmental challenges, including climate change, loss of biodiversity, and pollution, among others. These issues have far-reaching consequences for human, animal, and plant well-being, the economy, and the planet's overall health. Therefore, understanding the impact of the environment and human activities is crucial for developing sustainable and long-lasting solutions to these challenges.

Environmental science and education are critical in promoting environmental literacy and fostering sustainable behavior. A study by Djenontin and Meadowcroft (2010) found that environmental education can increase awareness, knowledge, and motivation to act sustainably. The authors argue that environmental education can empower individuals to become agents of change and contribute to the transition to a sustainable society.

Environmental science has also made significant contributions to our understanding of the environment and the impact of human activities on it. For example, studies on climate change have shown that human activities, mainly burning fossil fuels, are the primary drivers of global warming. This understanding has led to the developing of policies and strategies to reduce greenhouse emissions and mitigate climate change impacts.

Furthermore, environmental science has contributed to developing technologies that help humans address environmental challenges. For instance, advances in renewable energy technologies have made it possible to generate electricity from sources such as wind and solar power, reducing the reliance on fossil fuels. Similarly, innovations in waste management

technologies have made recycling and reusing waste materials possible, reducing waste sent to landfills and promoting a circular economy.

Therefore, environmental science and environmental education are critical components in addressing the environmental challenges facing the world today. Through environmental education, individuals can gain the knowledge and skills necessary to become change agents and contribute to a more sustainable future. On the other hand, environmental science provides the scientific understanding and technological solutions necessary to mitigate human activity impacts on the environment. Therefore, both fields must work together to promote sustainable development and create a more resilient planet for future generations.

### *Environmental Science in Middle Schools*

Environmental education prepares students to understand and address environmental challenges. In California, the State Board of Education adopted the Next Generation Science Standards (NGSS) in 2013, which include environmental literacy as a critical component. The standards emphasize the importance of interdisciplinary integration integrating science, engineering, technology, and mathematics (STEM) with social studies and English language arts. This synthesis will explore the current California environmental education standards for middle school students and the impact of these standards on student learning and engagement.

The NGSS standards integrate environmental education into the science curriculum by emphasizing the importance of understanding ecosystems, the impact of human activities on the environment, and the need for sustainable solutions. The standards are designed to provide students with the necessary skills and knowledge to address environmental challenges, including biodiversity loss and climate change. The standards also emphasize promoting scientific literacy and engaging students in hands-on, inquiry-based learning.



The research has indicated that the NGSS standards are having a positive impact on student learning and engagement. A study by Truitt and Ritter (2020) found that students who participated in an NGSS-aligned environmental education program demonstrated increased knowledge and understanding of environmental concepts. The study also found that the program improved students' critical thinking and problem-solving skills and increased their motivation to learn about environmental issues. Another study by Nardone et al. (2019) found that NGSS-aligned instruction increased environmental literacy and engagement among middle schoolers. The study founds that students who participated in NGSS-aligned instruction demonstrated a greater understanding of environmental issues and were more likely to engage in pro-environment behaviors.

Furthermore, the NGSS standards have encouraged the development of innovative instructional practices that integrate STEM with social studies and English language arts. For example, Kinzler et al. (2019) explored science journalism to promote environmental literacy and engagement. The study highlighted that students who participated in a science journalism program demonstrated increased knowledge of environmental issues and were likelier to engage in pro-environmental behaviors.

In conclusion, the NGSS standards have positively impacted environmental education in California middle schools. The standards emphasize the importance of interdisciplinary instruction and hands-on, inquiry-based learning, which have been shown to improve student learning and engagement. The standards have also encouraged the development of innovative instructional practices that integrate STEM with social studies and English language arts, such as science journalism. As California continues to prioritize environmental education, it is essential

to build on the successes of the NGSS standards and continue to innovate the field of environmental education.

### *Exposure to Environmental Science & Student Attitudes*

Exposure to environmental science can significantly impact middle school students' attitudes toward the natural world. Through environmental education, students gain knowledge and understanding of environmental issues, which can lead to increased appreciation and respect for the natural world. This section will explore how exposure to environmental science affects middle school students' attitudes towards the natural world, drawing from peer-reviewed academic sources.

Exposure to environmental science can increase students' awareness of environmental issues and the impact of human activities on the natural world. This awareness can lead to a greater appreciation of the importance of conservation and sustainability. According to a study by Nardone, Osborne, and Monk (2019), middle school students who participated in Next Generation Science Standards-aligned instruction demonstrated increased environmental literacy and engagement. The study found that students who better understood environmental issues were more likely to engage in pro-environmental behaviors.

Additionally, exposure to environmental science can promote a sense of responsibility and agency in students. Students who learn about environmental issues are more likely to feel empowered to take action and make a positive difference. According to a study by Skelton et al. (2018), middle school students participating in a community-based environmental education program demonstrate increased environmental action. The study found that students who learned about environmental issues and had opportunities to take action were also likely to participate in pro-environmental behaviors.

Furthermore, exposure to environmental science improves students' critical thinking and problem-solving skills. Students who learn about environmental issues are challenged to think critically about complex problems and develop innovative solutions. According to a study by Huang et al. (2018), middle school students who participated in an environmental education program demonstrated increased problem-solving skills and creativity. The study found that students who engaged in hands-on inquiry-based learning were more likely to develop problem-solving skills.

Finally, exposure to environmental science can improve students' overall well-being. Studies have shown that spending time in nature can reduce stress and improve mental health. According to a study by Zelenski and Nisbet (2014), middle school students who spent time in natural settings demonstrated increased well-being. The study found that students exposed to nature were more likely to experience positive emotions and reduced stress.

In conclusion, exposure to environmental science can profoundly impact middle school students' attitudes toward the natural world. Through environmental education, students gain knowledge and understanding of environmental issues, which can lead to increased appreciation, respect, and responsibility for the environment. Students who develop an appreciation for the natural world are more likely to take action to protect it and experience improved well-being. Therefore, it is crucial to continue promoting environmental education in middle schools to ensure that future generations have the knowledge and skills to address environmental challenges.

### *Methods and Procedures*

At the start of this semester, I was still determining what research question I wanted to pursue as the motif of my senior capstone project. When considering what I wanted to choose as

my topic, I examined what I am passionate about and how that could connect to education somehow. One thing that is a constant theme in my life is stewardship and conservation. My gratitude and love for the Earth and the animals that call it home are fundamental to who I am. With this self-knowledge and my minor at school being Environmental Studies, I started gathering a general idea of what I wanted to focus on. After completing my Prospectus Draft and meeting with Dr. Paoze Thao on Friday, February 3, 2023, I narrowed down the essence of my project and could begin my research.

Once I had my primary and secondary research questions, I began looking through different sources and the CSUMB library database for peer-reviewed academic articles and journals that could help answer these questions. I wanted to examine the existing literature and how the findings from my data could aid in some unanswered questions about environmental education and student retention and response. To do this, I compiled a collection of different sources that I believed would help answer my research questions, and then I reached out to some professionals in the field to gather my data.

The next step was contacting current sixth through eighth-grade teachers to discover how hands-on environmental education impacts middle school students learning and retention. I am interested in eventually teaching at the middle school level, so I chose to focus on this age group. Before beginning my research, I had heard of a local organization called LifeLab, a garden-based education program. I was interested in learning more about this program and if it can be adapted for the older grade levels. Currently, LifeLab is only working with K-5 grade students. To do this, I emailed various teachers and principals in my local school districts, intending to interview one principal whose school has a LifeLab program, one seventh-grade science teacher, and one

eighth-grade science teacher. Each interview was a series of ten open-ended questions lasting under 30 minutes.

After researching and contacting multiple school teachers and principals, I interviewed three seventh-grade science teachers (Appendix A) and one elementary school principal (Appendix B). One interview with a seventh-grade science teacher was conducted through email response because this teacher did not have time to meet for a phone interview. Two interviews were completed via Zoom meetings; the last was over the phone. In addition to the educator interviews, I prepared an anonymous student survey using Google Forms to gauge student attitudes and perceptions of Environmental Science and its role in their lives (Appendix C). These student surveys were also ten questions, the majority of which were open-ended. Two of the seventh-grade science teachers that I interviewed passed on the link to the survey to the various sections of their classes, which led to a significant amount of interaction. In total, I received 151 responses from seventh-grade students. Compiling peer-reviewed academic research, educator interviews, and student surveys, I gathered a deep understanding of environmental science in middle schools and consequently answered all of my original research questions.

### *Results and Discussion*

The findings from this research indicate that environmental education and hands-on activities can enhance environmental understanding and awareness among students. Hands-on education is essential for students to connect and internalize the content they are learning in school. These hands-on lessons have become essential in promoting environmental education and awareness among middle schoolers. Recent research has shown that these activities can positively impact students' behavior, knowledge, and attitudes toward the environment. The

results from this project indicate that hands-on environmental science programs can lead to increased knowledge and understanding while fostering critical thinking skills and problem-solving abilities. Hands-on environmental science lessons offer an engaging and interactive way to promote environmental education and empower the next generations of environmentally conscious citizens. By providing opportunities for students to connect with nature and engage in hands-on activities, educators can help cultivate a greater appreciation and respect for the environment and inspire students to actively protect the planet for future generations.

*What does the research say about the impact of hands-on environmental science lessons on middle students?*

Recent research suggests that hands-on environmental science lessons can positively impact middle school students' environmental attitudes, knowledge, and behaviors. A study published in the *Journal of Environmental Education Research* found that students who participated in a hands-on environmental science program improved their environmental attitudes and behaviors more than students who did not participate (Zhang & Chai, 2021). Similarly, student survey responses indicated that 68% of seventh graders who participated in the study reported that they thoroughly enjoyed hands-on science activities.

Another study published in the *Journal of Environmental Education* found that hands-on environmental science activities can increase environmental knowledge and understanding among middle school students (Bae, Lee & Choi, 2020). The study also found that these activities can help develop students' critical thinking and problem-solving skills. One seventh-grade teacher interviewee described the hands-on activities that the students do in class as a hook to hang knowledge. They said, "... it is really what students remember the most... it is

a hook for them to hang knowledge on because they remember the game or activity, and then they have that ah-ha moment...it gives me a clue to help them go back and remember things” (Teacher B, Personal Communication, March 14, 2023.) Compared to traditional lecture-style classroom lessons, hands-on activities help students recall and retain information better than they would simply practicing repetition and writing notes.

Furthermore, a study published in the International Journal of Science Education found that hands-on environmental science lessons can help to foster a sense of responsibility and stewardship among middle school students. The study demonstrated that students who participated in hands-on environmental science programs, such as LifeLab, showed a greater understanding of their role in protecting the environment and a greater willingness to take action to address environmental problems (Park & Kim, 2019). These sources, and the educator and student data collected through this research project, suggest that hands-on environmental science lessons can significantly impact middle school students’ attitudes, knowledge, and behavior related to the environment. By providing students with engaging and interactive opportunities to learn about the environment, educators can help to cultivate a new generation of environmentally conscious and responsible citizens.

*What is environmental science education, and what does it entail? How has it evolved over time?*

*What do the state standard and/or the common core standards say about teaching environmental science to middle school student level?*

Environmental science education is a field of study that focuses on the scientific study of the environment and its interrelationships with human society. Over time, environmental science education has evolved to reflect changes in society’s understanding of the environment and its relationship to human activities. In the early days, environmental science education was focused

primarily on natural history and ecology, with a narrow focus on the impacts of human activities on the environment. However, in the 1960s and 70s, the environmental movement brought about a new awareness of the negative impacts of human activities on the environment. This led to a shift in the focus of environmental science education toward studying environmental issues, such as pollution, resource depletion, and climate change, and their impacts on the environment and human health.

Even more recently, environmental science education has continued to evolve to reflect the growing awareness of the significance of sustainability and the need to reduce human impact on the environment. This has led to an increased focus on sustainability and the development of sustainable practices in various fields, such as agriculture, energy, and transportation.

Additionally, there has been an increased emphasis on the importance of an interdisciplinary approach to environmental issues, recognizing that studying the environment involves a complex web of interactions between natural, social, and economic systems. One seventh-grade teacher mentioned they would like to see this integration at a larger scale, “I would like to see [environmental education] evolve to be more integrated. I think that it should not just be about science...if we are talking about environmental science in science class, why is the humanities class not also reading a book about it...also, why isn’t the math class doing a graphing activity about it?” (Teacher C, Personal Communication, March 16, 2023).

Overall, environmental science education has evolved from a narrow focus on natural history and ecology to a more comprehensive study of environmental issues and their impacts on the environment and human society. As the understanding of the environment and its challenges continues to evolve, so will the field of environmental science education. Through this research and discussion with current educators, it became apparent that the California state standards for



science education must reiterate arguably the most relevant and essential topic, global climate change. As mentioned in one of the educator interviews, “Given what is happening with our environment and climate change, I wish that there was a standard for every grade level to be retouched on...so that kids are reminded every year” (Teacher B, Personal Communication, March 14, 2023). Most educator interviewees mentioned they would like to see their curriculum adapted to incorporate more discussion on current environmental phenomena.

While the California Next Generation Science Standards have been praised for their emphasis on environmental literacy and sustainability, they have been criticized for their lack of attention to climate change topics among middle school grades. According to a study published in the *Journal of Geoscience Education*, the California NGSS fail to adequately address climate change and its impacts on the environment in the middle school grades (Monahan et al., 2018). The study found that climate change is only mentioned briefly in the middle school standards, and the treatment of this topic is superficial and lacks detail. This is concerning because middle school students are at an age where they can begin to understand the complexity of climate change and its implications for the future. They should have the knowledge and skills to address this global challenge. The lack of emphasis on climate change is a missed opportunity to educate the next generation of environmentally literate citizens responsible for addressing this critical issue.

*How do teachers implement hands-on environmental science lessons for middle school students in the classrooms? To what extent do they engage students' learning?*

Every middle school science teacher that participated in this research study implements their unique variants of hands-on environmental science lessons. One teacher emphasized that they “... try for every concept we teach to do a hands-on activity with it” (Teacher B, Personal

Communication, March 14, 2023). These activities include things such as a tag game to talk about population cycles, a fishing game to discuss conservation and overfishing, going outside and laying transects, taking dirt samples and looking at nematodes in the soil, and much more, as one teacher noted, “They [the students] love being outside and learning about the natural world” (Teacher A, Personal Communication, March 14, 2023). Middle school students enjoy working and engaging with hands-on environmental science, especially when they can relate it to their lives and communities.

All the educators in this study agreed that hands-on learning is much more engaging for their students than memorization and note-taking for assessment prep. However, some lesson content is more significant to students than others. In the survey responses, students indicated that climate change is one of the science topics most important to them. Out of 151 student surveys, 76 percent of students reported that learning about the environment and climate change is imperative. One teacher explained, “I would like climate science to have more meaningful solutions for students. I think that it tends to run very doom and gloom, which is often what students take away. Many of my students do not have control over whether they are driven to school or bike, so telling a thirteen-year-old to drive less really is not a helpful solution to addressing the climate issue...telling them to write to their representatives they did not vote for...these solutions are not meaningful for students” (Teacher C, Personal Communication, March 16, 2023). The more the environmental science content is relevant to students, the more they can engage and interact meaningfully.

*According to teachers, how do hands-on environmental science lessons impact students’ learning inside and outside of the classrooms?*

The educators that participated in this capstone project all provided examples of how hands-on environmental science lessons have positively impacted their student's learning, both inside and outside the classroom. LifeLab is an excellent example of an educational program promoting hands-on environmental science through a garden and culinary education. When asked about student engagement with LifeLab, administrator Principal X said: "They love LifeLab. I see 100 percent engagement among all students, all classes... whether it is in the kitchen or the garden, they just absolutely love it... it is really exciting" (Personal Communication, March 23, 2023). When asked how these hands-on activities might affect students outside the classroom, she gave a specific example of one student. In response to the LifeLab activities at their elementary school, "One student said, "I feel like when I am helping the garden, I am helping the whole world." That is a beautiful statement. There is a lot to that statement, that child has student agency about their role in the school, as well as their connection to the whole world around them" (Principal X, Personal Communication, March 23, 2023). This articulation provides significant insight into how students internalize the hands-on environmental science content they are exposed to.

During the interview process, Teacher B provided another example of how her students have internalized the content they are learning in their seventh-grade Life Science class. This teacher has added a recycling and plastic use unit to her curriculum. In this particular unit, the students participate in an activity where they are asked to keep track of their family's plastic use at home. The students keep a monthly tally of their recyclables, intending to reduce the amount of plastic in their family's garbage cans. Teacher B noted, "By open house in May, parents have responded that their children had them buying plastic alternatives at home" (Personal

Communication, March 14, 2023). This is another example of how students translate their teachings from school into everyday life.

*Are there resources available for teachers should they want to implement more hands-on environmental science lessons for their middle school students? If there are, what are they?*

Many resources are available for teachers and educators who may want to implement more of these hands-on environmental science lessons for their middle school students. One of these resources is the National Environmental Education Foundation (NEEF). NEEF provides educators free resources, including lesson plans, activities, and professional development opportunities. Their website also features a searchable database of environmental education resources, which can be filtered by grade level, subject, and topic. Another resource for educators is the Environmental Protection Agency (EPA). The EPA's comprehensive website contains resources for educators, including lesson plans, activities, and multimedia resources. Their website also features information on professional development opportunities and grants for environmental education projects.

Another couple of resources available for teachers looking to implement more hands-on environmental education in their curriculum are Project Learning Tree (PLT) and the North American Association for Environmental Education (NAAEE). Project Learning Tree is a program of the American Forest Foundation that provides environmental education resources for pre-K-12 educators. Their resources include curriculum materials, workshops, and more professional development opportunities. PLT also offers a certification program for educators who complete their training. The NAAEE provides various resources for educators, including lesson plans, activities, and research articles. Their website also features a database of

environmental education programs and organizations, which can be filtered by location and type of organization.

These references are just a few examples of the many resources available for teachers who want to implement more hands-on environmental science lessons for their middle school students. As noted in one teacher interview, “...hands-on [activities] is what inspires students to want to learn more and to have a long-term relationship with enjoying science as a subject” (Teacher A, Personal Communication, March 14, 2023). By using these resources and more, educators can help to inspire a new generation of environmentally conscious and responsible citizens.

Through this research on various avenues of hands-on environmental science education, and its impact on middle school students, there is some clarity on the primary question of this research project, *How do hands-on environmental science lessons impact middle school students learning?* The data from the academic literature review, student surveys, and educator interviews all highlight the importance and value of hands-on environmental science lessons. This kind of instruction benefits middle school students by prompting them to think critically, problem-solve, and develop a sense of stewardship and responsibility for the planet. Hands-on environmental science lessons offer an engaging and interactive way to enhance environmental understanding and awareness among students.

### *Recommendations*

Therefore, while following the NGSS standards, middle schools should continue implementing hands-on activities focusing on environmental science education. I strongly urge middle school administrators and educators to connect with a local community-based organization focusing on hands-on environmental content and learning. The benefits of these

programs and the outcome for the students exposed to them are far-reaching. In regards to bringing new programs that focus on hands-on environmental learning, Principal X says, “I think that all of the [LifeLab] lessons could easily be adapted to [middle school] grades. I think that the kids... love being connected to the Earth...I think it very easily can happen. I think you start with the [NGSS] standards for that grade and look at what opportunities could be available...start with the standards and bring them to life” (Personal Communication, March 23, 2023). I also recommend that middle school environmental science curricula provide students with meaningful and appropriate solutions to climate change to prevent students from feeling hopeless or depressed in the wake of a massive consequence they have had little to contribute.

### *Problems and Limitations*

Throughout the data collection for this project, I learned a lot about the local science programs in my local school system and how students internalize that material. One of the significant challenges of this project was finding willing participants to collect data. Out of the seven elementary school principals I emailed, I only heard back from three of them. Those three principals who responded were critical in connecting me to teachers at their school and helping me gather the data for my project. School A and School C’s principals connected me with their seventh-grade teachers. Originally I had hoped to interview at least one sixth-grade and one eighth-grade teacher. This is because the one interviewee I know personally and have already associated with, Teacher B, is a seventh-grade teacher. Due to this, the scope of my data collection could have been expanded. If I had connected with a sixth-grade or eighth-grade teacher, my data would have been more diverse and comprehensive. This would have allowed me to examine how attitudes toward environmental science education differ among each middle school grade.

Originally I had hoped to get survey responses from sixth, seventh, and eighth-grade students. However, only the teachers I connected with could pass along my survey to their students, so my survey sample group was all seventh-graders. Due to this, the scope of my data collection was limited. The data group could have been expanded had there been more time for the research project. If I had connected with a sixth-grade or eighth-grade teacher, my data would have been more diverse and comprehensive. This would have allowed me to examine how attitudes toward environmental science education differ among each middle school grade rather than just one grade group.

### *Conclusion*

This project taught me much more about environmental science and education than I anticipated. The individual interviews I conducted with the teachers provided crucial insight into how environmental science content is applied and taught in the classroom. By providing hands-on experiences that allow students to engage with nature and understand the impact of human actions on the environment, educators can inspire the next generation to become advocates for change. Furthermore, integrating environmental education in the middle school curriculum can enhance academic achievement across multiple subject areas, providing students with a well-rounded education relevant to the 21st century. Moving forward, it is essential to continue to invest in hands-on education in middle schools and work towards building a more sustainable and resilient future for all.

As the importance of environmental sustainability continues to grow, hands-on environmental science education is becoming increasingly crucial for middle school students. In today's world, there is a pressing need to develop environmentally literate citizens with the knowledge, skills, and attitude necessary to address complex environmental issues. Hands-on

environmental science lessons allow students to learn about these issues tangibly and experientially, which can lead to deeper understanding and engagement. In the future, it is clear that integrating hands-on environmental science education in middle schools will play a vital role in promoting environmental sustainability and preparing the next generation of environmentally conscious citizens. By providing students with the tools and knowledge needed to make informed decisions about the environment, educators can empower them to take action and positively impact the planet.



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## Appendixes

### Appendix A: Teacher A, B & C Interview Questions

1. At what school do you teach?
2. What grade level do you teach?
3. What kinds of topics are covered in your curriculum?
4. How have the state standards for science changed throughout your teaching career?
5. What kinds of environmental science content are covered in your curriculum?
6. How do students respond to learning about environmental science topics?
7. What kinds of hands-on lessons do you incorporate into your curriculum, if any?
8. To what extent do hands-on science lessons engage students learning compared to lecture-style lessons?
9. How do these lessons impact your students' learning? Inside the classroom, at home?
10. How would you like to see environmental education in middle schools evolve?

### Appendix B: Principal X Interview Questions

1. At what school do you work?
2. How long have you worked at your current school?
3. What is Life Lab?
4. How did your school become a Life Lab Partner School?
5. How do your students engage with the Life Lab Science Lessons?
6. How do hands-on environmental science lessons impact students' learning inside the classroom?
7. How do hands-on environmental science lessons impact students' learning outside the classroom?
8. How do you think Life Labs could be adapted to be incorporated into the upper grades of middle school (seventh and eighth grade)?
9. What resources are available for educators who want to implement Life Lab in their schools?
10. How would you like to see environmental education evolve?

#### Appendix C: Student Survey

1. What is your favorite kind(s) of science activities?
2. What have you learned about the environment in school this year?
3. How does learning about the environment influence your feelings about the world?
4. What motivates you to learn more about the environment?
5. How interested are you in learning about climate change?
6. What aspects of science class do you find the most interesting?
7. What aspects of science class do you find the least engaging?
8. What kinds of science activities would you like to do more of in the future?