Literature Review and Content Analysis to Optimize the Virtual Field Trip Program at the Haystack Rock Awareness Program

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Abstract

The Haystack Rock Awareness Program (HRAP) is a marine conservation group that offers virtual field trips to K-12 students over Zoom and Facebook Live. It is well documented that lecture based learning like this is not the most effective method of teaching and working over Zoom may limit the amount of field trips that HRAP is able to offer. The purpose of this project was to make recommendations to optimize the virtual field trip program offered by HRAP to have further outreach as well as to be more engaging to K-12 students in hopes of encouraging them to be more involved in marine conservation and stewardship. This was done through literature review in three main areas: 21st century learning, field trip practices and barriers, and environmental education as well as content analysis of the current program and interviews with two teachers who have experience with both the in-person and virtual field trips offered by HRAP. These to update the program. These included switching to an asynchronous format, making curriculum connections direct and explicit, creating supplemental materials to help prepare teachers for their 'trips', and incorporating a live component designed to expose older students to possible career and volunteer paths that exist in the environmental field.

Background

The Haystack Rock Awareness Program (HRAP) is a marine conservation group that seeks to protect Haystack Rock, a federally and state protected intertidal zone and seabird nesting habitat, through education. This is done through interpreters at the beach, private tours, and field trips for schools. These field trips used to be offered in-person but due to the COVID-19 pandemic they switched to a virtual format. Currently HRAP's virtual field trips are being held over Zoom and can range anywhere from 20-200 students and average about an hour in length. One person records while another walks around the tide pools and talks through general ocean safety such as surge safety and the tides, the federal and state regulations that protect Haystack Rock, and the correct way to interact with the plants and animals in the tide pools. There is also extensive discussion about the various plants, animals, and birds that they come across while looking through the tidepools. This format offers many benefits such as being able to present to a much larger group of students than an in-person field trip, and being able to reach schools that typically can't come to the beach to have an in-person trip.

The first major limitation to this format is that you are only able to talk about what is found on the beach on that particular day. Because everything in these ecosystems is alive, and nothing is prepared in advance there is no guarantee that you will find certain organisms. This means that inevitably some days are going to be better than others for field trips and it also means that weather is a major factor and field trips might have to be rescheduled or canceled and students won't actually have an opportunity to engage with Haystack Rock.

Additionally, because the animals that are being talked about are being found in real time there is a lot of down time where the staff are searching and not interacting with the students. This makes it difficult for students to remain engaged for the hour-long trip if they have nothing

to actively watch or think about. Adding an interactive component would be extremely helpful in keeping students engaged as well as giving teachers a way to effectively measure their students' new knowledge.

There is also a lack of pre-trip information provided to the teacher or students so the field trip is much more like them just watching a documentary rather than being an active part of their learning. This is an issue because virtual field trips happen in teacher classrooms, so teachers bear some responsibility for answering student questions and being able to be an active part in facilitating their learning. However, most teachers do not have a deep knowledge of tide pools so providing them with some information or guidance would be helpful. Additionally, if students and teachers had some background knowledge they would not only be more engaged in the lesson but also more able to ask questions.

Another issue is that it is difficult for students to ask questions in real-time as they are learning something. Due to the zoom format, it is especially difficult to get all the students to maneuver the buttons correctly and ask questions in a way that they can be quickly answered.

Finally, the current virtual field trips lack the amount of engagement that a traditional in-person field trip might receive. The in-person trips are full of props and activities to show students how the various tide pool animals live and that element is much less prevalent and much more difficult to incorporate into the online format.

The goal of this project is to update the virtual field trip program that is currently being offered by HRAP to better align with teachers' learning goals for their students, lead to higher levels of engagement among students, and encourage long term environmental concern and stewardship within the students.

Methods

The methods used for this project were literature review in fields of 21st century learning, field trips, and environmental education as well as content analysis of the current field trip program in order to make recommendations to improve the current virtual field trip program in place at the Haystack Rock Awareness Program.

21st Century Learning and Corresponding Recommendations

What is 21st Century Learning?

21st century learning has many definitions but is commonly defined as, “authentic learning through doing” (Lombardi, 2007). It focuses on real-world problems and how they can be solved, rather than the traditional school learning that is based on the regurgitation of information. The field of research that centers on 21st century learning is vast and has numerous competing viewpoints, but there are a number of overlaps between them. The general consensus is that students that learn skills such as inquiry, critical thinking, and collaboration are better prepared to take on life outside of school environments. It advocates for a shift away from traditional lecture methods that center on a teacher and instead pushes for genuine, student-led learning that better prepares them for living and working in the 21st century by teaching skills like critical thinking and collaboration to prepare them for the unique challenges of the modern era, “The future of our students depends on flexibility and resourcefulness not teaching to the

test" (Alismail & McGuire, 2015). Another crucial tenant is that, "Learning science is something students do, not something that is done to them" (National Research Council (U.S.), p. 2). Ultimately, when students are engaged they are able to grasp more of the content and take responsibility for their own learning. A National Research Council report found that STEM education should prioritize, "inquisiveness, cognitive skills of evidence-based learning, and an understanding and appreciation of the process of scientific investigation" (Council, 2002). The overarching theme is that once students learn these skills they are more engaged in their own learning and have a better, deeper understanding of what they are being taught.

What are some of the Core Components of 21st Century Learning?

Inquiry

Inquiry based learning centers on students asking questions and finding the answers to those questions on their own. This idea of science inquiry is prominent in the National Science Education Standards (NSES). The NSES are a set of curriculum guidelines that were published in 1996 and are now used by multiple states in creating their state curriculums. In *Inquiry and the National Science Education Standards,* they describe the process of inquiry as, "Teaching science through inquiry allows students to conceptualize a question and then seek possible explanations to respond to that question" (Council et al., 2000). Science inquiry is seen as an integral part of any 21st century curriculum and (R. D. Anderson, 2002) says that the main change in inquiry based classrooms is the role of the teacher or instructor. He states that the instructor must act as a coach or facilitator rather than a "dispenser of knowledge" (p. 5). Meanwhile, students are expected to be more active and direct their own learning rather than just following teacher instructions. Additionally, a 2007 study found that students placed in inquiry

based classrooms performed better than their peers in traditional classrooms (Akkus et al., 2007) showcasing that teachers switch to being a facilitator and students are more responsible for their learning the students tend to perform better. Introducing inquiry into a classroom or field trip might look like letting students ask questions about what they are interested in and then letting them take control and pick what sources they want to look at to answer that question.

STEM Integration

STEM Integration is the integration of various STEM disciplines and teaching them as interconnected ideas rather than separate areas with no relationship to each other (Berland, 2013; Honey et al., 2014). This concept focuses on preparing students for the real world by promoting STEM literacy, workforce readiness, and the ability to make connections between the STEM disciplines. It has been found that problem solving is the key component of integration, as problem solving is a critical skill that should be developed to prepare students for the workforce (Wang et al., 2011). STEM Integration in a classroom or field trip setting could look like presenting a problem or project that requires students to use multiple disciplines to solve. For example, trying to create a solution for ocean acidification would require students to pull from their knowledge on chemistry, biology, and human behaviours. According to (Morrison, 2006) successful integration results in self reliant and logical students that can problem solve, innovate, and invent.

Collaborative Learning

Collaborative learning is an important component of the 21st century that places emphasis on collaboration between students. “Learning in collaboration is an educational approach to teaching and learning that involves a group of learners working together to solve a

problem, complete a task, or create a product" (Laal et al., 2012, p. 1696). This is in contrast to most current teaching models that rely on competition rather than cooperation. However, emphasizing collaboration rather than competition leads to students performing better in classrooms as well as learning how to exchange ideas, actively engage with their peers, and gain exposure to a diverse range of viewpoints (Srinivas, 2011; Swing & Peterson, 1982). In collaborative classrooms, teachers function more as moderators and coaches rather than experts dispensing knowledge (Laal & Laal, 2012). Additionally, many argue that the 21st century will demand even more collaboration due to the increasing need for society to, "think and work together on issues of critical concern" (Laal & Laal, 2012, p. 491). All of these factors combined create a need for students to be prepared for entering a workforce where they will frequently be expected to engage and work with their peers in meaningful ways. To teach this skill, teachers should try to incorporate more group work into their classroom. Rather than having one or two group projects a year, having students work on several smaller projects with groups throughout the year helps teach collaborative skills that are necessary for success outside of the classroom.

Implementing Core Components

The 5E's: Engagement, Exploration, Explanation, Elaboration, and Evaluation

One method of implementing inquiry learning is the 5E's. The 5E's model was introduced in 1987 by the *Biological Sciences Curriculum Study* to create a new science and health curriculum for schools. Their 5E's model consists of 5 phases; engagement, exploration, explanation, elaboration, and evaluation that are meant to align with the idea that. "Sustained use of an effective, research-based instructional model can help students learn fundamental concepts in science" (Bransford et al., 2000; Donovan & Bransford, 2005). For example, if students were

going to learn about ocean acidificiation, traditionally the teacher might define what it is, how it happens, and what the potential impacts could be. If scientific inquiry and the 5E's were implemented instead, first the instructor would either ask a question or show a discrepant event to engage the students and introduce the topic. The goal is successful student engagement which is defined as, "students being puzzled by, and actively motivated in, the learning activity" (Bybee et al., 2006, p. 9). The second step, exploration, is centered on building shared experiences that students can draw on when they try to solve their problem. In the ocean acidification example, this could be reading articles, or watching a documentary about ocean acidification. The next step, explanation is where most traditional, lecture based teaching would fall and is the phase where students learn the concepts, processes or skills required to understand and solve the problem or question that they are faced with. By the end of this phase students are able to have a basic understanding of the terms and concepts that the problem or question deals with as well as being able to explain what they have learned. The second to last phase, elaboration, is similar to exploration and explanation but is based on students being able to transfer their knowledge to new situations and contexts, which should clear any misconceptions that students might hold and also provides valuable opportunities for collaboration with each other. The final, and arguably most important step, is evaluation, where teachers measure each student's level of understanding through some form of assessment like a presentation or test.

The 5E's are incredibly useful because they provide a practical, applicable blueprint for how inquiry can be implemented in learning settings. Having such a concrete base to build curriculum is extremely important because it helps make modern teaching methods more accessible to a wider audience.

Problem Based Learning (PBL)

Much like how the 5E's present a practical way to use science inquiry in teaching situations, problem based learning (PBL) presents a way to incorporate STEM integration in classrooms and other learning environments. "In problem based learning students use 'triggers' from the problem or scenario to define their own learning objectives" (Wood, 2003). Much like in science inquiry the focus is on students being responsible for their own learning, being the ones defining their learning objectives, and designing the questions that they want to answer. Additionally, PBL provides a great opportunity for STEM integration since many problems do require interdisciplinary thinking and can rarely be solved by applying one discipline. For example, if a teacher wanted to teach students about ocean acidification through PBL and STEM integration, rather than lecturing about the issue and possible solutions they would present ocean acidification as an issue and then prompt students to propose their own solutions for how the issue could be solved. This allows the students to be engaged with what they are learning by giving them choice in what avenue they choose to pursue. It is also a great opportunity to tie in collaborative learning as this method does promote more creative thinking that can be better cultivated in group settings.

Project Based Instruction (PBI)

Project based instruction is exactly what it sounds like, using projects as the main mechanism of teaching, "Students develop a question and are guided through research under their teacher's supervision. Discoveries are illustrated by creating a project to share with a select audience" (Bell, 2010, p. 39). Here, the emphasis is on the students and what is interesting to them. The teacher or instructor's role is simply as a facilitator or guide who leads them through

their research. Since it is so heavily based on student inquiry and research it is considered to also be a method of inquiry based learning. It has also been proven that students that are more engaged in PBI tend to perform better on standardized tests than their peers who only receive a traditional education (Geier et al., 2008). PBI sounds very similar to PBL but PBI tends to take place over a longer time frame, such as weeks or months, while PBL tends to be shorter and therefore could be easily incorporated in a field trip setting. Additionally, problem based learning often uses case studies or fictional scenarios, while project based instruction focuses more on real world issues.

Engineer Design Process (EDP)

The EDP is a series of steps that are implemented to replicate the process that engineers might follow to solve a problem. In one method it is broken down into five steps; ask, imagine, plan, create and improve (Lottero-Perdue et al., 2016). The way that EDP is taught varies considerably between different teachers and researchers but the general idea remains the same; define the problem, do background research, specify requirements, brainstorm and choose a solution, design the solution, test the solution, and communicate results. These steps are simple enough that they can be applied to any problem and therefore, be introduced very early in most educational settings. For example, for a Kindergarten class the problem that they solve might be trying to build a house or design a new egg carton while EDP for a high school or college level class might instead focus on designing a solution for ocean acidification or solving for overfishing. In both of those examples students would have to take all of those steps to try to solve the problem that they have been tasked with solving. Much like the other methods, the role of the teacher or instructor here is much more hands off than traditional methods. No matter what

the problem that the students are trying to address, the key concept remains the same, students have control over their projects and they engage in an open ended method of problem solving.

Recommendations for Haystack Rock Awareness Program (HRAP)

Based on the research that exists in this field there are three main components that I recommend that HRAP should focus on in their redesign of the virtual field trips; the inclusion of problem or project based learning, an emphasis on inquiry based learning, and shifting their role as an instructor in the classroom.

The inclusion of problem or project based learning would help increase student engagement as well as incorporate many different educational goals into a single activity or project. For example, to teach about human trampling in the Marine Gardens, students could be presented with the issue of how humans can impact the tidepools in negative ways. Then they would be asked to design a solution that still allows people to come visit the tidepools and learn all about them, but keeps the tide pool organisms safe. This would also be a great opportunity to incorporate collaboration by suggesting that the students split into groups to work on the project. After they all present their solutions, talk about how the issue is actually addressed at Haystack Rock through the designation of federal and state protected areas, as well as having interpreters on the beach who can answer questions as well as try to prevent people from acting in harmful ways to the area.

Inquiry based learning has already been demonstrated as being useful for improving student learning and information retention and provides a way for students to learn more about the areas that they are most interested in. Implementing inquiry based learning would most likely look like the 5E's framework that was previously described, where students work through the 5

phases: engagement, exploration, explanation, elaboration, and evaluation. For example, if you want students to learn about sea anemones, rather than just lecturing about what that might be, a teacher might start by saying something like, “Did you know that anemones can fight wars with each other?” After the students are engaged, they move through the other four stages with the goal of deepening understanding and allowing students to guide the path of inquiry rather than sticking to a set list of things that they should have memorized by the end of the activity.

The role of the teacher or instructor in 21st century learning is a far cry from the traditional lecturer who is responsible for distributing all of the information and then testing students on whether or not they memorized the material that was given to them. Instead, the focus is on acting as a coach or facilitator who simply guides students through the material and helps them when they get stuck or lost. Of course, there is still some level of information distribution that must be done, especially in a field trip situation where students might be learning about a topic for the very first time and there likely won't be an extended amount of time that students can spend exploring and learning about topics completely on their own. However, the virtual field trips should be designed as a sort of guide that students and teachers can follow to go through activities and learn material rather than a list of facts that students should expect to learn by the end of the trip.

Throughout all of these recommendations there is the common theme of student guided inquiry. The teacher and HRAP staff are there to provide resources and to guide students through their learning process. This means that the curriculum, and resources provided should be intended as a guide that creates a general direction and flow for the activity rather than a rigid, step by step list of how everything should be done. However, it is still very important that both the teacher and student know exactly what they are supposed to learn through the experience. For

example, for the project about protecting ecosystems, they should be aware that the focus is on both learning about human impacts on an ecosystem and how we can take steps to reduce that impact. Having this objective be clear makes it much easier for students to understand what they're supposed to learn and makes it simpler for teachers to ensure that students are on the right track and getting what they are supposed to get out of an activity.

Overall, the most effective way to implement 21st century learning into the virtual field trip program is to include problem and project based learning, emphasize inquiry, and shift the role of the instructor in classroom settings.

Field Trip Expectations, Barriers, and Considerations

Introduction

There are three main avenues through which science can be taught- formal classroom education, practical work, and field trip experiences (Michie, 1998). Field trips have long been an integral part of school curriculums and many students look forward to visiting different institutions every year. There is no formal criteria for what officially constitutes a field trip, but one working definition is, “a trip arranged by the school and undertaken educational purposes, in which students go to places where the materials of instruction may be observed and studied directly in their functional setting” (Krepel & DuVall, 1981, p. 8). Under this definition there are two main components that must be fulfilled. The trip must be for educational purposes and students must observe or study the materials directly in their setting. When designing a virtual program, these two criteria should be prioritized to ensure that both students and teachers are getting the most out of their field trip.

Expectations for a Successful Field Trip

When undertaking a field trip there are two main stakeholders who are planning and preparing for the trip, teachers and host institutions. Each of these individual groups has their own goals and expectations that they want to fulfill and understanding these expectations can help in prioritizing and designing a program that fulfills all of these individual needs.

Teachers

A teacher's goals and expectations for field trips can be broken into three basic categories: short term satisfaction of students, meeting school criteria, and long term student growth and learning.

Some of the goals that fall into that first category of short term student satisfaction are providing a change of routine, presenting a reward to students, and increasing student motivation (Kisiel, 2005; Sorrentino & Bell, 1970). These goals are rather easy to fulfill and don't require much advance preparation from the teacher or host institution. This component also does not have any goals specific to learning and instead prioritizes providing new experiences for students. The relationship between learning and new experiences is also referred to as the 'novelty effect' which indicates that when the novelty of an experience is moderate or high, it is more conducive to learning in students. Informal learning environments, like field trips, are typically thought of as having high novelty compared to traditional classrooms which makes them good opportunities for further learning in students (Boeve-de Pauw et al., 2019). By seeking out new experiences that have moderate to high novelty teachers can create learning environments that are more conducive to learning than traditional classrooms.

The second category of expectations for teachers is satisfying criteria. The goals that fit into this are reinforcing curriculum, and satisfying school and parent expectations (Kisiel, 2005; Melber, 2015). These require more preparation from the teacher's side and involve more of the students' actual academic goals, especially in relation to the connection to curriculum, but they still don't necessarily facilitate learning and focus on the completion of arbitrary criteria. This category is the easiest to quantify and measure success in and has therefore been used as the main metric for school trip success, even though it doesn't measure learning itself.

The final category of goals, long term student growth and learning, is the broadest and most complex. Some of the expectations that fall into this category are providing first hand experience, stimulating interest in science, increasing observational skills, personal and social development, and giving meaning to materials learned in classrooms by having direct experiences with concrete materials (Kisiel, 2005; Marshdoyle et al., 1982; Orion, 1993; Sorrentino & Bell, 1970). This category is the most important in regards to facilitating learning, as well as creating direct experiences that will motivate students to continue to be interested in the material that they were introduced to in the long term. However, this category is more abstract and the hardest to quantify and measure which often makes it a lower priority to teachers.

Host Institutions

Host institutions' priorities and goals differ from the teachers that are coming in for field trips in that they typically only have one goal or expectation from the incoming trip: facilitating long term interest in whatever they are teaching. It's been proven that having early, positive, experiences with the subject matter can lead to long term engagement and interest (Marshdoyle et al., 1982). For example in the case of the Haystack Rock Awareness Program (HRAP),

providing that positive experience for kids is intended to lead to engagement with conservation and stewardship. Because they only have that one goal, they are free to focus on it wholly and ensure that it is met; however, long term engagement is difficult to measure and requires remaining in touch with field trip groups long after they've visited. Most host institutions do this by having an active social media and encouraging teachers to bring their classes on repeat visits.

Barriers to a Successful Field Trip

The most prevalent barriers to successful field trips that teachers report are budget restrictions, increasing transportation costs, scheduling inflexibility, increased emphasis on standardized testing and test preparations, and a lack of teacher training or preparation (D. Anderson et al., 2006; Mehta, 2008; Michie, 1998; Price & Hein, 1991). Most of these barriers are put in place by schools and school districts and are mostly logistical in nature. Because these are mostly logistical issues, there is often nothing that host institutions can do to offset these barriers. There are multiple federal grants such as the National Endowment for the Arts that are designed to provide funding to teachers and there are some host institutions that also have grant programs to make their programs more accessible.

Another major issue that teachers face is lack of training and professional development. Many teachers report that they received little to no training about how to conduct effective field trips, which can lead to a disconnect between classroom instruction and field trips. Even though teachers recognize that field trips are supposed to connect to curriculum many are, "unable to explain how field trips will ultimately lead to student learning and attempts to connect material to curriculum often fail (Meiers, 2010, p. 6)". Additionally, (T. White & Jacobson, 1994) reported that students only have high expectations for learning when teachers also have high

expectations. This means that unless teachers come into field trips understanding how they connect to the curriculum, and having high expectations about how much students can learn, students likely won't get the positive experience they need to gain long term interest. Providing professional development to teachers about the importance of field trips and how to effectively conduct them could be monumental in cultivating meaningful and educational experiences for students.

Considerations for a Virtual Field Trip

Virtual field trip programs have been rapidly popping up since the introduction of the internet, but the global COVID-19 pandemic led to a massive increase in the amount of virtual field trips being offered by different host institutions. However, there is currently minimal research about the impact and effectiveness of virtual field trips and science education presenting a great opportunity for further research.

It is also important to note that virtual field trips, especially asynchronous ones, rely heavily on teachers being able to communicate the information provided by host organizations which isn't always feasible. There is often a discrepancy on the quality and consistency of the field trip depending on individual teachers, their expertise, and the amount of time that they are able to dedicate to planning the field trip.

Some places offer more traditional 'field trips' that involve a day where they might be on Zoom or having a live interaction with a professional at a host institution. Another method that's been growing in popularity is setting up virtual modules that can be worked through and scheduled at a teachers own pace. These aren't 'field trips' by definition, but they do tend to contain similar information to what teachers and students might receive on an actual field trip.

This allows for more flexibility, since the modules can be used all together as a unit or individual activities can supplement the corresponding parts of the curriculum.

One example of this asynchronous, module based learning comes from the National Oceanic and Atmospheric Administration (NOAA). Their webpage contains an education section with multiple resource collections split into topics such as oceans and coasts, climate, and marine life. Each of these is further divided into individual topics. For example, the marine life section contains resources on aquatic food webs, coral reef ecosystems, fisheries and seafood, life in an estuary, marine mammals, and sea turtles. Some of these modules simply list out a couple facts about the topic, while others have animations, videos, and worksheets. This format allows a teacher to use the materials as they see fit and that the resources can be adapted for a variety of age groups rather than just being confined to one set field trip.

Another organization that provides virtual field trips is the McDonald Observatory. They offer both scheduled virtual visits as well as pre-recorded sessions that can be accessed at any time. Their pre-recorded videos utilize the same materials for different age groups. One video titled, “Our Solar System and Beyond” is intended for 3rd-12th grade, which is a large range, with students in different age groups learning different things; however, the worksheets that correlate with that video are split up by age group. These are still broad ranges but they are better than a catch all worksheet that isn't specific enough for any particular age group.

This divergence from the traditional field trips format offers unique opportunities that in-person ones can’t. For example, they allow groups from further locations that traditionally can’t access materials to get involved and take part in field trips that weren’t previously available to them. This is especially true for a program like HRAP where they are location specific. Virtual field trips also offer opportunities for students who might not be able to go on traditional field

trips. It is well documented that special education programs are much less likely to be able to actively participate in traditional field trips (Kelly & Mcglynn, 2017), but having virtual programs that can be personalized by teachers provide a great opportunity to engage students that haven't historically been included in field trip programs.

Recommendations

There are three recommendations that would help HRAP meet the expectations for both teachers and host institutions while simultaneously addressing most of the barriers to being able to take successful field trips: designing an asynchronous program, creating a pre-field trip module for teachers, and making connections to curriculum explicit and direct.

Having an asynchronous, online platform rather than a Zoom or Facebook Live is the most important recommendation that I can make. It will allow for more people to get involved, frees up HRAP staff, and allows teachers to tailor the 'trip' to their individual goals and expectations. Having an online platform that operates based on pre-existing modules that include videos, worksheets, and other materials will allow more people to go on these 'field trips' as well. The best way to do this would be to create a separate part of the website that is dedicated entirely to the virtual field trip program. Content should be divided by grade level, and each grade level should have separate activities that are tailored to their age group and also incorporate the ideals of 21st century learning discussed in the previous section. These activities should incorporate photos, videos, and worksheets with the goal of being as interactive as possible. Additionally, there are several stations that are used for in-person field trips that could be adapted to fit into a virtual space. Adapting those would be the quickest and most effective way to create a foundation for this virtual module. For example, the in-person field trip has a bird

station that includes various facts and specimens that students try to match up based on their knowledge of adaptations. Simply taking pictures of the specimens and typing up the facts would create a virtual version of that activity.

Students are still likely to ask questions that teachers are unable to answer and classes might have questions that aren't addressed in the online materials. Additionally, many people like having some face to face contact with institutions so that they can ask questions and get to have conversations with them. To remedy these two concerns, I would also recommend that HRAP host biweekly or monthly Q&A sessions or webinars and invite students and teachers to attend to ask questions or just get the chance to talk to professionals. This would also enable HRAP to maintain contact with students and encourage the lifelong learning and engagement that they are seeking out. Adding this live component would also be a great way to introduce careers in conservation work and the various research projects that are happening at Haystack Rock to older, high school students that might be interested in studying and working in environmental science.

In addition to student activities, there should be a pre-trip guide for teachers on the website. Creating a pre-trip module for teachers would address the issue of not having adequate teacher preparation by giving them an overview and guide to the materials that students would be learning, in turn enabling them to answer potential questions that students might have and bridge the gap between host institution and classroom. Additionally, this would act as professional development by providing access to resources that teachers might not previously have. This would also serve to reduce the variation in the quality of field trips offered by teachers since they would all be receiving the same information and guide on how the trips should be conducted.

One of the barriers to successful field trips was that teachers have trouble connecting the materials learned on field trips to the curriculum being taught in classrooms. This could very easily be addressed by including the corresponding NGSS learning targets for each of the individual activities or worksheets that would be part of the virtual module. Adding curriculum targets to each worksheet would also enable teachers to utilize individual activities as supplemental materials for their regular classroom instruction.

Switching to an asynchronous format and creating a separate virtual field trip section of the HRAP website that would have modules for student activities and resources, as well as a teacher guide to planning a field trip, would be the most high-yield way to combat the majority of the barriers presented by field trips as well as the most efficient way to meet the needs and expectations of both the schools and host institutions.

Environmental Education

Age Appropriate Environmental Education

By the age of five or six a majority of kids know some basic terminology around environmental protections such as environment or sustainability and can also name some 'rules' of environmental protection such as "don't throw trash on the ground" and "don't pick flowers". Additionally over half of six year olds thought that it was necessary to protect the natural world when asked (Lubomira, 2004). It is important to note that the study that found all this to be true was conducted in Europe where environmental education is taught at a much earlier age so children in America are likely to have different opinions. However, this shows that by this age kids are already aware of the natural world and understand the cause and effect relationship that

the natural world and humans have. Additionally, young children tend to view nature differently than adults and view the outdoors as an integral part of their activities while adults tend to view it as a resource that can be used to humans' advantage. It is also important to note that younger children are much more likely to have positive attitude shifts about the environment than older children so this is the prime age to promote healthy ecological choices (Liefländer & Bogner, 2014). Children also have a tendency to want to bond with nature and in order to nurture that instinct it is important that they get the chance to play and explore nature in a way that allows them to feel a connection with nature. If they are not given that opportunity they are likely to develop an aversion to nature (biophobia) as well as view nature as a source that can be exploited rather than something to protect (R. White & Stoecklin, 2008).

At this stage the best environmental education to provide to children is to let them explore and connect with nature as well as involving them in small community projects such as park clean ups or community gardens. This allows them to be exposed to environmentalism in a way that is local and not overwhelming.

As kids get older they both develop critical thinking skills and become increasingly aware of the climate crisis that they are growing up in (Clayton, 2020; Kuhn, 1999). Additionally, it is starting to be increasingly obvious that growing up during a climate crisis had negative mental health impacts such as increased anxiety, depression, and even PTSD (Bartlett, 2008). Unsurprisingly, climate anxiety tends to be higher in people who care more about environmental issues, and young people, particularly teenagers, tend to experience higher levels of stress due to greater feeling of responsibility as well as a higher sense of hopelessness compared to adults (Clayton, 2020). It is important to recognize and understand that most older students are more likely to be feeling some sort of anxiety about the natural environment and this

should play some role in how environmental education is taught in older classrooms. Two main goals of mitigating climate anxiety, "individual wellbeing, and engagement in efforts to mitigate climate change in an attempt to promote societal wellbeing (Clayton, 2020, p. 4)." There are very limited actions that an organization like HRAP could take to promote the individual wellbeing of students in a single field trip, but they do have the potential of being an avenue for engagement for older students.

Environmental Education Methods

Environments as an Integrating Context for Learning (EIC)

The EIC method aims to teach environmental issues in a holistic way by teaching them in their natural and socio-economic context while also using many tenets of education such as interdisciplinary learning, hands-on learning, and developing an appreciation for the natural world. EIC is designed to be flexible with the goal of being implemented in all schools, regardless of socio-economic status, with the main goal of environmental education being integrated into the other topics being taught. One example given is, "A creek running behind the playground: its relation to the region's watershed, local farming operations, and the economic health of the community (Lieberman & Hoody, 1998, p. 8)". It is easy to see how these kinds of examples take normal, everyday things that students are already exposed to and familiar with, like the creek behind their playground, and use them as opportunities to teach about the environment and the interconnectedness of the natural world. The core teachings of EIC can readily be applied to field trips through the hands-on experiences and interdisciplinary examples that EIC utilizes.

Environmental Based Education (EBE)

Environmental based education (EBE) is a general term that encompasses all the various forms of integrated environmental education such as EIC. These forms concentrate on using environmental education as a n overarching idea that integrates into the rest of students' curriculum, rather than being a subject that is taught individually. It has also anecdotally and qualitatively been shown to improve reading, science, math, and social studies scores on standardized tests (Glenn, 2000). These integrated approaches are gaining more traction and more teachers are starting to see the values of teaching environmentalism as a crucial part to most subjects rather than its own category.

Environmental Service Learning (ESL)

Environmental service learning is perhaps the most prevalent form of environmental education in most middle schools. Students either pick out or are given a project that aims to improve the local community while simultaneously teaching students about environmental issues and how to remedy them and developing leadership and critical thinking skills (Russ, 2015). Most of these projects are relatively simple and can include things like beach clean ups, implementing a composting program at their school, or creating a small community garden. Many critics of ESL argue that service projects do not promote long term behavioral changes and it is often difficult to find both relevant and engaging projects that can be completed within the given time frame (Gerrits, 2018).

ESL learning is harder to apply to field trips because it typically takes place over an extended period of time in the school’s local community. However, there are several prominent organizations such as National Geographic and NOAA that offer multiple resources that help

students get involved in ESL. National Geographic has a list of multiple ideas for service projects while NOAA has a grant program called the Environmental Literacy Program designed to empower people to advocate for safety in their changing communities. While these are both useful and engaging programs for students they are not necessarily 'field trips' and are definitely designed to be more long term.

Investigating and Evaluating Environmental Issues and Action (IEEIA)

Investigating and evaluating environmental issues and action (IEEIA) is a model of environmental education focused on teaching students how to understand environmental issues (Hungerford, 1985). There is a prescribed set of steps that students are led through to understand the whole issue; identifying the issue, looking at the facts and possible solutions to the issue, looking at the underlying values of the various viewpoints, and then drawing conclusions. Learning how to analyze environmental issues is a complex process that teaches a variety of skills to students such as understanding multiple viewpoints, and interpreting data (Hargrove, 1999). IEEIA was created to teach students how to think critically about environmental issues so that they could grow up to be responsible citizens in an increasingly tumultuous time (Paul, 2001). There is very little formal research about the implementation of IEEIA learning in field trips but I think that it could be a great opportunity for further research and that IEEIA would be useful to many host institutions.

Recommendations

When reading this research it is increasingly obvious that students care about the environment. Even from ages as young as six they understand that the things they do have an

impact on the world around them and the challenge with designing a program that teaches environmentalism and conservation is to find a balance between getting people involved and not overwhelming them and contributing to their pre-existing environmental anxieties. The recommendations that I would make about applying environmental education to field trips are twofold. One, I think that the environmental focus on field trips being given to younger students should not change, just be adapted to the online format. Two, I think that HRAP should put more emphasis on engaging older students and providing opportunities for them beyond just a field trip.

In the current live field trip program, students often get to partake in a microplastics activity where they sift through sand and collect microplastics. They then get to put the collected microplastic into a small glass vial on a necklace and take it home as a reminder that plastics stay around for a long time and can cause lots of harm in marine ecosystems. This serves as a reminder to them to be mindful of how much plastic they use and having a physical token of their learning helps them remember the lesson that they learned. This is a great activity for younger, elementary aged children because it gives them a concrete action to focus on, use less plastic, as well as giving them a physical reminder. Being able to find some sort of virtual equivalent to this could be useful and being able to still provide some physical reminder is something that HRAP should look into. However, this activity is much less effective for older students who likely already understand plastic pollution and would view this activity as childish and ineffective.

In order to engage older students, HRAP should include a bi-weekly or monthly live component, such as Zoom, that could serve as a platform for students to get to talk to professionals and ask questions that their teachers might not be able to answer. This

recommendation was also made in the previous section about field trips but it could also be used in this context in addition to a Q&A meant to engage students after their field trips are over. This platform could also be invaluable to older high school students to see what a career in conservation looks like and possible career paths that they could take to work in environmental science. In an interview with a high school teacher she mentioned that this was the thing she thought needed the most improvement from HRAP's current program. She said that many of her students are interested in studying conservation and environmental science and getting to see how volunteers get involved and what kind of background staff members have would be beneficial in showing them how they could potentially volunteer or have careers in those fields. Additionally, HRAP participates in a lot of research projects, such as seabird surveys, and these live meetings could be a great place to show those off as well. Overall, it would be a great opportunity to expose older students to careers, research, and other ongoing work in conservation. The end goal could also be some sort of community science project that students could participate in so they get to feel as though they are taking part in conservation efforts.

Discussion and Recommendations

The recommendations made throughout this report can be split into three basic categories; addressing the existing barriers to field trips, providing resources to teachers, and the introduction of a live component.

The most prevalent barriers that are currently preventing successful field trips were budget restrictions, scheduling inflexibility, an increased emphasis on standardized testing, and a lack of teacher training or preparation. To address these barriers I recommend that HRAP switch to an asynchronous system, make curriculum connections direct and explicit, and create

supplemental materials to help prepare teachers. The asynchronous platform could be a part of the current HRAP website and could contain an introductory video to get students oriented with HRAP and what they do as well as some very basic information about Haystack Rock. Then there could be various activities consisting of worksheets, videos, and photos sorted by grade level that teachers could use as either supplemental materials to their own curriculum or as a field trip by using all of them in a single day. Each of the worksheets or activities should directly state what NGSS standard they are meeting to make clear how this relates to the curriculum and including a reflection section that asks students to connect this to the rest of their learning would also solidify the connection between field trips and classroom curriculum that many teachers seek out. Additionally, switching to an asynchronous platform alleviates most of the major issues with scheduling field trips such as scheduling as well as budget restrictions because teachers can access the materials at their own pace and it would require little to cost cost.

Since teachers would be working through an asynchronous platform on their own within their own classroom there is likely to be a lot of variation in the quality of trips between schools depending on the background knowledge that the teachers have as well as how much time and resources they are able to put into planning the trip. Therefore, providing some sort of supplemental materials would be extremely useful. Many teachers reported that they received little to no professional development about how to make field trips effective and other research indicated that unless teachers can directly state the intended learning objectives of a trip students are unlikely to recognize the educational value of the field trip. So, providing teachers with some sort of handbook, module, or guide about how to conduct the trip and some background information would help maximize student engagement as well as increasing the consistency of these trips. This guide would also include information on 21st century learning and age

appropriate environmental education, as well as background information of tide pools so that they are able to answer student questions in a meaningful way.

The introduction of a live component would likely look like having a bi-weekly or monthly Zoom meeting that would be open to the general public. This live component would serve three main purposes. First, it is unrealistic to expect that teachers will have enough background knowledge and expertise to answer every question that students might have, so offering a platform for teachers and students who participated in field trips to ask questions to professionals that the teacher might not have been able to answer during the actual 'field trip'. Second, it offers students the opportunity to talk to professionals that work in conservation and to gain exposure to what hands-on environmental work looks like. Third, it could be a great platform to promote the research that takes place at Haystack Rock. Much like many library lecture series that organizations like Friends of Haystack Rock (FOHR) and the Hatfield Marine Science Center (HMSC) hold there could be various researchers and staff members presenting a range of topics, and gearing that towards middle and high schoolers could also present an opportunity to those researchers to expose more people to their research as well as practice presenting scientific information in a way that is easily understandable by the general public. Doing this would also enable older students to understand what careers exist in environmental fields and provide them more resources to reach out and learn more about this potential field of study.

Conclusion and Future Steps

In terms of future research opportunities I found that the most prominent gap in the current research is whether or not the use of virtual tools is as effective at promoting positive

conservation attitudes in young children as traditional, in-person experiences. This research will only become more important as more of our lives transition online and schools continue to face budget restrictions that make in-person trips less accessible. Another area of research that is yet to be thoroughly explored in environmental education is a comprehensive study comparing the various accepted environmental education models. This study would be incredibly useful because it would offer some quantitative data about which model is actually the most effective and comparing them between various age groups could also provide many educators the chance to modify their environmental education programs to the most effective form for their students' ages. There is also currently a major gap in research about age appropriateness of environmental education in that there is very little literature regarding middle schoolers on the topic. There is plenty out there about how to engage young, elementary children, as well as how high schoolers view and interact with their environment but there is an entire section students missing and researching them could also help us understand how to transition from the engagement and basic introduction of environmental concepts recommended for younger kids to tackling the climate anxiety that high schoolers typically face.

The next step in this project is to start designing the actual curriculum and activities for the virtual platform. The most practical way to do this would be to start adapting some of the current in-person activities to a virtual format. Some activities that would be good for this are the hula hoop identification activity, and the seabird matching activity. Additionally, creating the teacher guide and introductory video should be a priority. After there is a substantial virtual platform conducting a study on the efficacy of in-person field trips versus the virtual option in creating long term student engagement would be the reasonable next step in this study.

While the recommendations given in this project are specific to HRAP, the literature review could be useful to other institutions that are also interested in utilizing a virtual platform to reach a wider audience. Many of the recommendations made here can also easily be translated to other contexts and there is obviously so much more literature available on these topics and by condensing it down I hope to make these learning practices and education standards more accessible to environmental educators who feel lost on where to start with their virtual platform. I also hope that this project makes it abundantly clear that there is a space for virtual learning outside of just being a replacement or substitute for in-person instruction. As we all begin to rely more heavily on technology it should come as no surprise that our environmental education will do the same as well and shifting out mindset to understand that the virtual space hold new possibility beyond just replacement will be pivotal in having a successful transition that allows us all to maximize a resource and access a much broader group of people than ever before.

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