

INTEGRATING AUGMENTED REALITY INTO PLACE BASED NATIVE
TREE IDENTIFICATION

by
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CHAPTER 1

INTRODUCTION

Overview

The purpose of this capstone project, Integrating Augmented Reality into Place-Based Native Minnesota Tree Identification, is to build in 12th grade senior high school students an appreciation for native Minnesota Trees and understand how humans can use maple trees as a sustainable food source while using augmented reality technology in the field. The research question I am trying to address is, does the use of cell phones outdoors by 12th grade experiential environmental education students have a positive effect on the learning process? There has been an increase of invasive species and tree diseases to some native trees in Minnesota and I want students to see what we have and instil in them a passion to protect it. By taking students out of the traditional classroom and letting themselves become immersed in the local landscapes will hopefully be a start. This curriculum guide can be used as a stand alone unit of study or as a supplement to any native Minnesota Forest curriculum. The maple syrup collection and production is a benefit of learning about the native trees to Minnesota and their adaptations to be able to survive in such harsh places like Central and Northern Minnesota.

In this chapter I will outline my experiences that have led me to develop this curriculum, my history of making maple syrup, how I became interested in Minnesota Forests, and what augmented reality is and how my students would use it in class while using cell phones or other personal device.

For as long as I can remember, spring classes were always the toughest for me in high school. My grandparents had a home in Florida and coming back home to Minnesota after spring break from the beautiful warm weather to the cold and snow always got me thinking of the summer to come. The thought of being free and spending time on the water or in the woods was always on my mind when sitting in my 4th and final hour of the school day, the one that comes to mind is Advanced Algebra class Junior Year. The memories of summers past and the excitement about the memories to be made in the upcoming summer bombarded my mind while taking notes in a traditional classroom. One class that made high school a bit more memorable and took the pain out of sitting in a traditional class in the Spring was a senior only Outdoor Adventures class (OA). OA was an experiential environmental education class that focused on many different topics from ecosystems, nutrient cycles, and human impact while requiring the mastery of canoeing, snowshoeing, rock climbing, and an adventurous mind to “learn” the material. When meeting up with former high school classmates this class frequently gets brought up and our field trips, activities, and lessons on life are frequently discussed. We were required to journal in this class and although I was not a fan of it during high school I am fortunate enough to have hung onto it. The best part of the journal is the pictures that we were required to attach. I have pictures of me in the Boundary Waters, rock climbing at Interstate Park, snowshoeing and many other activities around the high school campus. Little did I know those pictures, that we had to buy for a nickel from our teacher, would bring me back to such great memories.

After high school I attended a University in Northern Minnesota which had a much different landscape than the suburban area I grew up in. I noticed while spending much of my time in the woods or on the lake that the landscape was much different. Conifer trees lined many of the lakes and the deciduous trees that were most commonly found were birches and aspens, vs the hardwood trees that dominated the landscape back home. I never really thought much about it during my time “up north” but since I have been teaching OA classes it really opened up my eyes to how different the landscapes are in Minnesota and how each landscape is shaped by its climate.

I want my students to appreciate what we currently have in the local area and what the original landscape looked like. By using the environmental education “lens” I am able to bring in many different aspects to the class. We learn about the history of some old growth trees and what was happening in the world around the time they were germinated. We analyze the riverbank and discuss what engineers have done to preserve the banks from erosion. We incorporate English and Art by reading short stories, articles, poems, draw pictures, and write reflections about our experience. The use of cell phones in the field in becoming more popular and by using augmented reality I am able to integrate an interactive technology into the lessons. I feel it is my duty as an environmental education teacher to help guide students to see that everything is interconnected. In this project students will see that if one system is altered or removed the rest of the ecosystem will change as well.

Rationale

I frequently hear that cell phones have no place in the classroom or in the field because they are too much of a distraction to the learning process, especially in some of my graduate coursework where we spent a lot of time outdoors with fellow outdoor educators and naturalists. The fear from some of my colleagues is that students are going to miss something when using their cell phone, could be an animal flying or running by, a gorgeous sight, or a teachable moment. I agree that when cell phones are used inappropriately they are a distraction to learning. However, the reason I wanted to design a curriculum using augmented reality to see if cell phones can have a positive effect on the learning process is because the use of cell phones in school continues to grow each year, a study by Pearson (2015) found that high school students have increased their use of cell phones in class by seven percent, up to 82% of students, from 2014 to 2015. Students in class today are known as 21st century learners or digital natives and have different needs and wants than the students before them. They have grown up with technology their entire lives and have been trained to use their technology in class. Kolb (2011) outlines various reasons why to integrate cell phones in class; students love their cell phones and many do not go anywhere without them, cell phones can facilitate learning at any time, both in and out of class, cell phones help prepare 21st century learners for life after school, and can be valuable tools for those with learning disabilities. After looking through the literature I thought this project would be a great way to integrate technology into the field and a way for students to design an augmented reality app and use cell phones as an appropriate tool in school.

I thought of this project idea because all of the stories I hear about from friends who go on trips always talk about the amazing pictures and videos that they have taken. I am an avid muskie fisherman and I would never go fishing without my cell phone, not to log into social media but to look up current weather conditions, sunrise and sunset tables, and to take pictures of the scenery or a giant muskie that was boated. When my wife and I went on our most recent trip out west to Utah, I made sure to bring my phone even though I did not have any service for the majority of the trip. Again it wasn't to look at posted pictures on Instagram or for Snapchatting my friends, it was to document the amazing sights with my wife. I want my students to be able to have the same opportunity, if they see something cool during our time outside, why shouldn't they be allowed to take a picture of it.

Recently there have been some amazing apps developed that can help people learn about the environment and the plants and animals around them. I currently use an app that allows me to take a picture of a plant or animal and upload it to a database which suggests a species that has similar characteristics and has been identified nearby. There are other online community members that suggest identifications or confirm what you have seen. Another group of apps that have been popular in the past few years is augmented reality, think Pokemon Go. In an augmented reality app the user looks through their cell phone screen and sees a three dimensional object that they can interact with and gain a better understanding of the object by zooming in and out. I thought how about putting the two worlds together. Each small group of students will prepare information about a native tree species and design a three dimensional model. Once the

groups are finished the other groups of students will find this tree location, scan a QR code, and use the facts and three dimensional model to gain a better understanding of the tree species.

I am fortunate enough to work at the high school I graduated from and am able to teach this class. Although some of the activities we were able to do in the early 2000's are now frowned upon, this class is very similar to when I took it as a student and I am looking for a way to freshen up the class by incorporating more technology in a way that students enjoy and provide all the students an opportunity to learn.

Maple Syrup

Ever since I can remember I have always enjoyed the taste of 100% natural maple syrup. There was something about eating pancakes at my grandparent's cabin in Northern Wisconsin and pouring the "liquid gold" maple syrup on our breakfast and getting dirty looks from other family members if you took too much. Years later my family and I started a tradition of making our own maple syrup from the stand of maple trees in the backyard. My parents were skeptical at first as none of us had any experience in making maple syrup and they thought tapping trees would be harmful to them. To get some background information I asked a coworker, who has been making syrup for over thirty years, when I was in college in Northern Minnesota who shared with me the ins and outs of making maple syrup. Just to be sure, my wife and I went to a maple syrup presentation at Fort Snelling State Park the next spring as well. For the last nine springs we have been tapping the trees in my parents back yard and making about one gallon of syrup per year, which equates to about forty gallons of sap that was collected. Over the

years I have learned many tips and tricks that I thought I could share with my students during the Human Impact unit in my experiential environmental education class. The goal of making maple syrup in class is to show students a sustainable food source and how easy it can be and for them to share the information to family and friends in the future. This has been a popular unit the last three years but I thought that adding more education about the native trees and incorporating more technology to this unit could really help with winter tree identification and the maple syrup project.

Forests of Minnesota

My love for where and how trees grow where they do in Minnesota came from a class called Biomes of Minnesota and reinforced in the Minnesota Forests course I also took in graduate school. There were so many connections that I never thought about but noticed throughout the different regions of the state. I first thought about why Northern Minnesota was so different than the central, southern, and western parts of the state. I have been trying to share that passion with my students and get them to think critically about why we have the trees we do around our school campus and think about what this place may have looked like pre-European settlement. We are lucky to still have a native oak savanna near the campus where students can get a look back to what the landscape used to look like.

Augmented Reality

The first time I was exposed to augmented reality was through the very popular game Pokemon Go. In this game the user walked around until a Pokemon would appear on their cell phone screen. The user would click on the Pokemon which would then

appear in the camera of the user's cell phone and the goal was to throw a ball and capture the Pokemon. The Pokemon would appear as a three dimensional figure in the background as the user looked through their cell phone camera to see them, they could walk around the image and see how it interacted with the real world. This game took the world by storm and millions of people would be walking around looking on their cell phones for pokemon. Augmented reality has also been introduced to show how furniture or other home decor would look in a room or what landscaping would look like in a yard. There are also other augmented reality apps that are being used in schools right now. A quick search in the Apple Istore showed the use of augmented reality to teach planets, layers of the earth, and bonding of molecules in chemistry.

Many people confuse augmented reality and virtual reality. Although they are similar they are used differently in education. Augmented reality uses computer generated images that are layered on the actual environment and the users of the app are able to interact with the image. Virtual reality is 100% computer generated simulations and the users get the experience of the computer simulated reality.

I thought this idea would work great as a project where students would scan a QR code next to a tree species and a three dimensional model of the tree species, that they designed, will pop up on their screens and students can use the information to identify the trees with summer characteristics in the early spring.

Conclusion

With the ever growing list of invasive species and a changing climate here in Minnesota I feel students need to learn about the native trees in their landscape and what

their native landscape looked like pre-European settlement. If they understand how the native trees are successful here and how some animal species depend on the trees I hope the students feel a little more need to protect them from our ever changing world. The guiding question that led me to this project was “how can technology and cell phones increase the learning process for students in an experiential outdoor science class?” I feel that I need to change my stance on the use of cell phones from “they are not allowed at all” to “have students use them in the field and in the classroom when appropriate” to better serve the students I have in class. Students need to have experience using technology in order to be successful after high school. I realize that not all lessons will have a better learning experience with using more technology and a place that would not benefit from using technology is in making maple syrup. This led me to another guiding question, “what project could students participate in and be engaged in that they can use sustainably each spring?” Since all of these trees that grow on the high school campus also grow throughout our community students will benefit by this project-based and place-based educational theories to inspire students to help protect what we have and share their newly gained knowledge with others in the community.

In this chapter I touched on how my OA class in high school changed my high school experience, why using cell phones in class is important to me, and my rationale for this project. In order to design the curriculum, the literature review in chapter two will look at using cell phones in school, student engagement, the learning process in environmental education, and 21st century learners.

CHAPTER 2

LITERATURE REVIEW

Introduction

In this chapter I have reviewed literature that relates to the use of cell phones in school, student engagement in environmental education, the experiential environmental education learning process, and 21st century learners. I have reviewed these topics to develop curriculum “*Integrating Augmented Reality into Place Based Native Minnesota Tree Identification*” and help me answer the question “does the use of cell phones outdoors by 12th grade experiential environmental education students have a positive effect on the learning process?” Cell phone use and the increasing power they have in education is increasing every year and the purpose of this project is to see if using them for augmented reality, pictures, reference, and reflection will help students learn about the native trees to Minnesota. Student engagement in environmental education is also different from the traditional classroom and current best practices for engagement in environmental education will also be addressed. Outdoor experiential environmental education classes look a lot different than the traditional science classrooms. They usually require students to be outside the walls of a traditional classroom and this chapter will look at some best practices for keeping students engaged with the material while outside of the physical school building. The students who are in classes today are sometimes referred to as 21st century learners because these students are learning the skills that are needed to be successful in the 21st century. These students are different from students in the past because they have been exposed to technology in school since

day one and are very technology-literate, especially in activities that help the overall learning process but also activities that hinder the learning process. There will be strategies outlined in this chapter about how to address some of the needs of 21st century learners and ways to keep them engaged throughout the lessons.

Cell Phone Use

According to a survey conducted by Pearson in 2015 found that over 82% of high school students use their cell phone regularly up from 75% in 2014. The survey also discovered that over half of high school students, 54%, would like to use cell phones even more in class than they do now and the numbers are even higher for the younger children; 72% of elementary children would like to use cell phones more often as tools for learning (Pearson survey, 2015). Based on this data, the use of cell phones in school looks like it will continue to rise in the coming years.

Many think that cell phones are an incredible tool to help with learning when used correctly because textbooks can only help students solve questions that are published in the material; with a cell phone students have the ability to solve their own questions with access to the internet and other educational apps. Textbooks are often times developed for only one reading level, which can leave some students out due to their reading comprehension skills. An advantage for incorporating more cell phone use would be addressing the range of students reading abilities in class (Strong, Silver & Robinson, 1995). Newsela is an example of this service and Mersand (2016) reported that Newsela is a great resource for students who struggle with reading. It can also be used for ELL and ESL students to gain confidence and their reading skills. Mersand

identified that Newsela can be used by teachers to offer differentiation, customization, and powerful feedback (Mersand, 2016). Once students are trained to think critically about these alternative sources they use to find their information it will not be out of date, depending on the subject some of the information that is printed in a textbook is out of date by the time the textbook is in the students hands (Zook, 2017). Some of the textbooks teachers use while teaching can be over fifteen years old because some school districts have not updated textbooks due to the large cost associated with purchasing them for a large school district. However, websites and journals are updated as soon as new information or discoveries are published.

Even though cell phones and technology can impair the learning process if not used correctly, further research shows how powerful the use of cell phones can be in the classroom. The biggest challenge that educators face is the fine line between letting students access their phone for educational purposes but making students keep them put away during other times of class. According to a study performed by Tessier in 2013 on students in an Environmental Issues Class, Tessier found that students felt their cell phones helped their learning, improved their success, improved attendance minimally, and were not a big distraction in class (Tessier, 2013).

Educational apps are also a tool teachers can have their students use while in class. The New York Times reported that there is a rise in educational apps; in 2015 there was over 80,000 apps listed under the “educational” category. In the article “think instruments, think apps” Heilbronner said it was inevitable that high-quality apps would eventually take the place of scientific instruments (Heilbronner, 2016). There are many

reference apps and the ability for phones to connect to apps via bluetooth to measure things like temperature (Fortner, 2011). The article continues to mention that students are much more likely to use the calendar or some similar app for reminders and will be less likely to leave their cell phone at home, unlike their textbooks and notebooks. Many of these apps are very specific to science and can replace some of the more expensive and older technology that many teachers use in their rooms such as calculators, stopwatches, sunrise/sunset tables, reference apps, maps, compasses, and communication tools. Instead of purchasing many different instruments, students can take out their cell phone or device and open apps instead. Research by Schaal and Lude (2015) found that students who use their cell phones for GPS, instead of compasses, for geocaching and other location based games had a positive effect on knowledge acquisition, situational interest, and motivation.

Cell phones are a very useful tool for students when they are asked to read an article or website, looking up facts, taking a survey or other formative assessment online, researching data, and other quantitative observations when researching while in school. Some examples could be using their phones to complete a Google form as part of a formative assessment, use Google docs to collaborate on a group project, look up current weather conditions during an outside observation, and taking a picture of a particular site outside to reflect on later (Graham, 2013). Students can use photos of our landscapes we study for reflection. Rather than the distraction of taking notes, students can be fully immersed with the environment. Research by Do and Yamgata-Lynch (2017) found that cell phones are starting to become more common in qualitative observations such as

recording conversations and and to take pictures (Do & Yamagata-Lynch, 2017). In the experiential environmental education class one way to assess students' mastery of a topic can be reflecting on their observations during class. An example of this is walking through a coniferous forest and stopping to identify conifer trees along the way. Students will use a dichotomous key to identify the tree, the teacher will add information about the species of trees and interesting facts about it, and students will come up with annotated observations of the day including pictures or recordings of the experience. Students can also make videos of the activity as proof of learning and mastery. An example is the belay process during rock climbing. Students can video themselves going through the process of belaying and review the video and make adjustments if necessary to belay another student safely. If students are recording their observations either by a notepad on their phone or photographically they will be able to participate in discussions in class as well as their reflections in their science journal once the class period is over (Stacy & Cain, 2015).

It is important for educators to help prepare students for life after high school, whether that is a two year college, trade school, working, or a four year university. Many employees who work in the science field use their cell phones, computers, and other forms of technology as an everyday tool (McCarty, 2014). Students need background data from other studies and other information to draw from in order to make a hypothesis or a prediction to come up with their own thoughts on what might happen in an activity or experiment. Students will be looking at databases or information from their cell phones or computers not looking through old journals on the shelf of the library. By

giving students the opportunity to use their cell phone in class will make them better students because they will be able to look up and answer their own questions. This is backed up by an article written by Tessier (2013) that says,

Given that students are comfortable with and eager to use their cell phones, it makes sense for science teachers to transition away from a negative attitude about cell phone use in the classroom. Instead, educators can shift toward a positive understanding of these ubiquitous tools, encouraging their use in an active and engaging classroom setting in which students take ownership of the knowledge they acquire.

Cell Phone Misuse

Unfortunately, students do not always use their phones correctly in class and it can have a negative impact on their learning in the classroom. In a study from 2017, results found that students using their cell phones excessively in class can lead to disengagement in the lesson, checking social media platforms, multitasking, texting, contacting friends, and exploring new apps; all of which can be detrimental to the learning process by distracting students from the learning taking place in front of them (Effect of cell phones, 2017). Therefore, teachers need to be aware of this and plan their lessons and units carefully to help avoid misuse of cell phones. Teachers also need to be careful when choosing educational apps for their students based around cell phones and technology. Students today can be very easily distracted by cell phones and technology tools and teachers can not assume that students are engaged with the learning process because too often students can be engaged with only the learning tool in front of them.

Research by Kolb also says that students can be distracted by electronic devices sitting on their desk even if the cell phone is not open or up and running. They can be distracted by the idea that they are missing out on something they feel is important such as a text message or some other form of electronic communication (Kolb, 2019).

In college students, there is evidence of distracted learning amongst students that use their cell phones for either texting or conversing in the classroom. The research also found that students who use social networking and texting during class found that their grade point averages are negatively correlated (Walsh, Fielder, Carey, Carey, 2013). Social media is also affecting interpersonal relationships with those in the present. Communication and collaboration are important concepts with the 21st century learners that are in the classrooms today. Social media can hinder that collaboration amongst peers because some students are more interested in their online social network rather than the people right in front of them. In a study published in 2012, researchers in Sweden found that 80% of students in a 1:1 technology school ended up working alone more than with groups even though the assignments were meant to be in groups. The major factor was access to social media (Andersson, 2012). In some social settings, people will disengage from their current company to other events in their social media. This will hinder the collaboration of students because the group will not get the feedback they need from all members or one part of the project might not get completed because a member is too tied up in what is happening online (Thornton, Faires, Robbins, & Rollins, 2014). If teachers are aware of this and are very diligent in planning their lessons around the use of

cell phones and use the following guidelines their students can effectively use their devices in class.

Setting guidelines for cell phone usage in class is important if teachers are going to allow students to use them. Tucker (2015) says one of the first things teachers can do is set norms for the use of cell phones in their class. Teachers can set these norms themselves or have the students help come up with them. By allowing students to have a voice in making the norms they will be more likely to follow through with them because the students will take ownership of them. These norms should include guidelines for texting and checking social media, turning notifications off during class, and privacy about taking pictures of each other when in class. The guidelines should be posted somewhere in the class where the students can see them and the teacher can point them out if a student needs to be reminded of them (Tucker, 2015).

Tucker continues to suggest another tip for cell phones is when they are not in use, they should be in the students pocket, backpack, or face down on their desk space. If the screens are put down the students will not be as tempted to continually look and check them for notifications and updates from social media or text messages. If teachers treat cell phones and other technology as a part of the learning process the perception of these devices will change as well from devices that distract to devices that can engage students. Teachers should also keep in mind that it is acceptable to have students put their cell phones away during a time where technology is not needed. This could be during testing where test security could be compromised. Hanging calculator pouches

with numbers on them are becoming popular so students can place their cell phone in their numbered pouch and pick it up once the activity is over (Tucker, 2015).

The articles and studies that have been laid out have focused on traditional classroom cell phone use, but this project would research the use of cell phones and technology in an experiential science education class that primarily meets outdoors.

Student Engagement

What really engages students in the lessons that they are sitting in? How can a teacher engage and motivate their students throughout a unit? What exactly is student engagement? Strong, Silver, and Robinson (1995) says there are four things that motivate students: success, curiosity, originality, and satisfying relationships, energy, is used to round out the acronym known as SCORE. The definition of engagement in the article used was from Phil Schlechty, an educational researcher, who said, “students who are engaged will show three characteristics: they are attracted to their work, persist in their work even when it is challenging to them, and they take delight when they accomplish their work.” What are some ways that teachers can incorporate the idea of SCORE into their lessons? First, teachers need to convince students they can and are able to succeed. The students have to believe in themselves and teachers have a big role in making the students feel like they can. To help students see they can succeed teachers need to show students all the skills necessary to be successful and explain to students the criteria for success in their lesson and provide feedback immediately, both positive and negative.

Second, to address curiosity, teachers need to make sure they have fragmentation or contradiction in their lessons and the material has to make a personal connection with

the students personal lives. Teachers can take a global challenge and try to link it or come up with a local idea for the students to make that connection. If teachers can spark curiosity with their students by asking a phenomenon question students might take a bigger interest in “why” they are learning the information. It might make them go home and do more research on their own or plan a family vacation around information they learned in class (von Stumm, Hell, Chamorro-Premuzic, 2011).

Third, self expression is the main idea behind originality which allows students to explore and really figure out who they are. To some ideas for teachers to try in order to help with originality could be connecting projects with students personal experiences and giving students more of a choice on their projects. Teachers can have students help come up with the criteria of the project, or the type of media they would like to present with (Hall, 2015).

Lastly, teachers should plan on peer to peer relationships and the use of collaboration when designing lessons. A “jigsaw” lesson would be an example of this where students need their peers to help solve a problem (Strong, Silver, & Robinson, 1995).

Sometimes the best engagement is when students are an active part in the learning. With a teacher-centered approach to learning students are often unable to think critically and creatively to solve a problem. By having the students take an active part in their learning it will create a more meaningful learner and will engage students in higher skills thinking and mind-on learning (Sesen & Tarhan, 2010). It could be very easy for an educator to use technology and have the students come up with a project about the

distinct ecosystems found near their location. If students are able to learn about the ecosystems and then interact with them outside the classroom they now are an active part of their learning. They are outside, immersed in the content making a more positive connection. Research by Schaal and Lude found that students are more motivated and engaged when using mobile technology in environmental education classes compared to field guides and even human guides (Schall & Lude, 2015).

In addition to hands on learning, students need to be social in their learning. When planning lessons, it is important that the social aspect of learning is not taken out of the plan. There should be multiple chances for students to engage in meaningful conversations and use others to reflect on what they are working on (Kolb, 2019). One great resource that many school districts offer is Google docs. By having students collaborate and work together on a project or some other learning assessment they are able to communicate, comment, add suggestions, and edit in real time.

Teachers have a large responsibility to create a place in their classrooms that students can feel like they are a part of their learning. In order for students to be fully engaged with the material the teacher should try to make positive relationships with their students, where they feel valued and respected. Teachers should think about both the physical classroom, such as noise level or how desks are arranged, as well as the psychosocial aspect, such as how the students are treated by the teacher and peers (Gariby, 2015). Teachers can ensure these pieces are included in their lessons by requiring their students to have a say in their learning, and teachers design lessons that are suitable for their students levels. If a lesson was designed for 9th graders but given to

seniors, the 12th grade students will not be as engaged as the material may seem too easy or something they have a great deal of understanding of from their previous learning. If a teacher was to go deeper and build upon the background the students already know then the students will be more likely to be engaged and willing to participate at a higher level. The skills and material should also be presented in a logical sequence to ensure the students are successful in the beginning stages and continue to be engaged as the lessons build on the previous material (Njui, 2017)

Motivation and engagement are also very important in the learning process. In order for students to be engaged they must be motivated to learn. Students will be motivated and engaged to learn when they feel the material is interesting to them and they have a real purpose in engaging with the material. When the students are motivated and engaged, they still need to practice the material. Just like in sports or fine arts there has to be opportunities for students to learn a skill and improve on the skill. If the students are engaged this will be much easier for them to practice (Irvin, Meltzer, and Dukes, 2007). After reviewing student engagement inside the classroom this project will take what is learned and apply it to students outside the traditional classroom.

Environmental Education Learning Process

The goal of many environmental education classes is to help shape students who are environmentally literate who can see that all systems are interrelated, see the need for sustainability, and are able to make educated decisions about where to live, what kind of car to drive, who to vote for, etc. By taking students out of the traditional classroom to where students can make a more personal connection to the content and nature will

hopefully get students to see what is out there and want to protect what they have. Outdoor learning can encourage a positive environmental content knowledge and personal attitudes, development and overall academic performance (Sobel, 2015). Since environmental education does not advocate for one side of the issue or a specific course of action the environmental education process looks to teach critical thinking and problem solving skills. Students will see both sides of an issue and can weigh the pros and cons to make a decision that best fits their personal ethics (“Outdoor Learning”, 2018). One strategy to help students get experience making these types of decisions is incorporating problem based learning into an experiential education class.

Outdoor environmental education can increase environmental literacy by engaging students in all three learning domains including cognitive, affective and psychomotor (Jeronen, Palmberg, Yli-Panula, 2017). Take riding a bike for example, a student can learn about riding a bike, parts of a bike, history of the bike but without hopping on and trying to pedal for themselves they will never learn how to ride a bike. Experiential science education can be very similar to that learning about bikes experience. Students can watch videos on a topic, study the history of the topic, learning about what it is humans are doing to the environment but without being outside to make those connections there usually is not an urge to do anything about it. Making connections by actually being outside is what will help students be engaged in the material and learn from the experience. This is important to keep in mind when planning meaningful lessons in experiential environmental education. Kolb’s 1984 theory of experiential learning is a cycle in which students first learn about an abstract concept,

secondly investigate the concept, then reflect on their experience, and finally generalize how that concept works and relates to a previous concept. In order for students to be successful in this type of learning the students must be fully immersed in every aspect of the cycle (Jose, Patrick, and Moseley, 2016). Students and teachers in a senior only experiential education class have a great advantage to use this cycle as many concepts of ecosystems, nutrient cycles, and other topics have been introduced in their required science classes throughout high school. In their experiential class the students are able to take a new or deeper level of a topic, apply it to what has been previously taught, then reflect and generalize their new knowledge. They are also able to be an active participant in their learning by being outside and connecting with the concepts.

Reflection is a very important piece to this cycle and it can not be complete without it. There has been research done on reflection and its power in learning in environmental education. A study by Tooth and Renshaw (2008) showed that encounters with the natural world, along with deep reflection arising from emotionally engaging experiences of place, create a vividness and sensuality and with heightened responsiveness that can not be simulated without actually experiencing the natural world. Adding the experience discussion and reflection provide the basis for a new kind of learning that brings together conceptual knowledge, emotional responsiveness, and positive values regarding sustainability (Tooth & Renshaw, 2009). In addition to giving students the opportunity to reflect the teachers should model and make students aware that they are also learners by continually asking students what they are learning and how they are learning it. Not only should teachers encourage the reflection but they should

challenge their students assumptions about learning and encourage them to take responsibility for the decisions they make about learning, including their personal reflection about how they prepare for exams and complete their assignments. Research by Njui has shown that students test scores improve when they take responsibility for their own learning (Njui, 2017).

By taking students outside the teacher can enhance their learning process through interdisciplinary curriculum such as art, history, and physical education by exploring the world around them, making observations, sketches, or reflections, conducting experiments, and making connections with what they have learned inside by actually participating in their education. Students are more likely to participate in hands on learning that will engage all learning styles that they can apply in a real world setting. Instead of reading about this particular skill or watching a video on the internet they get an experience that feels real to them (“Outdoor Learning”, 2018). By using an experiential environmental education class as a lens teachers can try to relate the information to some point in history, how a topic has been influenced by a group of people, have students draw or sketch a landscape to encompass art, or use physical activities to get from place to place whether it is by walking, hiking, snowshoeing, rock climbing, or canoeing. By relating the information to other subjects students who may not find the information very interesting by itself can connect it to a piece of information or activity from another class that they enjoyed.

Problem solving is a skill that will make students better learners and more productive within the field of environmental education. In order to enhance the problem

solving skills of students hands on activities are very beneficial, especially outside the traditional classroom walls. Hammond says, “when students are invited to move their education beyond the walls of the classroom and engage in genuine action, they are given the opportunity to synthesize knowledge, skill and character; to test their preconceptions and misconceptions against real experience; and to learn both to follow and to lead as members of a learning organization” (Hudson, 2001). Further in the article the idea of teaching about how horrible we, as people, have been to the environment and this is labeled as “psychology of despair.” In general, the teaching of what we have done to the environment can take center stage compared to the teaching of what we have done to save it. This is important because not all people are bad and humans are doing some really great things to change what has happened such as removing and promoting awareness of invasive species, restoring landscapes back to native plants, or educating people about sustainable lifestyles. By not teaching only the psychology of despair, students can learn about the accomplishments of individual people and organizations who make it a priority to save what we have, by allowing the students to choose their own organization or person to study allows them to learn about something they are interested in and care about. Another way to avoid the psychology of despair is to show and teach about how an individual can make a difference. By giving students a sense of hope they can feel empowered to make a difference. Any teaching without discussing the harms or dangers of what can happen would be incomplete but celebrating the victories can help create sustainable and creative learning environment (Hudson, 2001)

Experiential environmental education can also help students with careers after high school. Individuals within the environmental career stated that their reasoning for choosing that career was from their education among other things. Many people could think back to a time in school where we learned something and has stuck with them. For most almost every high school learning memory comes from some hands on experience or outdoor activity. Instead of learning through lecture and other passive means about how learning through doing and in that process the learning process feels genuine and the outcomes are meaningful and personal (Howden, 2012). Research also states that the outdoor experiential education class should often be student led activities. By being able to take charge of their education by going outside and actively participating the students find the activities to be more enjoyable and effective in learning (“Outdoor Learning”, 2018). This could be more inquiry based activities with less of a teacher led lesson to letting students have a say in what activities or lessons they would like to spend more time on.

Teachers of experiential science classes need to set the atmosphere in their class that it is ok to make mistakes during the course because learning by making mistakes is an important piece in experiential education. Research from Cure, Hill, and Cruickshank (2018) says that, through these mistakes students are able to become active participants in their learning with a little guidance from their teacher. Teachers can not be an inactive bystander during the learning, the teacher must create a dialogue with the student regarding their errors which can help with the learning from their mistakes. Students will be less likely to get out of their comfort zone if teachers are not able to make positive

connections. In order for the students to benefit from learning from their mistakes teachers must work hard at making positive relationships with students where the students feel there is trust, care, and respect. Another key component to learning in an experiential education class is placing students outside their comfort zone. In an article by Luckner and Nadler (1997), they claim that “through involvement in experiences that are beyond one’s comfort zone, individuals are forced to move into an area that feels uncomfortable and unfamiliar” and in doing so students are able to move into their growth zone (Cure, Hill, & Cruickshank, 2018). Teachers must be careful to not cross the line in terms of student safety risk or any undue stress which would be counter-productive for the students.

After researching what makes a positive experimental science education class I want to research how to incorporate more personal technology into the lessons that will help students with their learning.

21st Century Learners

Students today are exposed to technology that could not even have been dreamt about fifteen years ago when the most up-to-date personal technology meant sitting in class playing a game on a graphing calculator. Students have access to almost unlimited amounts of information at their fingertips. Some school districts are a 1:1 district which means every student has a piece of technology to use in each of their classes while some school districts are bring your own device, such as a cell phone or some type of personal technology and will usually offer some devices to use during the day for students who do not have their own. Since students have access to technology and internet whenever they

need it their behaviors and needs have changed with it. Throughout the history of education there have always been advances in technology. Onyema and Daniil (2017) highlight some important technology inventions and how they changed education. In 2700 BC the abacus was invented and soon became an important teaching tool because people could do mathematical calculations quicker; in 1892 the invention of the stenograph to make copies and post office deliveries allowed schools to talk and correspond with one another; in the 19th century the invention of the motion picture projector was introduced into classrooms for films, photographs, and slides. In the 1950's, radios and television programs were used to enhance instruction. Each time a new technology was introduced educators had to start changing their teaching practices to fit with the times. In the 21st century there has been an influx of changing technologies such as the personal computer, internet, cell/smart phones, educational apps, and instant video streaming services. If teachers have changed their practices every time a game changing technology was introduced it should be time to look at smartphones in the classroom (Onyema & Daniil, 2017).

Students that are currently in high school have been growing up with technology from a very young age and are very good at using their cell phones for school purposes. Since this generation of students have had access to this information and the need to be connected at all times they have a decreased tolerance for lecture-style dissemination of knowledge (Roehl, Reddy, Shannon, 2013).

According to Kolb (2019) 21st century learners are spending as much as a quarter of their day using some form of media and for a couple of those hours they are using

more than one media at once. These kids, in general, are technology savvy and can benefit from technology in the classroom. According to research by Herring and Notar (2011) 21st century learners do not like using textbooks, instead they suggest that the textbooks are replaced with an online subscription to allow students to explore content, use to remediate, or enhance standards based learning. Students should be taught to take responsibility for their learning at an early age and with cell phones or computers, they should be able to access content whenever they want which should enable them to take control of their learning (Herring & Notar, 2011). Besides just finding knowledge they should also be able to show what they know by being creative with the technology they have. Some options students could create instead of a traditional worksheet could be producing a blog or video listing their observations, reflections, artwork, and what they have learned (Kolb, 2019).

The Partnership for 21st Century Skills, which is a national organization who advocates for 21st century readiness skills has defined the 4Cs: critical thinking, creativity, communication, and collaboration.

Critical thinking is very important for 21st century learners because so much information they find on the internet or other places might not be valid. Students need to determine what is credible online and what is not. Students will also practice critical thinking on both sides of an issue to determine their course of action.

Creativity in the 21st century is looking at problems in a different way and thinking outside the traditional classroom box. By allowing students to be creative teachers can use that intrinsic motivation and allow students to express their learning by

other means than a traditional test. Students are always going to have problems to solve, both in their personal and professional lives. If students are allowed to make mistakes and be creative in their problem solving skills in school they will be better equipped for life after high school.

Collaboration allows students to work together to solve their problem or goal. Njui (2017) suggests that by collaborating on problems students learn that there is often times more than one way to solve a problem, learn from other people's point of view, and work together to solve the problem when they come up with the best course of action. This will take patience and practice by both the students and teacher to make sure students do not feel left out if their idea is not chosen as the best solution. Teachers will have a big role in helping students realize that it is not a bad thing if their method was not chosen but the idea was still valuable and instead it made other students look at the solution in a different way. Through group work collaboration, students can search for understanding, solutions, or meanings, or creating a product, collaboration helps them express and defend their position, and generate new knowledge as they exchange different points of view, question others, seek clarification, and participate in higher order thinking such as managing, organizing critical thinking analysis and innovation. Not only will students take ownership in their learning but the learning of their peers as well (Njui, 2017)

The final C is communication. According to the Applied Educational Systems [AES] Organization (2019), who develops curriculum nationwide, texting and sending messages has quickly become very popular amongst 21st century learners and it is very

important for students to practice communicating and conveying their ideas through speech. If the four C's are put together students will feel more engaged, feel they have a purpose in their learning, contributing to others' learning, and can achieve almost anything (AES, 2019). Students need to separate facts from opinions and by asking questions and instead of memorizing information they can discover the information themselves. In order to prepare students for a very technology rich life after graduating high school teachers need to give them the opportunity to learn in a very technology rich classroom.

Henderson (2008) suggests that students that are in class today need to be prepared for jobs and careers after high school, many that have not been created. "Many of the fastest growing jobs and industries rely on their employees creative capacity which includes them to think unconventionally, question the herd, imagine new scenarios, and produce astonishing work." Students need to be able to think on their own and in a split second, show creativity, adapt, and be flexible in order to be successful in their future careers.

Henderson continues to say that students need to be creative and think about the unimaginable. Robert Epstein, a scholar at the University of California, has identified four competencies in creating creative capacity: capturing- coming up with new ideas, challenging- solving tough problems, broadening- boosting creativity and learning interesting new things, and surrounding- associating with interesting and diverse things and people to collaborate. He says the most important piece is capturing, teachers can come up with ideas for students to capture their new ideas, such as an idea folder or box

(Henderson, 2008). Now that we know that 21st century learners are different than students of the past I would like to see how to incorporate technology into an outdoor experiential science classroom.

Conclusion

After reviewing the use of cell phones in school, student engagement, environmental education learning process, and 21st century learners has led me to the conclusion that there is a need for a unit that uses cell phones with augmented reality to help students learn about the native trees to Minnesota and how they can use the maple sap to produce their own maple syrup for years to come. By connecting the use of technology in the field and getting students outside to explore the native trees to Minnesota and make maple syrup the students will hopefully make a connection with the landscape and will create a relationship with nature that was not there before for some students.

Cell phones are becoming more and more powerful learning tools it would be foolish to ignore them and keep the old thought of no cell phones in school. Students will be using augmented reality to see trees in a different way even when there are no leaves on the trees. Student engagement and environmental education learning both are deeply rooted in place-based theory of education and the project also incorporated the needs of the 21st century learners.

In chapter three I will discuss the overall augmented reality project, share my rationale, process, the setting and participants, and the overall project outline.

CHAPTER 3

METHODS

Overview

The purpose of this capstone project, integrating augmented reality into place based native Minnesota tree Identification, is to build a greater appreciation for the native trees in Minnesota and for the participants to see an example of a sustainable food source from Maple Trees, 100% natural maple syrup. This project is designed to help answer the question, does the use of cell phones outdoors by 12th grade experiential environmental education students have a positive effect on the learning process? This project is designed for students to be active in their learning by participating in a place-based learning educational theory framework. Chapter three will discuss the methods of designing augmented reality in experiential outdoor education, the rationale for the curriculum, the setting and the participants, the process for the design, and an outline of what to expect. This curriculum can be used to enhance the current Minnesota Forests curriculum to integrate technology into the learning process. One phenomena for this project is “how do trees survive through the winter”? Minnesota winters are a very harsh place with both deciduous and coniferous trees having special adaptations to be able to survive the winter. Another phenomena that students will learn about is “why do Maple Trees produce sugar and why does the sap taste good to humans”? One benefit for the students is that many of them will find the reason for the success of maple tree in Minnesota is very tasty to humans. By using the placed-based theory my goal is to give the students an opportunity to gain a better appreciation for the native trees to central

Minnesota and be able to share the sustainable maple syrup process with their families and friends for years to come.

Rationale

By teaching students how to identify trees you are opening their eyes to the natural world. Unlike identifying animals, shrubs, and herbaceous flowers, trees are large, always there, and many students will be familiar with what a tree is. Students will get a glimpse of the native trees to Minnesota and use that to understand the native landscape. Invasive species numbers are increasing and human impact on the landscape has changed it dramatically. If students understand what there once was hopefully it will instill the need to protect what they have. If they understand how each tree is unique to the landscape and how many other animal species depend on it is one example of why the students might feel a need to protect the landscape. There are many maple trees found in Central Minnesota and by showing students how to tap, collect, and boil down the sap for their enjoyment is a tradition tracing back to pre-European settlement by the Native Americans. By having students design an augmented reality program for a species of tree that will give the user a 3-D model of the tree species along with facts and figures that go along with it they can take control of their education by using technology in the field.

Process

I used Understanding by Design by Wiggins and McTighe (2012) along with place-based and project-based theory as the guiding processes behind this project. Understanding by Design is a backwards design process that focuses on the learning goals first and the teacher designs learning activities and assessment to address those

learning goals. There are three stages to consider when designing a curriculum using Understanding by Design. The first stage is for the teacher to identify the desired results. This would include what the teacher wants the students to know, understand, or do. Teachers need to make essential questions for each of their lessons before the design starts. Stage two is determining assessment evidence, how does the teacher know if the students know the information? Wiggins and McTighe suggest that the assessments are both performance tasks and traditional means of assessment. Performance tasks are an authentic assessment where students are given the opportunity to explain the concepts, interpret data or experiences, apply what they know, demonstrate perspective of the big picture, perceive sensitivity and recognize others' viewpoints, and have self knowledge by reflecting on their experience. The traditional tasks that can be used along with original assessments are tests, quizzes, and teacher observations. The final stage is planning the learning experiences and the instruction. Since teachers already know they learning outcomes, they can plan the most appropriate lessons to address the outcomes. Teachers must account for the transfer of learning in stage three. If they focus on just presenting information they can't make the learning meaningful to the students.

I chose to use this curriculum writing model because environmental education is so much more than just recalling facts, it is much deeper than that. Environmental education should promote critical thinking and problem solving and Understanding by Design really promotes student understanding of a topic as a whole (Brown, 2004). These senior students are building off prior knowledge from their time throughout high school and can create meaningful connections to enhance their learning. Understanding

by Design also encourages assessments that are authentic and not traditional fact recalling. Students will be assessed in multiple ways in both the field and in the classroom from formative assessments to check in on their learning, rubrics to assess their projects, to the in the field summative assessment in identifying Minnesota's native trees.

The purpose of this project is to identify native trees to Minnesota by using a dichotomous key as well as three dimensional augmented reality that will show what the tree looks like during the summer and benefiting from the maple sap to produce 100% natural maple syrup. The students will use what they learned in the introduction lesson and improve upon their understanding by using the augmented reality program by learning about the history of the native landscape, why the tree species is important to the ecosystem, and the summer tree structures. By showing students and having them actively participating in making maple syrup they will be seeing how to sustainably make their own natural maple syrup for years to come.

Setting and Participants

This curriculum is written for formal and informal secondary educators, naturalists, and/or parents to help enhance the education about the native trees to Minnesota and the maple syrup process. The project will be focusing on a high school senior only experiential environmental education class but can be modified to fit any needs. Participants will need access to smartphones with the augmented reality app that displays the augmented reality projects for the tree identification portion. The app is created by the company Vuforia and called Vuforia View. The curriculum guide will

need to take place both inside and outside the classroom where any species of maple trees, including silver, red, box elder, and sugar maples, are located as well as other native minnesota trees. The curriculum must be completed in the spring when the temperatures consistently reach above freezing during the day and below freezing at night, usually the middle of March through the beginning of April. To design the augmented reality, tap trees, and identify trees the instructor should plan about two to three weeks for the unit. The participants will also need access to a hand or battery powered drill and a 7/16" drill bit, plastic tubing, maple sap spile, and a bucket with a lid. They will also need access to an evaporating dish with a heat source, a science hot plate with large beakers, a kitchen stove with a large pot, or a commercially made sap evaporator are all options. Any trees near a school campus will most likely be native to Minnesota and will work, maple trees might be a little more tough to locate, Silver Maples will be located on a flood plain near a river, a Sugar Maple can be found in a hardwood forest setting, but any maple species can be tapped for sap. Students will be expected and trusted to work without the direct supervision of the teacher. Caution and hazards will be outlined in the guide as there are certain risks associated with this unit of study.

Outline

Part 1- Conifers Vs Deciduous Trees

Big Idea- Conifers and deciduous are different.

Essential Question- What is the difference between conifers and deciduous trees?

Cones vs flowers

Resin vs sap

Hardiness zones in Minnesota

Part 2- Minnesota Native Trees

Big Idea- Minnesota has a large temperature swing from summer through winter and trees here have adapted to survive.

Essential Question- What adaptations have trees made to survive through winter in Minnesota?

Sap

Resin

Conifers characteristics

Deciduous characteristics

Part 3- Design the Augmented Reality

Big Idea- Using augmented reality can enhance the learning process.

Essential Question- How can students using a 3-D augmented reality model improve learning.

Research one tree species native to Minnesota

Design 3-D model of your tree species

Add required information to your program about your tree

Part 4- Maple Syrup

Big Idea- Humans can use maple syrup as a sustainable food source.

Essential Question- What part of the tree am I tapping into to collect sap?

What minerals and nutrients are found in the sap?

Native American history with maple sap

Maple tree identification

How to tap maple trees

When to tap maple trees

Maple sap collecting

Evaporating the sap

Finished product storage

Pancake feast

Part 5- Using Augmented Reality

Big Idea- Students use augmented reality to learn and identify Minnesota native trees

Essential Question- How does using augmented reality improve my knowledge of native Minnesota Trees?

Conclusion

In chapter three I discussed the methods for Integrating Augmented Reality into Place Based Native Minnesota Tree Identification. This included the guiding questions, rationale, participants, settings, process, and project outline. Chapter four will look at the results of the curriculum guide and a conclusion of the project.

CHAPTER 4

CONCLUSION

Introduction

When writing this curriculum I learned about environmental education, engagement and motivation outside the traditional classroom with 21st century learners, and about integrating more technology in education. The driving question throughout my project was, does the use of cell phones outdoors by 12th grade experiential environmental education students have a positive effect on the learning process? I have designed a multi-week curriculum that uses an augmented reality program by Vuforia to identify winter trees and why the native trees are successful in a harsh place like Minnesota. Students will also learn about the history of making maple syrup while being able to make some themselves.

Chapter one looked at my personal journey and experiences that led me to where I am and why I am interested in using technology in the field. I had such a great experience taking the class, Outdoor Adventures, in high school and I am thrilled to be able to teach the class now and I want my students to be able to share that same experience I had. One common theme throughout chapter one was being outside and wondering about the natural world. By designing this project students will see a small part of the native trees in Minnesota and hopefully spark some interest in saving what we have or instill some passion to enjoy nature for years to come.

Chapter two looked at the literature that supports my decision to design curriculum that incorporates both a very old method of making maple syrup along with

very new augmented reality technology. I needed to narrow down a very broad topic into smaller subtopics to be able to complete this chapter. This chapter opened my eyes to research that supported what I was doing in my classes everyday such as project based learning, collaboration, and a small use of cell phones.

Chapter three touched on the framework about how the curriculum was written along with setting and participants for which this curriculum is designed for. Understanding by Design along with place based education were used as the framework for designing this curriculum. By knowing what I wanted my students to be able to do before I started writing my lessons helped me build some solid lessons I am anxious to try out with my students in the spring.

This chapter will include an overall reflection of this capstone project along with what I learned along the way, limitations of the project, future projects, and how the curriculum will impact the teaching profession.

Learnings

Throughout this process I was able to reflect on both my personal and professional learning. My goal is to share what I have learned throughout the project with colleagues and students and my hope is that what I learned will benefit my students while making me a better teacher. I was very interested in integrating more technology and specifically the use of cell phones into my classes which led me to my research question. Throughout this process I also became a better writer, researcher, and curriculum designer.

I have never been a very confident writer and I have never written a paper for others to use for their research. Through using the Hamline Library's Writing Center to peer reviewing other capstone projects I feel that I have learned a lot about academic writing. Researching credible sources and determining which ones to use and which ones are legitimate can be a challenge for any level of research. I was able to use the Hamline Bush Library online database as a tool for research as well as recommendations from my classmates for journals and other online resources.

In my limited experience with curriculum writing I mainly went along with what was already in place at my school. I never really had a need to question it until now. One thing I learned was what a powerful tool the Understanding by Design planning actually is. By blending the three stages of curriculum writing I feel that my lessons are much more effective than what I was doing before. Since my environmental education class curriculum and daily plans always seemed to be a lower priority because I usually only have one or two sections per trimester. It is also difficult to plan a large unit and stick to the schedule when weather has such a big effect on class being held outside or if a day inside is needed. I feel like this unit is solid and the days can be rearranged due to weather if need be.

Literature Review

I found the literature review to be a very beneficial piece to this curriculum project. I have always assumed some of the topics and ideas that I was researching were true but to find actual research to back it up was a positive thing. The literature looked at

four topics; cell phone use in school, engagement of students, environmental education learning process, and 21st century learners.

From the cell phone use in school section I learned that cell phones, when used correctly, can be an amazing tool in the classroom. Research by Tessier (2013) has shown that cell phones can have a positive effect in the classroom as it engages students more than a traditional textbook and the possibilities are virtually endless when it comes to apps and learning tools on phones (Heilbronner, 2016). Pearson study (2015) showed that more students are looking to use cell phones during school to help enhance their learning. By taking what the research has shown and trying to implement more technology into an experiential outdoor education class will hopefully enhance the student learning and have a positive effect.

I was also intrigued with my research into 21st century learners. Most of the research I found was from after I graduated college and started teaching. Some of my older colleagues would say things like “kids are different today” or “students have changed since I started here” and that is true. As teachers we need to continue to change our teaching strategies and continue to take a close look at our lessons to keep up with the needs of today’s students. Kolb (2019) found that 21st century students spend as much as a quarter of their day on their cell phones and are less motivated to use a textbook to gain information as students before them. Njui (2017) said that 21st century students need the four C’s in their learning, critical thinking, communication, creativity, and collaboration and when all of these are put together students will feel more apart of the lessons and can achieve a higher level of learning.

Limitations

The curriculum has many limitations that the teacher needs to address before implementing it. First, the teacher has to have a lot of trust with their students and have a positive relationship with them before they start. If the teacher can not trust students to be on their own without supervision the curriculum needs to be modified for their class as there will be independent work time outside the classroom. Second, it is best to have a variety of native trees to Minnesota either on campus or within a short walk from school. However, with the augmented reality students are able to see what the trees look like even if the tree species are not on campus. Third, there needs to be maple trees on campus or within a short walk to make maple syrup and access to maple sap evaporation materials. If there are not maple trees near by the teacher could collect the sap off campus and bring it to school or modify the lessons to however they see fit. Fourth, if students do not have access to a smartphone or personal device, the school will need to have a device for students to use. Lastly, the school needs access to software that allows students to make a 3-dimensional model of the native trees. If the software is not available to the school district there are some free augmented reality apps that might have three dimensional models of the trees.

Overall, this project is specific to my high school but can easily be modified to fit at any school that would like to implement more place based projects. I am excited to see

the results of this project and hopefully see the benefit of using augmented reality in the field.

Future Projects

Augmented reality has its place within any science education class. I feel this curriculum is just the start of what could be done. Not only can my students use this app in my outdoor experiential science education class but I can see where the app could be used in my chemistry classes as well. Molecular bonding is one area I can see using this. Instead of using the traditional ball and stick models to show bonding between atoms students could use a virtual three dimensional model instead. Students would still be able to interact with the molecule and rotate it around to see the molecular geometry. I would also like to use augmented reality to make three dimensional models where students would design an element along with its characteristics during the periodic table unit. Students can show what is in the nucleus for their assigned element along with its electrons and its electron shells to show how the electrons react with other atoms during a chemical reaction. This could replace the two dimensional models that are regularly done on paper.

Benefit to Profession

By being the first teacher to use this Vuforia augmented reality app in our school I will be able to explain the benefits or the downside of using it to the rest of my colleagues. Since the number of cell phones and cell phone apps are still growing the need to start integrating technology in the classroom is still very relevant and teachers who might know very little about the app can have a resource in the school. I could see

where this would work well within Social Studies classrooms by bringing some of the locations they are talking about to the desks or in Biology class looking at cells or body systems.

This curriculum will also be an experiment for integrating augmented reality into the classroom and data will be collected. I will have student data collected from the winter tree identification vs the augmented reality tree identification assessments. Along with the scores on both of the assessments I will also have a survey for each of the students to fill out which addresses their thoughts on the augmented reality in class. The results of the survey will also help me with modifying some of the lessons to better benefit the students. I am planning on sharing this data with my school administration along with colleagues and other educators to show the benefit of the curriculum and make a case for implementing more augmented reality into other classes.

I am also planning on reaching out to the local park systems both at the county and city levels. I feel this could be a benefit to the community by having the QR codes along walking paths to help with tree identification and information about the landscape they are in. The town I live in has a rich history along the river with many signs explaining what was here before. Having models of the buildings or logging operations along with the signs might be of interest to the citizens.

Conclusion

In this chapter I wrote about my overall journey and my learnings from this project. I looked back at the literature review, covered some possible limitations, and future projects, and benefits to the profession and local community. This journey has

been a whirlwind and I am grateful for my opportunity to further my education and hopefully change the lives of the younger generations. I am excited to have my students try these lessons out and get feedback from them. I think these lessons are a good starting point and I am proud of the project that I have put together.

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