Using Existing Educational Tools to Support and Enhance Environmental Education: Utilizing Ecoliterary Texts, Gamifying Education, and Integrating Technology

by

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Abstract

Raising the next generation of environmental stewards is essential to addressing growing environmental degradation, and therefore, effective and accessible environmental education is more important than ever. However, research shows that there are many barriers facing educators when implementing environmental education in their practice. As such, this portfolio asked: how can teachers use existing educational tools and techniques to improve and support environmental education for students, specifically through the use of children's literature, technology integration, and gamification. An extensive literature review uncovered many common themes in answering this inquiry, including known barriers to educators, best practices in environmental education, and how ecoliterary texts, technology, and gamification practices can be used to enhance environmental education for all. A website, 3Eguide.com, was developed for teachers to help them in their quest to implement environmental education, and includes lesson plans, videos and other resources, available to teachers who seek to better their practice and the world. The following document includes an introduction, my personal positioning within the research, a literature review, methods, and of course, links to the website.

Keywords: Environmental education, ecocriticism, children's literature, gamification, technology,

Introduction

> If fully educating our children means accepting possibilities for teaching that are not as conventional, but present the information through a means that better connects with our children, shouldn't we at least give it a shot? (Kacoroski, 2015, p. 34).

This assertion effectively describes the incredible potential of existing educational tools to be used in new and innovative ways to support environmental education. The following portfolio was designed to investigate the ways in which teachers can improve their environmental education practice, specifically through the use of existing educational tools and techniques. The main research question addressed by this portfolio was: how can teachers use existing educational tools and techniques to improve and support environmental education for students? Sub questions include: (a) how can technology be used in environmental and outdoor education; (b) how can children's literature be used to support environmental and outdoor education; and (c) how can gamification be applied to environmental and outdoor education? Topics explored throughout the portfolio include, but are not limited to, environmental education, its definitions, goals, barriers, and best practices; children's literature and the environment, focusing on the themes in children's texts, ecocriticism, ecoliterary texts, and implications for practice; the integration of technology in education, including the benefits, barriers, strategies, and research specific to technology use in environmental education; and the gamification of education, investigating strategies, benefits, and environmental education games.

Environmental education has been a long time passion for me. My own environmental education started at home. It began with a love of nature that was nurtured by my parents and heightened with every hour we spent outside. From cottaging and camping, to hiking and foraging, we took every opportunity we could to be outdoors, no matter the season. My environmental education grew and changed as I grew up. In eighth grade I was lucky enough to have a teacher who valued environmental education. He incorporated environmental ethics and theory into our lessons, and started the Beechgrove Environmental Team, of which I became Student Director. This experience taught me how to share my love of nature with others. We developed a documentary on climate change that included animations, skits, infographics and

more, and shared it with schools in our district. It was here that I discovered how useful technology could be in environmental education. I took this new knowledge with me into high school as a Green Gryphon club member, and eventually to Trent University as an Environmental and Resource Studies major. I knew that I wanted to be an environmental educator. During this time, I took a job as a children's programmer at Gravenhurst Public Library. I was fascinated by the children's literature that surrounded me, and discovered that I was easily able to integrate what I was learning at university into my library programs for children of all ages. Even better, I was able to use technology as a tool to do so! However, I knew after graduating from Trent that I needed to learn more, so I enrolled in Lakehead's Faculty of Education. Here I took every environmental education course available to me. Following this, I entered into Lakehead's Masters program, specializing in Environmental and Sustainability Education. I took a course on gamification, and everything clicked into place. There are so many tools available to educators, many are familiar ones, and I realized that these tools could easily be used to help educators better incorporate environmental education into their practice, if only someone would show them how.

This is the true essence of my project, its main purpose and goal: to create a one-stop shop for educators who want to enhance their environmental education practice through the use of existing and familiar tools and techniques. By developing a website, 3Eguide.com, I've produced a platform in which educators can explore environmental education and the tools and techniques available to them. The website is broken into sections for educators to explore: Environmental Education, Children's Literature, Technology Integration, Gamification, and Resources. I have provided visitors with information on environmental education best practices, how to overcome barriers, ways to use children's literature for effective and powerful environmental lessons, how to integrate tech into both outdoor and indoor environmentally themed activities, and of course, methods for gamifying environmental education, among many other topics. The website focuses on presenting educators with well-researched, easily digestible information, both academic and practical. There is a lot of information already available arguing why environmental education is important, but I believe that my website fills a crucial hole in the research, which is the practical side of actually implementing environmental education. To address this need further, in addition to the website, I also created a resource series for teachers, which includes fifteen lesson plans, a book selection checklist, an ecocritical teacher's guide, as

well as numerous other infographics, videos, and presentations.

With this in mind, the following literature review will explore existing literature and studies concerning environmental education, the role of children's literature in education, ecocriticism and eco-literary children's texts, the gamification of environmental education, and technology's role in supporting environmental education. Through the discussion of recurring scholarly themes, insight into modern environmental education tools and techniques will be explored.

Literature Review

Environmental Education

Environmental Education: Definitions and Goals

Although there are numerous definitions of environmental education (EE), and various proposed best practices for instruction, EE is most commonly characterized through its dual intent to foster harmonious relationships with the environment and positive ecological behaviours in students (Omoogun et al., 2016; Otta & Pensini, 2017). Many environmental educators advocate for a holistic approach to EE that increases pro-environmental behaviours (PEB) through the use of an intrinsic driver – connectedness to nature (Otta & Pensini, 2017). EE encourages the development of sustainable practices in its participants through its promotion of environmental ethics and values (Muthukrishnan & Kelley, 2017). When implemented effectively, EE acts to change human views and attitudes of the environment and the utilization of its resources, focusing on deliberate responsibility and stewardship (Omoogun et al., 2016). EE teaches environmental literacies to students with the hope of nurturing a new generation of environmental stewards (Stevenson et al., 2014). Omoogun et al. (2016) provide a more substantial definition, stating that EE is "concerned with teaching conceptual knowledge and skills, a process in which individuals gain awareness that will enable them to act and the development of the values and attitudes which will motivate and empower individuals and groups to work and promote sustainability to solve present and future environmental problems" (p. 64). Karcoroski (2015) gives a more simple and spiritual definition, explaining that it is the goal of environmental educators to "increase environmental literacy in those we educate and to instill a fierce love for nature that will encourage our children to choose to protect nature for their children and their children's children" (p. 34). In part, these definitions largely describe the cultivation of stewardship in pupils. Dueck and Rodenburg (2017) describe the importance of stewardship explaining that nurturing this quality in students requires exposure to suitable experiences and tools at the appropriate ages and developmental stages, resulting in a deep knowledge, love, and respect for the natural systems that not only sustain us, but all life on our planet. They delve further, asserting that stewardship suggests a deep attachment to the environment, and achieving such a state requires a proactive approach on the part of educators. Deuck and Rodenburg (2017) conclude that EE experiences should generate a "sense of awe and

wonder" (p. 4) in students, educating the head, touching the heart, and producing positive action. Clearly, environmental stewardship is a common theme within related literature (Anderson et al. 2015; Bell & Dyment, 2008; Dueck & Rodenburg, 2017; Liefländer et al., 2013; Louv, 2008; Omoogun et al., 2016; Otto & Pensini, 2017; Stevenson et al., 2014) when discussing the intent of environmental and outdoor education, and many would agree that fostering a love of the environmental and pro-environmental behaviours is one step that environmental educators can take in the fight against modern neo-liberal, industrial, and consumerist systems that promote the utilitarian environmental values that currently compromise the health of the environment (Omoogun et al., 2016). This corresponds with a notion presented by Kacoroski (2015) in her paper, in which she quotes Nelson Mandela as saying environmental "education is the most powerful weapon which you can use to change the world" (p. 35), and ultimately has the potential to "cultivate empathy and respect for all life" (Dueck & Rodenburg, 2017, p. 4).

In their literature review, Omoogun et al. (2016) deconstruct this extensive, and overarching ambition, and describe detailed goals, objectives, and principles of EE. Three main goals were identified: (1) to promote an awareness of, and concern for, the interdependence of human social/political/economic structures and ecological systems within rural and urban communities, in students; (2) to provide equal opportunities to access educational experiences promoting the acquisition of the "knowledge, values, attitudes, commitment and skills needed to protect and improve the environment" (Omoogun et al., 2016, p. 63); and (3) to nurture new attitudes and behaviours toward the environment. These goals can be supported and achieved through five core categories: awareness, attitudes, skills, knowledge, and participation. According to Omoogun et al., EE students should, through their experiences, acquire: an awareness of environmental issues, knowledge and basic understanding of ecological concepts, protective attitudes and concerns for the environment, the skills required to identify and address environmental problems, and, the motivation to actively participate in solutions for environmental issues.

Environmental Education: The Benefits

EE (when implemented effectively and including outdoor experiences) produces a tremendous number of positive outcomes (Omoogun et al., 2016). Outcomes identified by Louv (2008) include: differentiation for various intelligences, "student gains in social studies, science, language art and math; improved standardized test scores and grade-point averages; the

development of problem-solving, critical-thinking and decision-making skills," (p. 148) improved classroom behavior and attendance, enhanced cooperation and conflict resolution, improved self-esteem and motivation to learn, therapeutic benefits regarding attention-deficit disorders, increased resistance to stress and depression, improved emotional health and wellbeing, enhanced cognitive abilities, sustained concentration, engagement in creative play, and improved physical health. These findings are supported by various other sources, including a 2010 study that systematically reviewed current research on outdoor play, as well as time spent in nature, and found numerous mental and physical health benefits (McCurdy et al., 2010). Mental and physical health benefits were also identified as outcomes resulting from time spent in nature by a 2015 study (Anderson et al.). A 2008 review that investigated research regarding green school environments expounded these benefits, identifying the outcomes of student exposure to green spaces, natural places, and the environment when in elementary school, including: improved academic performances, increased learning opportunities, positive motor skills development, reduced obesity rates, diversified play and educational experiences, improved attentional functioning, improved interpersonal relationships, constructive channeling of energy, heightened sense of productivity and readiness to learn, improved self-esteem, positive disposition toward new learning experiences, and increases in hope (Bell & Dyment). The authors also identify improved relationships with the nonhuman other, including the development of a nurturing attitude toward plants and animals, as well as increased environmental stewardship, and improved relationships with the environment, as positive outcomes resulting from nature experiences.

Speaking of relationships with the environment, a common outcome that emerged in the literature was the potential for outdoor EE to foster stronger, deeper, connections to nature in children (Liefländer et al., 2013; Otta & Pensini, 2017). A 2013 study that investigated the development of nature connections in children ages 9-13, found that participating in EE resulted in a robust short-term increase in connectedness with nature (Liefländer et al.). However, researchers note that only the younger students' connectedness to nature remained sustained four weeks following the experiment and as such, they recommend that "environmental educators should keep in mind that strengthening connectedness to nature is more sustainable before the age of 11" (Liefländer et al., 2013, p. 370). Similarly, a 2017 study, that evaluated the effect of participation in nature-based environmental education in 4th to 6th graders, determined that

increased participation in nature-based environmental education was related to greater ecological behaviours, resulting from increases in environmental knowledge and connectedness to nature (Otta & Pensini).

Becker et al.'s (2017) literature review identified numerous additional positive outcomes from outdoor educational programs, including improved student enjoyment and attitude toward educational experiences, increases in attention regarding homework, reduced disruptions and disturbances, improved understanding of ecological issues, improved communication skills, increased relevance of schoolwork to real- life, relatable contexts for students, enhanced self-confidence, the development of active responsibility for the environment, increased respect for others, and better cooperation, teamwork, and social relationships within the class dynamic. A 2005 report described similar positive outcomes relating to outdoor classrooms in rural contexts, sorting the identified benefits into five categories (1) Cognitive outcomes: increases in knowledge and understanding, improved ability to use technical terms and relate their knowledge of concepts to other curriculum areas, improved perceptions of learning (outdoor learning seen as more fun), (2) Affective outcomes: increased excitement, perceived as novel and new, increased empathy for nonhuman other, enhanced personal development, encouraged the development of values and beliefs related to the environment, (3) Social/Interpersonal outcomes: development of social and interpersonal skills, increased student confidence and self-esteem which leads to improved academic performance, improved cooperation and teamwork, improved student behaviour, (4) Physical/Behavioural outcomes: young people learned how to promote positive environmental action and influence change in society, and, (5) Relationships with Students: outdoor educational experiences creates a new dynamic between students and educators, more informal, easier to create positive relationships outside of pupil/teacher dynamic, leading to improved student/teacher relationship (Dillon, et al.).

James and Williams' (2017) study worked with 7th and 8th grade students, coupling classroom learning with outdoor EE experiences, and found a long list of pay-offs including: the creation of memorable, comprehensive, and long-term learning, higher levels of engagement in and motivation for learning, deeper and more effective learning, increased emotional engagement, demonstrations of critical thinking skills, and the development of an intrinsic love of learning in the outdoors. The researchers report that outdoor EE in conjunction with traditional classroom lessons are particularly valuable for students who struggle with traditional

school tasks or have developed an apathetic stance toward school and learning. They suggest that said students are able to take on leadership roles in the outdoors, thus leveling the academic playing field. These benefits are similar to those described by Holloway and Mahan (2012) who state that the benefits of outdoor EE include: physical, emotional, and mental development, increased motivation, enjoyment in learning, and improved skills such as communication. Kilburn's (2012) *Into Nature* guide also presents the following additional benefits of outdoor education: creates a foundation for future environmental sustainability and stewardship practices, decreases childhood bullying rates and injury rates, and reduces physical and cultural barriers.

To further add to this mass of research, numerous researchers agree that outdoor EE has the potential to support the healthy development of risk assessment skills in students (Beames, 2012; Brussoni et al., 2012; Gilbertson et al., 2006). One source explains that simply put, outdoor educational experiences expose students to risks they can learn from (Gilbertson et al., 2006). Beames (2012) describes it best, arguing that,

> A mindset that is solely focused on safety does children and young people no favors. Far from keeping them safe from harm, it can deny them the very experiences that help them to learn how to handle the challenges that life may throw at them. There is an emerging consensus that our society has become too focused on reducing or eliminating risk in childhood. (p. 79)

Outdoor education is often associated with risk in the minds of educators, however Beames' assertion makes clear that far from being a deterrent for outdoor EE, risk should act as an essential part of the EE experience.

Environmental Education: Barriers

Risk is a perceived barrier to outdoor EE for many teachers, but it is not alone. There are a great many obstacles that teachers identify when discussing the inclusion of EE (both indoor and out) in their practice. Regarding outdoor educational experiences, educators have identified a number of barriers in their efforts to implement meaningful and effective outdoor lessons. These include: funding, attitudes, time, motivation, safety risks, and the development of effective lessons and activities (Wait, 2009). Other barriers include lack of access to greenspace, fear of the unknown, and excessive emphasis on standardized tests in contemporary educational models (Louv, 2008). Stevenson et al. (2014) identify a similar list in their literature review, and study, which surveyed 627 elementary school teachers in North Carolina. They found that lack of time

for environmental science education, testing pressure, lack of background knowledge, low self-efficacy in teaching science and emphasis placed on math and literacy in standardized testing and teacher education, were all barriers identified within related literature. From their survey, they determined that lack of time and resources were the most important barriers identified by participants, followed by the heavy focus on math and literacy (both in terms of instructional time and standardized tests), and finally, that environmental literacy was more easily taught in science, and thus less frequently integrated into language arts and mathematics. Additionally, teachers also identified the need for environment-related lesson plans, children's literature, EE curriculums, professional development, field-trips, and guest speakers, to support EE in their classroom and teaching practice.

Dillon et al. (2005) identify various barriers relating to the integration of the curriculum into outdoor educational experiences off of school grounds, including: (1) timing the lesson and outdoor experience effectively, (2) competing curriculum pressures limiting the opportunities for follow-up after outdoor lessons, (3) students not seeing outdoor visits as connecting with their learning, (4) not all members of a class are able to take part in an outdoor visit, (5) certain kinds of activities being difficult to repeat in the school environment, and (6) outdoor educators having few opportunities to support/follow-up with students following a field trip or excursion off of school grounds.

Environmental Education: Approaches, Strategies, and Best Practices

Despite this extensive list of obstacles, some researchers argue that currently, environmental education is ineffective not because of the barriers faced by teachers, but because of a lack of good pedagogy and teaching practices (Omoogun et al., 2016). In order to address this, the following section identifies strategies to overcome barriers, as well as best practices in EE. To begin, Wait (2009) identified strategies for overcoming EE hurdles following the completion of her study which collected data from 1933 educators in England. Firstly, Wait asserts that understanding and embracing the value of outdoor learning will improve the motivation and commitment of educators in their endeavor. Essentially, educators need to recognize that outdoor education supports many diverse learning types, supports behavioral, personal and social development, and thus is in itself an effective lesson with incredible benefits for students. Secondly, adopting a positive attitude and willingness to seek solutions to barriers is key to the successful integration of EE. Wait indicates that teachers need to communicate and

work together to develop strategies to overcome concerns (for example, ask for parent volunteers to mitigate supervision issues). Wait goes on to say that educators should also involve students in the planning process for the experience as this will increase student ownership and personal responsibility concerning the success of the lesson, and leads to enduring learning and autonomy. Another source suggests that in order to overcome institutional barriers, schools, communities, families, and teachers should develop positive, common goals for outdoor education (Dueck & Rodenburg, 2017). Not only will this empower children, but provide them hope as well.

From there, a common theme in the literature expresses the need for a paradigm shift regarding risk assessment, moving from keeping children as safe as possible, to keeping children as safe as necessary is crucial for outdoor learning experiences (Brussoni et al., 2012). Beames (2012) provides an off-site safety checklist (p. 86), and a risk/benefit analysis for improved safety (p. 88), as well as general guidelines for environmental educators (p. 106) to assist in this effort. She also states that students need to be responsible for managing risks on their own during outings, and as such their involvement in risk planning is essential.

Providing additional information regarding the integration of EE into the traditional classroom, Stevenson et al. (2014) assert that early intervention is key, which is supported by Liefländer et al.'s (2013) research findings. From there, Stevenson et al. (2014) goes on, arguing similarly to Wait (2009) that teachers with positive environmental attitudes, high levels of environmental literacy, and high receptiveness to EE, are more likely to overcome the barriers to teaching environmental literacy. Stevenson et al. make numerous recommendations such as: the development and provision of curricular materials/lesson plans (including cross-curricular lessons and strategies for the integration of environmental literacy into non-science subjects), pre-service EE methods courses, training, and professional development on EE, as well as the use of children's literature to support EE. Gilbertson et al. (2006) also makes many useful recommendations for practice regarding EE. They suggest addressing student preconceptions of EE prior to lessons, making lessons and assessments authentic and relevant to real life, teaching concepts not facts, creating challenges for students, and providing students with direct, first-hand experiences (including with specialized equipment). Bell and Dyment (2008) provide a list of attributes that environmental educators can facilitate, including: providing a healthy physical and social environment, engaging parents and the broader community, providing equal access to multiple educational opportunities, nurturing empowerment and the ability to take action, cope,

and generate change, and finally, ensure that the curriculum is relevant to the needs of students.

Ultimately, Omoogun et al. (2016) believe that by targeting environmental attitudes, EE can change the dominant human views of the environment and the ways in which we utilize and access ecological resources. They argue that this can be achieved through the five categories mentioned previously: awareness, knowledge, attitudes, skills, and participation. In addressing awareness, effective EE should help social groups and individuals to "acquire an awareness of and sensitivity to the total environment and its allied problems" (Omoogun et al., 2016, p. 63). In terms of knowledge, EE should provide groups and individuals with a variety of experience in, and basic understanding of, the environment and the issues that surround and threaten it. Regarding attitudes, Omoogun et al. recommend that EE facilitate student acquisition of positive environmental values, concern for the environment, and motivation to actively participate in environmental improvement and protection. With respect to skills, the authors suggest that environmental educators should focus on teaching skills that help students to identify and solve environmental problems. Finally, concerning participation, it is recommended that teachers provide all groups and individuals with an opportunity to be actively involved at all levels in working towards resolutions of environmental problems.

Omoogun et al. (2016) also provide a list of additional principles that govern effective EE. These include a mindset that considers the environment in its totality - natural and built, technological and social. Moreover, EE should be an ongoing process that begins at the pre-school level and continues throughout all forms of education, both formal and informal. It is also advised that EE take an interdisciplinary approach, promoting a holistic and balanced perspective. Furthermore, Omoogun et al. (2016) propose that EE should "examine major environmental issues from local, national, regional, and international points of view so that students receive insights into environmental conditions in other geographical areas" (p. 64). As well, environmental educators are encouraged to promote the value and necessity of cooperation at all levels (local to international) in the prevention and solution of environmental problems. Next, it is recommended that educators enable learners to have a role in their planning and learning experiences, allowing them to make decisions and accept their outcomes or consequences. Omoogun et al. (2016) urge environmental educators to nurture environmental sensitivity, knowledge, problem-solving skills, and values in every age group, while placing a special emphasis on environmental sensitivity to the learner's own community in the early years.

EE should help students to uncover the symptoms and causes of environmental problems while teaching the complexity of environmental issues. Finally, EE "should move beyond the walls of the classroom so that students can engage in concrete action and have the opportunity to integrate knowledge, skill and attitudes with action" (Omoogun et al., 2016, p. 68). This final principle relates well to Louv (2008), who asserts that there is a need to better integrate real life science experiences into the curriculum, instead of teaching abstract and non-contextualized EE concepts that appear to be separated from the natural world. He recommends a natural history curriculum as one potential solution to this.

For more information regarding EE for beginners, Kilburn's (2012) guide introduces the 'Big Ten of Outdoor Experiential Education': (1) Improve teaching for the teacher, and learning for the student, (2) Explore, discover and inquire, (3) Prepare, (4) Be Safe, (5) Communicate, (6) Gather Support, (7) Manage your class effectively, (8) Be a facilitator, (9) Teach in the outdoors on a regular basis, and (10) Nurture care for the natural world. The guide also contains a 'Getting Started Planning Guide' which includes an outdoor education vision creation process, sample letters to parents and administrators, teacher and student outdoor education kit checklists, and a quick readiness checklist for outdoor educational learning experiences. Dillon et al. (2005) also provides an extensive list of considerations and strategies to combat barriers and begin implementing EE in one's teaching practice.

Lastly, numerous researchers in the field suggest that teachers use the tools already available to them in their classrooms to support, integrate, and enhance EE. For example, Muthukrishnan and Kelley (2017) state that it is a common practice for teachers to use books to introduce environmental concepts and to help students envision the natural world. Ecology teacher, John Berry, believes that "most kids have an innate awe of nature that can be tapped into using technology combined with hands-on experiences" (Ferrie, 2009, p. 17). Ferrie (2009) states that "computer technology—iPods, PDAs, video games, etc.—is here to stay… The key is to use [technology] to the advantage of nature and the environment, sparking what Berry called the innate awe of nature in kids" (p. 19). In order to effectively address these assertions, the following sections will investigate the use of children's literature, technology and gamification in EE, and will explore the research and academic fields related to their use.

Children's Literature and Environmental Education

Children's Literature and Environmental Values

Picture books are storytellers (Burke & Cutter-Mackenzie, 2010). They serve as a form of cultural communication (Wason-Ellam, 2010). They are cultural products while simultaneously functioning as cultural contributors, influencing and transforming culture by presenting new or outlying ideas that are not necessarily present in mainstream society (Bland, 2014; Caruso, 2014; Rainbow, 2014). The idea that literature functions as an impactful multimodal media, influencing the outlooks, attitudes, and behaviours of readers, specifically children, is well researched. Prior et al. (2012) report that because picture books tell a story through both pictures, and text, they require special and deliberate consideration as their visual information plays a "dominant role in the development of character traits, interests, and emotions" (p. 196) of young children. Wason-Ellam (2010) claims that illustrations add to text and make the messages in books more understandable and meaningful for children. This sentiment is repeated in Muthukrishnan and Kelley's (2017) work, in which it is argued that illustrations and images in children's books leave a more profound impression in the minds of children than the text. Additionally, Muthukrishnan and Kelley assert that because we live in a time of technology, visual literacy is highly developed in children (they can read and interpret images well) and thus the images in children's literature needs to be closely examined. More than that however, the overall messages and belief systems presented in children's literature need to be evaluated. Muthukrishnan and Kelley state that this is because books often portray two stories, one consciously and the other unconsciously. Writers intentionally address social, political, and moral beliefs, but unintentionally perpetuate harmful values and beliefs. This is especially true regarding environmental ethics.

Op De Beeck (2018) provides a thorough examination of the evolution of environmental messages in children's literature, as summarized in this paragraph. To understand where we must go, we must know where we have been. So, beginning in the early to mid-twentieth century, children's literature historically features what Op De Beeck refers to as the fairytale of modernity, in which pre-industrial nostalgia, technological optimism, capitalist perspectives, and the exploitation of land, dominated as defining themes. Popular children's literature of this time positively portrayed machines and humans as allies against the natural forces of the inanimate earth. Technological progress and industrial landscapes were prevalent themes, displacing preservation and natural habitats. The books presented worldviews that mourned damaged

nature, but ignored the cost of progress. Moving on to the late-twentieth century and into the twenty-first, anxieties about industrial development coupled with a sense of urgency caused by habitat loss and extinction, lead to a new type of children's book. These books typically portray humans and nature at odds (or at least urban and wild spaces), and according to Op De Beeck fall into two categories: picture book dystopias (showing Victorian style images, or distant futures with extinct animals), and observational accounts of natural phenomena (which combine lyrical prose with factual information about the lives of animals, nonhuman others, and natural cycles). Op De Beeck argues that because humans have not yet balanced urban development with conservation and environmental sustainability, our perceived division from nature shows in our picture books, which reinforces our ethical failures.

Muthukrishnan and Kelley (2017) discuss modern picture books in a similar light. Their study examined how images in nonfiction children's books approach the topic of sustainability and whether or not they support the goals of environmental education. The researchers selected seven books that had the following common features: nonfiction genre, sustainability as the main theme, used photos instead of cartoons, had a K-12 intended audience, and were published in the USA or Canada. They analyzed their total of 384 images looking at the coded categories of gender and age, actions of people, depictions of nature, and depictions of objects, structures, and habitation. They found that depictions of humans and human-made systems were dominant in the children's books. Industrial and urban environments were the most frequent settings. Nature was most frequently depicted in the form of a single plant. Females were more often shown as consumers, with males being depicted engaging in pro-environmental behaviours such as recycling. No images in any of the books portrayed the connection between consumerism and environmental degradation. Sustainable actions and lifestyles were not portrayed, which led the authors to infer that consumerism is a societal norm. Lastly, Muthukrishnan and Kelley found that consumerism was promoted by the overwhelming depiction of objects in the images.

Echterling (2016) also investigated environmental children's literature. He argues that children's books rarely discuss the interconnectedness of environmental issues, and do not bring up the need for government intervention and corporate responsibility. He adds to this, stating that children's literature often oversimplifies environmental issues and separates them from larger systems, portraying them as easily fixed by individual lifestyle changes. As such, he asserts that most children's books assimilate into neoliberal, and capitalist society, rather than highlighting

structural inequalities and marginalized others including animals and the environment. He goes on to say that environmental children's books often present pro-environmental behaviours as hobbies rather than necessities, and do not discuss topics like environmental and social justice. He argues that when children's literature does present pro-environmental behaviours, they promote individual lifestyle changes that position youth as apolitical and incapable, rather than promoting youth agency and activism in environmental movements, a stance that depicts children and young people as political subjects with the ability to grasp and act on complex political and economic issues. Finally, Echterling (2016) concludes that sadly, many environmental children's books do very little to encourage beliefs and behaviors that will actually help us quell the environmental crisis we face "because of their over-simplification, overwhelming focus on individual acts and lifestyle changes, and unwillingness to address the relationships between environmental degradation and systemic social problems" (p. 288).

In a 2010 study, Wason-Ellam investigated the environmental messages in Canadian picture books that feature the natural environment, and examined their potential use in exploring childhood identity and its relationship to the environment. Wason-Ellam explains that Canadian children's literature often focuses on the landscape in their illustrations, depicting many examples of Canada's terrain, contrasting urban and virtual spaces. It is explained that when children experience these places, their local or national landscapes, in literature, they become sensitized to them which causes them to develop an ethic of caring. This idea is echoed by Burke and Cutter-Mackenzie (2010) who contend that picture books have the power to teach children about the environment and to connect them to places. Op De Beeck (2018) furthers this notion, maintaining that by studying nature in books, we are led into the natural world. Op De Beeck argues that the modern movement in environmental education generally uses adults as gatekeepers to nature, in which children access nature in a controlled way through supervised and structured lessons and activities, while promoting books as tools to learn about the environment. What is great about books however, is that reading books about nature can invoke a sense of wonder about the environment in children, and that is something that they can explore independently.

Carolyn Sigler identifies three approaches that children's literature has taken regarding the natural world and the position of humans in it (Martin, 2004). First, the domination model, which promotes an anthropocentric view that assumes the primacy of humans, and accepts and

encourages the domination of nature. The care-taker model is second, and it promotes environmental stewardship for the benefit of humans (if we continue to care for the earth, we will have the resources we need to survive). The third approach, a biocentric model, undergirds many traditional Indigenous philosophies, and combats traditional Western ideologies by decentering humanity's importance in nonhuman nature and exploring the complex interrelationships between humans and nature. It emphasizes the connectedness of all living things.

This field of inquiry investigating the potential for literature to influence the perceptions and actions of readers goes beyond the human world to include research regarding human treatment and understandings of nonhuman others. For example, in her essay Kummerling-Meibauer (2014) investigates the representations and portrayals of insects in children's literature and the resulting impacts of such depictions. She argues that following the release of Charles Darwin's study *The Descent of Man, and the Selection in Relation to Sex* (1871) an increased interest in insects emerged, due to its inclusion of chapters analyzing the social and emotional lives of insects. This interest has led to the use of insects, serving a multitude of functions, in children's texts, and a series of positive repercussions have evolved as a result. These include provoking awareness in children of ecological topics, fostering empathy for non-human others and reducing 'otherness', understanding the complexity of biospheres and ecosystems, as well as recognizing the importance of insects in such systems, acknowledging the superior numbers and adaptability of insects, and identifying insects as subjects, rather than objects. Kummerling-Meibauer believes that children are able to relate to the insect-human paradigm found in picture books because it reflects their own relationships and power struggles with adults. To conclude, Kummerling-Meibauer states that children's books successfully allow children to see from an insect's perspective, and entice their sense of wonder at a world so much smaller than their own.

Through his writing, Bartosch (2014) explores the importance of teaching animality, rather than anthropomorphism, particularly through the use of children's literature. He argues that children's texts should focus on the 'like us, and not like us' paradigm, instead of portraying fallacies by providing animals with unrealistic abilities. By this, he means that children's authors should highlight the tension between human/animal comparisons, and the acceptance that humans can learn to understand others, by not really understanding them at all. This

disorientation provides a shock value that will appeal to young readers, and maintains a more truthful portrayal of the human-animal relationship. Bartosch suggests that one way to accomplish this is to focus children's texts on compassion for animals through the lens of finitude. We, animals and humans, all have an expiration date, and this truth can foster compassion for animals. To provide examples of this, Bartosch examines Shaun Tan's *The Rabbits* and Wolf Erlbruch's *Ente, Tod und Tulpe* (Duck, Death and the Tulip). He states that *The Rabbits* does an excellent job of maintaining the like us, and not like us paradigm by using animals to represent the English colonization of Australia, while maintaining the distinction between humans and animals. Erlbruch's work thoughtfully and tastefully examines the concepts of finitude that we share with animals. Bartosch argues that both texts are also examples of trusting in the capacity of children to understand complex and difficult themes. To conclude, Bartosch explains that children's authors should focus not on consciousness raising, but instead use shock value and disorientation to portray similarities and differences between humans and animals as a source of reflection for readers, rather than of division between the human and animal world, because once we see ourselves as a part of nature, we will begin to think of it in the correct way.

Shirai (2011) reviews numerous publications featuring human/animal relationships and concludes that children's literature, when used and written effectively, can convey important messages regarding animal ethics and animal welfare. Shirai (2011) stresses that "contemporary books not only advocate for animal welfare but also protest strongly against speciesism and the exploitation of animals" (p. 171). Despite these positive findings, other scholars warn of the negative implicit messages regarding animals that are being conveyed through children's picture books. Marriott (2002) examines images of nature and animals in modern picture books. He argues that picture books act as windows to the world for children, impacting their acquisition of moral concepts regarding animals and nature, and thus, examining the ways in which picture books frame such topics is of great importance. In his study, Marriott examined over one thousand picture books, and observed two themes in relation to animals and the environment: domestication and transformation. Under the theme of domestication, Marriott notes that animals portrayed in most of the picture books were characterized by their closeness, familiarity, or proximity to the ordinary lives of urban children (pets or farm animals). When wild animals did appear, they were typically displaced from their natural habitat. Under the theme of

transformation, Marriott discusses the common practice of anthropomorphizing animals within picture books. Marriott also notes that environments are frequently transformed to appear more exotic, welcoming, and magical.

The anthropomorphism and displacement of animals in children's literature is a common critique. Timmerman and Ostertag (2011) for example discuss the negative impacts of such representations, arguing that the anthropomorphism of animals reinforces ideas of human superiority and dominance over animals because it goes beyond recognition of the self in the other, and does not allow for opportunities for children to recognize the nonhuman animal in themselves. The dis/misplacement of animals in children's literature is also problematic, as children learn that animals are entities separate from their respective habitats and ecosystems. The recurrent representations of exotic animals also rob children of the opportunity to form meaningful relationships with nonhuman others that they may actually encounter in their lives, and that live in their local environment. Timmerman and Ostertag recognize a third theme that Marriott (2002) grouped under domestication, and that is the lack of animal subjectivity in children's media; animals are typically portrayed through human perspectives, for human needs. As Op De Beeck (2018) points out, this results in the human habit of "thinking anthropocentrically and [results in] our failure to imagine animals' own experiences" (p. 81). In opposition to this reality, Timmerman and Ostertag (2011) call attention to the value of animal wisdom, and state that regardless of its use to humans, animal subjectivity has intrinsic value that should be represented within children's literature.

Such a large range of ethical issues regarding children's books, coupled with the clear impact of literature on children's value systems, might cause educators to ask, 'How do I distinguish between positive environmental picture books and negative ones?'. Luckily, there is a field of study that specializes in answering that question.

Ecocriticism, Ecopedagogy, and Ecoliterary Texts

There are many definitions of ecocriticism, and though the term is widely used, its meaning remains ambiguous among academia (Dobrin & Kidd, 2004). Despite this, scholars agree that the various strands of ecocriticism "share a fundamental commitment to the physical world" (Massey & Bradford, 2011, p. 111). One particularly common definition describes ecocriticism as "the study between literature and the physical environment" (Dobrin & Kidd, 2004, p. 3; Gaard, 2008, p. 11; Glotfelty, 1996, p. xviii), "[taking] an earth-centered approach to

literary studies" (Dobrin & Kidd, 2004, p. 3; Glotfelty, 1996, p. xviii). Chang (2016) explains that "in the twenty-first century [ecocriticism] has come to include cultural and literary studies, science and animal studies, ecophilosophy, environmental ethics ... the environmental justice movement... among other academic domains" (p. 150). This framing of the term is expounded upon by Glotfelty (1996), who explains that at its core, "ecocriticism takes as its subject the interconnections between nature and culture, specifically the cultural artifacts of language and literature ... as a theoretical discourse, it negotiates between the human and non-human" (p. xix).

As such, ecocriticism can be distinguished from other forms of literary studies, which explore the world in terms of human and social understandings, through its expansion of said focus to include the entire ecosphere (Glotfelty, 1996). In its infancy, ecocriticism focused primarily on literature for adults (Glotfelty, 1996). Slowly however, children's literature began to be recognized within the field. As Gaard (2008) explains, a new branch of ecocriticism that focused on "interrogating the relationship of culture and nature through the relationships of children and animals" (p. 14) became formally established throughout the mid 90s and into the early 2000s. This branch of ecocriticism formally took shape in 2004 with Kidd's *Wild Things: Children's Culture and Ecocriticism* (Gaard, 2009). Gaard (2008) goes on to suggest that in order to be a force for social change, ecocriticism must be paired with ecopedagogy. Ecopedagogy builds on ecocriticism in many ways: (1) demanding civic engagement in the ecoliterary classroom; (2) questioning the invisibility of animal studies in ecocritical fields; and (3) upholding children's literature as an agent of social change. With this in mind, it is suggested that an approach to children's literature that is informed by ecopedagogy could aid in the development of a "just, democratic and sustainable planetary civilization" (Gaard, 2008, p. 14). Gaard (2009) goes on to raise three questions for consideration when analyzing children's literature:

> First, how does the text address the ontological question, ''who am I?'' Is human self-identity constructed in relation or in opposition to nature, animals, and diverse human cultures/identities? In other words, how does the narrative/text provide an antidote to the first step in the logic of domination? Second, how does the narrative define the ecojustice problem? Does the narrative conclusion offer an appropriate strategy for responding to the problem posed in the story, rejecting hierarchy in favor of community and

> participatory democracy? Are children left alone to solve ecojustice problems originally created by the adults? Third, what kind of agency does the text recognize in nature? Is nature an object to be saved by the heroic child actor? Is nature a damsel in distress, an all-sacrificing mother, or does nature have its own subjectivity and agency? (p. 327-330)

Finally, Gaard provides six boundary conditions for for an ecopedagogy of children's environmental literature: (1) praxis, or a commitment to acting based upon ethical theoretical frameworks – what actions does the text recommend and what actions does the educator model; (2) teaching about the social and natural environment – does the text teach about environmental issues, the causes of those issues, and how to appropriately respond; (3) teaching in the social and natural environment – where will environmental lessons be taught and how will they connect the text to the natural world; (4) teaching through the social and natural environment – do the assignments related to the text and its teachings allow students to engage in action for social and environmental justice, sustainability, and health; (5) teaching the connections of sustainability – does the text teach ecocentric values and the interconnectedness of systems, or does it promote hierarchies and domination; and (6) urgency – does the text emphasize a need for action?

Muthukrishnan and Kelley (2017) agree with Gaard's (2009) fifth condition, stating that educators (and publishers) should look for children's literature focusing on environmental education and sustainability. The images and overall messages of the book need to show whole systems, and the impact of human actions (Muthukrishnan & Kelley, 2017). A good example of a book that presents the interconnectedness of living things and the agency of nature, is discussed by Simpson (2014) in her deconstruction of *Kwezens Makes a Lovely Discovery*, a traditional Nishnaabeg tale in which young girl learns to collect sap from a squirrel. Simpson identifies key differences between Western knowledge systems, and Indigenous Knowledge, including the portrayal of the more than human in traditional storytelling. She asserts that Indigenous Knowledge systems use the land as pedagogy, and are underpinned by an appreciation for, and understanding of, animal knowledges, stating that in the story, Kwezens "already understands the importance of observation and learning from our animal teachers" (Simpson, 2014, p. 6). This is similar to Bone's (2013) classification of animals as the fourth educator. Through stories such as these, morals are passed on to the next generation, which is similar to the Western tradition of using picture books to teach societal values to children. Through an ecocritical lens, stories, like those found in the Indigenous tradition, that promote ecocentrism in children, are essential in

stimulating a cultural paradigm shift which results in the recognition of animal rights and their intrinsic value.

According to Chang (2016), the "willingness to 'revalue' nature-oriented literature has led many readers to seek wisdom in Native American texts'' (p. 150). This is also true of educators, who use literature as a method through which to reconnect children with nature. Chang (2016) suggests that using books from Indigenous authors that encompass Indigenous values, such as Louise Erdrich's *Chickadee*, is one way for educators to pass on the "all-embracing respect for nature" (p. 149) that is found at the heart of Indigenous culture, to children. This respect for nature is characterized by its acknowledgement of other creatures as elders, and relatives that guide and protect us. Chang (2016) concludes that,

> One way that Native American children were taught how to live in harmony with their environment was through the oral storytelling of their elders. Contemporary Native American children's literature with an ecocentric focus can accomplish the same end. But books like Erdrich's Chickadee have the ability to reach a wider audience, teaching the beginnings of environmental literacy to children who have lost or who never had that kind of connection to the world. (p.158-159)

Outside of the use of Indigenous literature, other scholars have compiled helpful guidelines for educators in their attempt to choose environmentally conscious books that promote positive attitudes and actions towards nonhuman others and the environment. Firstly, seeking out and utilizing ecoliterary texts – texts that are characterized by scientific validity and credibility, and educate readers in order to maintain ecological affinity for other species, the landscape, and the environment as a whole – is an important first step toward improving one's EE practice (Rainbow, 2014). Buell (1996) presents four criteria present in environmentally oriented children's books that educators should look for: (1) the nonhuman environment is present not merely as a framing device (human history and natural history are one); (2) the human interest is not the only legitimate interest; (3) human accountability to the environment is part of the text's ethical orientation, and; (4) some sense of the environment as a process rather than as a constant is implicit in the text. Additionally, as discussed by Kimmerer (2017), Freeman et al. (2011), Bell and Russell (1999), and Russell and Semenko (2016), language use is also incredibly important. Language frames the way we view and interact with the world, and as such, the way that picture books discuss animals impacts children's perceptions of nonhuman others. For example, the use

of the pronoun ‘it’, the use of industry names to refer to animals as tools or products (poultry for example), using animal names as insults (whale or pig), and using language that removes human accountability toward animals and the environment are all red flags for educators to watch out for (Bell & Russell, 1999; Freeman, Bekoff, & Bexell, 2011; Kimmerer, 2017; and Russell & Semenko, 2016).

Bland (2014) makes reference to this in her work, discussing the terms we use to put down humans such as ‘swine’, ‘beastly’, and ‘feral’, all of which refer to our animal counterparts and thus assume human superiority. She begins her essay with an exploration of children’s literature arguing that it has cultural influence. She explains that EFL/ESL educators should use environmentally themed texts in their classrooms because the environmental crisis is a global issue and thus its urgency extends beyond cultural barriers. She goes on to state that environmental issues should be considered of equal importance to issues such as race and gender. Bland claims that educators must introduce such issues during early childhood, before traditionally Western ideologies influence children’s paradigms, promoting the idea that humans are separate entities from the natural world. Bland continues her chapter by asserting that Western culture traditionally classifies the world in opposites (male/female, reason/emotion, human/nature) resulting in parallels between women, emotion, and nature. Where this was once considered detrimental to the women’s rights movement, it can now be embraced and women can use it to make change in society. In addition, the child’s connection to nature is another source of strength when influencing social changes. Bland goes on to explore the use of collateral learning in EFL/ESL classrooms, disclosing that while acquiring language skills, English language learners are also acquiring attitudes and paradigms.

Wason-Ellam (2010) discusses EE practices in the classroom that utilize texts and suggests, similarly to Bland (2014), that classroom dialogue about the stories (unpacking them) leads to the development of cultural values, beliefs and practices that contribute to sustainable relationships with the environment. Op De Beeck (2018) states that an ecopedagogy of children’s environmental literature that engages in these types of activities can develop basic environmental literacy in students, inform individuals and their actions, and help students to resist and critique capitalist, industrial, colonial, and anthropocentric values. What educators need to do is discuss literature with children through an ecocritical lens. Echtering (2016) pushed this notion even further, arguing that environmental educators also need to provide students with opportunities to

be activists. He cautions however, that educators must avoid scaring children regarding environmental issues, and instead empower them to act within realistic boundaries.

Bhagwanji and Born (2018) explore how to start this process. They begin by identifying the two predictors of pro-environmental behaviour in students – direct experiences in nature, and second-hand learning through books – and then propose research based strategies for implementation in the younger years. They couple outdoor environmental experiences with children's literature in their approach. Beginning with toddlers, the primary focus in outdoor EE is exploration and security. Toddlers need to explore the environment and learn about it in relationship to self, while developing physical skills. In regard to books, toddlers like books about animals because they like to imitate their movements and noises. Next, Bhagwanji and Born state that preschoolers need to spend time outdoors in natural settings with caring adults in order to form relationships with nature. Books need to have captivating stories that help children to reflect on their own time in nature. Books should be ethical, accurate, and positive, and nature should be portrayed as a safe and welcoming place. Bhagwanji and Born report that at this age, children internalize cultural values, and develop morality and a sense of right and wrong, and so adults should model positive environmental behaviours. Bhagwanji and Born continue, discussing learning through play for all ages of children. They argue that children take positive action toward the environment by virtue of the time they spend in nature, and that play leads to a deeper connection to the natural world. Bhagwanji and Born also recommend scaffolding children's nature experiences to create a sense of safety and familiarity, regardless of age. After this is established, agency in nature can be nurtured, leading to a sense of responsibility for nature. Next, Bhagwanji and Born encourage intentional teaching in which educators consider a child's development stage to craft nature experiences and choose books that are best suited to their needs. They should avoid themes that children are not developmentally ready for that may lead to despair, loss of hope, and fear. Alternatively, appropriate children's picture books serve as sources of inquiry, content information and guides in conscious thought development. Bhagwanji and Born conclude by providing both a list of book recommendations, and selection criteria for books. Paraphrased, their selection suggestions include: choose books with sensitivity and grace (books should inspire wonder, curiosity, and provide positive environmental messages, not fear, despair, and divisive values), look carefully at the roles or responsibilities of children encouraged in the stories (does it match what your students are developmentally ready for?),

question how nature is portrayed (avoid books that perpetuate a disconnect from nature), be aware of how animals are portrayed (avoid books that anthropomorphize animals or that villainize them) and, obtain multiple copies of books available (so that multiple students can explore them independently). For further strategies regarding animal ethics, specifically in the language arts classroom, see Bell and Russell (1999).

In the science classroom, children's books have immense benefits, and numerous uses. Rainbow (2014) argues that children's literature can be used to teach environmental scientific knowledge as well as ecological values. He expands upon this stating that books can be used as tools to make science more engaging by presenting scientific knowledge in more accessible formats. He solidifies this point, stating that traditional science is mechanistic, reductionist, impersonal, and frankly, dry, while literature is emotional, empathetic, and relatable. Caruso (2014) agrees that science and literature can collaborate to improve science education. In her paper, she begins by introducing Charles Pierce Snow's two cultures of science and literature. According to Caruso, Snow claimed that the interdisciplinary use of both cultures can greatly contribute to learning due to the range of outcomes achieved by engaging with both cultures. Caruso believes that this relationship can be used as a new educational method, through which students can learn science (including environmental science) through literature, and can learn about literature through science. Caruso sets the stage for this educational endeavor by exploring past relations between the two camps, arguing that scientific literature during the 20th century shared a common vocabulary with readers from all disciplines making scientific knowledge more accessible during that time. This contrasts today's scientific publications as they use terminology so specific that only experts in the field find the publication accessible. Dissimilarly, science fiction presents real science concepts in an accessible way, and pairs them with the social ramifications of scientific discovery. In this way, literature opens up the conversation about science. Caruso then applies these ideas to the use of science fiction in the classroom, stating that students engage with the journey of self-discovery as well as with the scientific processes and methods through science fiction. Working with science fiction can lead students to discover many genres of study including history, earth and space sciences, physics, technology, government, and natural history. An interdisciplinary approach using science fiction may include the reading and analysis of science fiction texts in order to test the knowledge of scientific principles of the reader by either falsifying or confirming those principles presented in the text.

A Great Divide

Technology vs. Nature: The Growing Movement Toward Technology Integration and Gamification in Environmental Education

In their review, Omoogun et al. (2016) state that effective EE encourages a paradigm that "considers the environment in its totality - natural and built, technological and social" (p. 64), however, this ideal is outside of the norm in traditional environmental educational practices and beliefs. Many environmental educators have historically viewed 'nature' as a sacred, peaceful, and pure, place that people can access to escape the hustle and bustle of modern society, an entity that is entirely separate from the human built world (Anderson et al., 2015). This traditionally Western view links modern societal structures and progressive developments to increases in alienation from wild nature, specifically citing cyberspace, virtual reality, and online environments, as prime contributors to our divided worlds (Omoogun et al., 2016). This sentiment is expanded upon within the literature, as researchers note that a common belief within environmental fields argues that our faith in technology and human innovation has directly contributed to the exploitation and degradation of natural resources, linking technological advances and progress to ecological disturbances and growing environmental issues (Omoogun et al., 2016). As such, technocentricism, the belief that human technology will serve as a remedy for all environmental issues, has previously been condemned by environmental educators (Omoogun et al., 2016).

This worldview has led to the general misconception that children must 'unplug' from technology in order to successfully achieve a meaningful relationship with, and experience in, the natural environment, and prompted one source to state that EE and computers were traditionally considered to be an antagonism (Anderson et al., 2015; Louv, 2008). Many studies and acclaimed environmentalists have associated contemporary sedentary lifestyles, and increases in technology-related indoor activities (amongst other barriers) with the current disconnect between today's youth and the environment (Anderson et al., 2015; James & Williams, 2017; Louv, 2008; McCurdy et al., 2010). Another source argues that "the rapid progress and integration of technology and electronic media in our society .... has become the dominant force detracting from physical activity and outdoor time" (McCurdy et al., 2010, p. 103). Simply put, we have a love-hate relationship with technology (Ferrie, 2009).

This is evidenced by the fact that on average, children in the United States, between the

ages of eight and eighteen, spend seven hours a day interacting with media, and only thirty minutes a week outside (James & Williams, 2017; Holloway & Mahan, 2012), with a staggering 97% of American youth playing computer and video games (McGonigal, 2011). Video games specifically are played by 64% of Canadians of all ages, with 80% of Canadians considering computer and video games to be mainstream entertainment, and 71% of Canadian parents playing some form of video game with their children at least once a week (ESAC, 2018). According to one source, by the time a student is 21 he or she will have played nearly 10,000 hours of video games (Bruder, 2015). Richard Louv (2008), author and environmental advocate, describes this perceived detachment from the natural world and ecological systems as the third frontier, an era characterized by humanity's ignorance of our dependence on the environment and overdependence on technology. In his book, Louv (2008) describes an interview with a fourth-grade student who explains that, "I like to play indoors better, 'cause that's where all the electrical outlets are" (p. 10), a response that would appear to support the argument that technology is hindering the formation of childhood relationships with the environment.

However, later in his book, Louv (2008) goes on to explain that "the problem with computers isn't computers— they're just tools' the problem is that overdependence on them displaces other sources of education..."(p. 137). This statement encompasses the growing movement that maintains that technological advancements and tools are not the true source of our modern disconnect from nature, rather, ineffective integration of technology into, and general lack of, environmental education are (Anderson et al., 2015; Ferrie, 2009; McGonigal, 2011; Ruchter et al., 2010). Only recently, "many [educators] have come to the conclusion that there is a time and place for these digital technologies. We cannot fight them, so instead we should embrace the educational potential and develop a method of integration that does not detract from the natural experience" (Kacoroski, 2015, p. 35). Many educators are growing less skeptical of technological support in EE, and are beginning to explore the potential of technology to enhance outdoor educational practices (Anderson et al., 2015; Ruchter et al., 2010). A 2018 study found that in reality, 42% of teen and child gamers participate in outdoor activities (ESAC). As such, perhaps the gamification of EE, integration of serious games, as well as other computer/video game technologies, focusing on environmental literacies, could be the key to engaging the other 58% of students in outdoor, or environmental activities.

In her paper, Ferrie (2009) explores this potential in three case studies. In one such study,

technology coordinator Clancy Wolf explains that the outdoor education center for which he works is incorporating technology as a way to cater to different learning styles (Ferrie, 2009). Technology is an "amplifier," he explains, that helps extend our senses and "since we interact with the environment through our senses, using technology seems a logical element of instruction about the environment." (Ferrie, 2009, p. 16). It is also recognized that technological competencies are a high priority in many classrooms across the country, while place-based EE receives little, to no attention, and so, in an effort to remain competitive and up-to-date, environmental educators are investigating methods through which they can support ecological and experiential education with technology, creating meaningful and memorable experiences for students (Anderson et al., 2015; Ferrie, 2009; Kacoroski, 2016; Ruchter et al., 2010).

Part of this movement includes teaching digital literacy skills as they relate to EE. As defined by Ontario's Ministry of Education (2021), digital literacy is the ability to solve problems using technology, to engage with emerging technologies, to identify the rights and responsibilities of a digital citizen, and to recognize the "opportunities that come with living, learning, and working in an interconnected digital world" (Digital Literacy Section, para. 1). Many of these themes parallel the learning outcomes of EE, which explores global environmental citizenship, the interconnectedness of the world's environmental systems, and solving environmental problems. Students can easily use and improve their digital literacy skills through environmentally themed lessons that integrate technology.

Today's youth are digital natives (also called screenagers); they have had access to technology for the entirety of their lives, and it may be in the best interest of environmental educators to use this reality to their advantage by incorporating technology into their pedagogy (Hechter & Vermette, 2013; Kacoroski et al., 2016). One source explicitly states that digital natives have different ways of expressing themselves, and different learning preferences because of their profound relationship with interactive, multimodal, information and communication technologies (Bonora et al., 2019). Their educational preferences are characterized by multitasking, visual media, activity/project-based learning, and technology-infused learning environments. They are less motivated to work in environments that lack these characteristics, and thus technology, including the use of video and computer games, and the general gamification of education, arise as a potential educational tool for 21st century students and educators. McGonigal (2011) cites Marc Prensky, author of *Teaching Digital Natives*, who states:

> "Engage me or enrage me," today's students demand. And believe me, they're enraged. All the students we teach have something in their lives that's really engaging—something that they do and that they are good at, something that has an engaging, creative component to it… Video games are the epitome of this kind of total creative engagement. By comparison, school is so boring that kids, used to this other life, can't stand it. And unlike previous generations of students, who grew up without games, they know what real engagement feels like. They know exactly what they're missing. (p. 127-128)

This sentiment is echoed by Nand, et. al (2019), who argue that children are more motivated to play games than learn in school, therefore in order to increase student motivation, we need to design education tools that resemble popular computer/video games. Lee and Hammer (2011) support this argument, stating that school simply does not engage students the same way games (or technology) do, and as such, effective gamification could "motivate students and affect their emotional experience, sense of identity and social position" (p. 2). McGonigal (2011) goes on to explain that interest in educational games is growing, and that educators are beginning to bring more and more games into schools. Bruder (2015) states that an astonishing 95% of educators already use digital educational games. Such educational games are used to teach subjects including math, history, science, foreign language, social sciences, and language arts (Kapp, 2012; McGonigal, 2011). Kapp (2012) argues that educators already possess many of the required skills, knowledge, and abilities, to take a leadership position in the gamification of learning, education, and instruction. Furthermore, he asserts that gamification can be used to "promote learning because many of the elements of gamification are based on educational psychology" (Kapp, 2012, p. 23), and the difference between traditional education and gamification is that "gamification provides another layer of interest … that both motivates and educates learners" (Kapp, 2012, p. 12). One study found that there are numerous commonalities between videogames and classrooms that educators can build upon, including clear learning goals, opportunities for practice and reinforcing expertise, monitoring of progress, and adaptation to the level of the learner (Morris, et al., 2013).

Returning to technology in general, Woong Choi et al. (2018) argue that we adopt mobile devices, not only for their usefulness and diversity in everyday life, but also for their data, image, and voice capture features that can be used to support learning and attract learners. Moreover, today's mobile devices with larger screens can support collaborative learning activities in the

outdoors, and are becoming commonplace devices and promising tools for environmental education (Schneider & Schaal, 2018; Woong Choi et al., 2018). They navigate students to relevant places and enrich outdoor learning experiences (Schneider & Schaal, 2018). Additionally, Anderson et al. (2015) states that they can be used for knowledge acquisition through internet connections, collaboration in learning, file sharing, organization and scheduling, content creation, assessment and feedback, and consumption of content. Frankly, environmental educators who compete for attention and face new challenges in an age of mobile devices, have begun to explore the opportunities that mobile computers may offer in supporting environmental learning experiences (Ruchter et al., 2010). As Ruchter et al. explains, young people are interested in technology so there is extra encouragement to integrate it into their practice.

Technology and Environmental Education

A Review of Current Research: Technology Integration into Environmental Education

As one would expect, there have been numerous studies conducted on technology use in the regular classroom, and recently, researchers have expanded their scope of investigation to include the educational potential of technology in supporting outdoor learning and EE (Anderson et al., 2015). The findings of said new research has shown a resounding positive impact on student learning experiences. For example, in their 2015 study, Anderson et al. compared traditional environmental education methods with technologically enhanced instructional practices and noted many positive results. Researchers conducted a watershed activity with students, providing some groups with conventional tools and methods, and others with tablets, mobile data loggers, and wireless connectivity, for instruction, data collection, and proof of learning. Researchers preface their study by citing related literature that states that mobile technology is effective in facilitating and supporting nature walks, field experiments, outdoor classrooms, and student reflections and inquiry, and can enhance student observations, collaboration, and social interaction. It is also noted in the study that technology use supporting EE can lead to improved engagement, and knowledge retention in students. The overall findings of the study concluded that students in the technologically enhanced outdoor environmental education group were more motivated, exercised critical thinking and deeper exploration of topics, experienced more unique, novel learning opportunities, were better able to understand instructions, found the methods for data collection more engaging and accessible, showed bigger

increases in test scores, had better understanding of the lesson content, exhibited eagerness to share their learning, and had improved observation, communication and inquiry skills during the experience.

Results from a 2016 study that assessed content knowledge, environmental attitude, fun, and connectedness to nature of 747 children, grouped into traditional instructional groups and technologically enhanced instructional groups during an outdoor EE experience, found that mobile technology use during lessons is "just as effective at connecting children to nature and retaining new scientific concepts as more traditional ways of non-formal environmental education, but the mobile application offered additional benefits such as higher ratings of fun" (Crawford et al., 2016, p. 959). More specifically, researchers concluded that there were no noteworthy differences in nature relationships or attitudes toward nature, but there were higher levels of fun, higher test scores, and increased social interaction, for groups using the mobile technology.

A 2018 study analyzed how children (ages 9-12) used problem-solving strategies to identify and capture the tree cycle with the help of mobile tablets (Woong Choi et al., 2018). Researchers determined that mobile learning experiences supported engagement in deep learning, use of real-time decision-making strategies, and use of critical thinking skills to approach a problem. Tablets allowed children to access disciplinary information remotely, to interact with others and their environment, and to seamlessly capture data. This is echoed in another publication that states that students using mobile technologies were simply more interested in interacting with nature as a part of their education (Kacoroski et al., 2016). Importantly, it is noted that the interest in devices was not greater than the interest in nature:

> It was interesting for the researcher to observe nature prevailing over digital technologies as digital technologies are often perceived as having a negative impact on children's interactions with nature, though some research suggests the possibility of digital technologies enabling students to create deeper connections to the natural world, aiding in child development. (Kacoroski et al., 2016, p. 308)

Ferrie (2009) discusses a case study at Green High School with ecology teacher John Berry. Berry explains that most kids have an intrinsic awe of nature that can be tapped into using technology combined with hands-on experiences. The tech tools that Berry uses with students during both indoor and outdoor lessons include laptops, sound amplifiers (for bird calls),

PowerPoint presentations, CDs, and radio telemetry equipment. Ferrie also provides examples of virtual tools for the exploration of nature, which include computer activities and games, as well as virtual tours, provided by Monterey Bay Aquarium, Yellowstone National Park, the National Park Service, and National Geographic, and include an E-Quarium, eTrips, and other virtual explorative experiences. Holloway and Mahan's (2012) paper also provides an excellent example of technology use in environmental education in the form of a digital storytelling activity, stating that their "idea was to use technology as a tool to provide or enhance students' connection with nature. Students are already engaged with technology; we wanted to use that interest to foster outdoor experiences that promote learning" (p. 24).

Looi et al.'s (2010) study conducted twenty-one weeks of mobilized science lessons using smart devices with nine grade-three classes. They found that students who used the mobile technology for their science lessons performed better, learned science in a personal, deep, and engaging way, developed positive attitudes towards mobile learning, and showed improved self-discipline as well as higher levels of inquiry. Teachers showed increased self-efficacy in technology integration and were more easily able to move to student-centered learning. Similarly, Bleck et al.'s (2012) study, which reviewed literature, surveyed experts, distributed web-based surveys, and selected twelve pilot projects to serve as case studies, found that technology can be used to meet EE goals, to teach EE morals and value systems, for general educational purposes, to improve cognitive achievement, to motivate and interest learners, and to create content. They also identify the following new potential uses for technology in EE, including the ability of students to work on personalized content, to support outdoor activities and site-specific learning, as geographical reference and location-based activity tools, and to engage in a blended learning model that combines traditional classroom teaching with outdoor EE.

In their study, George and Archontia (2013) set out to answer the question: can educational software applications based on constructivist principles help students acquire knowledge, develop skills, capabilities, environmentally friendly attitudes and behaviors in relation to waste management issues? They worked with sixteen students, ages eleven and twelve, collecting data through the use of questionnaires, focus group interviews, and recorded observations. Their results show a significant change in knowledge regarding recycling before and after the use of the program. This includes knowledge regarding waste management methods, causes of

environmental problems, personal impacts on the environment, pro-environmental behaviours, solutions to environmental problems, and benefits of protecting the environment. Students enjoyed the software and actually refused breaks, they worked collaboratively and creatively with the software and developed critical thinking skills. George and Archontia also reported that the software resulted in improved communication between groups, positive changes in attitudes, and increases in inquiry skills.

Kamarainen et al. (2013) used smartphones, augmented reality (AR) technology, and environmental probes with students during a field trip to a local pond. They wanted to know what students' learning and motivation, as well as teachers' experiences, looked like following an experience that utilized a combination of AR technology and environmental probes. They found positive shifts in student attitudes regarding their understanding of topics and ability to engage in scientific skills. Much like other studies, there were also significant learning gains for students. Additionally, teachers noted that the experience, which provided specialized equipment, taught students to better understand what scientists actually do, improved the productivity of the students, and promoted both social interactions between students, and interactions with nature.

In their study, Lai et al. (2007) hypothesized that mobile technologies can increase the level of knowledge creation through experiential learning beyond that which is achieved with traditional methods. They worked with two fifth grade classes, completing six stages of outdoor learning activities, with one group being guided by PDAs. They discovered that the group with PDAs had significantly higher achievement scores and engagement, as well as higher knowledge retention and motivation. As such, the researchers contend that mobile technologies have the potential to support experiential learning in a very productive way. They state that mobile technology delivers educational content regardless of time or place, supports authentic and seamless learning, provides instant feedback and guidance, has interfaces that meet diverse learning approaches and needs, makes learning expedient, immediate, authentic, accessible, efficient and convenient, provides real time information, keeps learners on task and provides rapid access to recording methods (note taking, pictures, sound/video recording etc.). Rutcher et al. (2010) also provides a list of benefits and uses of mobile devices in EE, including, scaffolded learning, recoding abilities such as note taking or voice recording, access to resources, assisting educators in guiding activities and monitoring student progress, increased interest in nature, awareness of environmental problems, and knowledge gains.

Clearly there are numerous benefits to technology integration in EE, however there is also a large body of research that identifies the benefits of technology use, and outdoor environmental education, as separate entities. For example, both the use of technology in the classroom, and outdoor environmental education, have the individual potential to increase the academic success and achievement of students when examining scientific concepts (Looi et al. 2010; Louv, 2008). Similarly, both the application of technology, and outdoor environmental education, can result in increased student engagement during lessons, increased motivation, reduced apathy toward schooling, and higher levels of satisfaction in students (Becker et al., 2017; James & Williams, 2017; Looi, et al., 2010).

On its own, there are many benefits achieved through the integration of technology into the classroom. In addition to improving student academic success and engagement, technology integration into the elementary classroom results in additional positive learning outcomes. The most prominent of which is identified as the development and acquisition of 21st century competencies, including critical and digital literacy, in which technology use plays a significant role (Ontario Ministry of Education, 2016). Not only do digital teaching platforms provide powerful support for collaborative learning, but technology integration has also led to improved communication, innovation/creativity, personal inquiry skills, and critical thinking, as well as differentiated learning experiences for students (Anderson et al. 2015; Ontario Ministry of Education, 2016). Another source confirms that digital technologies are “proven to create engagement in learning, improved behaviors and attitudes, as well as advancement of a child’s understanding of material” (Kacoroski et al., 2016, p. 302).

Furthermore, it is noted that technology allows students to engage in social issues (Anderson et al., 2015). An additional publication furthers this sentiment explaining that, "technology is changing the shape of civic education in the 21st century” (Ontario Ministry of Education, 2016, p. 17). Dueck and Rodenburg (2017) expound the importance of this, asserting that “as children begin to learn how the world functions, they understand the impacts that people can have, and explore solutions to challenges in their community. As they develop leadership skills by participating in local action, they develop confidence, a sense of agency, and belonging” (p. 4). This sentiment is reflected in the Ontario Ministry of Education 2016 publication, which emphasizes research showing that,

Students are more engaged, intrinsically motivated to learn, and more successful when

> they can connect what they are learning to situations they care about in their community and in the world. Technology can provide access to real-time data, simulations to situate learning in the real world, and opportunities for students to link learning to their personal interests. (p. 34)

The same source goes on to explain that competencies supported by technology-use greatly contribute to students' identities as members of society, and can lead to civic literacy, global awareness, and ethical citizenship. These traits promote respect for other cultures and participation in addressing problems like environmental degradation (Ontario Ministry of Education, 2016). Undoubtedly, there are a number of probable benefits for students, and consequently educators, from both the integration of technology, and outdoor environmental education, and many of these benefits align, including their ability to create reflexive citizens, and promote critical thinking and leadership skills (Bell & Dyment, 2008; James & Williams, 2017).

Perceived Barriers

Despite these incredible benefits and large body of research, a number of educators have identified obstacles hindering their ability to implement both technology integration, and outdoor learning experiences, into their classrooms. Barriers specific to technology use that were identified in Brush and Foon Hew's (2006) study, include lack of technology or lack of access to technology, insufficient time, the absence of technological support, lack of know-how or technological skills, insufficient pedagogical support for implementation, poor understanding of classroom management as related to technology use, institutional barriers such as unsupportive leadership and incompatible time-tables, and lastly, the absence of information pertaining to the assessment of technology-based assignments. Hechter and Vermette contribute to this list with their 2013 study that identifies "inadequate: access; time; resources; training; budget; and support" (p. 73) as the prime restrictors of educators when considering the incorporation of technology into their classrooms. These findings are confirmed by a 2006 article on techno-resiliency in schools (Graham). A 2010 study on the impacts of mobile computers in EE adds that distraction by novel devices is also considered to be a barrier for many educators during their attempts to integrate technology into their classrooms (Ruchter et al.).

Bleck et al. (2012) identified cost, technological dependency, the continuous outdating of mobile technology and its defective handling of nature, and loss of holistic experiences, as

barriers to integrating technology into outdoor EE. Anderson et al. (2015) argue that teacher skepticism toward the integration of technology into EE is the primary barrier faced by educators, and that it is exasperated philosophical opposition to technology in nature, and lack of knowledge and know-how. Kamarainen et al. (2013) add that some teachers are simply worried about managing technology on their own.

Clearly, these would all be of concern to educators when trying to use technology to support EE for the first time. However, there are a number of well researched strategies and approaches to overcome these obstacles.

Technology Integration: Approaches, Strategies, and Best Practices

In an effort to overcome these barriers, there are a number of strategies identified by recent literature and research studies that educators can employ. Firstly, Kacoroski et al. (2016) recommends that technology be integrated as a tool for learning, rather than as a main focal point of lessons by keeping its use simple, allotting time to ensure student and staff confidence in the use of devices, and providing students with instructions on behavioral expectations. Additionally, educators should choose to use multiple digital technologies in their teaching practices and instruction. In their report, Brush and Foon Hew (2006) identify various strategies to overcoming the identified obstacles and presented them under five headings: obtaining the necessary resources, shared vision and technology plan, facilitating attitudes/beliefs change, professional development, and assessment. Under the obtaining the necessary resources category, they propose gradual and slow technology integration, the use of cheaper, more efficient computer systems and resources, technology installations in every classroom, sharing devices, and collaboration among teachers to create technology-integrated lesson plans. Next, it is suggested that in order to overcome institutional barriers, schools should create technology plans that encompass a shared vision and understanding. They note that this could include reworking timetables to provide longer class sessions, as well as the redesign of classrooms. Within the context of professional development, teachers need access to educational opportunities that are appropriate for their needs, and their classroom practice, that allow them to engage in active learning, and focus on the acquisition of technological skills and knowledge, as well as technology-related classroom management. Finally, regarding perceived barriers to assessment, teachers require new ways to assess students' multimedia work that closely align with the curriculum.

Hechter and Vermette (2013) note that technology is a valuable tool in schools where teachers have wiggle room regarding curriculum instruction, have ample access to technology, are prepared and trained to use it, and have beliefs that align with student centered and constructivist pedagogies. As such, they recommend: (a) having a shared vision and technology integration plan; (b) overcoming the scarcity of resources; (c) changing attitudes and beliefs; (d) conducting professional development; and (e) reconsidering assessments. They also point out that teachers with the skill and motivation to integrate technology into the classroom will use their critical thinking and problem-solving skills to make it happen!

Finally, Bitner and Bitner (2002) highlight 8 areas that directly impact the ability of teachers to effectively integrate technology into the classroom: (1) fear of change; (2) training; (3) personal use; (4) teaching models; (5) learning-based; (6) climate; (7) motivation; and (8) support. Under fear of change, they assert that helping teachers to overcome their anxieties regarding technology use is crucial to its successful integration into their teaching practice. Training, the second identified area, can address this by instructing teachers and educators in the basic skills associated with technology use. Pertaining to personal use, the authors insist that technology can improve teachers' lives, allow them to communicate with other educators, and give them tools for their daily tasks and routines. When teachers become aware of the ways in which technology can improve their lives and enhance their personal productivity, they lose some of their fear, gain skills, and can more easily understand how technology can be incorporated into their practice (Bitner & Bitner, 2002). In respect to teaching models, teachers require examples of how to use technology in their practice, and need to be made aware of the various technologies available to their students and how the students can use it. In addressing learning-based, Bitner and Bitner assert that learning is the ultimate goal. Technology shifts from classroom dynamics from a teacher centered model, to student driven one, as students use technology to discover knowledge, actively communicate with others, and problem solve independently. In terms of climate, the authors state that teachers must be able to experiment with technology without fear of failure and its repercussions. When discussing motivation, Bitner and Bitner are referring to extrinsic incentives (provided by administration) that can nudge teachers to try technology and endure the frustration that comes with learning something new. Once learning takes place, the intrinsic motivation follows (Bitner & Bitner, 2002). Finally, support. All of these require time, money, planning, which is the support teachers need (Bitner &

Bitner, 2002)!

Current research in this discipline identifies many technological tools for assessment in EE including: computers, tablets, and iPads (or other mobile computers), mobile data loggers, cell phones, eBooks, movies, environmental probes, portable music players, radio telemetry equipment, CD's and players, social networking sites and applications, AR/VR technology, virtual learning environments, games, microscopes, technological presentation devices, and videography and photography equipment (Anderson et al. 2015; Brooks- Young, 2010; Ferrie, 2009; Gilbertson et al., 2006; Kacoroski, 2015; Kacoroski et al., 2016; Kamarainen et al., 2013; Lai et al., 2007; Woong Choi et al., 2018). According to one source, technological tools such as these allow students to create their own, diversified artifacts and products that show their learning, and promote differentiated and effective instruction (Woong Choi et al., 2018). Using these tools, students can record notes, create posts sharing their thoughts and new learning, record interviews, access relevant information on the internet, upload data to a shared class database, connect with experts and peers, create video blogs or podcasts, administer a survey to peers or community members, complete quizzes, engage in personal inquiry, create digital stories, capture photos, explore virtual worlds, collect data about the environment, make music, play games, and so much more (Brooks-Young, 2010). Many of these mobile assessment techniques are well suited to outdoor EE, as the tools they require are portable and appropriately sized for collaborative work (Woong Choi et al., 2018). They also allow students to complete traditional EE assessment techniques, such as journaling, in new, up-to-date, and unconventional ways (Gilbertson et al., 2006). This results in authentic assessment for students, which requires experiences to be real-to-life and incorporate diversified and differentiated methods. That being said, this literature review will explore one technological tool in depth: games.

Gamification in Environmental Education

What is Gamification and Why is it Important?

There are many definitions of gamification, the simplest defining it as "the use of gaming elements in nongame contexts" (Nwogu, 2019, p. 20) or the "application of game-design elements/principles in non-game contexts" (Nand et al., 2019, p. 1-2). Morris et al. (2013) expand upon this definition, stating that gamification "is a term used to describe using game elements in other environments to enhance user experience (p. 2). Bruder (2015) adds to this

definition by contributing the qualifier that to "be classified as gamification, an entire unit or classroom must use gaming techniques" (p. 56). Lee and Hammer (2011) offer an even more in-depth definition of gamification, relating it to education and defining it as, "the use of game mechanics, dynamics, and frameworks to promote desired behaviors. Gamification attempts to harness the motivational power of games and apply it to real-world problems – such as, in our case, the motivational problems of schools" (p. 1). Finally, Kapp (2012) offers the most all-encompassing, and for the purposes of this paper, accurate definition, arguing that "gamification is using game- based mechanics, aesthetics, and game thinking to engage people, motivate action, promote learning, and solve problems" (p. 10). He defines a game as "a system in which players engage in an abstract challenge, defined by rules, interactivity, and feedback, that results in quantifiable outcomes often eliciting an emotional reaction" (Kapp, 2012, p. 7). Game-based mechanics include game elements (the defining features of games) such as interconnected systems, players, abstracted reality, challenges (goals), rules, feedback, measurable outcomes, and emotional reactions, as well as levels, points/badges/scoring systems, and time constraints, that make up the content or matrix of a game (Kapp, 2012). According to Kapp, players become immersed in games because of these defining features. Their attention is held by the instant feedback, the constant interaction required, the alternate versions of reality presented in the game, the amusing and perfectly leveled challenges they must face, and the well-defined rules and structure of game play. He goes on to explain that players experience an emotional response to the game that is pleasurable and thus continually sought after. Aesthetics in gamification refers to the visually engaging characteristics of a game, which may include graphics, or other well-designed experiences (Kapp, 2012). Game-thinking is the action of transforming an everyday activity to a social process that fits within the game matrix described above (Kapp, 2012). McGonigal (2011) describes four defining traits of games (which closely resemble Kapp's elements); goals, rules, feedback systems, and voluntary participation. According to McGonigal, goals orient players' participation in the game, and provide players with purpose. Rules set limitations on the game play and push players to explore. Feedback systems allow players to track their progress toward achieving the goal, and thus provide motivation to continue playing . Finally, voluntary participation requires all who play to accept a common set of rules, and ensures players are intentionally participating in a combination of stressful and fun challenges.

Morris et al. (2013) classify games and their contribution to education in a different way, arguing that they are 'cultural tools'. They define cultural tools as artifacts and institutions including books and schools, which serve to educate in some way. Their study asserts that videogames, as well as more traditional games, qualify as cultural tools and can compete with traditional cultural tools like books when it comes to student motivation and learning outcomes. They believe that video games should be used in conjunction with more traditional learning and teaching techniques to support and enhance education. They explore three ways in which video games can support all types of scientific thinking and science education. Firstly, through the use of Serious Educational Games which are essentially gamified scientific knowledge. Kapp (2012) and Morris et al. (2013) both define Serious Games as games that teach a specific content domain, usually using a platform such as a board or computer browser (this is in contrast to gamification, which applies game elements to contexts outside of a game). Serious Games are designed to teach distinct concepts such as recycling do's and don'ts, the parts of a plant cell, or the energy flow in food chains. Secondly, games exist that have embedded scientific processing, and teach scientific skills through participation in the game (Morris et al., 2013). Finally, games can also promote the development of skills, attitudes, and values that are useful in science, but they do not explicitly instruct players in science skills or knowledge. For example, games may teach strategic thinking, long-term planning and foresight, resource management, an understanding of the interaction of complex variables, multitasking, decision making, compromise, problem-solving, and creativity (Kapp, 2012; McGonigal, 2011; Morris et al., 2013).

The Benefits of Gamification

Which leads us to the benefits of gamification and the integration of games into education. The listed learning outcomes of games above do not begin to describe the scope of rewards resulting from gamification. For example, numerous studies identify the cognitive effects of games. Morris et al. (2013), state that video games enhance spatial resolution of vision, visual short-term memory, spatial cognition, probabilistic inference, and reaction time of players. Bruder (2015) also agrees that gamification can increase cognitive growth. Similarly, Kapp (2012) discusses a 2006 study that found higher cognitive gains and attitude changes in students who participated in games and simulations, when compared to those who were engaged using traditional teaching methods.

Lee and Hammer (2011) state that games provide opportunities to experiment through a mastery process in which players try, observe outcomes, reflect, plan, and try again. Gee (2005) describes a similar process in games, which he calls the cycle of expertise. Essentially, games provide players with multiple attempts at success and practice through scaffolded learning opportunities that adapt to different levels of player knowledge and motivation (Morris et al., 2013). Games provide players with challenges that are perfectly tailored to their skill level and have multiple routes to success (Lee & Hammer, 2011). Gee (2005) describes this as well-ordered problems, in which early easy levels and problems in games help players to form skills/knowledge for future, complex problems. It is how players move from novice to expert. Lee and Hammer (2011) argue that the promotion of practice through the mastery process results in the development of persistence and resilience. Morris et al (2013) support this, stating that the use of mastery approaches promotes behavioural persistence and extends time spent on task. They argue that games allow players to demonstrate their learning in ways that are better than traditional tests. Bruder (2015) calls this quality of games personalized instruction, while Gee (2005) calls it customization. Gee (2005) argues that games are customizable based on players' learning and playing styles, as well as their interests. He states that games allow players to work at their own pace. Kapp (2012) expands upon this notion, stating that different types of people have different styles of playing games, and different levels of players need different types of attention. As Gee (2005) states “in school, poor students do not get time to consolidate a skill, while good students do not get good enough new challenges” (p. 36). The essence of this argument is that education systems should scaffold learning like games do because “you can't treat a new player the same as an existing player, and master players need special attention to keep them engaged” (Kapp, 2012, p. 131). By applying scaffolded learning levels and multiple attempts and practice to the education system through gamification, it is possible to transform student perspectives of school, their problem-solving abilities, and thinking processes when they approach new challenges, while increasing their persistence when working on difficult tasks (Lee & Hammer, 2011).

Following a new, but related branch of gamification benefits, it can be argued that games allow students to experience a state known as flow. Flow can be defined as “the satisfying, exhilarating feeling of creative accomplishment and heightened functioning” (McGonigal, 2011, p. 35). Flow keeps players within the limits of their skill level (McGonigal, 2011) or what Gee

(2005) calls their regime of competence. Games are pleasantly frustrating, they are doable, but challenging, and they continually adapt to keep the learner in a constant state of interest. (Gee, 2005; Kapp, 2012). As Kapp (2012) says, they maintain the precise challenge level required by the learner; never too difficult, never too easy. They position the player within an optimal state characterized by intense focus, high sense of agency, and the merging of action and awareness (Morris et al., 2013). Kapp (2012) reports eight components that make flow possible: achievable tasks, required concentration, clear goals, feedback, effortless involvement, control over actions, disappearance of concern for self, and loss of sense of time. Nwogu (2019) describes flow as the final piece of the puzzle in education, the optimal state between boredom and anxiety that is achieved through video games, and can be applied in learning. If educators could induce a state of flow through their teaching practice using knowledge of games and gamification, students' educational experiences would be greatly improved as they would be more motivated to learn, and gain more satisfaction from the act of learning (McGonigal, 2011; Morris et al., 2013).

Moreover, Morris et al. (2013) explain that flow combines low levels of anxiety with an optimal skill gap. Low levels of anxiety are indicative of a positive relationship with failure. Many sources suggest that video games promote positive relationships with failure (Gee, 2005; Lee & Hammer, 2011; McGonigal, 2011; Morris et al., 2013), because players are allowed many attempts at low stakes. In games, effort is rewarded, not mastery of skill, and risk taking is encouraged (Gee, 2005; Lee & Hammer, 2011). In games, there are lower consequences when players take risks, which encourages exploration (Gee, 2005). Additionally, players' perception of failure in games is changed from negative criticism to positive constructive feedback which fuels players to keep trying again and again (Morris, et al., 2013). Unfortunately, many researchers agree that school on the other hand provides students with few attempts at high stakes, allowing little room for exploration and risk taking (Gee, 2005; Lee & Hammer, 2011; Morris et al., 2013). As such, educators can learn from video games and strive to improve student relationships with failure by implementing the same structures that exist in games.

As one may have predicted by learning of the cognitive impacts, customization of learning, low stress levels, and positive relationships with failure that are produced by gaming, games also result in a number of emotional outcomes (Lee & Hammer, 2011). Firstly, games invoke emotions, such as joy, frustration, pride, and curiosity (Lee & Hammer, 2011). Kapp (2012) argues that games have strong potential to create episodic memories because they evoke

said emotions, which in turn causes players to more richly encode lessons from the game in their memory. Emotional responses improve engagement and thus improve learning (Kapp, 2012). Furthermore, games allow players to engage in hard fun (McGonigal, 2011). Because games are voluntarily played, players experience positive stress, which means they are confident and optimistic (due to low risk of games) and have entered the stressful situation (participating in a level that is on the outer edge of their regime of competence) on purpose (McGonigal, 2011). According to McGonigal (2011), such stress, or hard fun, "leaves us feeling measurably better than when we started" (p. 32). If players are lucky, they may even feel a primal emotional rush called fiero, which is defined by McGonigal as the emotional high humans feel after triumph over adversity.

Experiencing hard fun, fiero, and other mentioned emotions, are not the only emotional outcomes of playing games. McGonigal (2011) maintains that games can invoke prosocial emotions - positive feelings directed toward others - such as love, compassion, admiration, and devotion, which are crucial to our long-term happiness. Games allow players to build strong social bonds and to participate in active social networks by playing together, and thus cause the side effect of prosocial emotions. According to McGonigal, this contrasts reality, which can feel disconnected, disorganized and divided. She argues that games bring players together with a common goal, and result in what she calls collaboration superpowers. She is not alone in the sentiment, with many other studies finding that games promote collaboration, teamwork, and cooperation (Kapp, 2012; Morris et al., 2013; Nand et al., 2019; Nwogu, 2019). Morris et al. (2013) explain that distributed knowledge or virtual collaboration, occurs in games, as different players are able to offer their unique and individual knowledge and skills to aid in the completion of a task. In this way, games promote collaboration by allowing players to utilize their strengths (Lee & Hammer, 2011; McGonigal, 2011). So, not only do games cater to players' skills and knowledge, encourage collaboration and teamwork, and build social bonds and trust, they also encourage and nurture players' unique strengths and talents as well.

Every player is unique and comes to the game with their own identity, values, and beliefs. These individuals each possess their own epistemic frames which are "ways of knowing about the world that are influenced by specific disciplines" (Morris et al., 2013, p. 8). Whether playing a video game or learning in school, a student's way of knowing influences their attitude toward learning. Interestingly, games have a tried and true method for shifting thinking in players:

avatars (Kapp, 2012). Bruder (2015) and Kapp et al. (2014) agree that avatars are a crucial component of game structures and can be utilized during the process of gamification. As Lee and Hammer (2011) contend, games allow players to try on new identities, and thus, to try on new attitudes, values, beliefs, and perspectives that belong to said identity. In games players assume their new roles, and act as they believe their character would, which can lead to the adoption of values that may not be the same as their own (Morris et al., 2013). Experience as an avatar can change a person's real-life perceptions, and help them with the formation of their own identity as they add to their belief systems (Kapp, 2012; Morris et al., 2013). This process can also reduce personal bias and fear, regarding marginalized professions such as scholars or scientists (Gee, 2005; Lee & Hammer, 2011). As one researcher argues, watching your avatar, or one that resembles you, performing an activity, may influence you to pursue similar activities in the future (Kapp, 2012). In a fascinating development, it turns out that behavioral changes that occur in virtual environments can transfer to a player's real life (Kapp, 2012). Knowing this, the implications for education are incredible. Students can become mathematicians, environmentalists, scientists, and scholars, simply by 'trying on' that avatar.

The benefits of gamification and games are numerous, and well researched. They include: increased student engagement, the facilitation of assessment, boosts in enthusiasm, the lessening of disruptive behaviours, the encouragement of growth and development, and improved attention span (Bruder, 2015). Other academic benefits of gamification include: improved ability to follow directions, increased motivation, the development of technological skills, increased student ownership of learning, increased intrinsic motivation, and increased comfort levels (Nwogu, 2019). Additionally, games are self-directed, encourage inquiry, provide infinite patience, and provide players with deeper understandings of concepts and their applications (Morris et al., 2013). Games are interactive and reactive, and as such provide players with instant and authentic feedback which allows the player to learn, adapt, and succeed (Bruder, 2015; Kapp, 2012; McGonigal, 2011; Morris et al., 2013; Nand et al., 2019). Games and gamification can increase problem solving skills in players, on small and large-scale tasks, and push them to think the unthinkable, to imagine what was previously thought to be impossible, and thus result in new and innovative solutions (Bruder, 2015; Kapp, 2012; Lee & Hammer, 2011; Morris et al., 2013; Nwogu, 2019). Games foster creativity (Lee & Hammer, 2013; McGonigal, 2011). Gamification can help with the learning of both physical and mental skills, and has positive impacts on

learners of all ages (Kapp, 2012). It results in the generation of urgent optimism, the desire to act immediately to tackle an obstacle with a reasonable belief of success, social fabric, the building of trust, bonds, and cooperation, blissful productivity, the happy completion of challenging and meaningful work, and epic meaning, the sense of involvement in awe-inspiring missions (McGonigal, 2011). Games allow players to not only consume information, but to take an active role in producing content, give players agency, provide information just when it is required for learning, anchor new concepts and understandings to experiences, and encourage system thinking as well as the consideration of relationships (Gee, 2005). Gamification can increase user engagement, encourage positive behaviours, and promote organizational productivity as well as learning and participation (Nand et al., 2019). Ultimately, Gamification can motivate students to engage in the classroom, give teachers better tools to guide and reward students, and get students to bring their full selves to the pursuit of learning. It can show them the ways that education can be a joyful experience. (Lee & Hammer, 2011).

Approaches, Strategies, and Best Practices in Gamification

But how do they do it? How can educators achieve these benefits within their own practice? Educators can start by utilizing the learning principles that good games incorporate in their own practice. Gee (2005) lists and defines these principles: (1) identity; good games allow players to explore their own identity through the use of a character, (2) interaction; games are interactive and reactive to player input (educators must ensure that they, as well as the resources they employ, are reactive to student actions), (3) production; players are producers, and as such students should be producing content, learning goals, and curriculum, (4) risk taking; lowered consequences for failure encourage exploration in students and game players alike, (5) customization; challenges are well suited to individual student needs, skills, and knowledge, (6) agency; give students voice, choice, and control, (7) well-ordered problems; early challenges prepare students for future, more complex problems, (8) challenge and consolidation; provide opportunities for practice and repetition before moving on, (9) just-in-time information; teach new concepts only when students are ready, (10) situated meanings; anchor new concepts to real experiences, (11) pleasant frustration; provide work that is challenging, but not frustratingly so, (12) system thinking; teach students about relationships, not isolated facts and skills, (13) lateral thinking; explore new concepts thoroughly before moving on (especially student inquiries), (14) distributed knowledge; provide opportunities for collaboration, mentorship, and sharing, (15)

cross-functional teams; help students to learn about their classmates and their unique strengths, (16) performance before competence; allow students to participate before they are experts at something. Bruder (2015) offers similar advice, sharing the following characteristics of a good game which can be applied to education; games offer continuous challenge, interesting storylines, flexibility (more than one way to win), immediate and useful rewards, combination of fun and realism, feedback, empowerment, and dynamic, immersive, and interactive experiences. Practically, this could include the use of awards, rewards, badges, and point systems, storylines or themes, avatars or characters, quests and boss levels, timely feedback and instruction, trial and error problems, and inquiry (Bruder, 2015). Finally, in their study, Nand et al. (2019) identify five steps in the gamification of education process: (1) understanding the target audience and the context, (2) defining the learning objectives, (3) studying the experience, (4) identifying the resources, (5) applying gamification elements. Key considerations identified for this process include the duration of the learning program, location of the learning, the nature of the learning program, and size of the class.

Moving on, Kapp et al. (2014) provide guidelines for the implementation of structural gamification, which is defined as:

> The application of game elements to propel learners through content with no alteration or changes to the content. the content does not become game-like only the structure around the content does. The primary focus behind this type of gamification is to motivate the learners to go through the content and to engage them in the process of learning. (p. 224)

Structural gamification includes the use of clear goals, as well as incremental goals and rewards (Kapp et al., 2014). As Kapp explains, this translates to the chunking of larger goals or content, into smaller manageable tasks, and the provision or rewards only upon completion of the large goal (if goals are too big, students become overwhelmed, and if they are rewarded at each small step, they will not feel a need to complete the task in its entirety). Next, transparent progression is required. Students need to see their progress visually, which includes what they have already accomplished, and what needs to be done to reach the goal. Additionally, transparency should also apply to rewards, success criteria, and learning goals - every student should have an equal understanding of these. Kapp suggests that students should also be acknowledged and given status upon the completion of goals or mastery of content and skills. Status is a powerful educational tool. Furthermore, lessons should include elements which are challenging enough to

capture student attention. Lastly, Kapp contends that educators should employ distributed practice, which is the learning and studying of content over multiple short sessions. Recommended elements that educators should incorporate into the structural gamification of their classroom include rules, reward structures (leaderboards, points, currency, badges, leveling up), and social sharing (Kapp et al., 2014).

Kapp et al. (2014) also provide the guidelines for content gamification, defined as, "the application of game elements, game mechanics, and game thinking to alter content to make it more game-like... The idea is not to create an entire game but to add elements and concepts from games to the instruction" (p. 237). The elements of content gamification include story (creating a story around the task that needs to be done), challenge, curiosity (inquiry-based learning), character (have a character or avatar present the information, task, or content), interactivity, feedback, and freedom to fail (Kapp et al., 2014). Kapp (2012) adds to these recommendations by providing a description of theories which support the gamification of education, and their implications for practice. Without exploring the theories themselves, the following provides a summarized list of practical suggestions and their associated theories as outlined by Kapp. Social learning theory states that educators should model desired behaviours for learners to observe, resulting in the internal processing of said behaviour by students, and later, the demonstration of said behaviour. Situated cognition theory suggests the creation of a cognitive apprenticeship for learners, in which the environment, feedback, and guidance, which the learner engages with, is authentic. Mihaly Csikszentmihalyi's concept of flow, which has been discussed thoroughly, would indicate that learning environments and educators need to adapt to the changing levels of learners, maintaining their interest through the creation of just right challenges (Kapp, 2012). Next, the motivation of learners through operant conditioning would require educators to provide learners with appropriate rewards, points, and badges on a variable basis in order to maintain their interest (Kapp, 2012). The ARCS (attention, relevance, confidence, and satisfaction) model recommends that educators act to grab learners' attention, convey the relevance of content to students, provide the appropriate level of challenge so that the learner will be confident in their ability to achieve success, and include both intrinsic and extrinsic motivational elements (Kapp, 2012). Malone's theory of intrinsically motivating instruction advocates for the inclusion of challenge, fantasy, and curiosity in one's teaching practice (Kapp, 2012). Lepper's instructional design principles for intrinsic motivation indicates that teachers should include learner control,

challenge, curiosity, and contextualization in their lessons (Kapp, 2012). Self-determination theory maintains that educators should provide learners with opportunities for autonomy, feelings of competence, and relatedness to others (Kapp, 2012). Finally, distributed practice and scaffolding require that educators engage in the gradual release of responsibility to students, which includes plentiful opportunities for short practice over an extended period of time with the slow withdrawal of support from the educator until the learner is working independently (Kapp, 2012).

A common theme in the above recommendations, and throughout this paper, has been the motivation of students. This is a frequent problem across traditional classrooms and something that many educators struggle with. Kapp (2012) provides guidance in this area, arguing that games motivate action, a process that is characterized by its ability to energize learners by providing them with direction, purpose, and meaning, related to their behaviours and actions. Stimulating the participation of learners in an action or activity is a core element of gamification (Kapp, 2012). To accomplish this, Nwogu (2019) recommends identifying student motivations and selecting the most appropriately aligned gaming features to meet the needs of the individuals. Morris et al. (2013) provides examples of motivational gaming features that can be used in this endeavor. One such feature is the fostering of curiosity and exploration by providing optimal levels of uncertainty (50%), knowledge gaps and skill gaps (Kapp, 2012; Morris et al., 2013). The second feature is praise, the positive evaluation of a student's performance, which should focus on a student's effort and encourage growth mindset (Morris et al., 2013). This ties into the third feature, the motivational orientation of the students, who must believe they are capable of success. Immediate and relative feedback for students regarding their work is the fourth feature recommended. Finally, the incorporation of fun failure is necessary to motivate students, which means changing their perception of failure to one that views feedback as constructive and helpful, and removes the harmful and negative stigma associated with imperfection.

Kapp et al. (2014) propose the use of both intrinsic and extrinsic rewards in gamification to motivate students. Intrinsic rewards include feelings such as satisfaction in work, the hope and experience of being successful, social connectivity, and meaning (being a part of something bigger than ourselves) (McGonigal, 2011). Intrinsic motivation can be achieved by providing learners with a sense of control and agency, providing them with confidence in their own

abilities, setting up a clear path to content and skill mastery, rewarding incremental and long-term goals, and to helping learners to connect to others through social interaction (Kapp et al., 2014). Alternatively, extrinsic motivation can be effectively used to increase a learner's expression of tasks enjoyment and free time spent performing a task (Kapp et al., 2014). This results from using performance contingent rewards and leads to a strengthened perception of freedom, the engagement of learners in an activity that they would not typically value, and the narrowing of attention and focus (Kapp et al., 2014). Kapp (2012) cautions that extrinsic reward systems can undermine intrinsic rewards, however, a reward system that seems to be extrinsic only - like points - can have intrinsic value if it still provides feedback to the learner. (For information on the creation and selection of games, see Kapp, 2012.)

A Review of Current Research: The Gamification of Environmental Education

Using games in environmental education is not a new concept by any means, as evidenced by McLean's 1973 paper, *Simulation Games: Tools for Environmental Education*, which provides numerous examples of EE games that do not utilize technology. However, the idea of using digital games, simulations, and applying game mechanics and principles to EE is new, and there is very limited research on the subject. One source that does investigate the use of digital games in EE researched the impact of playing GREENIFY, a real world action game designed to teach adult learners about climate change and motivate informed action (Lee et al., 2013). The findings from Lee et al.'s 2013 pilot study, in which 26 adult graduate students participated, suggests that the game fostered the creation of peer-generated user content, motivated informed action, created positive pressure, and was perceived as a fun and engaging experience. More specifically knowledge gains, and the empowerment of participants occurred, with 46.2% of participants agreeing that they were far more aware of how their lifestyle and actions impact the environment. When asked whether they believe their actions contribute to global warming and climate change, 88.5% agreed. Most importantly, players reported feeling more empowered, due to their new understanding of their individual actions and impact. Lee et al. (2013) also report increased "personal relevance and accessibility" (p.358), reduced feelings of fatalism, and a sense of meaningful accomplishment, as a result of the manageable environmental actions promoted by game play. Furthermore, 61% of players expressed that sharing knowledge, ideas, and deeds within a social network was a very positive and motivating experience. 65.4% of players noted that the peer teaching/learning promoted by the game created

a desire to teach others about climate change and spread awareness. Lee et al. also found that 82.6% of participants reported that GREENIFY changed their behaviors and generated pro-environmental habits. Moreover, 79.3% of players agreed that the game play was a fun experience. Lee et al. conclude that these findings suggest that (1) gamification principles are congruent with needed changes to climate change education efforts; and (2) social media technologies can enable peer-to-peer education and can motivate behavior change effectively. The authors finish their report, stating that 'gamification can be a powerful strategy that converts serious real-world problems into engaging and meaningful gameplay that promotes peer-to-peer education and behavior change through social interactions" (Lee et al., 2013, p. 362).

In a similar study, Schneider and Schaal (2018) address the research questions: (1) do location-based games with smartphones influence subjects' connectedness to nature; and (2) does the development of connectedness to nature depend on the game format? The team developed two different location-based mobile games, which were played by 339 secondary students broken into two groups/game formats: geogame and treasure hunt. They define geogames as complex location-based games for smartphones that offer free and non-linear access to all tasks displayed on the map, while the treasure hunt mobile game provides a linear narrative and pre-defined path for students. The aim of the study was to assess if smartphone games are suitable to foster connectedness to nature and if there are differences between a complex geogame and a less-demanding treasure hunt. A pre-and posttest were given to participants and used the Inclusion of Nature in Self scale (INS) and the Disposition to Connect to Nature scale (DCN). The results reveal a significant increase of the INS for both game formats, with the strongest effect for the more nature distant subjects (measured via the DCN-scale). Between the two game formats, no significant difference was detected. So, the main effect seems to be the location-based activity in nature guided by smartphones, not the complexity of a geogame. The findings show that even a quite short intervention like the smartphone-supported treasure hunt or the geogame provides an opportunity for fostering connectedness to nature.

In Morganti et al.'s (2017) report, the authors begin by framing their research and its significance within the global warming crisis, citing the need to reduce greenhouse gas emission and switch to renewable energy as the justification for their research, and call to action. As such, they focus on changing consumer behaviours to improve energy efficiency, while still acknowledging that in addition to addressing individual actions, structural changes are needed as

well. The authors state that gamification and serious games are being applied to education, helping gamers to learn valuable skills, and thus games should be considered as a useful and attractive new method of learning. They review ten papers, looking at the potential of applied gaming methods–both serious games and gamification- that have been tested in recent years to engage users in pro-environmental behaviours, specifically energy efficiency, highlighting their effectiveness and discussing the key features that lead to success. Morganti et al. identify five interventions that can engage consumers in pro-environmental behaviours; structural interventions, informational strategies, feedback, social approaches, and comprehensive interventions. They note that much of the initial research on games focused on negative impacts (such as the promotion of aggression by violent video games) but acknowledge a recent shift toward studying positive impacts such as: engaging and motivating learners, attractiveness of games to learners, and the teaching of valuable skills. They define serious games (learning experiences in game-like contexts), and their three components (simulations, gaming, and educational goals), arguing that playing them has been shown to improve people's ability in real-world tasks. They found three target areas of serious games that apply to energy efficiency: environmental education games, consumption awareness games, and games that promote energy efficient behaviors. Environmental education games included EnerCities and Trashwar (Morganti et al., 2017). The consumption awareness games cited include PowerAdvisor OPower, and Energy Chickens (Morganti et al., 2017). Energy efficiency behaviour games noted were Power Explorer and Power Agent (Morganti et al., 2017). Finally, Morganti et al. identified comprehensive intervention games, which targeted more than one objective, and included EcoIsland, Energy Battle, and Social Power. Their main conclusions were: (1) serious games for EE can increase awareness of the impact of behaviours in students; (2) consumption awareness games target families, increasing their awareness surrounding the impact of their behaviour and give feedback in a fun way; and (3) serious games for energy efficiency behaviours, developed for mobile phones, can be effective at decreasing electricity consumption, directly targeting specific behaviours within the game mechanics with a possible effect on knowledge and attitudes towards energy efficiency.

In her book, McGonigal (2011) also discusses games that can promote pro-environmental behaviour, and thus may be beneficial in EE. She begins by arguing that in order for games to be effective in generating positive action on a large scale, they need to help us to master the ability

to change how our ecosystem works, and to figure out the right ways to change it. This involved many complex and interconnected systems, and the games that teach you to manipulate those systems engage in a process called Planet Craft. Within the genre of Planet Craft games McGonigal identifies subcategories, including God Games and Forecasting Games. Examples of God Games include Sims, Spore, Civilization, and Black and White (McGonigal, 2011). All God Games encourage players to practice the three skills that are critical for real planet craft: taking a long view (considering our actions in the context of far reaching future-human lives), ecosystems thinking (looking at the world as a complex web of interconnected, interdependent, parts), and pilot experimentation (the process of designing and running many small tests of different strategies and solutions to discover the best course of action to take) (McGonigal, 2011). While it is true that games oversimplify, McGonigal maintains that we can learn from them. Forecasting games combine collective intelligence with planetary-scale simulation (McGonigal, 2011). They ask players to reimagine and reinvent the way we feed ourselves, the way we transport ourselves, the way we get water, the way we design cities, the way we manufacture everything, the way we power our lives – they are 'what if' games (McGonigal, 2011). McGonigal cites World Without Oil, Superstruct, Evoke, and the Long Game as examples of forecasting games.

Of course, there are numerous other free environmentally focused SG's online that are available for educators to use. A good resource to begin exploring digital games for EE is changegamer.ca. Of course, educators can also apply the numerous principles listed previously to their practice, gamifying EE without the use of serious games. This could include playing real-world games, such as those found in Coyote's Guide to Connecting With Nature (Young et al., 2018). Additionally, educators could use online resources that add game elements to their classrooms, such as ClassDojo, Chore Wars, and even Kahoot!

Conclusion

"The use of technology, such as computer games, to enhance students' learning in the classroom is a timely topic that permeates a lot of educational literature" (Nand et al., 2019, p. 2). The gamification of education has clear benefits and there are many practical ways that educators can implement gamification in their classrooms that are supported by theory and research. McGonigal (2011) "argues persuasively that it is time for us to reconsider the negative connotations that we associate with video games—that they are escapist or time wasters" (Morris

et al., 2013, p. 2). Instead, educators must embrace games and ask “how can we make learning in and out of school, with or without using games, more game-like in the sense of using the sorts of learning principles that young people see in good games every day?” (Gee, 2005, p 37).

Additionally, with new studies being published, an existing literary foundation supports the use of technology in EE and outdoor learning experiences. The use of tools and technology can enhance outdoor educational experiences, connect learning to concrete action and the global community, and enable students to enjoy freedom, creativity, and exploration throughout their education (Anderson et al., 2015; Kacoroski et al., 2016; Omoogun et al., 2016). With that said, an effort to investigate and explore innovative ways to improve student learning and educational experience in EE requires a close examination of technology integration.

Finally, Children’s literature can act as a positive force for enacting social change and as such, can be used as a resource in EE. Children’s books can influence the ethical understandings that our children inherit, and through the field of ecocriticism, scholars have identified the ways in which said books can provide youth with positive representations of nature, and reinforce healthy and ecocentric relationships with nonhuman others and the environment. As Jennifer Wagner-Lawlor argues, children's books can act as a literary device ‘‘giving voice to those (trees, animals, etc.) who have no voice’’ (Chang, 2016, p. 149).

To conclude, technology, games, and children’s books are tools that educators should consider in their environmental education practice.

Methods

As one might have guessed, following the completion of my literature review, there were numerous next steps involved in turning such a large collection of academic research into a practical resource for educators. Said steps are outlined below.

Reviewing Academic Literature & Engaging in Exploratory Research

To begin, I reviewed my literature review and sources, looking for two things: (1) common themes, and (2) knowledge gaps. First, I identified numerous common themes, and used these themes as the template for my website. I was able to break them down into sections which would act as the pages for 3EGuide.com. These included barriers to both the implementation of environmental education by regular classroom teachers, and the use of technology to support learning in the classroom. I also found many commonalities in the research regarding best practices for integrating technology into environmental education and overcoming barriers, as well as how to use gamification and children's literature to support and improve EE. Finally, I found clear evidence regarding the benefits to EE, technology integration, and gamification, throughout the literature. Essentially, I was able to summarize the key points and themes found throughout related academic literature in the form of a digital guide for teachers, or at this stage, in the form of an outline for a guide.

From there, I identified the areas in which there was little research, and/or few resources for educators regarding environmental education, and the use of technology, gamification, and children's literature. After I identified these gaps, I addressed them through the creation of 3E educational resources. That said, I had to do additional research to find ways to fill these gaps. That included looking for EE games, lesson plans and resources, recommended books, and more. I used the internet, books, teachers guides, youtube channels, etc. as sources, as well as many of my own ideas and practices from my teaching experience and environmental science background.

Building the 3E Website & Creating Resources

After I had compiled all of the required information and resources, I built my website using wix.com. The website pages are: Home, About, Environmental Education, Technology, Children's Literature, Gamification, Resources, and Portfolio. I used the information and themes from my literature review and exploratory research to fill my website with content and useful

information for educators. My goal was to make the website as easy to follow as possible. I want educators to be able to find what they need. I also added videos, images, titles, and graphic designs to improve the aesthetics of my website.

From there, I designed numerous 3E resources for teachers including fifteen EE and technology lesson plans, an EE overview infographic, a technology and EE infographic, a book selection checklist, and an ecocritical teachers guide. Next, I added all of the related presentations from my time as a graduate assistant at Lakehead, editing them to make them user friendly, and relevant to this portfolio. I also included numerous virtual lessons from my time at both Gravenhurst Public Library and Midland Public Library, in response to the shift to virtual learning as a result of the Covid-19 pandemic.

Branding

While building my website and designing the related resources, I decided to create a logo that could be used to maintain consistency throughout the various components of my portfolio. I wanted teachers to be able to identify where the resources were coming from. This is when I decided to call my website 3E: Enhancing Environmental Education. Not only was it catchy, but 3E made for a visually appealing logo. It is my hope to continue adding to my portfolio and brand, treating it as an ever evolving educational entity.

Personal Reflection

After completing my website, and resources, I finished my portfolio by creating a reflection video. For the video, I asked myself three questions: (1) what was the process like, (2) what questions do I still have, and (3) how can I improve? After reflecting on these questions, I filmed my honest answers!

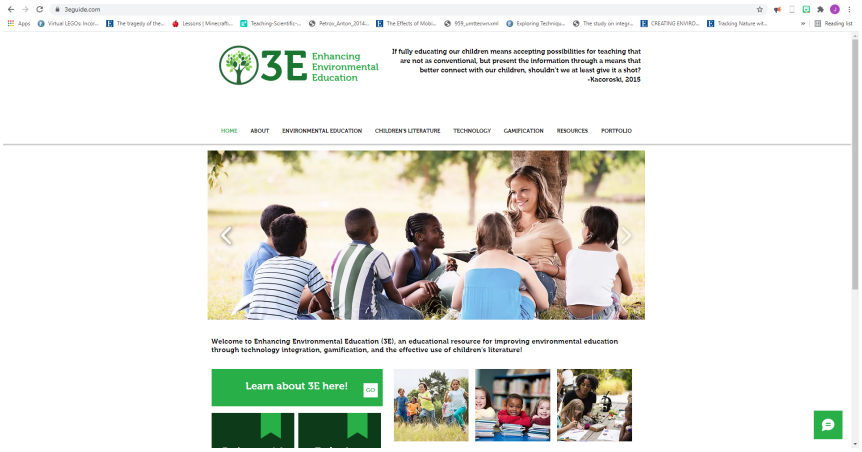
Multimedia Portfolio Tasks

This chapter presents links to the multimedia tasks developed as part of the portfolio. For ease of access to the tasks, live hyperlinks and QR codes are provided to guide readers to the content, but screenshots are presented as well for readers' convenience.

Practical Task Part 1: 3E Enhancing Environmental Education Website

The *3E: Enhancing Environmental Education* website (see figure 1) (Whipp, 2021) provides information for educators on numerous topics, including: environmental education's definition and goals (figure 2), barriers to environmental education and best practices (figure 3), the importance of environmental education (figure 4), the use of children's literature in education (figure 5) and in environmental education (figure 6), the use of technology in education (figure 7) and in environmental education (figure 8), and, the gamification of education (figure 9) and environmental education (figure 10).

Figure 1. 3E Website Screenshot, QR Code, and Link

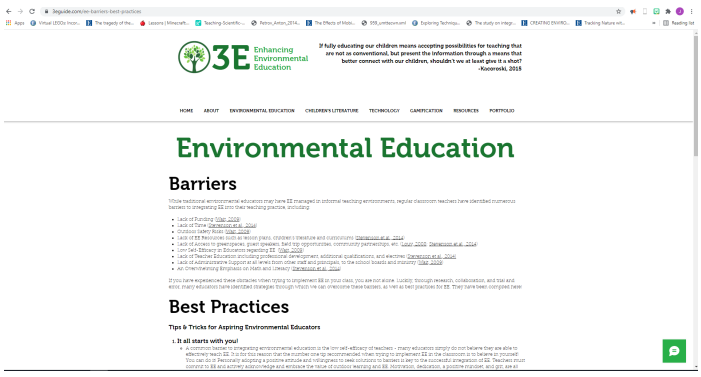


https://www.3eguide.com/

Figure 2. 3E Website: EE Definitions and Goals: Screenshot, QR Code, and Link

https://www.3eguide.com/ee-definitions-goals

Figure 3. 3E Website: Barriers to EE and Best Practices: Screenshot, QR Code, and Link



https://www.3eguide.com/ee-barriers-best-practices

Figure 4. 3E Website: Importance of EE: Screenshot, QR Code, and Link

https://www.3eguide.com/importance-of-ee **Figure 5. 3E Website: Children's**

Literature in Education: Screenshot, QR Code, and Link

https://www.3eguide.com/children-s-literature-in-education

Figure 6. 3E Website: Children's Literature and EE: Screenshot, QR Code, and Link

https://www.3eguide.com/children-s-literature-ee

Figure 7. 3E Website: Technology in Education: Screenshot, QR Code, and Link

https://www.3eguide.com/technology-in-education

Figure 8. 3E Website: Technology in EE: Screenshot, QR Code, and Link

https://www.3eguide.com/technology-ee

Figure 9. 3E Website: The Gamification of Education: Screenshot, QR Code, and Link

https://www.3eguide.com/gamification-in-education

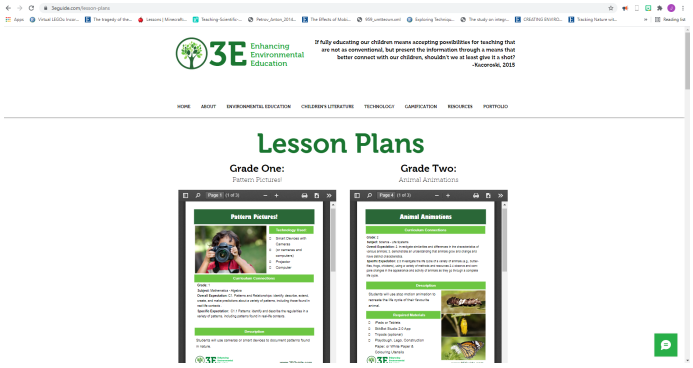
Figure 10. 3E Website: The Gamification of EE: Screenshot, QR Code, and Link

https://www.3eguide.com/gamification-ee

Practical Task Part 2: Resource Series

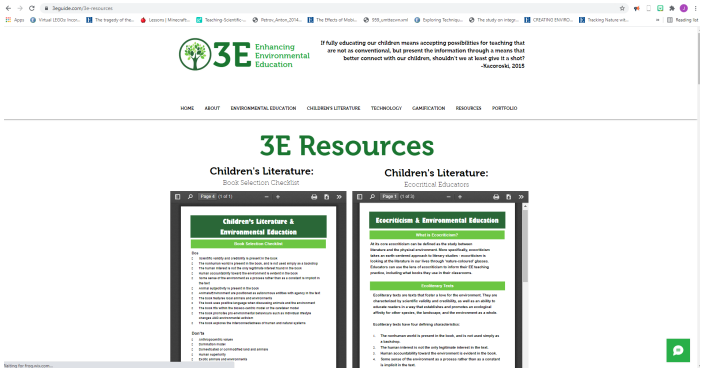
Available on the website are numerous resources for educators to help them implement environmental education within their teaching practice, including: lesson plans (figure 11), presentations and guiding documents (figure 12), a virtual book display (figure 13), and sample videos (figure 14).

Figure 11. 3E Website: Lesson Plans: Screenshot, QR Code, and Link



https://www.3eguide.com/lesson-plans

Figure 12. 3E Website: Presentation and Guiding Documents: Screenshot, QR Code, and Link



https://www.3eguide.com/3e-resources

Figure 13. 3E Website: Virtual Book Display: Screenshot, QR Code, and Link

https://www.3eguide.com/recommended-books

Figure 14. 3E Website: Sample Videos: Screenshot, QR Code, and Link

https://www.3eguide.com/ee-videos

Reflective Task: Reflective Video

Lastly, a reflective video was created as shown in figure 15.

Figure 15. 3E Website: Reflective Video: Screenshot, QR Code, and Link

https://www.3eguide.com/reflective-video

References

Anderson, C. L., Miller, B. M., Eitel, K. B., Veletsianos, G., Eitel, J. U. H., & Hougham, R. J. (2015). Exploring Techniques for Integrating Mobile Technology into Field-Based Environmental Education. *Electronic Journal of Science Education,* 19(6), 1-19.

Bartosch, R. (2014). Teaching a Poetics of Failure? The Benefits of Not-Understanding the Other, Posthumanism, and the Works of Shaun Tan and Wolf Erlbruch. In R. Bartosch & S. Grimm (Eds.), *Teaching Environments: Ecocritical Encounters* (pp. 37-57). Peter Lang GmbH

Beames, S. (2012). *Learning outside the classroom: theory and guidelines for practice*. New York: Routledge.

Becker, C., Lauterbach, G., Spengler, S., Dettweiler, U., & Mess, F. (2017). Effects of Regular Classes in Outdoor Education Settings: A Systematic Review on Students' Learning, Social and Health Dimensions. *International Journal of Environmental Research and Public Health*, 14(5), 485.

Bell, A. C., & Dyment, J. E. (2008). Grounds for health: the intersection of green school grounds and health-promoting schools. *Environmental Education Research, 14*(1), 77-90.

Bhagwanji, Y., & Born, P. (2018). Use of Children's Literature to Support an Emerging Curriculum Model of Education for Sustainable Development for Young Learners. *Journal of Education for Sustainable Development,* 12(2), 85-102.

Bitner, N., & Bitner, J. (2002). Integrating Technology into the Classroom: Eight Keys to Success. *Journal of Technology and Teacher Education,* 10(1), 95-100.

Bland, J. (2014). Ecocritical Sensitivity with Multimodal Texts in the EFL/ESL Literature

Classroom. In R. Bartosch & S. Grimm (Eds.), *Teaching Environments: Ecocritical Encounters* (pp. 37-57). Peter Lang GmbH.

Bleck, S., Bullinger, M., Lude, A., & Schaal, S. (2012). Electronic mobile devices in environmental education (EE) and education for sustainable development (ESD) Evaluation of concepts and potentials. *Procedia - Social and Behavioral Sciences*, 46, 1232-1236.

Bone, J. (2013, June 2). The animal as the fourth educator: A literature review of animals in young children in pedagogical relationships. *Australasian Journal of Early Childhood, 38*(2), 57-64.

Bonora, L., Martelli, F., & Marchi, V. (2019). DIGITgame: gamification as amazing way to learn STEM concepts developing sustainable cities idea in the citizen of the future. *Journal of Strategic Innovation and Sustainability*, 14(4), 10-19.

Brooks-Young, S. (2010). *Teaching with the tools kids really use: learning with Web and mobile technologies*. Thousand Oaks: Corwin.

Bruder, P. (2015). Game On: Gamification in the Classroom. *Education Digest*, 56-60.

Brush, T., & Foon Hew, K. (2007). Integrating technology into K-12 teaching and learning: current knowledge gaps and recommendations for future research. *Educational Technology Research and Development*, 55(3), 223-252.

Brussoni, M., Olsen, L. L., Pike, I., & Sleet, D. A. (2012). Risky Play and Children's Safety: Balancing Priorities for Optimal Child Development. *International Journal of Environmental Research and Public Health,* 9(9), 3134-3148.

Buell, L. (1996). *The Environmental Imagination: Thoreau, Nature Writing, and the Formation of American Culture.* Cambridge, MA: The Belknap Press of Harvard University Press.

Burke, G., & Cutter-Mackenzie, A. (2010). What's there, what if, what then, and what can we do? An immersive and embodied experience of environment and place through children's literature. *Environmental Education Research,* 16(3-4), 311-330.

Caruso, C. (2014). Scientific Encounters in Literature: How the 'Two Cultures' Can Profit from Each Other In and Outside of the Classroom. In R. Bartosch & S. Grimm (Eds.), *Teaching Environments: Ecocritical Encounters* (pp. 37-57). Peter Lang GmbH.

Chang, L.-p. (2016). Spirits in the Material World: Ecocentrism in Native American Culture and Louise Erdrich's Chickadee. *Children's Literature in Education, 47*, 148-160.

Crawford, M. R., Holder, M. D., & O'Connor, B. P. (2016). Using Mobile Technology to Engage Children with Nature. *Environment and Behavior*, 49(9), 959-984.

Dillon, J., Morris, M., O'Donnell, L., Reid, A., Rickinson, M., & Scott, W. (2005). *Engaging and Learning with the Outdoors – The Final Report of the Outdoor Classroom in a Rural Context Action Research Project.* National Foundation for Education Research, http://www.bath.ac.uk/cree/resources/OCR.pdf

Dobrin, S. I., & Kidd, K. B. (2004). Introduction: Into the Wild. In S. I. Dobrin, & K. B. Kidd (Eds.), *Wild Things: Children's Culture and Ecocriticism* (pp. 1-15). Detriot, Michigan: Wayne State University Press.

Dueck, C., & Rodenburg, J. (2017). *Pathway to Stewardship & Kinship: Raising Healthy Children for a Healthy Planet.* Peterborough: Trent University.

Echterling, C. (2016). How to Save the World and Other Lessons From Children's Environmental Literature. *Children's Literature in Education,* 47, 283-299.

Ferrie, C. (2009). Exploring Nature in Cyberspace. *PERCReport,* 27(3), 16-19.

Freeman, C. P., Bekoff, M., & Bexell, S. M. (2016). GIVING VOICE TO THE "VOICELESS". *Journalism Studies, 12*(5), 590-607.

Gaard, G. (2008). Toward an Ecopedagogy of Children's Environmental Literature. *Green Theory & Praxis: The Journal of Ecopedagogy , 4*(2), 11-24.

Gaard, G. (2009). Children's environmental literature: from ecocriticism to ecopedagogy. *Neohelicon,* 36, 321-334.

Gee, J. P. (2005). Good Video Games and Good Learning. *Phi Kappa Phi Forum*, 85(2), 33-37.

George, A., & Archontia, M. (2013). Educational Technology as a Teaching and Learning Tool in Environmental Education. *International Journal of Academic Research in Business and Social Sciences*, 3(9), 191-205.

Gilbertson, K., Bates, T., McLaughlin, T., & Ewert, A. (2006). *Outdoor Education: Methods and Strategies*. Champaign: Human Kinetics

Glotfelty, C. (1996). Introduction: Literary Studies in an Age of Environmental Crisis. In C. Glotfelty, & H. Fromm (Eds.), *The Ecocriticism Reader: Landmarks in Literary Ecology* (pp. xv-xxxii). London: The University of Georgia Press.

Graham, R. (2006). *Techno-Resiliency in Education: A New Approach For Understanding Technology in Education*. Cham: Springer.

Hechter, R. P., & Vermette, L. A. (2013). Technology integration in K-12 science classrooms: An analysis of barriers and implications. *Themes in Science & Technology Education*, 6(2), 73-90.

Holloway, P., & Mahan, C. (2012). Enhance nature exploration with technology. *Science Scope*, 35(9), 23-28.

James, J. K., & Williams, T. (2017). School-Based Experiential Outdoor Education: A Neglected Necessity. *Journal of Experiential Education*, 40(1), 58-71.

Kacoroski, J. (2015). Time for Change: A New Frontier for Digital Nature Experiences. *Parks & Recreation*, 34-35.

Kacoroski, J., Liddicoat, K.R., & Kerlin, S. (2016). Children's use of iPads in outdoor environmental education programs. *Applied Environmental Education & Communication,* 15(4), 301-311.

Kamarainen, A. M., Metcalf, S., Grotzer, T., Browne, A., Mazzuca, D., Tutwiler, M. S., & Dede, C. (2013). EcoMOBILE: Integrating augmented reality and probeware with environmental education field trips. *Computers & Education,* 68, 545-556.

Kapp, K. M. (2012). *The Gamification of Learning and Instruction: Game-Based Methods and Strategies for Training and Education*. Pfeiffer.

Kapp, K. M., Blair, L., & Mesch, R. (2014). *The Gamification of Learning and Instruction Fieldbook: Ideas into Practice.* Wiley.

Kilburn, B. (2012). *Into Nature: A Guide to Teaching in Nearby Nature.* Back to Nature Network. https://www.back2nature.ca/teachers-guide-into-nature-english/

Kimmerer, R. W. (2017). Learning the Grammar of Animacy. *Anthropology of Consciousness, 28*(2), 128-134.

Kummerling-Meibauer, B. (2014). Ants, Bees, Bugs, and Spiders: Insects in Children's Literature. In R. Bartosch & S. Grimm (Eds.), *Teaching Environments: Ecocritical Encounters* (pp. 37-57). Peter Lang GmbH.

Lai, C.H., Yang, J.C., Chen, F.C., Ho, C.W., & Chan, T.W. (2007). Affordances of mobile technologies for experiential learning: the interplay of technology and pedagogical practices. *Journal of Computer Assisted Learning,* 23, 326-337.

Lee, J. J., Ceyhan, P., Jordan-Cooley, W., & Sung, W. (2013). GREENIFY: A Real-World Action Game for Climate Change Education. *Simulation & Gaming*, 44(2-3) 349-365.

Lee, J. J. & Hammer, J. (2011). Gamification in Education: What, How, Why Bother? *Academic Exchange Quarterly,* 15(2), 1-5.

Liefländer, A. K., Fröhlich, G., Bogner, F. X., & Schultz, P. W. (2013). Promoting connectedness with nature through environmental education. *Environmental Education Research,* 19(3), 370-384.

Looi, C.-K., Zhang, B., Chen, W., Seow, P., Chia, G., Norris, C., & Soloway, E. (2010). mobile inquiry learning experience for primary science students: a study of learning effectiveness. *Journal of Computer Assisted Learning, 27*(3), 269-287.

Louv, R. (2008). *Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder.* Chapel Hill: Algonquin Books of Chapel Hill.

Marriott, S. (2002). Red in Tooth and Claw? Images of Nature in Modern Picture Books. *Children's Literature in Education, 33*(3), 175-183.

Massey, G., & Bradford, C. (2011). Children as Ecocitizens: Ecocriticism and Environmental Texts. In K. Mallan, & C. Bradford (Eds.), *Contemporary Children's Literature and Film: Engaging with Theory* (pp. 109-126). New York, NY: Palgrave MacMillan.

McCurdy, L. E., Winterbottom, K. E., Mehta, S. S., & Roberts, J. R. (2010). Using Nature and

Outdoor Activity to Improve Children's Health. *Current Problems in Pediatric and Adolescent Health Care*, 40(5), 102-117.

McGonigal, J. (2011). *Reality is Broken: Why Games Make Us Better and How They Can Change the World*. New York: The Penguin Press.

McLean, H.W. (1973). Simulation Games: Tools for Environmental Education. *The Elementary School Journal,* 73(7), 374-380.

Morganti, L., Pallavicini, F., Cadel, E., Candelieri, A., Archetti, F., & Mantovani, F. (2017). Gaming for Earth: Serious games and gamification to engage consumers in pro-environmental behaviours for energy efficiency. *Energy Research & Social Science,* 29, 95-102.

Morris, B. J., Croker, S., Zimmerman, C., Gill, D., & Romig, C. (2013). Gaming science: the "Gamification" of scientific thinking. *Frontiers in Psychology*, 4, 1-16.

Muthukrishnan, R., & Kelley, J. E. (2017). Depictions of sustainability in children's books. *Environment, Development, and Sustainability,* 19, 955-970.

Nand, K., Baghaei, N., Casey, J., Barmada, B., Mehdipour, F., & Liang, H. -N. (2019). Engaging children with educational content via Gamification. *Smart Learning Environments*, 6(6), 1-15.

Nwogu, C. (2019). Embracing the Power of Gaming In Education: Substance, Engagement, and Flow. *Information Today,* 19-20.

Omoogun, A. C., Egbonyi, E. E., & Onnoghen, U. N. (2016). From Environmental Awareness to Environmental Responsibility: Towards a Stewardship Curriculum. *Journal of Educational Issues, 2*(2), 60-72.

Ontario Ministry of Education. (2016). *21st Century Competencies: Foundation Document for Discussion*. www.edugains.ca:http://www.edugains.ca/resources21CL/About21stCentury/21CL_21stCenturyCompetencies.pdf

Ontario Ministry of Education. (2021). Curriculum Resources: Transferable Skills. https://www.dcp.edu.gov.on.ca/en/program-planning/transferable-skills/digital-literacy

Otta, S., & Pensini, P. (2017). Nature-based Environmental Education of Children: Environmental Knowledge and Connectedness to Nature, Together, Are Related to Ecological Behavior. *Global Environmental Change, 24*, 88-94.

Op De Beeck, N. (2018). Children's Ecoliterature and the New Nature Study. *Children's Literature in Education,* 49, 73-85.

Otta, S., & Pensini, P. (2017). Nature-based Environmental Education of Children: Environmental Knowledge and Connectedness to Nature, Together, Are Related to Ecological Beahvior. *Global Environmental Change,* 24, 88-94

Prior, L. A., Wilsson, A., & Martinez, M. (2012). Picture This: Visual Literacy as a Pathway to Character Understanding. *The Reading Teacher, 66*(3), 195-206.

Rainbow, A. (2014). Pedagogy and the Power of the Ecoliterary Text. In R. Bartosch & S. Grimm (Eds.), *Teaching Environments: Ecocritical Encounters* (pp. 37-57). Peter Lang GmbH.

Ruchter, M., Klar, B., & Geiger, W. (2010). Comparing the effects of mobile computers and traditional approaches in environmental education. *Computers & Education, 54*, 1054-1067.

Russell, C., & Semenko, K. (2016). We Take "Cow" as a Compliment: Fattening Humane, Environmental, and Social Justice Education. In E. Cameron, & C. Russell (Eds.), *The Fat Pedagogy Reader: Challenging Weight-Based Oppression Through Critical Education* (pp. 211-220). New York, NY: Peter Lang.

Timmerman, N., & Ostertag, J. (2011). Too Many Monkeys Jumping in Their Heads: Animal Lessons within Young Children's Media. *Canadian Journal of Environmental Education,* 16, 59-75.

Schneider, J., & Schaal, S. (2018). Location-based smartphone games in the context of environmental education and education for sustainable development: fostering connectedness to nature with Geogames. *Environmental Education Research*, 24(11), 1597-1610.

Shirai, S. (2011). Recent Books about Relaltionships between Humans and Animals. *Tennesse: Young People, Texts, Cultures, 3*(1), 163-172.

Simpson, L. B. (2014). Land as pedagogy: Nishnaabeg intelligence and rebellious transformation. *Decolonization: Indigeneity, Education & Society, 3*(3), 1-25.

Stevenson, K. T.m Carrier, S. J., & Peterson, M. N. (2014). Evaluating strategies for inclusion of environmental literacy in the elementary school classroom. *Electronic Journal of Science Education,* 18(8), 1-17.

Wait, S. (2009, April 15-18). Outdoor learning for children aged 2-11: perceived barriers, potential solutions. *International Outdoor Education Research Conference.* Victoria: La Trobe University.

Wason-Ellam, L. (2010). Children's literature as a springboard to place-based embodied

learning. *Environmental Education Research,* 16(3), 279–294.

Whipp, J. (2021). 3E: Enhancing Environmental Education. https://www.3eguide.com/

Woong Choi, G., Land, S. M., & Toomey Zimmerman, H. (2018). Investigating children's deep learning of the tree life cycle using mobile technologies. *Computers in Human Behavior, 87*, 470-479.

Young, J., Haas, E., & McGown, E. (2010). *Coyote's Guide To Connecting with Nature.* Shelton, Washington: Own Link Media Corporation.