Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.14, No.9, 2023

Bridging Western Theories and Indigenous Perspectives to Implement STEM in Outdoor Early Childhood Educational Settings

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Abstract
During the Covid-19 pandemic, educators were obliged to rethink traditional classroom settings and explore alternative learning environments. Consequently, numerous outdoor education programs and forest schools emerged in North America during that time. These outdoor alternatives were met with great enthusiasm given that these programs offered a unique advantage during the pandemic, as they could easily enforce physical distancing while also providing a natural space with fresh air circulation. Concurrently, STEM (Science, Technology, Engineering, and Mathematics) education has become a popular focus in 21st-century classrooms. By incorporating STEM subjects into outdoor education programs, children are given the opportunity to develop their problem-solving, critical thinking, and analytical skills in a natural environment. By engaging in STEM activities such as building structures, observing and analyzing natural phenomena, and experimenting with technology, children can develop an appreciation and develop a deeper understanding and sense of belonging with the natural world while also gaining important skills for the future. This article emphasizes on how combining outdoor education and STEM subjects can result in a holistic approach to education that addresses the needs of the whole child. Children are not only able to learn about the natural world but also to develop fundamental skills that will help them in their future education and careers. Additionally, outdoor education can provide children with a sense of well-being and connectedness to the natural world, which can have positive effects on their mental and physical health.
Keywords:STEM learning, Indigenous, Outdoor Learning, Forest School, Land-Based Learning, Western Theories, Early Childhood Education.
DOI: 10.7176/JEP/14-9-01
Publication date: March 31st 2023

1. Introduction

The new integrated educational approach known as STEM (Science, Technology, Engineering and Mathematics) combines the teaching of these subjects in a multidisciplinary or one-disciplinary manner. The desire to support pupils to learn STEM can be traced back to the 1990s when the US National Science Foundation (NSF) officially introduced the merging of engineering and technology with science and mathematics in undergraduate and K - 12-school education (Li, Wang, Xiao, & Froyd, 2020). STEM emphasizes on promoting collaboration, community engagement, encouraging multi-perspective viewpoints to develop interdisciplinary ideas, and offering investigative learning experiences, all of which are facilitated through the use of available technologies. In order to effectively implement STEM education, it is necessary to include science and engineering practices and use project-based and problem-based learning (Kennedy & Odell, 2014). Research by Yildirim (2016) demonstrated that STEM positively impacts student achievement at school and their attitudes toward individual STEM disciplines. Furthermore, Kanadli (2019) acknowledges the positive impact of STEM concluding that the most important contributions of STEM education to the science curriculum are developing life skills, attracting students' attention, creating career awareness, and learning while having fun.According to Henderson and Potter (2001), outdoor education (OE) can be broadly defined as an all-encompassing educational experience that includes environmental and adventure education in the outdoors. Similarly, Ford (1986) defines OE as education in, about, and/or outside. However, for the purpose of this paper, OE will be defined as education that is held outdoors, learning not only about nature, but learning in and with nature. In this sense, OE also fosters the development of the whole child, including physical, social and emotional skills, as well as language and intellectual development (Cooper, 2015). Additionally, OE encourages risk taking, child-led learning, learning through play and place-based learning (Lindfors et al,. 2021). OE also supports children's learning by scaffolding interests, wonders, ideas, creations, questions, thinking, and interactions with the natural environment they are immersed in (Makovichuk et al,. 2014). OE and place-based education are also closely connected to Indigenous land-based education and seen as a means to work on reconciliation with the new and future generations (Webber et al, 2021). One vital component to both of these educational approaches is the emphasis on building reciprocal learning communities and relationships with the land. While staying within the zone of proximal development and honouring the interests of the child, OE allows for children to take ownership of their learning

and explore according to their interests.Recent studies have highlighted that physical inactivity and poor academic performance in STEM subjects are pressing issues in the education system (Speldewinde, 2022). Can forest schools or outdoor education settings that incorporate STEM provide a solution to this problem? At present, there is limited research on STEM education in nature-based settings such as forest schools and nature kindergartens (Speldewinde, 2022). This article aims to explore the natural connection between STEM and outdoor education (OE) and provide a method for educators to incorporate these practices into their own teaching environments. Furthermore, this paper offers specific examples and guidance for early childhood educators who wish to include STEM activities in forest kindergartens, schools or outdoor settings.

2. Indigenous Perspectives On Young Child Learning

Indigenous children are among some of the most vulnerable members of society, and their education must be a top priority. Romero-Little (2010) claims that in order to ensure that Indigenous children are well-prepared for learning, early childhood education must be culturally relevant, holistic, and trauma-informed. First, for Indigenous early childhood education to be culturally relevant it should be based on the Indigenous community's values, beliefs, and cultures. Education should be based on the language and customs of the Indigenous community, including traditional storytelling by Elders of the community and music so as to ensure that Indigenous children can connect with their culture, heritage, and identity. Second, for Indigenous early childhood learning to be holistic, teaching should consider the child's physical, social, mental, emotional, and spiritual dimensions. Education should be tailored to the individual child and his or her particular needs. Third, if Indigenous early childhood knowledge is to be trauma-informed learning, learning should be designed to address the trauma that Indigenous children may have experienced. The curriculum should focus on building resilience and providing opportunities for healing (Romero-Little, 2010).Indigenous perspectives in early childhood education emphasize the importance of connecting young children to their culture, land, and community through activities such as storytelling, music and dance, art, and play (Iwasaki, 2007). Educators strive to create learning environments that are culturally appropriate and respectful of Indigenous traditional knowledge, values, and beliefs, such as in nature. Incorporating Indigenous perspectives into early childhood education helps to build children's understanding of their identity and connection to culture, spirituality, and land (Barnhardt and Oscar Kawagley, 2005). Townsend-Cross (2004) stated that educators strive to ensure that Indigenous children feel a sense of belonging, safety, and acceptance in their learning environment, educators also use activities that help children to understand the history and culture of their Indigenous community, as well as their place in the world. Townsend-Cross also added that it is imperative that educators be aware of the historical and present-day issues faced by Indigenous peoples. In addition to providing cultural and historical contexts for learning, Indigenous perspectives in early childhood education also focus on developing children's connection to land and with nature (Townsend-Cross, 2004). Chawla (2020) explained that activities such as a nature walk, traditional land practices, and exploring local Indigenous plants and animals help to foster a sense of respect and responsibility for the natural environment. This connection is particularly important for Indigenous communities, as their culture and way of life are often closely tied to the land. By incorporating Indigenous perspectives into early childhood education, educators can help children develop a strong connection to their culture, land, and community, which can lead to positive outcomes for both individuals and communities.

3. Western Theories Perspectives On Young Child Learning

Mooney (2000) explained Vygotsky's theory of the Zone Of Proximal Development (ZPD) as the distance between the most difficult task a child can do alone and the most challenging task a child can do with help to solve problems to learn "problem-based learning." Mooney emphasized the importance of observing children and planning a curriculum that encourages children's emerging abilities to push children using the maximum of their skills (ZPD) to solve problems to conduct a project. In order to achieve this, Mooney recommended pairing children who can learn from each other and providing opportunities for children to work together in multidisciplinary learning environments such as STEM settings.According to Vygotsky, adults play a crucial role in fostering children's cognitive development by engaging them in challenging and meaningful activities. In addition to this, adults also convey to children the ways in which their culture interprets and responds to the world. They help children to understand the meaning attached to objects, events, and experiences. They provide the child with what to think, "the knowledge," and how to think, "the processes, the tools to think with" (Vygotsky,1978). This results in giving children the necessary knowledge on how to think and process information, as well as the tools to think with. By creating an environment that is both challenging and culturally relevant, educators can help children to develop their cognitive abilities while also fostering their understanding of the world around them.Mooney (2000) also showed that Piaget believed that children learn through active exploration of their environments and through hands-on experiences. Piaget designed a theory of cognitive development that concludes that children progress through four distinct stages of development: sensorimotor, preoperational, concrete operational, and formal operational. Each stage is characterized by the development of

specific abilities such as object permanence, conservation, and abstract reasoning. Piaget believed that children learn best through play and that they should be provided with opportunities to explore, experiment, and use their imaginations. He also believed that teachers should be facilitators who provide guidance and resources to help children construct their own knowledge.In the early 20th century Dr. Maria Montessori introduced a new child-centered learning theory and created her own educational approach. The Montessori approach is based on scientific observations of children and encourages a hands-on learning experience that allows children to explore their environment and learn at their own pace (Isaacs, 2018).The Montessori approach recognizes the importance of children developing self-confidence and independence. It encourages children to take part in activities that help them develop self-discipline and self-regulation skills. Children learn to use their own judgement and make decisions based on their own experience and knowledge. Mooney (2000) explained that Montessori emphasizes the importance of physical, social, and cognitive development. She encourages children to learn through exploration and play in a safe and stimulating environment. Activities are designed to encourage children to explore their environment, interact with their peers, and use their imagination. The Montessori approach also highlights the importance of respect for the child including respecting their individuality, autonomy, and self-determination. It also advocates for creating a supportive and nurturing environment where children can grow and develop without fear of judgement or criticism (Isaacs, 2018). The ideas proposed by Western theorists regarding outdoor learning have been extensively discussed and researched. However, it is important to recognize that these theories did not originate with Western thinkers alone. Indigenous perspectives on child development have always placed emphasis on the importance of play and child-led learning. These ideas have been an integral part of Indigenous knowledge for centuries (Thomas et al., 2018). Indigenous communities have long recognized that children learn best when they are allowed to explore and experience the world around them. This approach to learning is based on a deep understanding of the interconnectedness of all things and the importance of developing a relationship with the natural world and the land. Therefore, it is crucial to acknowledge and respect the contributions of Indigenous knowledge and incorporate it into the discourse on outdoor learning to create a more holistic and inclusive approach. As a society, we must recognize the value of different knowledge systems and work towards a more collaborative and respectful approach that acknowledges and values diverse perspectives.

4. Why STEM outdoors?

Perhaps you are still questioning the rationale behind arranging STEM lessons in outdoor settings? As the Norwegian saying goes, "there's no such thing as bad weather, just the wrong clothing" (Hayes, 2013). Equipping children with weather-appropriate attire enhances their enjoyment of the experience outdoors. Additionally, outdoor learning provides a myriad of physical benefits (Cooper, 2015). Not only does outdoor learning enable children to reap the advantages of being outdoors and inhaling fresh air while learning in a natural environment, but it also facilitates place-based education. According to Sobel (2004), place-based education involves utilizing the local community and outdoor environment as learning spaces to facilitate hands-on, cross-curricular learning experiences that mirror real-world scenarios. Additionally, incorporating physical activities into STEM learning within an outdoor setting offers numerous benefits, including providing students with adequate time to process information, promoting risk-taking, fostering problem-solving skills, developing 21st-century competencies, enhancing student engagement, and striking a balance between fun and learning (Prieto, 2022).Incorporating STEM education outdoors can also improve literacy skills, in addition to its other advantages. As it is impossible to carry out STEM activities without communicating with others, this communication can improve reading abilities, demonstrating a deeper understanding of the world (Prieto, 2022). STEM activities also facilitate the development of oral language and writing skills, as children have to convey their learning and outcomes through graphing and charting. Communication of outcomes can also be achieved in group settings for early childhood classrooms. Studies reveal that children who participate in hands-on activities have better academic outcomes, including improved literacy skills (Prieto, 2022). In addition, according to Adams (2014), incorporating STEM activities in outdoor teaching also enhances the confidence of teachers and administrators in teaching STEM subjects. Outdoor STEM activities enable children to connect with nature, rather than being detached from it. Additionally, there are methods to integrate aspects of nature into classroom learning, which can be used to simulate STEM activities. For instance, a stick from the outdoors could be used to create a tool, or rainwater measuring activity could be conducted outdoors and then analysed in the classroom.

5. Method of integrating STEM in outdoor early childhood classes

Exploring and collecting materials in the natural environment to build a structure such as a bridge, a tower or a nest. (Khwaengmek et al., 2021), Creating a natural art project using the leaves, stones and sticks from the environment. (Khwaengmek et al., 2021), constructing a shelter from the environment such as a lean-to or a tent. (Khwaengmek et al., 2021) use natural environmental resources to make a toy such as a spinning top or a marble run. (Khwaengmek et al., 2021) and exploring the natural environment to understand the different plants and

animals that inhabit that environment. (Khwaengmek et al., 2021).These outdoor STEM activities can be used to enhance a child's learning, develop problem-solving and critical thinking skills, and foster a real-world connection to the content they are learning. Early childhood educators should use outdoor STEM activities to encourage their students to develop a deeper understanding of the world and appreciate the natural environment.The Learning Cycle Approach is an effective way to teach STEM. It follows a five-phase process that encourages students to explore, understand and apply STEM concepts. The five phases are: Engage, Explore, Explain, Elaborate, and Evaluate. In the Engage phase, students are asked to explore the problem or concept by posing questions and considering its context. During the Explore phase, students use observations and experiments to collect data and test hypotheses. In the Explain phase, students analyze their data and explain the findings. In the Elaborate phase, students use the data to draw conclusions and connect to other concepts. Finally, in the Evaluate phase, students assess their work and reflect on their learning. By following the Learning Cycle Approach, students develop a deeper understanding of STEM concepts and gain the skills necessary to apply them in real life. The diagram below shows the Learning Cycle Approach (Dass and P.M, 2015).

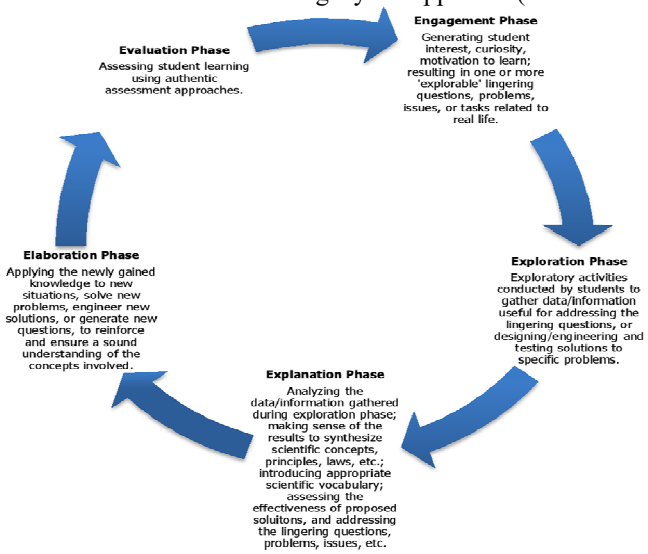

Figure 1. Learning Cycle Approach

6. Example of STEM Learning Cycle used outside in an early childhood education class

In this example of the Learning Cycle Approach, the engagement phase is characterized by the children's keen interest in gardening. As a result, the class decides to undertake a gardening unit and sow sunflower seeds in the school garden.The exploration phase ensues as the children observe the sunflowers grow and discover that one particular plant is growing at an accelerated pace but keeps falling over. They question why this is happening and seek to find an answer. During the explanation phase, the class decides to compare the falling sunflower with the other plants and document changes through drawings every few days. With the help of their teacher, they gather information from books, the internet, and a special guest from a local greenhouse. The children also decide to organize a seed share, preferring to use local native plants.The guest provides valuable information about the plant and establishes a reciprocal relationship with the class. The class learns that the sunflower is falling over because of the watering conditions and its tendency to follow the sun. They conclude that it needs to be repositioned in a direction that reduces its need to lean and stretch towards the sun. In the elaboration phase, the class decides to create a tool to support the sunflower stem, using a stick they found outside. Finally, during the evaluation phase, the class reflects on their journal entries and concludes that the tool they created successfully enabled the plant to stand upright after it was repositioned towards the sun. Below are some tips for early childhood educators to implement effective STEM outdoor activities. Educators can encourage children to explore their natural environment and observe what interests them. In turn, their responses can be used as a basis for a lesson. Allow children to bring natural objects such as pine cones, leaves and sticks into the classroom if they are enthusiastic about them. These can be used to integrate STEM activities later on. Use natural resources such as water, sand, soil and other natural to stimulate the students. STEM lessons should be based on the interests of your students and be developmentally appropriate. In addition, educators can challenge their students within their zone of proximal development. They can also foster curiosity by being spontaneous with teaching and learning, asking questions, getting to know their students, and understanding what excites them. Value the community and natural environment as members of the learning community, and foster reciprocal relationships. Teachers should reveal their sense of curiosity and demonstrate that they are lifelong learners, willing to take risks, make mistakes and learn from them. Communication is essential, especially in the form of guided

questions. How can we solve this problem? I wonder what it would be like to be a …? I wonder how we can do this together? I wonder what would happen if …? I wonder why this happens when I do that? By continually asking questions, teachers can help to scaffold student thinking when doing STEM activities outdoors.

7. Conclusion

This paper provides a comprehensive overview of the potential benefits of engaging with STEM activities outdoors in an early years setting. It highlights the importance of bridging theory and practice, as well as providing concrete examples and guiding questions for early childhood educators to consider when doing so. Despite the wealth of information presented, there remain gaps in the research that need to be explored. It is suggested that future research and educational programs might focus on the benefits of student-led versus teacher-led activities in fostering optimal conditions for engagement and self-determination in STEM activities outdoors. This research could help educators better understand how to structure outdoor STEM activities to promote a sense of ownership and autonomy among young learners. Additionally, more focused examinations of place-based learning approaches should be conducted when implementing STEM in the outdoors in the early years. Place-based learning involves using the local environment as a teaching tool, with a focus on exploring the natural and cultural resources of a particular place. By incorporating this approach, early childhood educators can help children develop a deep understanding of the natural world and their relationship with it, which could potentially lead to a more sustainable future. Overall, this article provides a strong foundation for understanding the potential benefits of STEM activities in outdoor settings for young children. However, there is still much more to explore, and future research and educational programs should continue to focus on these important areas to promote optimal learning outcomes for young children..

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