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RESEARCH ARTICLE

Creating a watermill through STEAM activities for preschool children in the schoolyard

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Abstract: STEAM (Science, Technology, Engineering, Arts and Mathematics) initiatives engage in classroom and schoolyard activities in early childhood education. In early childhood, learning through play provides children with the resources they need for an enjoyable learning environment, especially when the activities take place in the schoolyard, as this is where children can better concentrate and, at the same time, increase their creativity. This work investigates whether preschool children can create watermills through STEAM activities in the schoolyard. Thirty-four children aged 4-6 years participated in the research, and the results were encouraging as the children liked that the activities were outside. At the same time, the teachers were worried if they would be able to support such activities. Preschoolers have a spontaneous disposition toward science with a sense of curiosity and creativity. More research needs to be done on out-of-class activities with the STEAM app, and this training should be incorporated in all kindergartens.

Keywords: STEAM activities, outdoor STEAM, preschool education, sustainable development

1 Introduction

There has been a trend to do STEAM activities in the last five years (Chaldi & Mantzanidou, 2021). This is because STEAM simultaneously integrates multiple disciplines while allowing children to gain new experiences, explore, wonder, discover and create their innovative constructions (Spyropoulou et al., 2020). The main goal of STEAM training is to provide students with a model learning experience that includes a problem that children can solve in multiple ways, and if they fail, they are allowed to redo what they created to see what went wrong (Colker & Simon, 2014).

STEAM concepts are easy for preschoolers (Kropp, 2014) who are persistent and determined when making plans. Preschool is a great age when scientific literacy is introduced (Koester, 2013). studies show that early childhood educators often need help handling sustainability issues in teaching (Walshe & Tait, 2019). Research shows preschool teachers need to create conditions for children to take action, make their voices heard and understand that there are alternative ways of acting (Caiman & Lundegård, 2014). Furthermore, children need to use their imagination and be creative when dealing with the complexity and uncertainty of sustainable development challenges (Lundegård & Caiman, 2019).

2 Sustainability in preschool education

Sustainability issues such as climate change are characterized by a high degree of complexity and involve unpredictable consequences when addressed (Kalliontzi, 2022). Since these issues simultaneously concern the environment, society and economy, including education for sustainable development in early childhood education are emphasized (Hedefalk et al., 2015). Researchers in this field call for new ways of teaching for sustainable development that go beyond current teaching practices (Lundegård & Caiman, 2019; Huggins & Evans, 2017). Kindergartens in Sweden have a long tradition of teaching about the environment rather than teaching about sustainable development issues. Ärlemalm-Hagsér and Sundberg (2016) show that preschool teachers primarily associate sustainable development education with nature encounters and waste sorting, while other studies reveal that preschools mainly function by teaching children about preventive environmental habits, such as resource conservation and waste sorting, as well as by supporting them in turning recycled materials into useful things with the help of STEAM (Ärlemalm-Hagsér et al., 2018). The teaching described above can be understood as an event-based approach or a prescriptive approach to teaching. The teacher focuses the learning content on scientific facts about how the world works or appreciates the right way to handle sustainable issues before the teaching situation (Kalogiannakis & Papadakis, 2022). A pluralistic teaching approach

includes teachers who do not necessarily present or have the answers to what is sustainable. It is up to the child to critically investigate the sustainable issue and understand how it should be approached (Sandell et al., 2005). Contact with STEAM activities seems to promote fostering a greater interest in science and its value in everyday reality (Foti, 2021; Papadakis, Alexandraki & Zaranis, 2022). Early experiences and skills developed early are necessary for later school success. Young children are natural engineers and scientists. However, in some research, doubts are also expressed about the success of implementing STEAM education at such a young age. However, the condition is also set for the essential role of teachers who can shape the appropriate educational framework for the positive outcome of this effort (Ashurova, 2022). Therefore, the central role of the teacher is to guide the children in the discovery in order to give children the opportunity to develop creativity in order to be able to work for a more sustainable future.

3 ICT and STEAM in education

As Wing (2006, p. 33) states: ". . . Computational thinking is a fundamental skill for everyone, not just those associated with computer science. In reading, writing and arithmetic, we should add computational thinking to every child's analytical ability." In advanced countries, HS has been introduced since the preschool age as it is considered an essential skill for today's students in today's society (Skaraki & Kolokotronis, 2022). Technology integration in education is a direction of scientific literacy, while in scientific literacy, emphasis is placed on inquiry-based learning (Kalogiannakis et al., 2018). HS is not just a tool but a way of producing science and has gradually been treated by other sciences, not as a concept derived from Computer Science, but as a concept derived from the science itself. This new way of producing science was only recently available, and its advent allowed scientists to experiment, both in the virtual and real world, with new solutions and problem-solving strategies (Louka & Papadakis, 2023). There has been a rapid increase in Greece in recent years in the learning of computational thinking, as teachers and students need to create in a more imaginative and, at the same time, interactive way (Kastriti et al., 2022). At the same time, the HS and the education of our students in it will occupy us in the coming years. It is a crucial skill that can be mastered by them even when they are younger (Skaraki & Kolokotronis, 2022).

4 The benefits of STEAM activities in Kindergarten

STEAM activities in preschool education should be nurtured in preschool children through ongoing opportunities through play and discussion; children cultivate attitudes and skills. The skills children learn when they engage with STEAM concepts in infancy are transformative and valuable later in life. More specifically, activities that promote process skills, including observation, hypothesis, and critical thinking, are essential for math and science and valuable skills for learning any subject. It is difficult to imagine what career options children may have as adults, but what educators can do is prepare them to be able to deal with various issues in the future.

Also, STEAM activities help children to gain learning motivation and creativity through science which aims not only to answer questions but also to ask questions about how they can create an object. On the other hand, technology refers to the application of scientific knowledge that a child can acquire by combining the simplest materials to make something like a ruler and a marker to the more complex ones like a tablet and a microscope. At the same time, the mechanical activities in the preschool age concern the design and construction of an object as the child tries various materials and hypothesizes possible combinations and solutions to create an object. On the other hand, art encourages creativity and the development of processes as it allows children to explain the concepts they are learning, while mathematics is not only about numbers for children but includes the ability to see, observe, create shapes, patterns and classify various objects according to the needs a child has each time.

5 The creation of a watermill through STEAM

This work aimed to create a water mill in the schoolyard through STEAM activities. The children who collaborated to create the watermill were 34 preschool children, of which 18 were boys and 16 girls, while four kindergarten teachers from the 4th Kindergarten of Kissamos collaborated. International guidelines regarding the study ethics was considered (Petousi & Sifaki, 2020).

5.1 The problem

We told the children an improvised story about a miller turning a hand mill. Nevertheless, the miller got tired of turning the millstone until the water fairy appeared in his sleep and gave him

a riddle through the children so that they would help him. Four groups of children are formed: blue, orange, green and yellow. In order to find the solution, the children are asked to compose a puzzle (Figure 2) depicting watermill impellers. The impeller is a crucial component of the watermill mechanism and the basis of hydrokinesis.

Figure 1 Creating a puzzle

5.2 Investigation

Children observe the puzzle pictures. How do we make a new fender? (one child asks) What shape will it be? (asks someone else) How will he come back? Where else have we seen wings? We encourage the children to discuss possible materials we can use and possible ways to move. We record their ideas. We support children in their search for information about the impellers used by watermills in Crete and other parts of Greece or abroad.

5.3 Planning – Implementation

We divide the children into small groups. Children try to design their wings (Figure 2). Then each team tries to combine various available materials and build the propeller (Figure 3). They test the effectiveness of their constructions by using water. The experiments are videotaped using a tablet.

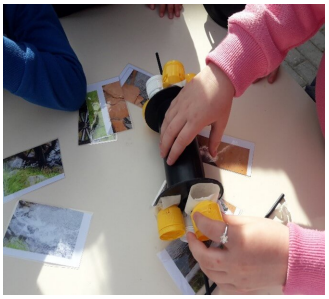

Figure 2 Experiments to create winglets

Figure 3 Wing construction

5.4 Conclusions & presentation

The children compare their results and decide their wing's best choice (Figure 4). They are encouraged to build a mock-up of a watermill with their chosen impeller. They can photograph the connecting stages of construction.

Figure 4 Tests if the impellers are working

5.5 Walkthrough codes to create a watermill

The children were again divided into four groups; one child had the drop signal, and the other three children gave orders according to the colours of the arrows on how to lead to the finish line. More specifically, the yellow arrow meant that the child would turn left for the red one, right; for the green one, he would take a step up, and for the blue one, a step down. Pictures were placed, and the child with the drops had to follow the directions the assistants had made for him with the arrows (Figure 5).

Figure 5 Code path

6 Conclusion

The present research investigated whether preschool children can create a watermill through the STEAM approach as students' skills and teamwork bring students closer. It increased their motivation to create their water mills (Mercan et al., 2022). Based on the findings of the research, one can say that the present research can contribute to the literature as the teachers themselves were positively influenced to do a schoolyard activity again through STEAM as the teachers are afraid of the new (Uğraş & Genç, 2018). Students significantly increased social product creation, teamwork, presentation and engineering skills. Additionally, as each STEAM activity application increases students' skills, this effect carries over to later measurements. However, preschool STEAM activities produced highly effective (Gulhan & Sahin, 2018).

7 Discussion

STEAM education in Kindergarten is possible in Greek Kindergarten. The skills and innovative thinking offered by STEAM education are critical. They must be possessed by all students, especially those who will be involved in these branches of science in the future, as they are critical skills for the 21st century (Ariffin, Sidek & Mutalib, 2018). STEAM education prepares children and equips them with qualifications and skills valid for their later professional life and beyond. It achieves this by connecting real-world problems with knowledge and activating student participation in solving them through well-structured group activities (Majeed et al., 2021). Of course, for the inclusion of STEAM education in schools, some conditions are required: proper training of the educational staff of the schools must be carried out, and emphasis must be placed on the cooperation of teachers of different specialities. In contrast, STEAM training should focus not only on acquiring sterile knowledge but mainly on developing skills. STEAM transforms the school space into a place of experimentation and exploration through activities directly intertwined with real life.

Conflicts of interest

The author declares that they have no conflict of interest.

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