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A New Outdoor Learning Geodesic Dome School Design

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Graphical Abstract

Abstract

In this study, it is aimed to ensure that out-of-school learning environments for a sustainable environmental education in our world, which is under the threat of global warming, are started to be implemented in science and mathematics disciplines as of pre-school period, apart from primary, secondary and high school levels. The procedures for obtaining permission for school managers and teachers, high operating costs, seen as dangerous and a waste of time for parents are the problems of reaching out-of-school learning environments. In order to eliminate these problems, a school model was designed, which is located in the school garden, with an architecture in the form of an atomic model and included workshops created as a geodesic dome.

Keywords: Science and mathematics, out-of-school, geodesic dome, workshops.

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Introduction

Out-of-school learning environments and sustainable environmental education are among the topics that have increased the interest strongly in recent years. Out-of-school activities are becoming an indispensable part of the learning-teaching process. The most effective strategies in education; It is thought that it is a teaching approach in which the student takes an active role in learning, learns by doing, associates the subjects learned with his environment, and establishes connections with social life. One of the methods in which this understanding can be applied most effectively is out-of-school learning methods, which have come to the fore with definitions such as "Out of School Education, Out of Class Education, Nonformal Education, Informal Education" in recent years and which advocate that information should be obtained by contacting the outer world (Saraç, 2017).

According to Saraç, 2017; out-of-school practices and activities in education-teaching processes comprisea very wide rangesuch as sightseeing-observation and field studies, excursions and visits to places with social, cultural, industrial and scientific functions (museums, natural history museums, science and technology museums, planetariums, botanical gardens, zoos, meteorology stations, water treatment plants, dams, industry) organizations, virtual reality applications, nature education, environmental club activities, homework and projects directly related to the place, sports activities, social, cultural and scientific programs (exhibitions, meetings, congresses, panels, conferences and symposiums) and lifelong learning.

Out-of-school learning environments are classified in two categories as non-formal and informal learning. Non-formal learning environments are the institutional areas outside the school that can be visited at specified time intervals, and informal learning environments are the areas that can be visited at any time in our close environment without institutional qualification (Saraç, 2017). Non-formal learning environments, which support the learning of individuals, enable the structuring and development of knowledge. In these environments, a more effective learning environment is created by guiding individuals. On the other hand, Informal learning environments include spontaneous learning processes in life. It is not purposeful and planned, but random. Many studies have been carried out in various disciplines on the effect of out-of-school learning environments on education and teaching. Some of these studies on out-of-school learning environments are: Teachers And Teacher Candidates Participating In Field Trips And Natural Activities (Tatar & Bağrıyanık, 2012), Opinions Of Pre-Service Science Teachers About OutdoorEducation (Kubat, 2018). In addition, Aquarium As An Out-Of-School Learning Environment (Falk & Adelman, 2003), Museums And Science Centers (Aktekin, 2008; Sturm & Bogner, 2010), zoo (Yavuz, 2012) energy park (Balkan Kıyıcı & Atabek Yiğit, 2010;) , (Şen & Parmasızoğlu, 2011), botanical gardens (Wiegand, Kubisch, & Heyne, 2013), industrial establishments (Bozdoğan, Okur, & Kasap, 2015), national parks (Güler, 2009).

In addition to these, The Effect Of Trips Made To Out-Of-School Learning Environments On Academic Achievement And Attitude (Şentürk & Özdemir, 2014), Out-Of-School Learning Environments; Providing Students With Experience(Tatar & Bağrıyanık, 2012), Providing Permanent Knowledge With Observation Skills (Balkan Kıyıcı & Atabek Yiğit, 2010), Making It Easier For Students To Relate To Daily Life (Tortop & Özek, 2013), Enabling Students To Develop Cognitively And Emotionally (Tatar & Bağrıyanık, 2017) are also other studies.

Studies in the literature show that teachers have a positive view of learning in out-of-school environments, but they mostly do not prefer these environments (Tatar & Bağrıyanık, 2015). In the studies, as the reason; It has been revealed that teachers do not have sufficient knowledge and self-efficacy about field visits. In addition, it was stated that the teachers' inability to provide guidance before and during the trip, and that teachers see time, cost, responsibility and bureaucratic work as a problem (Bozdoğan, 2008).

The pre-service teachers expressed the difficulties they experienced before the trip in the categories of transportation, group climate, bureaucracy and inexperience. The fact that the planned out-of-school environments are far away and the addresses of these places are not known exactly by the teacher candidates were emphasized as the most common problem. It can be said that the most inherent problem that can be experienced during out-of-school activities may be the transportation problem (Gürsoy, 2018).

It is an undesirable situation when the informal education environments are created that the teacher candidates have experienced a lot of trouble before the trip. The troubles they experienced before the trip may cause them not to enjoy the trip and to see the trip process as unnecessary. This situation may prevent educational trip environments from reaching their goals.

Developing out-of-school learning environments activities for science lessons and evaluation of the effects of students on scientific process skills (Erten & Taşçi, 2016), school administrators views on out-of-school learning environments (Aydemir &Toker Gökçe, 2016) In the studies conducted in the literature, there are opinions of parents that out-of-school learning environments can be risky and waste of time. Due to the fact that parents, who are an important part of education and training, do not see out-of-school learning environments as educational areas, it has been difficult to obtain the necessary permissions. (Bozdogan 2007), determined that the rate of families going to out-of-school learning environments with their children is low, and (Yavuz, 2012) made suggestions for changing the perceptions of parents about out-of-school learning environments. The findings obtained in this study showed that, despite such difficulties, out-of-school learning environments are alternative learning environments that support in-class education activities and contribute to the development of students. (Erten & Taşçı, 2016)

School administrators experience various problems before, during and after the utilization of out-of-school learning environments. These are financial deficiencies, official procedures, problems arising from student age difference, in-school problems and out-of-school learning environments. Financial deficiencies can bring the administrator and the teacher, the teacher and the parent, and the administrator and the parent face to face. The most common problems faced by administrators are that official letters take time, the time spent in the process of parental approval, vehicle inspection procedures, requesting appointments from institutions and organizations where the event will take place, traffic density and accident news in the press. (Aydemir& Toker Gökçe, 2016).

At the same time, it is seen that studies on the use of out-of-school learning environments are concentrated at primary, secondary and high school levels, and there are very limited studies in which science and mathematics activities are included in out-of-school learning environments in the pre-school period.(Uludağ, 2017)

In the light of all these research results, a school model has been designed in order to support out-of-school learning environments, where children can experience first-hand, gain knowledge through more than one sense organ, and examine the object, existence or event in their natural environment, through workshops designed in the form of a geodesic dome in the school garden.

School Gardens as an Out-of-School Environment

The benefits of using school gardens can be listed as follows (Loxley, 2016): It offers children an environment in which they are familiar and therefore feel comfortable. It provides the opportunity for children to see various patterns of nature (change of seasons) and to make observations over and over again. Children can carry on their research for days and weeks. They feel pretty responsible for their own learning. The use of the school garden is less complicated than taking the children to other out-of-school learning environments (transportation cost, health, safety, etc.).

In the first workshop, the cultivation of vegetables and fruits with soilless plant growing method (hydroponic) will be farmed by the children. In all processes, it will be ensured that children learn by doing and experiencing. Almost all of the world's vegetable production is carried out in soilless culture greenhouses. Hydroponic farming is practiced in many countries in the world such as the Netherlands, Spain, France, Belgium, Germany, Italy, Japan, South Korea, USA, Colombia and China. Soilless agriculture is achieved most intensively in the Netherlands in the world. In recent years, a serious trend towards soilless cultivation has been observed in other countries as well. Studies conducted in our country have revealed that the cultivation environment is suitable for our greenhouse conditions. In the cultivation environment, organic such as peat, sawdust, bark, rice husk and inorganic materials such as sand, gravel, perlite, vermiculite, volcanic tuff, rock wool and plastic foams can be used. Among these, especially perlite and volcanic tuffs are abundant in our country. These cultivation environment can be used alone or mixed with peat or mushroom compost waste (https://www.turktob.org.tr). It is met by giving the solutions by drip irrigation system. This hydroponic method completely eliminates the leading causes of houseplant death and achieves with little watering. Without soil, plants will also be much less likely to encounter disease or pest problems. Vegetables and fruits will be grown without the use of pesticides. Also, in hydroponic growing, daily maintenance will be reduced to a monthly watering. The energy obtained from solar panels will be used for the water circulation system. Some vegetables and fruits that you can easily grow are as follows; vegetables such as tomatoes, potatoes, green onions, carrots, eggplants, cucumbers, zucchini, peas, beans, spinach, lettuce, arugula, parsley, hot-sweet peppers, bell peppers and broccoli, corn, wheat, sugar beet, tea and cotton industrial plants, fruits such as watermelon, melon and strawberry (https://www.turktob.org.tr).

The second workshop will include sericulture and silk fabric making. Silkworm was first discovered 4000 years ago in China. It has also been kept a great secret by China for many years. Silk, after leaving China, first reached Anatolia and then Europe via the Silk Road. Silkworm farming is an auxiliary agricultural activity that provides an additional source of income. Mulberry leaves are the silkworm's only food source. Therefore, silkworm breeding can be carried out wherever mulberry trees can be grown. Silkworms have been cultivated in Anatolia for 1500 years. Although the climate and geographical features of Turkey are suitable for growing mulberry trees, this agricultural activity is losing its importance in Turkey day by day (Odabaş, Günbey et al., 2020). There are four different periods in the life of the silkworm. These are respectively egg - larva (caterpillar) - chrysalis and butterfly periods (https://www.tarim.gov.tr). Children will learn by doing the life cycle here. The only food of the silkworm is mulberry leaves, and about 500 kilograms of mulberry leaves are needed for one box of silkworms. The mulberry garden should be close to the silkworm feeding place (https://www.tarim.gov.tr).

In the third workshop, planetariums or observatories are the most effective training environments for astronomy education. Reed and Campbell (1972), Fletcher (1980), Mallon and Bruce (1982) concluded in their studies that planetariums have a very important place in astronomy education and student success. Because Fletcher (1980) stated that subjects that take hours for teachers to explain on the board and which may be difficult for students to comprehend and visualize in their minds can be comprehended more easily and more efficiently in a planetarium or observatory environment.(Sontay, Tutar et al. ,2016)

In the fourth workshop, archeology and the museum: Museums are places that invite individuals to experience, think, observe and learn by making connections through museum education. Especially considering the contribution of early childhood experience to learning, museum education is an important opportunity for the preschool period. Children find opportunities to observe, question, imagine and connect with their daily lives through activities in museums (Şentürk &Gülsen, 2021). UNESCO world heritage sites in the regions where they are located should be miniaturized and children should be able to discover and find them through excavations. Thus, children will be effective in establishing a connection between the past and the future, establishing a cause-effect relationship, cooperation, self-confidence, language development, and psychomotor skills.

Fifth workshop,wheat cultivation and transformation of wheat into flour: Bread is used synonymously with food in our country and in many parts of the world. Human's relationship with wheat began in the hunter-gatherer period. With the transition to the settled order (8500 BC), it was necessary to find food sources. Wheat and barley emerged as the most suitable plant sources. In recent years, some scholars state that the basis of Western civilization is not the Greek Civilization, but the Sumerian Civilization. The main resources of the Sumerian Civilization, which rose in the Fertile Crescent, were grain and ovine breeding. Among the cereals, wheat, barley and legumes were the most important species as they are today. Wheat, which later spread to the world from this region, has been the staple food of people on almost all continents until today. Aquarium in the sixth workshop; It is important to instill a love and awareness of animals in children, to make them realize that they live in other creatures other than themselves in the social areas they live in, to be able to distinguish differences by meeting animals they have never seen before, and to contribute to their cultural development. It will also be ensured that they have social responsibility by feeding living things.

The energies required for these geodetic workshops will be provided through solar panels. Solar energy; It is the conversion of the rays coming from the sun into electrical energy by using special technologies. Solar energy is the most abundant and clean energy in the world. It does not pollute the environment and is noiseless. It is a renewable and sustainable energy. Although solar energy accounts for only a small portion of overall global energy use today, the cost of installing solar panels is falling.

Most of the electricity sources we use today are fossil fuels, which produce harmful waste to the environment due to carbon dioxide. However, solar energy is the cleanest energy source that does not cause pollution and does not harm nature. When this situation is brought to pre-school children, today's children, tomorrow's adults, will be brought up with environmental education.

Method

In this study hypothetical model design was used. Here, the structural buildings architecture and educational buildings are united into outdoor environment buildings. The school departments and outdoor environment elements have brought together by semi meta-analysis method with incorporation readily theoretical framework. The resultant model designs were presented in sketched figures. The computer assisted program was used to obtain the final outdoor school environments.

Figures

The New School Model Project We Designed for Out-of-School Learning Environments

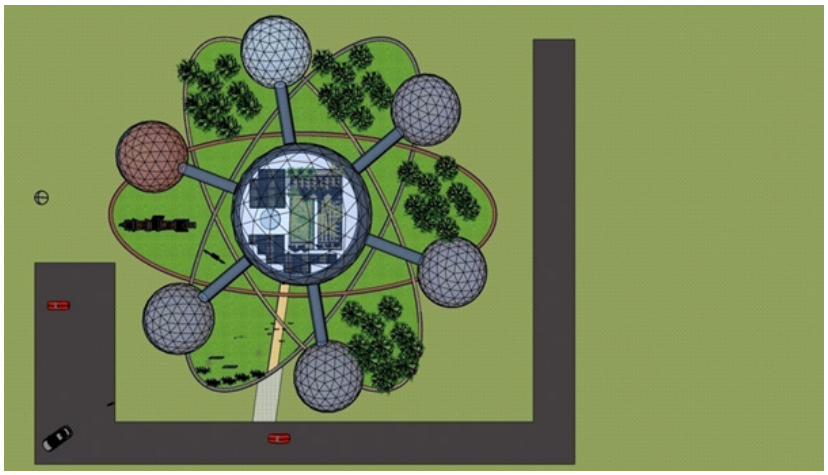

Figure 1. Schools and workshops designed as an Atom model

In Figure 1, the school building is centered in the school garden in the middle, and it consists of workshops with geodesic domes around it. This model is similar to the atomic model in appearance. Children are provided to learn by doing and living in the fields of chemistry and physics, as well as other disciplines. From the time of the historical Turkish states, triangular structures were rejected and it is seen that dome-shaped structures and tents resembling the sky were included. With these geodesic dome workshops, historical information can be given to children.

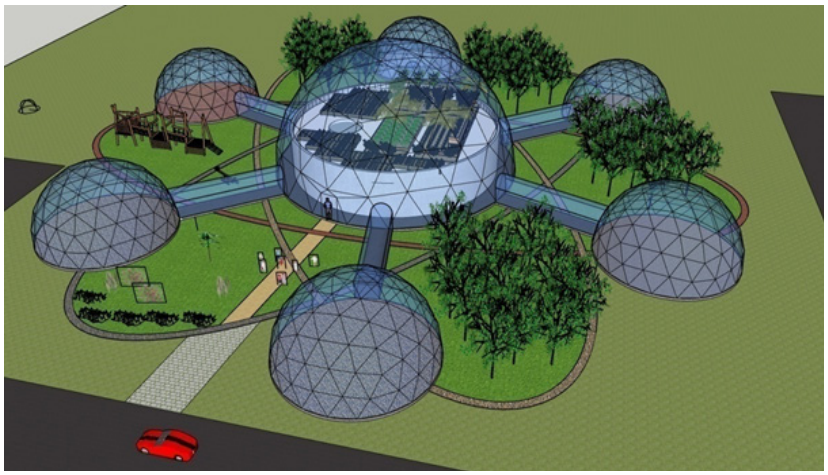

Figure 2. Workshops and Their Themes

There are 6 workshops in the picture in Figure 2, and hydroponic (soilless) farming activities will be carried out in the first one. The aim here is to compensate for our losses due to environmental pollution and global warming. Hydrooponicfarming is achieved most intensively in the Netherlands in the world. In recent years, a serious trend towards soilless cultivation has been observed in other countries as well. As of the pre-school period, it is aimed to give children within the scope of environmental education. Silkworm breeding will be produced in the second workshop. How silk fabrics are obtained will be learned from the very beginning by doing and experiencing with children. Shelving systems for silkworms will include mulberry trees to feed them. It is aimed to give children the cycle of emergence of silkworms from the cocoon and formation of fabric from silk.

In the third workshop, children will learn about the stages of wheat cultivation from wheat to flour by doing it themselves in the mills. In the fourth workshop, miniatures of historical places in the province where the children are located will be made and information such as how archeology studies are carried out and how to preserve the found artifacts will be presented to the children. Historical information will be told to children. In the fifth workshop, a plenatarium will be built and space, solar system, planets will be presented with virtual reality. Telescope will be used for sky surveys. In the sixth workshop, an aquarium will be created, and children will learn by doing and living in processes such as maintaining the aquarium, feeding sea creatures, and cleaning the aquarium.

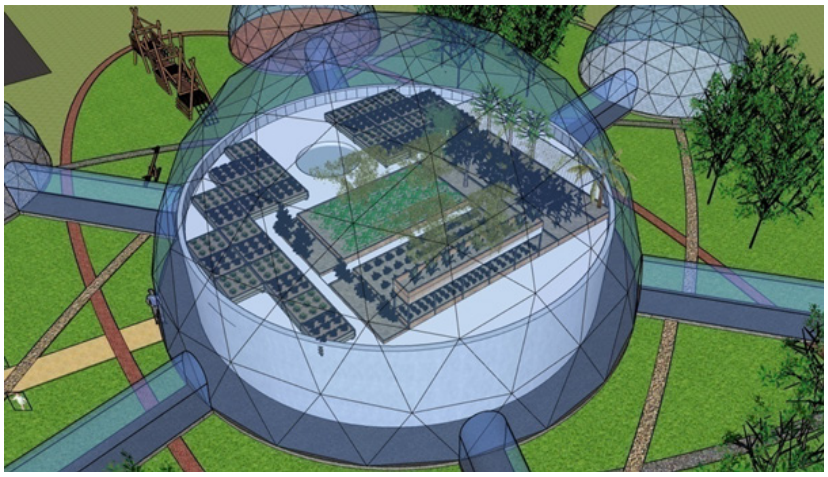

Figure 3. The School Located In The Center

In the picture in Figure 3, there are tunnels that will provide passing from school to workshops in the school model located in the center. While passing through the tunnels, children will be given mathematical information about the concept of time and the size of the tunnels. Children will decide for themselves which workshop they want to work in during the day. The botanical garden will be located in the upper part of the school. The glass coverings inside the dome will be in the shape of a triangle. In this way, children will see their knowledge of geometric shapes in a concrete way.

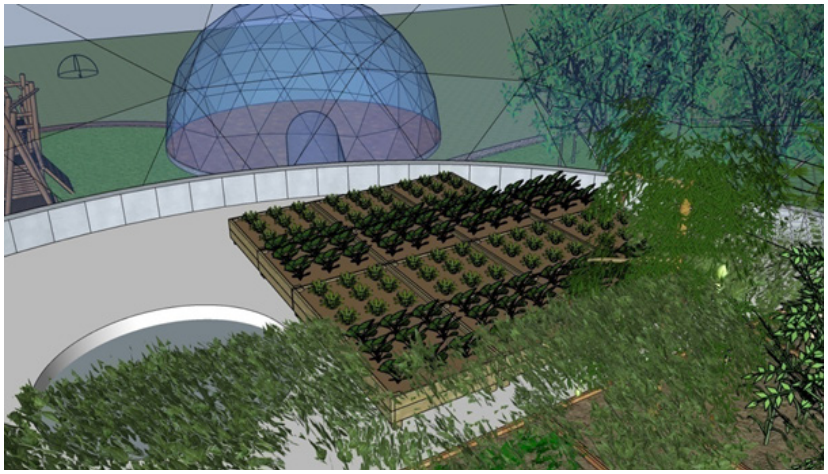

Figure 4. Botanic Garden

The picture in Figure 4 shows the images of the botanical garden on the roof of the school. This garden will be reached by the stairs passing through the middle of the building. Geodesic domes will be covered with glass. In this way, children will have the chance to examine natural events in more detail. They will see the sight of rain and hear the sounds of falling raindrops. In the same way, they will be able to watch the snowflakes and observe the melting and freezing events.

Figure 5. Garden, on the outside of the school and workshops

In the picture in Figure 5, the open areas outside the workshop will be afforested. By examining the growth of fruits and vegetables on the ground, it will be ensured that they consume the fruits and vegetables they have cultivated. At the same time, they will be able to see the difference between hydroponic agriculture and ground agriculture. Children will learn in both open and closed workshops. Furthermore, solar energy panels will be placed in the open area of the garden and the required energy will be produced with these panels by using geodesic dome-shaped workshops. Environmental education and the foundations of sustainable development will be given to children from an early age.

Conclusions and Recommendations

Environmental education should consider the environment as a whole consisting of natural and artificial, technological and social elements, and should be carried out as a life-long education in all formal and non-formal education stages, starting from pre-school education. (Sever& Yalçınkaya, 2018)

Computer-aided models, simulations or animations may be the best educational program options for learners (Seven, 2013). As Dahlqvist (2000) quoted from Scaife and Rogers (1996), he stated that “a picture is better than words, an animation is better than a photograph” and the argument put forward for the use of multimedia in educational settings follows the “more, more” approach. Computer-based materials are very successful tools in offering different possibilities that support 3D presentations (Seven, 2013). 3D computer models are an effective and scientific way to embody some abstract concepts. Students understand and learn processes that are not in their minds. In the field of education, virtual environments supported by three-dimensional materials provide many benefits to students. They argued that three-dimensional worlds would provide students with experiences that make them feel the essence of being in a certain environment and that the students could give meaning to the concepts with their own experiences. The use of computers, with the help of applications such as three-dimensional models, animations, simulations and virtual laboratories, allows for more effective teaching of hard to understand physical phenomena. In addition to these benefits, it is very important that especially “abstract” concepts and subjects are concretized, facilitating their intelligibility and presenting their representations. For computer-aided applications, both technical equipment and well-prepared instructional software are required.(Kıllı& Seven, 2013)

Through these workshops, it is aimed to ensure that children receive out-of-school education in safe environments, without the need for permissions and procedures, and to gain concrete experiences at first hand. At the same time, it is aimed to provide children with scientific process skills in mathematics and science by providing cooperation with school administrators, families and teachers. In the field of mathematics for children through geodesic domes; geometric shapes, measuring by observing the growth of plants, length by passage through tunnels, time spent passing through tunnels, the concept of area with the placement of materials in geodesic domes, water channels used for plant growth and volume concepts. In the field of science, physical science is reached with silkworm breeding and life science, our planet and space with the planetarium, temperature, humidity and light processes in the area created for the growth of plants.

The geodesic dome workshops will be in the form of an atomic model when viewed from above, and the children will be introduced to the atomic model with the help of 3D in the workshops. It is thought that these workshops will make an important contribution to the development of spatial animation skills.

Sustainable development is structured on the fact that people deserve a healthy and productive life in harmony with nature. Through this system, the foundations of environmental education and sustainable development will be given to children at an early age.

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