Triangles, squares, rectangles … let's get to know each other better

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Abstract

"Triangles, squares, rectangles ... let's get to know each other better". This is about an educational scenario, comprising of four educational sessions, which was designed in the context of the STEM Postgraduate Studies Programme in the field of education. More specifically this constituted a paper of the class "Educational robotics constructions' utilisation (Lego, Mindstorms, EV3) for educational scenario planning." The present scenario is addressed to third grade students and regards geometrical shapes. In more detail it aims at recognising, drawing as well as understanding the properties of the basic geometrical shapes. The activities are designed for the educational goals the will be subsequently mentioned. This purpose has been aided by the institutions of Science, Mathematics and Science, Technology, Engineering and Mathematics (STEM).

Keywords

Geometrical shapes, Lego Mindstorms EV3, STEM in education

1. Introduction

According to research, the use of technology by increasingly younger people is constantly rising. More specifically in 2015 a research that was conducted in the US (Rockville, MD – May 8, 2015) among 1000 parents to children 0-8 years old, showed that 68% of the children, who are 2 years old, use tablets as a primary source of entertainment, 59% use smartphones and 44% use gaming consoles. When children reach the age of 8 the parents are hugely dependant on technology for their children's entertainment, but also children themselves embrace it as their primary source of entertainment. This situation requires the enforcement of boundaries and control by the parents but it also raises certain issues in the educators' community regarding the proper use of technology. On one hand children need to understand what the correct use of technology is about, whereas on the other hand they must comprehend that a great opportunity arises for them and their education as well as their long term well being, through the use of the same technological means [1].

Therefore, its integration in the educational procedure becomes essential and its multiple benefits for students and teachers alike is a certainty. An effective way to achieve that is through the use of STEM (Science, Technology, Engineering and Mathematics) applications in teaching. STEM provides opportunities for the development of skills, encouraging children to answer questions and get involved in playful activities that regard Physics, Mathematics and Technology, with the usage of computational models of simulation.

2. Definition of the educational subject.

This specific educational plan includes a STEM application, which aims to help children understand in depth and in a pleasant manner the properties of geometrical shapes through the use of educational robotics.

The planning of this educational scenario is consistent with the Elementary Mathematics Curriculum in Greece. In the school's textbook for the 3rd grade's Mathematics the geometrical shapes are discussed in Chapter 3, Unit 1 entitled "Geometrical shapes and solids".

This educational scenario is designed to be implemented in 3rd grade students and four educational hours will be required divided into 2 two-hour lessons.

During the scenario's implementation the children will be called to participate in the activities in small groups of three, but diverse in regard to sex and skills. Then the groups will present the results of their project in front of the whole class.

4. Educational approach

The planning of this teaching course was based on the exploratory and discovery learning as well as the experiential learning, which are more entertaining for the students and enable them to comprehend in great depth the educational subject.

The *exploratory and discovery learning* is a teaching approach that aims to awaken the students' interest in order for them to actively participate in the process of learning. During discovery the student process terms and reasonings without interference by the teacher. This psychological construct aims to produce new ideas and functions as a teaching method [6].

The *experiential learning* emphasizes the essential role that experience plays in the process of learning. The search for meaning and the emotional and mental motivation of the student is suggested instead of simply memorising information. Furthermore the students' own experiences are utilised and they are encouraged to participate actively in the process of learning while at the same time they are urged to research, discover and activate their imagination and creativity [2].

Additionally, during the conduct of this scenario students are called to operate according to the *teamwork teaching method.* In the teamwork teaching method, students are responsible not only for their learning but for their fellow students as well. This is accomplished through helping each other and giving each other feedback. Individual and team performance is the final purpose [4].

In order to achieve in-depth understanding, this scenario includes the usage of the Lego, Mindstorms, EV3 technology, which comprises a full robotics environment.

Also, for the development and planning of this educational scenario the *methodology of the computational experiment* was used and thus, the present paper is divided to the corresponding stages that it is comprised of.

The computational experiment comprises the computational simulation of a real experience or the computational implementation of a hypothesis. The educational value of such applications lies in the fact that they are a tool for explaining terms and theories, as they enable the trainees to observe a situation. Furthermore they have the advantage of granting students under difficult circumstances (e.g. unable to access the campus due to disability or living in isolated areas) access to the educational procedure [7].

The methodology of the computational experiment as analyzed by Sloot [3], involves the following three main phases:

1) The modeling phase: In this phase, an abstract model is developed regarding the phenomenon that is to be studied.

2) The simulation phase: In this phase the mathematical methods of solving the model are applied. This phase is essentially an experimental method that aims to optimise the system in place as well as to analyse its sensitivity, the control of the hypotheses regarding the system and the estimation or the prediction of the system's development.

3) The computational phase: This phase refers to the implementation of algorithms and numerical techniques and consequently the writing of a code in a language for the solution and visualization of the simulation.

In the scientific discovery learning and more specifically in the design and implementation of applications with the methodology of the computational experiment, we can create the spaces:

a. Hypotheses space, where the students along with the teacher decide, clarify and formulate the hypotheses of the problem or problems or the scientific field that is studied.

b. Experiments space, where the computational experiment is conducted and which includes simulative activities of discovery, through which the students, using conversation and social interaction (students with students and students with teachers), actively construct knowledge and generate conclusions, general results and solutions of the problems or subjects in question.

c. Predictions space, where the results, the conclusions or the solutions formulated in the experiments space are reviewed with the analytical and mathematical solutions of the problem/problems or the analytical debate of the field that is studied in order to establish their credibility.

4. Determination of the application's objectives.

4.1. Regarding the cognitive field

✓ Recognition, description and drawing of the geometrical shapes (square, rectangle, triangle, circle, polygon).

✓ Consolidation of the geometrical shapes' basic properties.

4.2. Regarding the usage of new technologies

✓ Identification of the computer as a machine that enables a person in the field of work and knowledge accumulation as well as a source of entertainment.

✓ Familiarization with the Lego, Mindstorms, EV3 environment.

4.3. Regarding the learning process.

✓ Communication and cooperation with group members by trading ideas and suggestions and developing alternative approaches and solutions to a problem.

✓ Expression of ideas not only to their group but to the whole class as well.

✓ Description, explanation, interpretation and argumentation of their thoughts.

✓ Promotion of their observational skills, their critical thinking and the free expression of their ideas.

✓ Observation of the applications' results and generalization

✓ Development of partnership, communication, observation, investigation, processing and information recording skills.

Familiarization with teamwork and the ascertainment that learning is the product of team effort.

5. Teaching procedure

5.1. Hypotheses space

5.1.1. 1st teaching session (45 minutes)

To present to the students the new teaching subject they are given coloured cardboards shaped as squares, rectangles and triangles and are called upon to discuss in their groups and name them.

Afterwards, with the projector's help the following image is projected (Figure 1):

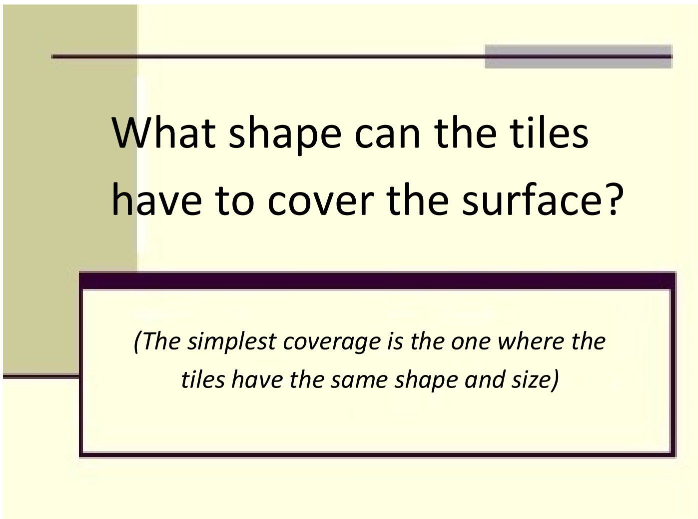

Figure 1

Students are asked to discuss the question given to them, by the image they were shown, in their groups. Then they are asked to present it before the whole class.

Students are originally expected to suggest the square, as it can be used to plank the whole surface, with every square's edge coinciding with the next square's edge, thus leaving no voids or discontinuities in the planking of the given surface (Figure 2).

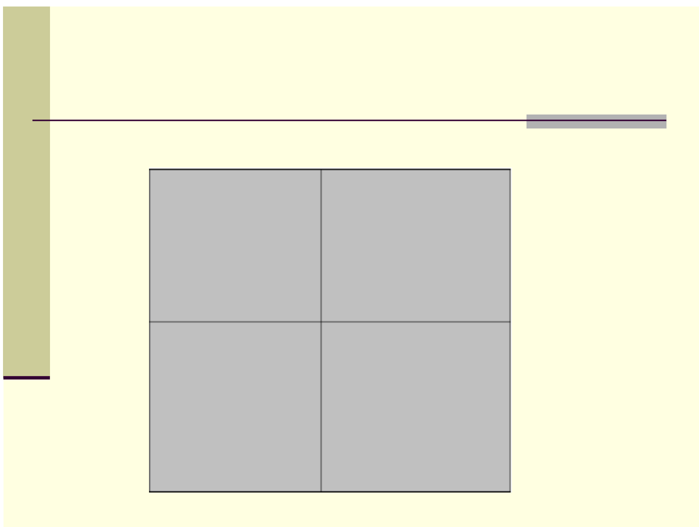

Figure 2

Next, and after a series of the proper questions by the teacher, the students will be lead to the rectangular tile and then to the triangular.

They will be asked to try to cover the surface with triangular tiles. At the same time the will be asked to figure out the easiest way to achieve that (by dividing the square tile into two triangular tiles drawing a diagonal line – Figure 3).

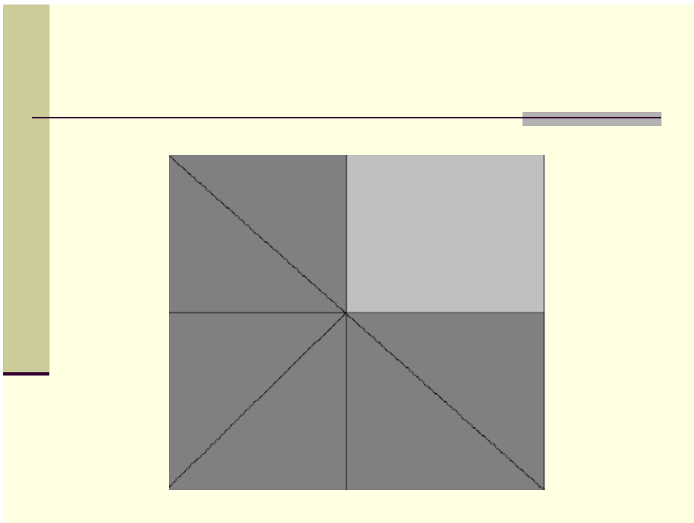

Figure 3

The discussion will expand around shapes with more than 4 angles (e.g. pentagon). The students will be asked to examine, after analyzing the square and the triangle, if the pentagon is suitable for an edge to edge coverage of a surface.

Next, the students will be asked to discuss and record in groups, in the paper sheet that they are given, the properties of squares, triangles and rectangles that regard their sides and angles.

5.2. Experiments space

5.2.1. 2nd teaching session (45 minutes)

The second teaching session will be devoted in assembling the robot that will be used in teaching. Figure 4 will be in the work space of every group, printed in a hard surface, as well as a Lego Mindstorms EV3 kit of the model 45544. In every kit all the pieces needed for the assembly will be provided. Furthermore detailed instructions for the assembly will be given.

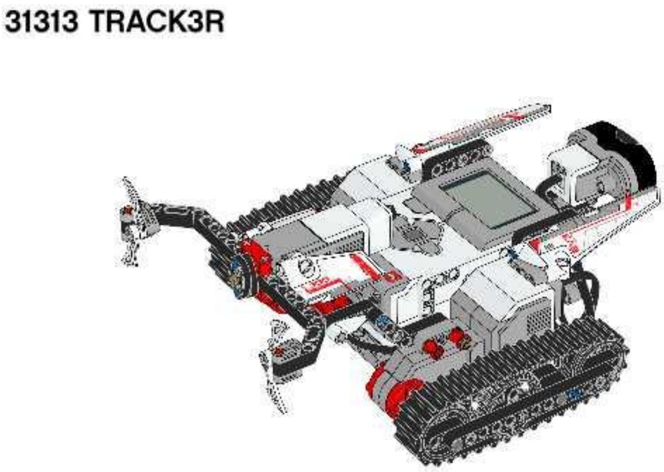

Figure 4

5.2.2. 3rd - 4th teaching session (90 minutes)

Initially the students will upload to the robot the software that will control the movement of the robotic system, with help from the teacher. Due to the students' young age as well as the time that would be demanded the code will not be created by the students. Should that be the case, we would also be declining from the original purpose of the scenario.

The function that is set on the code is that the robot follows a black line on a white surface. Students will be given paper sheets with the instruction to draw the geometrical shapes in measured paper (square, rectangle, triangle). Also instructions will be given regarding the way the robot is to be set in motion on the shapes. The students are asked to observe the robot's movement along the perimeter of the shapes and to record their observations on the paper sheets. Their observations regard the properties of the shapes.

5.3. Predictions space

5.3.1. 4th teaching session (15 minutes)

At the end of the 4th teaching session and only after the activities of the experimental procedure have been completed, the students will be asked to compare their conclusions with the ones they had recorded at the end of the 1st teaching session kai to assess the validity of those conclusions. A discussion will be held afterwards with the whole class in order to compose a summarized chart with the properties of the shapes.

6. Evaluation

With the implementation of an educational programme an evaluation is crucial, because, through that, not only can the effectiveness of the educational practice be assessed but also a continuous improvement of the learning results is pursued. The evaluation's criteria and keystones arise from the objectives that were initially set and by the degree of their attainment.

The type of evaluation that will be used during the implementation of this educational scenario is the formative one. This type of evaluation is used during the course of teaching and at regular points in time. The main objective of the formative evaluation is to help both the students and the teacher to organize the kind of learning that is needed in order for the student to master a subject. It has an informative character and aims to control the course of the student towards the attainment of the specific educational purpose. The essential information that is needed to adjust the programme or the teaching methods arise from this control. The performance of the student is not graded, as there is only an indication for adequate or inadequate attainment of the objective that was set [5].

7. References

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