

STEM APPROACH TO CREATING MODELS OF TECHNICAL OBJECTS

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Abstract: The STEM (Science, Technology, Engineering, and Mathematics) approach encompasses both pedagogical and technological aspects to promote interdisciplinary learning and promote skills in science, technology, engineering, and mathematics. Creating models of technical objects allows students to better understand the technologies, machines, mechanisms, and devices that surround them by applying knowledge from chemistry, physics, information technology, and mathematics. This article aims to examine the pedagogical and technological aspects of applying a STEM approach to creating technical objects in technology and entrepreneurship education. The stages in creating models of technical objects are defined as: object research (science), object planning (technology), model making (engineering), and model evaluation (mathematics). The place of the STEM approach in creating models of technical objects in technology and entrepreneurship education is outlined, as is its role in separating, describing, and studying the most important characteristics and functions of technical objects, which provokes active learning, the development of technological literacy and competence, the manifestation of creativity, technical thinking, and technical creativity in technology and entrepreneurship education.

Keywords: model, technical objects, STEM, STEM approach.

1. INTRODUCTION

STEM (Science, Technology, Engineering, and Mathematics) is an approach that facilitates students understanding of the world in its entirety by integrating knowledge from different scientific fields. Through STEM education, students will be trained to be better problem solvers; in addition, they are expected to become innovators, inventors, independent workers, logical thinkers, creative, collaborative, and technologically literate (Wang, N., Moore, T., & Roehrig, G., 2011). STEM approach integrates the disciplines into a cohesive paradigm of learning based on real-world applications outside the classroom (Garov, K., Peikova, D., 2019). STEM education is a global movement in educational practice which integrate with different patterns of integration to develop the quality of human resources in accordance with the skills to claim the 21st century (Milaturrahmah, N., Mardiyana; Pramudya, I., 2017).

The STEM approach requires a change in the educational environment, in the learning content, in the teaching methods, and in the organization and management of the learning activity. STEM education is directed from practice to theory or so on. learning by doing. (Borisova, P., 2024). An integrated STEM learning environment breaks down disciplinary boundaries and allows students to apply multidisciplinary knowledge in solving problems (Yang, D. Baldwin, S., 2020). The application of the STEM approach in the design, construction, and modelling of technical objects of various complexity helps students develop competences in the fields of technique and technology.

2. PEDAGOGICAL ASPECTS OF APPLYING THE STEM APPROACH IN CREATING MODELS OF TECHNICAL OBJECTS

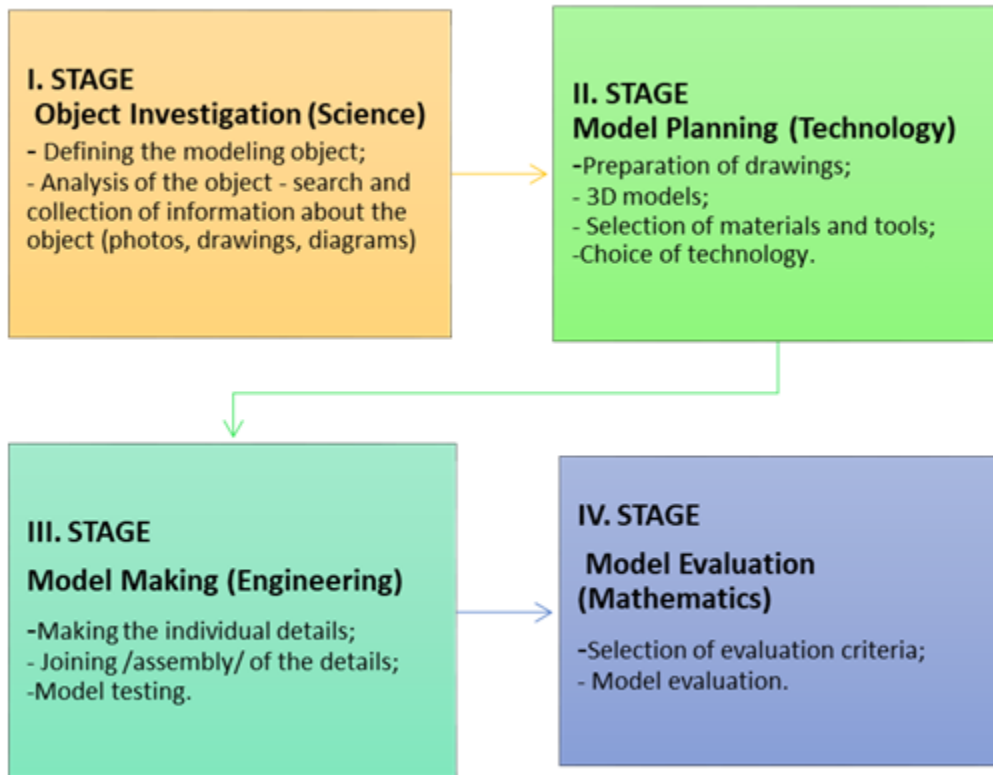
Education in technology and entrepreneurship develops in three main study areas: technology, engineering, and entrepreneurship (Vitanov, L., 2022). In the study of "technology and entrepreneurship," not only cognitive skills and habits are formed but also construction, research, graphic, environmental, and others (Staneva, Kr., 2020), which makes it a suitable subject for implementing a STEM approach in training.

Creating models of technical objects allows us to isolate, describe, and study the most important characteristics and functions of technical objects or systems. The modelling of details, mechanisms, and machines, on the one hand, contributes to an understanding of the physical regularities on which their function and application are based, and on the other hand, creates an idea of the essence of technology as a process in terms of organization, content, stages, sequence, and final product, including its testing and evaluation (Peicheva, J., 2020).

3. TECHNOLOGICAL ASPECTS OF APPLYING STEM APPROACH IN CREATING MODELS OF TECHNICAL OBJECTS

The STEM approach to creating models of technical objects in technological education allows using knowledge from the fields of science, technology, engineering, and mathematics to design, model, and program educational robots using different materials or constructors (Makeblock, Lego Education, Robotics Engineer Kit 1, etc.). Students can create different robots capable of moving, shooting, flying, etc. The STEM approach can be applied to the stages of creating models of technical objects, as indicated in Figure 1.

Figure 1. STEM approach applied to the stages of creating models of technical objects



I stage. Site research stage (science).

During this stage, the modelling object is defined.

- Answering the question, What are we going to model?
- The purpose of modelling is determined by the design parameters of the model. Most often, this is a search for an answer to the question posed during the formulation of the problem.
- Object analysis: it is necessary to answer the following question: can the object or process being studied be considered as a whole, or is it a system consisting of simpler objects? If it is the system, it is necessary to start an analysis of the objects that make it up to determine the relationship between them.

Ii. Stage. Site planning (technology)

- After analysing the structure, students prepare sketches, drawings and 3D models. 3D modelling allows to create a prototype of a technical object in a three-dimensional format. 3D modelling plays an important role in project presentation and product demonstration. Therefore, one of the most necessary competencies is the development of programming and 3D modelling skills in students, allowing them to master innovative 3D design methods where students can become familiar with the technology. You can also master the skills of creating a visualization of 3D models using software from various graphic editors: SweetHome, TinkerCad, Blender, Autodesk AutoCAD, etc. Using TinkerCad programs.
- Selection of materials and tools.

III stage. Model making (engineering)

- Making the individual details.
- Assembly of the details.
- Model testing.

IV stage. Evaluation of the model (mathematics)

IV stage. Model Evaluation (Mathematics)

The assessment is carried out according to model assessment criteria:

- volume and quality of the collected material; degree of -independence in developing the model;
- novelty of the design; performance quality.

At this stage, recommendations are made to improve the model.

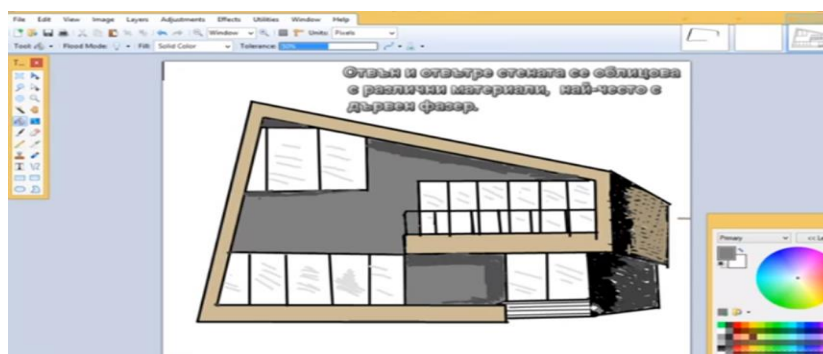
The STEM approach in creating technical objects in technology and entrepreneurship education is implemented through various projects such as "Model of a mountain hut" - 5th grade, "Model of a signal installation" - 6th grade, "Model of a smart house" - 7th grade, as well as through the construction and modelling of learning robots.

4. CREATION OF A MODEL OF A "SMART"HOUSE—TECHNOLOGIES AND ENTREPRENEURSHIP, 7TH GRADE

The "Smart house" model aims to demonstrate the capabilities of smart homes and show how the Arduino board can be used to automate and control various aspects of household life.

The creation of a "Smart House" model is directly related to the students' technological competence in the field of engineering and technology. The Genius graphics tablet (Figure 2) and the SIMS 3 game were used to implement the project.

Figure 2. Conceptual model of a smart house with a Genius tablet



Source: The authors

The 3D model of a smart house was created with the game SIMS 3 (Figure 3).

Figure 3. A 3 D model of a smart house created with the SIMS 3 game



Source: The authors

The proposed 3D model of "Smart House" contributes to the formation of practical skills for working with various software products and contributes to the formation of digital competences.

5. CONCLUSIONS

The application of STEM learning as a preventive approach is expected to help students interpret learning, especially science, so that it influences to improving learning quality (Nurwahyunani, A., 2021). The modelling of technical objects occupies an important place in the education of technology and entrepreneurship, helping to develop students' technological knowledge and skills. Creating models of technical objects in technology and entrepreneurship education allows students to better understand the world of technology and technology by developing technological knowledge, skills, and abilities through project work, teamwork, and work on a specific technological problem.

The STEM approach to creating models of technical objects in technology and entrepreneurship education helps to separate, describe, and study the most important characteristics and functions of technical objects, provoking the active participation of students in the learning process and the manifestation of creativity, technical thinking, and technical creativity.

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