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STUDENTS' TECHNICAL LITERACY IN TECHNOLOGY LESSONS BASED ON ELEMENTS OF ROBOTICS

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Abstract

This article discusses the pedagogical and methodological possibilities of developing students' technical literacy in technology lessons based on robotics elements. The content of technical literacy, its components, the role of robotics tools in the educational process, and ways to organize practical exercises are analyzed.

Keywords: Technology education, technical literacy, robotics, construction, problem-based learning, project method, engineering thinking, practical exercise, digital competence.

Аннотация

В данной статье рассматриваются педагогические и методические возможности развития технической грамотности учащихся на уроках технологии с использованием элементов робототехники. Анализируются содержание технической грамотности, её компоненты, роль робототехнических средств в образовательном процессе и способы организации практических занятий.

Ключевые слова: техническое образование, техническая грамотность, робототехника, алгоритмизация, конструирование, проблемно-ориентированное обучение, проектный метод, инженерное мышление, практическое занятие, цифровая компетентность.

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Introduction

One of the important tasks facing the education system today is to form a student not only as a person who assimilates ready-made knowledge, but also as a person who can apply knowledge in practical situations, work intelligently with technical devices and offer new solutions. Digital technologies, automation and smart devices are entering many areas of everyday life and production. Therefore, the content of technology in general secondary education should also be aimed at developing modern technical thinking and practical competencies in students.

Robotics elements can be an effective didactic tool in achieving this goal. In the process of working with a robot model, the student assembles mechanical parts, observes movement, understands the function of electrical circuits or sensors, builds a sequence of commands, and checks the result. Such activities connect theoretical concepts with concrete experience. The student learns to perceive errors not only as shortcomings, but also as information for improving the solution.

To substantiate methodological approaches and develop practical recommendations for developing students' technical literacy through the use of robotics elements in technology lessons. The article describes the content of technical literacy, stages of lesson design, sample tasks, and assessment criteria.

1. The concept of technical literacy and its components

Technical literacy is the ability to understand the function of technical devices, materials, mechanisms and technological processes, to use them safely, to identify simple problems and to choose appropriate solutions. It is not limited to knowing the names of equipment. The student must be able to explain how a device works, understand the connections between its parts, read a technical drawing or diagram and evaluate the result of the work.

Several interrelated components are important in developing technical literacy.

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The first is knowledge: basic concepts of mechanics, electricity, sensors, control, materials, and safety.

The second is practical skills: measuring, assembling, connecting, testing, adjusting, and recording the results.

The third is to analyze the problem situation: identify the cause of the failure, make a hypothesis, and verify it.

The fourth is communicative and social skills: distributing tasks in a group, explaining one's opinion with evidence, and listening to the suggestions of others.

The fifth component is digital and algorithmic literacy. The student can construct a sequence of instructions, create an algorithm in a simple block programming environment, or represent the operation of a device through a circuit. The main emphasis is not on writing complex code, but on understanding cause-and-effect relationships, planning a sequence, and checking the result. Only when these components are developed together will the student approach the independent implementation of a technical task.

2. Educational opportunities of robotics elements

Robotics combines elements of mechanics, electronics, computer science, mathematics, and design within a single task. Due to this feature, it creates favorable conditions for interdisciplinary integration. For example, when building a simple moving model, a student takes into account the strength of the structure, wheel diameter, friction, and direction of movement. If the model is equipped with sensors, it can monitor changes in distance or light. A model controlled by commands develops algorithmic thinking.

Robotics classes is that the student can directly see the result. If the mechanism does not work, he checks the connections, revises the design or changes the sequence of commands. This process naturally combines analysis, testing and improvement. Since students can solve the same task in different ways, it also allows for creative thinking and independent decision-making.

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However, the introduction of robotics into the lesson does not automatically increase the quality of education. The training should be appropriate to the specific learning objective, age characteristics and available resources. The robot model should not be a decoration of the lesson, but a tool that serves to master a certain concept or skill. For each task, it is determined in advance what the student will learn, what results he will show, and how the results will be assessed.

Methodology for using robotics in technology lessons

The following sequence is recommended for organizing a lesson based on robotics elements: creating a problem situation, specifying the task, planning a solution, designing and assembling a model, testing, analyzing the result, and improving it. This sequence corresponds to the engineering design cycle and encourages the student to actively explore rather than repeat a ready-made model. In the first stage, the teacher presents a real-life problem. For example: “How can a small model travel a specified distance?” or “What device can stop when it approaches an obstacle?” The question activates students’ prior knowledge. In the second stage, groups determine the necessary parts, materials, and work order. In the third stage, a drawing, diagram, or algorithm is created. During planning, students distribute tasks: constructor, tester, recorder, and presenter.

the fourth stage, the model is assembled. The teacher provides guidance where necessary, but avoids making all the decisions himself, if possible. In the fifth stage, a test is conducted and the results are compared with a predetermined criterion. In the sixth stage, the reasons for the shortcomings are discussed and the model is improved. Finally, the groups present their solutions, explaining which decisions were successful and what will be changed next time.

In this process, it is advisable to combine the project method, problem-based learning, collaborative learning, experimental and reflective methods. The teacher acts not as a ready-made answerer, but as an organizer of the process, a provider of security and a guide for students' thinking.

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Sample assignments for practical exercises

4.1. Creating a moving model

The goal of the assignment is to understand the interconnection of mechanical parts , assemble simple structures, and observe the movement of the model. Students are given safe materials for wheels, axles, and bodies, fasteners, and, if available, a small motor or a ready-made robotics kit. First, groups create a simplified drawing of the model, then assemble the parts and test the movement. The test checks that the model is moving in the right direction, the structure is solid, the wheels turn freely, and the model is safe to operate. If the model is leaning to one side, students check the weight distribution, wheel alignment, or axle alignment. This way, they learn to see the problem, state a possible cause, and test the solution in practice.

4.2. Sensor or conditional signal-based model

If the school has a sensor kit, students can create a simple model using a distance sensor or a light sensor. In resource-limited settings, the principle of the sensor is explained through cards, diagrams, or teacher demonstration. For example, a conditional algorithm is expressed as follows: “If the obstacle is close, stop; otherwise, move forward.”

Students identify the condition in the algorithm, enter different situations into a table, and predict the behavior of the model. This activity helps to understand the logical structure of “if-then” and the connection between the input data and the action to be performed. The teacher can simplify the task or complicate it with several conditions, depending on the readiness of the class.

4.3. Designing a “smart” device idea

Groups are asked to choose a problem from everyday life: an alarm when there is not enough light in a room, a model that indicates the need to water a plant, or an alarm that indicates that a door has been opened. Students describe the problem,

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the user, the function of the device, the required parts, and the expected result. If it is not possible to assemble a real device , a model, block diagram, or paper prototype is made.

Such a project teaches students to consider not only the technical aspects of a technological solution, but also user needs, convenience, cost, safety, and environmental aspects. As a result, technical literacy is linked to understanding real-life problems and developing appropriate solutions.

5. The role of the teacher and the organization of the learning environment

To effectively organize a robotics lesson, the teacher must first define the learning objective and adapt the task to the age and level of preparation of the students. Even if complex devices are not available, basic concepts can be taught using simple mechanical models, reusable safe materials, cardboard models, drawings and algorithm cards. The important thing is to create conditions for the student to understand the problem, plan a solution and analyze the result.

In group work, it is important to give each student a clear task. By rotating tasks, all students gain experience in constructing, testing, recording, and presenting . The teacher stimulates thinking through questions: “Why did the model turn this way?”, “What change affected the result?”, “How can this be verified?” Such questions lead the student to an evidence-based conclusion.

In an educational environment, the attitude towards error is also important. Instead of blaming the student when the model does not work, the error should be seen as an opportunity to observe and analyze. It is recommended that students write down their predictions, test them by changing one factor at a time, and compare the results. This creates a culture of simple scientific inquiry.

6. Evaluation criteria

robotics classes, the performance of the final model should not be the only thing that should be evaluated. Process, planning, collaboration, safety, and reasoning

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should also be taken into account. If the evaluation criteria are explained to students at the beginning of the lesson, they will consciously guide their work.

Criterion	Observable pointer	Score
Technical concept	Explains the parts and functions of the structure	0-2
Planning	Draws a drawing, diagram, or algorithm.	0-2
Practical implementation	Assembles the model correctly and neatly	0-2
Testing and analysis	Returns the result, suggesting at least one improvement	0-2
Cooperation and security	Performs duties and follows safety rules	0-2

The student 's performance can be assessed on a 10-point scale . 9–10 points - completed the task independently and reasonably; 7–8 points - completed the task mostly correctly , needed some assistance; 5–6 points - completed some parts of the task, analysis needs to be improved; 0–4 points - more guidance and additional practice are required. These indicators can be changed by the teacher according to the grade level and complexity of the task.

7. Safety and responsible use

When working with robotics, safety requirements take precedence over any practical results. Students are taught how to hold tools correctly, keep their workspace tidy, check wires and connections, and use electrical sources only with the teacher's permission. In school settings, it is necessary to use only low-voltage, educational sets , not to use damaged wires and batteries, and not to touch moving parts.

If cutting or heat-generating devices are required , work with them is organized under separate instructions and supervision. Before starting the finished device, students should check the connections, the stability of the structure and the safety

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of the work area. It is also useful to discuss the protection of personal data when using digital tools, respect for the copyright of programs and materials, and the impact of technical solutions on people and the environment.

8. Implementation problems and their resolution

There are a number of challenges that can be encountered when introducing robotics into education. These include a lack of specialized kits, a teacher's lack of experience in programming or electronics, limited class time, and varying levels of student readiness. These challenges can be mitigated by using a step-by-step approach.

First, it is recommended to start the training with simple mechanical structures and then introduce sensor and programming elements. Second, in the absence of expensive kits, reusable materials, models, algorithm cards and teacher demonstrations can be used. Third, teachers should exchange experiences, prepare small methodological developments and form a bank of tasks for existing devices. Fourth, by varying the level of complexity of tasks, it is possible to involve students of different levels of preparation in the lesson.

robotics projects with other subjects and clubs in the school. For example, in mathematics, measurement and proportions are considered, in computer science, algorithms are considered, in natural sciences, energy and motion are considered, and in fine arts, design is considered. This integration shows students the integrity of knowledge in life.

Conclusion

The use of robotics elements in technology lessons creates a great methodological opportunity for the development of students ' technical literacy. In this case, the student not only receives theoretical information about the technical device, but also actively participates in the process of designing, assembling, testing,

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identifying errors and improving it. Thus, technical thinking, algorithmic thinking, problem solving, creativity and cooperation skills are formed together. To achieve results, robotics tasks must be linked to a clear learning objective, be age-appropriate, provide safety rules, and be evaluated based on criteria that include the process. Even in conditions where special equipment is limited, it is possible to develop important components of technical literacy using simple models, schemes, and project tasks. Thus, robotics is one of the effective tools for transforming the science of technology into practical, research-based, and student- centered education.

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