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Application of AI Technologies in STEAM School Education

Abstract

Artificial intelligence is increasingly entering all spheres of our lives, including the sphere of education. These technologies offer numerous advantages and opportunities to perform various activities and tasks throughout the educational process. This article discusses some aspects of the application of AI technologies to improve personalization, accessibility, and interactivity in school education, and especially in learning STEAM subjects. The authors aim to propose approaches to successfully integrate AI into the work of teachers and facilitators during the pre-planning phase of lessons, the preparation of personalized tasks for students, the process of testing and assessing knowledge, as well as in group and project-based learning. The article shares the experience of teaching a compulsory computer science course as well as working in an interest club related to artificial intelligence and robotics with 6th grade students in secondary school, highlighting the potential of certain chatbots to support and enrich the process of programming.

Key words: Artificial Intelligence in Education (AIED), Chatbots, STEAM education

The development of AI technologies in the digital age has the potential to fundamentally change and modify traditional approaches, methods and technologies for teaching and learning. In school education, some of the opportunities that these technologies provide are increasingly used in various aspects such as: establishing and analyzing learning outcomes, personalizing educational resources and the learning process, providing immediate feedback and increasing the activity and motivation of the students, etc.

The implementation and use of intelligent learning platforms that include personalized learning and assessment systems offer great potential for increasing students' knowledge, building essential key competencies, and assisting teachers in organizing personalized education (Glushkova, 2015). This way, teachers can focus their attention on more critical activities such as lesson planning and supporting students, while using automated assessment and feedback systems. It is a fact that providing a learning environment tailored to the personal expectations, characteristics, goals and interests of each individual student leads to increased interest and motivation of students and increases the effectiveness of the learning process (Noskova et al., 2021).

Despite these advantages, the use of AI in education (AIEd) also raises important ethical questions. These issues are largely related to the exacerbation of existing inequalities in the educational system because AI algorithms often tend to perpetuate biases and distort information embedded in machine learning algorithms. Another significant problem is the fact that most professors have not studied AI at all during their university education. Therefore, for teachers to use AI effectively in their teaching practices, they need appropriate additional and ongoing training and support.

The article discusses some aspects of the application of AI technologies to improve personalization, accessibility and interactivity in school education and, in particular, STEAM learning.

Related works

Artificial intelligence has the potential to change many aspects of our lives – commerce, business, tourism, agriculture, healthcare and, of course, education (Alawi, 2023). Artificial intelligence, as defined by John McCarthy as far back as 1955, refers to machines being able to perform tasks that normally require human intelligence (McCarthy, 1987). Indeed, AI is not itself intelligent, but rather can perform tasks that are considered intelligent with a certain degree of success (Chiu et al., 2022). Based on these concepts, we can consider any theory, methodology or technique that facilitates the analysis, simulation and study of human thought

processes and behavior by machines such as AI. Intelligent systems cover a wide range of technologies such as robotics, natural language processing, semantic knowledge modeling with common sense, expert systems, neural networks, machine learning, etc. (Sarker, 2022).

AI is considered a powerful tool for creating new paradigms in the organization of the learning process, the assessment of technological progress and the conduct of educational research. Three main AIEd paradigms are defined (Ouyang & Jiao, 2021):

- *AI-directed learning* – AI is used to introduce cognitive learning tools, with learners in the role of recipients of AI services.
- *AI-supported learning* – AI supports learning through the application of various cognitive and social constructivist theoretical foundations. Students collaborate with AI to obtain desired knowledge, skills, and competencies.
- *AI-empowered learning* – this paradigm is based on collaboration, with AI empowering learners to take initiative in their own learning, and collaboration between students, facilitators, teachers, information, and technology increasing the added value of learning.

In AIEd, two aspects are clearly distinguished: the development of AI-based learning tools and the use of AI to manage, evaluate and improve learning. AIEd includes the integration of different social, cultural, economic and pedagogical approaches in the use of AI technologies such as intelligent learning cyber-physical systems (Stoyanov et al., 2022), chatbots, learning robots, learning tracking and analysis tools, adaptive learning systems and automated assessment and analysis, etc.

One of the most commonly used AI technologies to support teaching and learning activities is the utilization of Chatbot technology (Deng et al., 2023). By nature, a Chatbot is an intelligent agent that engages in meaningful conversations with users, thanks to a well-structured knowledge base. Creating a Chatbot is based on Natural Language Processing (NLP) technologies. The first Chatbot, “Eliza,” was developed to act as a psychotherapist as early as 1966. As technology advanced, numerous Chatbots were created, including SmarterChild, Apple Siri, Amazon Alexa, IBM Watson, Microsoft Cortana, Google Assistant, and more (Reis et al., 2018). We will look at some chatbots and their functionalities through the prism of school education.

ChatGPT was created by OpenAI and launched in November 2022. ChatGPT is described as a powerful machine learning software that uses the Generative Pre-Trained Transformer (GPT) algorithm to generate answers to text questions. ChatGPT is trained on a huge set of diverse data such as articles, websites, books, and written conversations. However, through a fine-tuning process that includes dialog optimization, ChatGPT is capable of having a conversation with users (Rahman, 2023). Generative pre-trained transformers (GPTs) are a class of advanced language models that use deep learning to improve their output.

By identifying patterns and regularities in the data, GPTs generate relevant phrases and words or produce relevant images in response to user queries. ChatGPT can perform a very wide range of tasks such as: language translation, conversation and answering questions, generating long or short text, explaining complex concepts or topics, generating or debugging program code, etc. ChatGPT's ability to understand natural language queries and generate responses has made it a popular tool for getting quick answers to a wide variety of questions in the classroom. For example, it can quickly summarize a long and difficult topic in a few sentences. It not only discovers what the problem is, but also provides descriptive solutions to mathematical and physical problems; can help detect program errors; comment and explain program fragments and modules.

Microsoft 365 Copilot is another chatbot that aims to improve collaboration between participants in the educational process and facilitate team and project work. It provides personalized advice and suggestions to help teams perform their tasks more effectively. It is integrated into Microsoft 365 applications such as Word, Excel, PowerPoint, Outlook and Teams and offers collaboration to all participants in the learning process. To implement these features, Copilot provides personalized access to user profiles and manages personal calendars, emails, chats, documents, meetings, contacts, etc. (Quibeldey-Cirkel, 2023). In addition, this chatbot can also be embedded in programming environments such as Visual Studio Code and support the teaching of programming in various programming languages in the middle school (Puryear & Sprint, 2022).

All this explains the significant potential of AI to improve the process of learning and teaching, as well as to implement pedagogical innovations in the field of monitoring the development, assessment, and management of education.

Methodology of research

The potential of AI to transform education is undeniable, but achieving good educational outcomes requires extensive scientific research and pedagogical experimentation to ensure the necessary reliability, validity and security of the learning process. The use of AIED technologies, learning content and pedagogical approaches must be integrated and adapted to the characteristics of the learning environment in the modern school. Therefore, when designing learning activities supported by AI, teachers should consider six key elements to achieve the expected learning goals: learners, context, tasks, pedagogical approaches, methods of interaction and application of AI technologies.

When we talk about the application of AI in school education, we usually mean different aspects aimed at improving learning, teaching and administration

processes. We base our research on the understanding that AI can provide significant benefits to education, but that it can only complement and enhance teacher teaching, rather than replace it entirely.

The peculiarities of different educational systems and schools determine the need to conduct research on the effectiveness of the application of AIED technologies. Given the stated realities and processes in modern education, it is necessary to conduct research on various aspects of the application of AI in school education. This motivates the authors, who have set themselves the task of studying the possibilities of applying some AI technologies in STEAM education in the conditions of Bulgarian schools.

In Bulgaria, school education is mainly conducted in a classroom-lesson format with predetermined curricula for each subject. This does not allow for formal training in artificial intelligence, but enables the use of AI technologies in separate activities in the training of various academic subjects. New opportunities for experimentation in this direction are provided by the creation of STEAM centers in all schools in the country, and the organization of interest clubs as an optional form of education. The methodological toolkit, in addition to the development of educational materials, also includes a test measurement of knowledge, as well as the results of the project work of an experimental group of 6th and 7th grade students on the subject „Computer Modeling and IT“ related to Python programming. In addition, the results of project work in a STEAM club on interests in the field of AI and robotics with students of the same age group are also measured.

The research methodology includes the development of teaching materials on „Computer Modeling and IT“ (as a coauthor of textbooks for compulsory training (Garov, Glushkova et al, 2022),); the development of a curriculum for the STEAM interest club in AI and robotics (Stoyanov, Glushkova et al., 2019); the creation of Learning and Creativity Plans for the application of AI technologies in individual school subjects (FACILITATE-AI, 2023); preparation of tests to check students' knowledge; preparation of a survey among students, teachers, and parents. The study was conducted during the 2022-2023 school year at „Hristo Smirnenski“ secondary school in the town of Brezovo and partially in several other secondary schools in the Plovdiv region. 76 students, 7 teachers, and 32 parents participated in the research.

The participation of the authors in several national and European projects related to the development of educational content on AI and the application of AI technologies in the classroom helped to use both personal and shared collective experiences that allowed us to make some of the summaries and analyses shared in the article.

Our experience in the application of AI Technologies in STEAM training

In the last few years, a team of scientists and pedagogical specialists from Plovdiv University „Paisii Hilendarski“ in Bulgaria, together with teachers in secondary schools of the Plovdiv region, have developed different approaches for the application of AI in school education in almost all aspects discussed above. A prototype of an intelligent educational platform Virtual Educational Space (VES) was developed as a cyber-physical and social system that provides adapted learning resources and services to students of various specialties in the Faculty of Mathematics and Informatics (Valkanov, 2016) (Rahnev, 2014). VES is realized as a multi-agent platform, with the personalization of learning realized through the interaction between the personal assistants of all users – students, teachers, and university administration (Todorov, 2019 a).

As an adaptation of VES for school education, a prototype cyber-physical space called BLISS was developed (Todorov et al., 2019 b). This platform is multi-agent and enables personalized learning for self-studied students, as well as personalized access to learning resources and services for regular students. By using blockchain technologies in BLISS, an electronic diary related to the administrative process of issuing documents with factory numbering is modeled and is in the process of prototyping (Krasteva, 2022). The system for checking and evaluating knowledge is connected to the electronic diary, which monitors the progress of students and, in the presence of educational problems, informs the parents and teachers of the student.

In parallel with the development of BLISS, the team also turned its attention to the integration of AI chatbots, which, on the one hand, can interact with the personal assistants and other intelligent agents in the space, and on the other hand, help to solve various tasks in the present classroom training. Over the past two years, with the rapid development of LLM and chatbots, we have been experimentally using the capabilities of AI in STEAM education in the school in the following aspects: for planning the learning process and lessons by the teachers; for personalization of the learning process; for supporting the programming process; for evaluation and testing of students.

Organization of training in STEAM education

Working in interest clubs in the established STEAM centers in schools provides an opportunity to develop students' creativity, analytical and critical thinking. Teamwork, when working on common projects, unites students and builds the skills of understanding, tolerance, empathy, and inclusion so necessary for modern development. In order to achieve these goals, the teacher must plan his/her activity well, create an appropriate curriculum, think about interesting projects and think about organizing team activities. For example, let us organize a robotics interest club activity with 6th and 7th grade students with the help of ChatGPT.

First, let us create the curriculum. The request to ChatGPT is: “*Create a curriculum of 30 lessons on the topic “Robotics” for a STEAM interest club in the 6th grade*”. The part of chatbot answer is presented in Figure 1.

Curriculum: Robotics for 6th Grade STEAM Interest Club

Lesson 1: Introduction to Robotics

- Learning Objectives:**
 - Understand the concept of robotics and its applications in real-world scenarios.
 - Identify the main components of a robot and their roles.
- Key Digital Competences:**
 - Digital Literacy: Understanding basic technological terms related to robotics.
 - Computational Thinking: Introducing the logic behind robot actions and decisions.
- Assessment:**
 - Quiz on robotics concepts and terminology.
 - Participation in a group discussion about potential robot applications.

Lesson 2: Robot Design and Construction

- Learning Objectives:**
 - Learn about the engineering design process and its application in robotics.
 - Create a simple robot design using 3D modeling software.
- Key Digital Competences:**
 - Digital Creativity: Designing and customizing robot parts using digital tools.
 - Information Literacy: Researching existing robot designs for inspiration.
- Assessment:**
 - Evaluation of individual robot designs and explanations of design choices.
 - Completion of a 3D model of the robot part.

Lesson 3: Programming Robots with Blockly

- Learning Objectives:**
 - Understand block-based programming concepts and their application in robotics.
 - Develop basic programming skills to control a robot's movements.
- Key Digital Competences:**
 - Digital Skills: Operating programming software and writing code blocks.
 - Problem-Solving: Debugging and troubleshooting robot programs.
- Assessment:**
 - Completion of programming exercises to make the robot perform specific tasks.
 - Peer review and feedback on e

Lesson 4: Sensing and Perception in Robotics

- Learning Objectives:**
 - Explore various sensors used in robotics and their functionalities.
 - Understand how robots gather data from their environment and react accordingly.
- Key Digital Competences:**
 - Data Literacy: Analyzing sensor data and making decisions based on it.
 - Critical Thinking: Evaluating the effectiveness of different sensors in specific scenarios.
- Assessment:**
 - Practical demonstration of sensor integration in a robot.
 - Quizzes on sensor types and their applications.

Lesson 5: Robotics Challenge and Showcase

- Learning Objectives:**
 - Apply knowledge gained throughout the curriculum to solve a robotics challenge.
 - Collaborate with team members to design, program, and present a functional robot.
- Key Digital Competences:**
 - Collaboration: Working as a team to achieve a common goal.
 - Digital Communication: Presenting the robot design and functionality effectively.
- Assessment:**
 - Performance in the robotics challenge based on criteria such as efficiency and accuracy.
 - Presentation and demonstration of the robot's capabilities in the showcase.

The curriculum aims to introduce 6th-grade students to robotics while fostering their interest in STEAM subjects. Each lesson has specific learning objectives, and key digital competences are integrated into the activities. The assessment methods include quizzes, hands-on tasks, individual and group projects, and peer evaluations. This approach encourages active participation, creativity, problem-solving, and collaboration among the students, making the learning experience engaging and enjoyable.

Figure 1. Created STEAM curriculum

Source: Own work.

The next step in the organization of learning in the interest club is the creation of a learning and creativity plan for individual lessons. For example, when requesting the development of a lesson plan for “Robot Design and Construction”, ChatGPT generates the following (Figure 2):

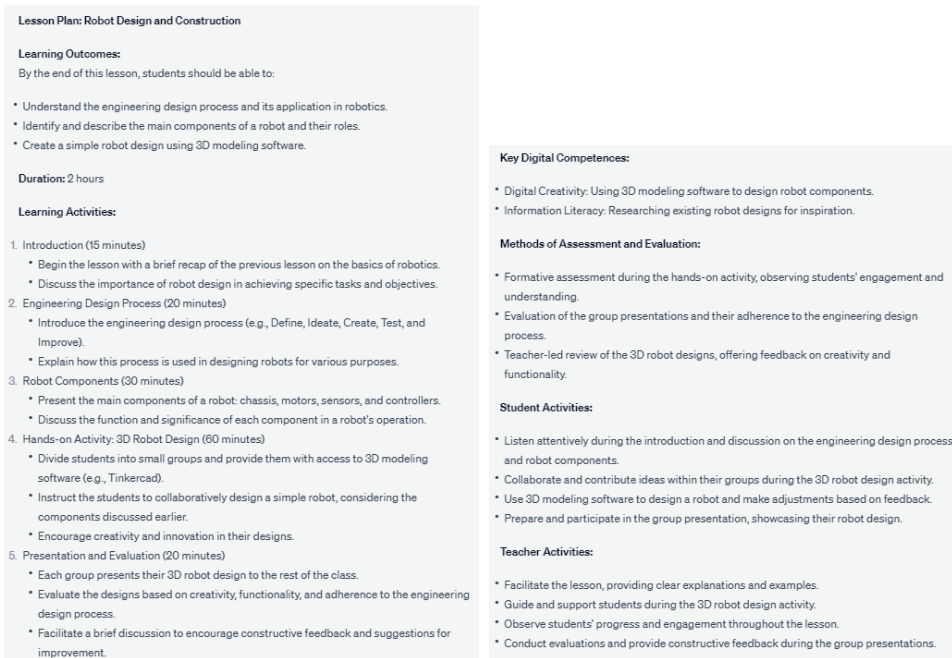


Figure 2. Created Lesson Plan

Source: Own work.

Support the programming process

Programming the movement and behavior of robots can be realized in various programming languages. In Bulgaria, students study „Computer Modeling and Information Technologies“ as a compulsory subject starting from the 3rd grade of primary school. The two main languages taught in this subject are Scratch and Python. Since both Scratch and Python are widely used in programming educational robots, let us explore some possibilities for supporting the programming process using chatbots like ChatGPT and Copilot. These bots can also be used by teachers in initial preparation for classes and by students in interest clubs. Since students already have a basic knowledge of programming, the application of these AI tools can be mainly aimed at:

- *Idea generation:* Chatbots can help students generate ideas for realizing their robots' „missions.“
- *Coding help:* Chatbots can act as coding helpers by helping students with syntax and logic errors in their Scratch or Python code. On the other hand, students can share some code snippets with the bot and discuss the received suggestions to improve the code.

- *Access to additional information:* Chatbots can provide links to relevant learning resources, tutorials and documentation for both Scratch and Python.
- *Troubleshooting:* When students find errors and inconsistencies in their bot's behavior, they can seek help from the chatbot to identify the problems and find solutions.
- *Organize project work:* Students can discuss the assignment and project goals with the chatbot, and it can offer guidance for achieving those goals, given the capabilities of both Scratch and Python.
- *Real-time code examples:* Copilot, which is designed to generate code, can provide real-time code examples based on student descriptions. This can be especially useful for students who are interested in new programming concepts or techniques.

It is important to note that while chatbots are valuable tools to support the learning process, they should not replace human interaction and guidance. Teachers as moderators and facilitators are the ones who organize the whole learning and research process, they provide personalized feedback, to address individual learning needs, to encourage students with educational difficulties and to provide a supportive environment. Chatbots can serve as additional tools to enhance overall learning.

Microsoft 365 Copilot is only one of the AI tools in the Microsoft's Copilot ecosystem which include Github Copilot (and the new Github Copilot X), Dynamics 365 Copilot, Copilot in Microsoft Viva, Microsoft Security Copilot, and the expected soon Copilot in PowerBI, Copilot in Power Pages, Copilot in Windows, etc. Microsoft also announced the work on new features that will help developers build their own copilots and AI-enabled applications. Github Copilot seamlessly integrates with the widely used programming environments like Neovim, JetBrains IDEs, Visual Studio and Visual Studio Code for Python, JavaScript, TypeScript, Ruby, Go, C#, and C++ programming.

In the preparatory phase in the Robotics club, the teacher can use Copilot, which provides specialized support in the field of programming. He/she can define his/her request to the bot, and get different ideas and solutions to the tasks. The teacher, relying on his/her knowledge and experience, reviews and accepts or rejects the proposed solutions. For example, to consolidate the knowledge of the movement of the turtle in the first lessons of the Robotics club and the drawing of various figures, the teacher can make the appropriate requests to Copilot and receive appropriate suggestions (Figure 3).

```
File Edit Selection View Go Run ... draw square with turtle.py - Python&Copilot - Vi
Welcome Draw rectangle Untitled-1 draw square with turtle.py X
draw square with turtle.py > ...
1 # draw square with turtle
2 import turtle # import turtle module
3 wn = turtle.Screen() # create a turtle screen
4 wn.bgcolor("lightgreen") # set background color
5 wn.title("Turtle Square") # set title
6 tess = turtle.Turtle() # create a turtle named tess
7 tess.color("blue") # set tess color
8 tess.pensize(3) # set tess pensize
9 tess.shape("turtle") # set tess shape
10 for i in range(4): # repeat 4 times
11     tess.forward(100) # move forward 100
12     tess.left(90) # turn left 90 degrees
13 wn.mainloop() # wait for user to close window
15
GitHub Copilot Labs

File Edit Selection View Go Run Terminal Help • draw figure 2.py - Python&Copilot - Visua
Welcome Draw rectangle Untitled-1 || ↺ ↻ ↕ ⏪ ⏩ Launch
draw figure 2.py > ...
1 # draw figure with rotation of square 12 times with turtle
2 import turtle # import turtle module
3 wn = turtle.Screen() # create a turtle screen
4 wn.bgcolor("white") # set background color
5 wn.title("Turtle Square") # set title
6 tess = turtle.Turtle() # create a turtle named tess
7 tess.color("blue") # set tess color
8 tess.pensize(3) # set tess pensize
9 tess.shape("turtle") # set tess shape
10 for i in range(12): # repeat 12 times
11     for j in range(4): # repeat 4 times
12         tess.forward(100) # move forward 100
13         tess.left(90) # turn left 90 degrees
14         tess.left(30) # turn left 30 degrees
15 wn.mainloop() # wait for user to close window
16
```

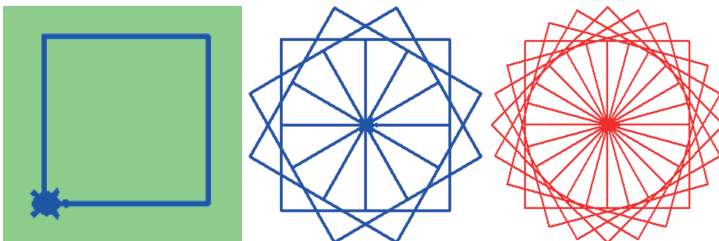
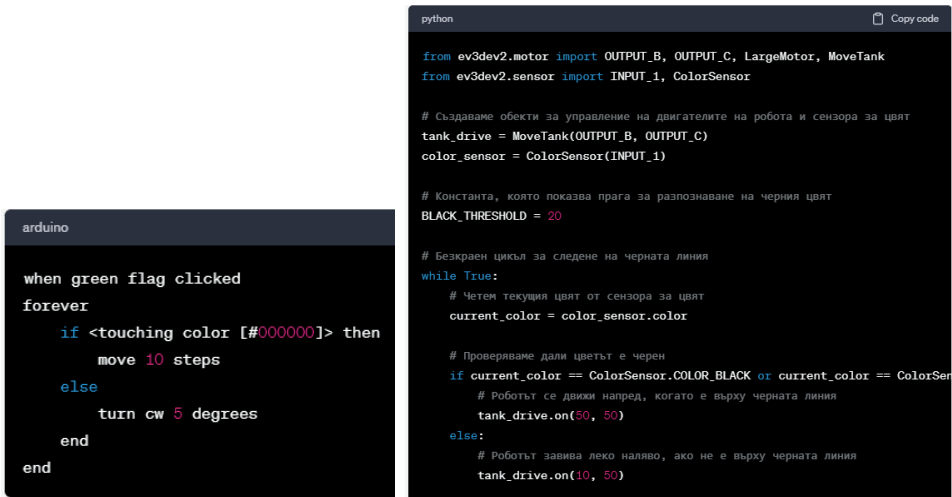


Figure 3. Application of Copilot in programming

Source: Own work.

When working on various assignments in the Robotics Club, students can also use ChatGPT and MS Copilot using some of the options suggested above. The following figures present different proposals for programming the movement of a robot that follows a black line of a script transformation of Scratch and Python, proposed by ChatGPT (Figure 4) and the proposal of Copilot built into the Visual Studio Code programming environment (Figure 5).



```
arduino

when green flag clicked
forever
  if <touching color [#000000]> then
    move 10 steps
  else
    turn cw 5 degrees
  end
end
end

python

from ev3dev2.motor import OUTPUT_B, OUTPUT_C, LargeMotor, MoveTank
from ev3dev2.sensor import INPUT_1, ColorSensor

# Създаваме обекти за управление на двигателите на робота и сензора за цвят
tank_drive = MoveTank(OUTPUT_B, OUTPUT_C)
color_sensor = ColorSensor(INPUT_1)

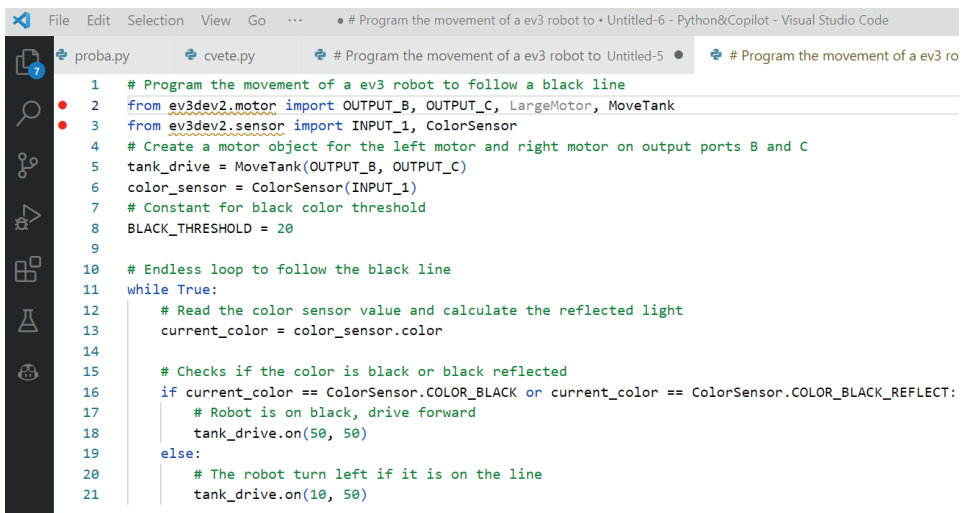
# Константа, която показва прага за разпознаване на черния цвят
BLACK_THRESHOLD = 20

# Безкраен цикъл за следене на черната линия
while True:
    # Четем текущия цвят от сензора за цвят
    current_color = color_sensor.color

    # Проверяваме дали цветът е черен
    if current_color == ColorSensor.COLOR_BLACK or current_color == ColorSen
        # Роботът се движи напред, когато е върху черната линия
        tank_drive.on(50, 50)
    else:
        # Роботът завива леко наляво, ако не е върху черната линия
        tank_drive.on(10, 50)
```

Figure 4. Application of ChatGPT in SCRATCH and Python programming

Source: Own work



```
File Edit Selection View Go ... # Program the movement of a ev3 robot to • Untitled-6 - Python&Copilot - Visual Studio Code

proba.py cvete.py # Program the movement of a ev3 robot to Untitled-5 # Program the movement of a ev3 r

1 # Program the movement of a ev3 robot to follow a black line
2 from ev3dev2.motor import OUTPUT_B, OUTPUT_C, LargeMotor, MoveTank
3 from ev3dev2.sensor import INPUT_1, ColorSensor
4 # Create a motor object for the left motor and right motor on output ports B and C
5 tank_drive = MoveTank(OUTPUT_B, OUTPUT_C)
6 color_sensor = ColorSensor(INPUT_1)
7 # Constant for black color threshold
8 BLACK_THRESHOLD = 20
9
10 # Endless loop to follow the black line
11 while True:
12     # Read the color sensor value and calculate the reflected light
13     current_color = color_sensor.color
14
15     # Checks if the color is black or black reflected
16     if current_color == ColorSensor.COLOR_BLACK or current_color == ColorSensor.COLOR_BLACK_REFLECT:
17         # Robot is on black, drive forward
18         tank_drive.on(50, 50)
19     else:
20         # The robot turn left if it is on the line
21         tank_drive.on(10, 50)
```

Figure 5. Application of Copilot in Python programming

Source: Own work.

Assessment and evaluation of students' knowledge

Assessment of the learning process and feedback are particularly important for all participants in learning process. And in this process we can use the capabilities of AI technologies. For example, when asked to create a test to check students' knowledge of the above topic, ChatGPT offers the test form in the following Figure 6. The teacher can clear this test and use it in his/her work.

Assessment Test: Robot Design and Construction

Part 1: Multiple Choice Questions

- What is the purpose of the engineering design process in robotics?
 - To program the robot
 - To build the robot using 3D printing
 - To design and create robots for specific tasks
 - To test the robot's sensors
- Which of the following is NOT a main component of a robot?
 - Chassis
 - Sensors
 - Wheels
 - Software
- The part of a robot responsible for providing structure and support is called the:
 - Actuator
 - Controller
 - Chassis
 - Sensor

Part 2: Design Challenge

- In the 3D modeling software provided, design a robot with the following specifications:
 - The robot should have a rectangular chassis.
 - It should have two wheels for locomotion.
 - Include a front-mounted ultrasonic sensor for obstacle detection.
 - The robot should also have a light sensor on top for detecting light intensity.(Note: Students can sketch their designs on paper or use any 3D modeling software available.)

Part 3: Presentation and Evaluation

- In the group presentation, each team will present their 3D robot design to the class. Consider the following criteria while evaluating:
 - Creativity: How innovative and unique is the design?
 - Functionality: Does the robot seem capable of performing the specified tasks?
 - Adherence to Design Process: Did the group follow the engineering design process during the creation of the robot design?

Part 4: Reflection

- Explain the importance of each of the following components in a robot design:
 - Chassis
 - Sensors
 - Controllers
- Describe the steps you followed during the engineering design process to create your robot design. How did this process help you in the design and construction of the robot?

Assessment Evaluation:

- The multiple-choice questions assess students' understanding of key concepts and components related to robot design.
- The design challenge evaluates their ability to apply knowledge and creativity in creating a robot design using 3D modeling software.
- The presentation and evaluation portion assesses their communication skills and adherence to the engineering design process.
- The reflection questions provide insights into their understanding of the significance of different robot components and the design process.

Note:
This assessment can be adjusted based on the specific tools and software available to students. Teachers can adapt the questions to suit their classroom resources and requirements. Additionally, the assessment should be conducted in a manner that aligns with the overall learning objectives of the lesson.

Figure 6. Created Test for Evaluation of students on this topic

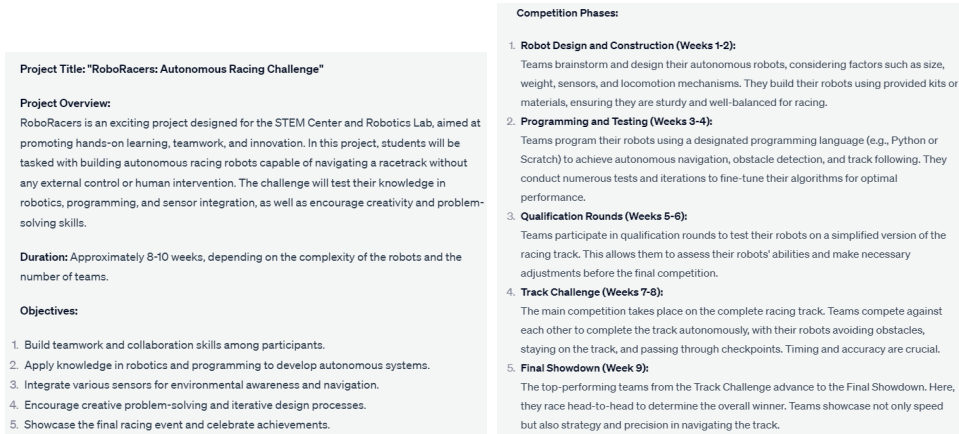
Source: Own work.

Personalization and project work in STEAM interest club

Personalization of education and differentiated approach are key characteristics of contemporary learning. While in distance, self-paced, or blended learning, personalization is achieved through the use of various educational platforms and technologies (Glushkova, 2015), in project-based teamwork, this personalization is achieved through different approaches. Typically, participants in each team take on formally or informally different roles, such as a leader, speaker, presenter, experimenter, etc. Teachers, acting as moderators and facilitators in this process, can organize role-playing games where participants take on different roles. Each role represents a typical set of characteristics, which, in essence, is very close to the concept of Persona (Nielsen et al., 2013).

Application of AI Technologies in STEAM School Education

Let us continue with the example of the STEAM robotics interest club. For every robotics club, it is necessary to organize a project work. ChatGPT can give us ideas for work on the project “RoboRacers: Autonomous Racing Challenge” to the school STEAM center (Figure 7).



Project Title: "RoboRacers: Autonomous Racing Challenge"

Project Overview:
RoboRacers is an exciting project designed for the STEM Center and Robotics Lab, aimed at promoting hands-on learning, teamwork, and innovation. In this project, students will be tasked with building autonomous racing robots capable of navigating a racetrack without any external control or human intervention. The challenge will test their knowledge in robotics, programming, and sensor integration, as well as encourage creativity and problem-solving skills.

Duration: Approximately 8-10 weeks, depending on the complexity of the robots and the number of teams.

Objectives:

1. Build teamwork and collaboration skills among participants.
2. Apply knowledge in robotics and programming to develop autonomous systems.
3. Integrate various sensors for environmental awareness and navigation.
4. Encourage creative problem-solving and iterative design processes.
5. Showcase the final racing event and celebrate achievements.

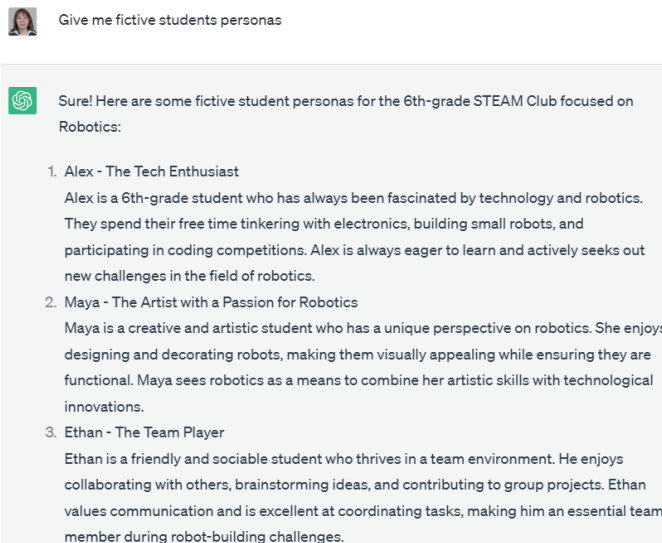
Competition Phases:

1. **Robot Design and Construction (Weeks 1-2):**
Teams brainstorm and design their autonomous robots, considering factors such as size, weight, sensors, and locomotion mechanisms. They build their robots using provided kits or materials, ensuring they are sturdy and well-balanced for racing.
2. **Programming and Testing (Weeks 3-4):**
Teams program their robots using a designated programming language (e.g., Python or Scratch) to achieve autonomous navigation, obstacle detection, and track following. They conduct numerous tests and iterations to fine-tune their algorithms for optimal performance.
3. **Qualification Rounds (Weeks 5-6):**
Teams participate in qualification rounds to test their robots on a simplified version of the racing track. This allows them to assess their robots' abilities and make necessary adjustments before the final competition.
4. **Track Challenge (Weeks 7-8):**
The main competition takes place on the complete racing track. Teams compete against each other to complete the track autonomously, with their robots avoiding obstacles, staying on the track, and passing through checkpoints. Timing and accuracy are crucial.
5. **Final Showdown (Week 9):**
The top-performing teams from the Track Challenge advance to the Final Showdown. Here, they race head-to-head to determine the overall winner. Teams showcase not only speed but also strategy and precision in navigating the track.


Figure 7. Suggested Project Idea in Robotics STEAM Club

Source: Own work.

We organize the group work on projects by creating typical profiles (personas) with which we will organize a role-play (Figure 8).



 Give me fictive students personas

 Sure! Here are some fictive student personas for the 6th-grade STEAM Club focused on Robotics:

1. **Alex - The Tech Enthusiast**
Alex is a 6th-grade student who has always been fascinated by technology and robotics. They spend their free time tinkering with electronics, building small robots, and participating in coding competitions. Alex is always eager to learn and actively seeks out new challenges in the field of robotics.
2. **Maya - The Artist with a Passion for Robotics**
Maya is a creative and artistic student who has a unique perspective on robotics. She enjoys designing and decorating robots, making them visually appealing while ensuring they are functional. Maya sees robotics as a means to combine her artistic skills with technological innovations.
3. **Ethan - The Team Player**
Ethan is a friendly and sociable student who thrives in a team environment. He enjoys collaborating with others, brainstorming ideas, and contributing to group projects. Ethan values communication and is excellent at coordinating tasks, making him an essential team member during robot-building challenges.

Figure 8. Suggested by ChatGPT Personas to role play with

Source: Own work.

Results, problems and discussion

The experimental work carried out on the implementation of AI tools and chatbots in the compulsory classroom training in the subject “Computer Modeling and IT” in some classes of the 6th grade showed the achievement of higher results on the tests conducted at the end of the school year (compared to the results of their classmates who were trained according to the traditional methodology) (Figure 9). 48 students were included in the experimental study.

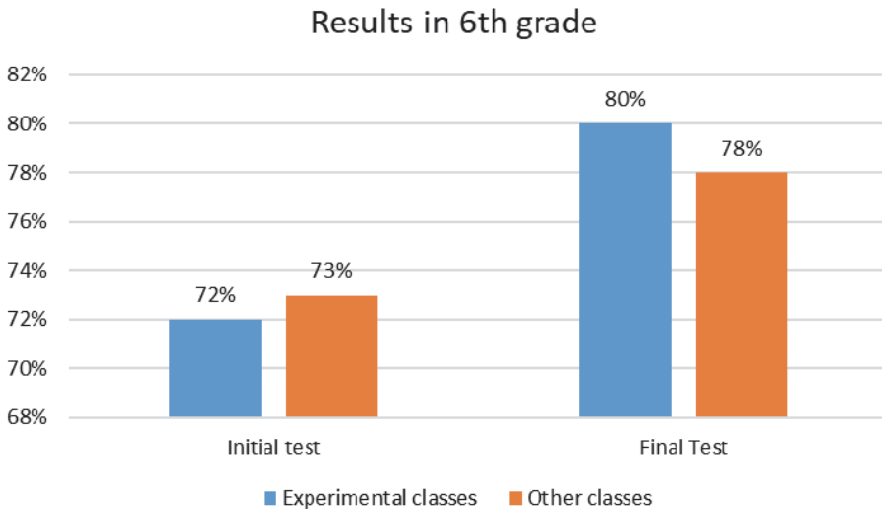


Figure 9. Results of compulsory education in the 6th grade

Source: Own work.

Since students are still in the period of initial accumulation of programming knowledge, despite the increased interest and activity, a tendency to decrease the desire for independent preparation and deepening of knowledge was noticed among some students. For the stability of the results, we conducted an additional experiment with the 12th-grade students (18 students), where the use of chatbots in programming education is much more responsible and critical. There, the results of the students compared to their results from the previous year (without using the AI chatbot) are steadily higher (Figure 10).

Training in the STEM clubs according to interests is optional. Students with interest and motivation to study are included in these clubs, therefore the results are significantly higher. The results are even better when conducting project-based group training. Within the experiment, the students were divided into 5 teams of 4 students and had to program certain missions of the robots. The training results are presented in Figure 11.

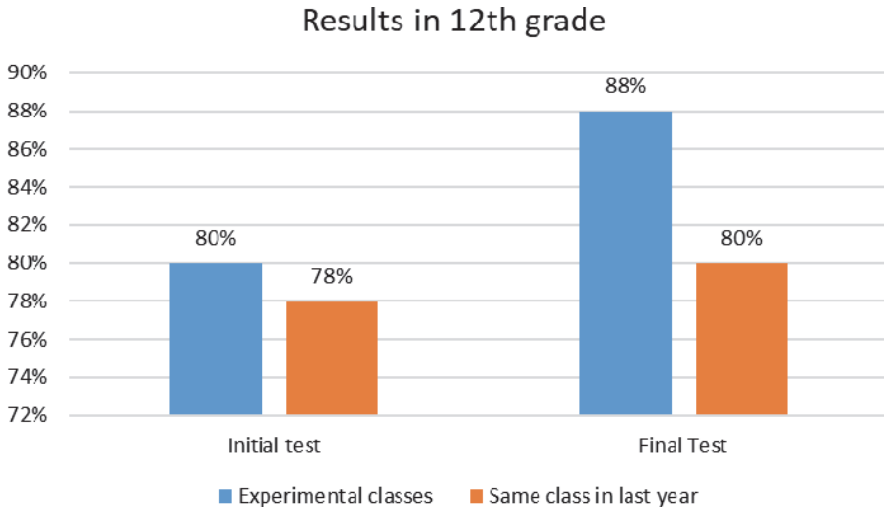


Figure 10. Results of compulsory education in the 12th grade

Source: Own work.

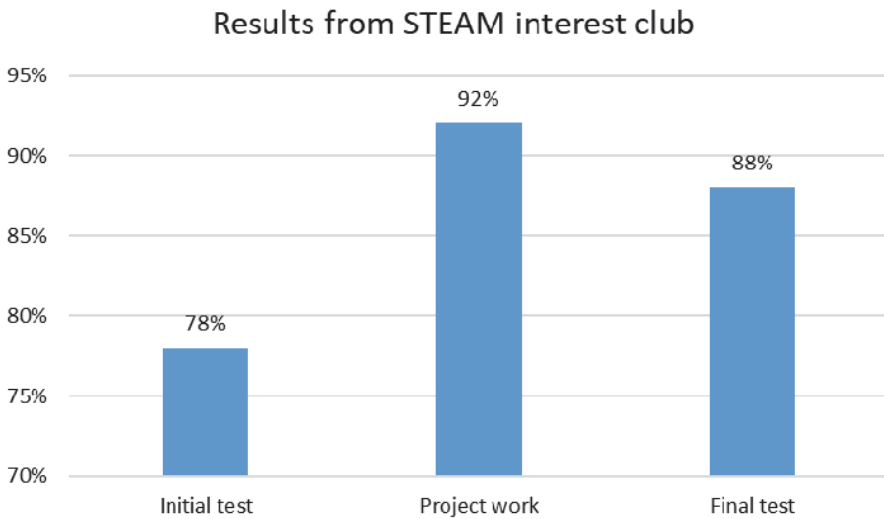


Figure 11. Results of STEAM interest club in AI and robotics

Source: Own work.

Surveys conducted with students, teachers and parents showed the following results:

- 90% of the students with desire and interest use the presented opportunities of chatbots to support the work of teams in solving project tasks.
- In the survey conducted with the students, 92% expressed a desire to work in this way and to use AI technologies to solve specific problems (Figure 12 a).

- 50% of teachers shared that they do not feel confident in the application of these technologies and need additional qualification. Additionally, over 65% of teachers and parents shared concerns about using chatbots freely outside the classroom without teachers present (Figure 12b).

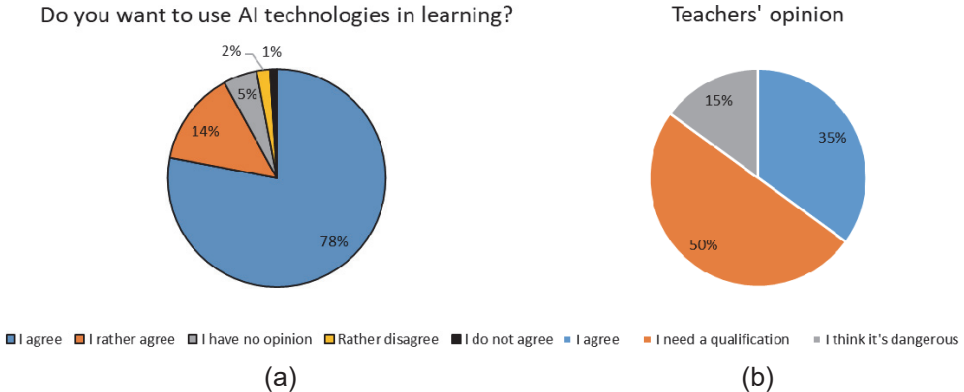


Figure 12. Results of surveys with students (a) and teachers (b)

Source: Own work.

Although the use of AI technologies has many advantages, it is important to carefully assess their limitations, problems and challenges. One of the main concerns of both teachers and parents is the fact that ChatGPT and other chatbots can spread false and unverified information as well as allow plagiarism during exams. Another reason for their fears is the privacy and protection of personal information. World experience shows that these concerns are not groundless and they are reflected in the changes to the AI Act of the European Union ([https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI\(2021\)698792](https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2021)698792)).

Conclusion

The modern development of education poses new challenges and requirements that must be discussed and researched in the conditions of dynamic changes and lack of time. The use of AI in education has many advantages, but also certain challenges. AI can improve learning outcomes, productivity, and student engagement by opening new avenues for personalized education, feedback, collaboration, and support. The conducted research established the need for the training and use of AI technologies in the classroom and extracurricular work.

Given that versions of ChatGPT and Microsoft 365 Copilot can be integrated into Office applications including Word, Excel, PowerPoint, and Outlook, it is not hard to predict that ChatGPT's impact on education will grow rapidly in the coming years.

The study was conducted in classes and groups of students with different ethnic, religious and social affiliations, which gives higher reliability of the obtained results. The students were interested and willing to join the learning activities, but it was found that the younger students took the information from the AI chatbots as completely true and correct, and their cooperation - as a reason not to take responsibility for their own preparation. During training, the chatbots provided sometimes detailed but incomplete information, as well as some poor programming advice and solutions. This was used by the teachers to draw attention to the critical reception of the information received.

Teachers are largely reserved and pay more attention to the problems and challenges of using these technologies. They state that they do not have the necessary knowledge and show readiness for additional training and qualification. Parents are also wary of the rapid introduction of new and insufficiently tested technologies into education. All this determines the need for joint efforts by teachers, researchers, scientists, and politicians to ensure the ethical and responsible use of AI in education.

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Todorka Glushkova, Anna Malinova

Zastosowanie technologii AI w edukacji szkolnej STEAM

Streszczenie

Sztuczna inteligencja coraz częściej wkracza w różne sfery naszego życia, także w sferę edukacji. Technologie te oferują wiele możliwości wykonywania różnych czynności i zadań w całym procesie edukacyjnym. W artykule omówiono wybrane aspekty zastosowania technologii AI w celu poprawy personalizacji, dostępności i interaktywności w edukacji szkolnej, a zwłaszcza w nauce przedmiotów STEAM. Celem artykułu jest zaproponowanie podejść umożliwiających skuteczne włączenie sztucznej inteligencji do pracy nauczycieli i facylitatorów na etapie wstępnego planowania lekcji, przygotowywania spersonalizowanych zadań dla uczniów, procesu testowania i oceniania wiedzy, a także nauki w grupach i pracach projektowych. W artykule przedstawiono doświadczenia związane z prowadzeniem obowiązkowego kursu informatyki oraz pracą w kole zainteresowań związanych ze sztuczną inteligencją i robotyką z uczniami szóstej klasy szkoły średniej, podkreślając potencjał niektórych chatbotów do wspierania i wzbogacania procesu programowania.

Słowa kluczowe: Sztuczna inteligencja w edukacji, Chatboty, edukacja STEAM

Todorka Glushkova, Anna Malinova

Aplicación de tecnologías de IA en la educación escolar STEAM

Resumen

La inteligencia artificial está entrando cada vez más en todos los ámbitos de nuestras vidas, incluido el ámbito de la educación. Estas tecnologías ofrecen numerosas ventajas y oportunidades

para realizar diversas actividades y tareas a lo largo del proceso educativo. Este artículo analiza algunos aspectos de la aplicación de tecnologías de IA para mejorar la personalización, la accesibilidad y la interactividad en la educación escolar, y especialmente en el aprendizaje de materias STEAM. Los autores tienen como objetivo proponer enfoques para integrar con éxito la IA en el trabajo de profesores y facilitadores durante la fase de planificación previa de las lecciones, la preparación de tareas personalizadas para los estudiantes, el proceso de prueba y evaluación de conocimientos, así como en grupos y proyectos. aprendizaje basado. El artículo comparte la experiencia de impartir un curso obligatorio de informática y trabajar en un club de intereses relacionados con la inteligencia artificial y la robótica con alumnos de 6º de secundaria, destacando el potencial de ciertos chatbots para apoyar y enriquecer el proceso de programación.

Palabras clave: Inteligencia Artificial en Educación, Chatbots, educación STEAM

Тодорка Глушкова, Анна Малинова

Применение технологий искусственного интеллекта в школьном образовании STEAM

Аннотация

Искусственный интеллект все активнее входит во различные сферы нашей жизни, в том числе и в сферу образования. Эти технологии предлагают многочисленные преимущества и возможности для выполнения различных действий и задач на протяжении всего образовательного процесса. В этой статье обсуждаются некоторые аспекты применения технологий искусственного интеллекта для улучшения персонализации, доступности и интерактивности в школьном образовании, и особенно при изучении предметов STEAM. Авторы стремятся предложить подходы для успешной интеграции ИИ в работу учителей и фасилитаторов на этапе предварительного планирования уроков, подготовки персонализированных заданий для учащихся, процесса тестирования и оценки знаний, а также в групповых и проектных работах. основанное обучение. В статье рассказывается об опыте преподавания обязательного курса информатики, а также работы в кружке по интересам, связанном с искусственным интеллектом и робототехникой, с учащимися 6-х классов средней школы, подчеркивая потенциал некоторых чат-ботов для поддержки и обогащения процесса программирования.

Ключевые слова: Искусственный интеллект в образовании, чат-боты, образование STEAM