

ChatGPT as a tool for creating educational games for school education in computer technology

Maria BORISOVA, Stanka HADZHIKOLEVA, Emil HADZHIKOLEV

University of Plovdiv Paisii Hilendarski, 236 Bulgaria Blvd., Plovdiv, Bulgaria

mimi880503@gmail.com, stankah@uni-plovdiv.bg, hadjikolev@uni-plovdiv.bg

Abstract: *The article outlines the possibilities of using the ChatGPT chatbot for creating educational games. A methodology for game creation is proposed, highlighting certain requirements for formulating prompts for ChatGPT. Examples of creating three different types of games are discussed, which are suitable for strengthening of knowledge and skills, as well as for learners' self-study. The main risks and limitations of using AI in education are also presented.*

Keywords: AI in education, Educational games, Game creation, Prompt engineering, ChatGPT.

1. Introduction

In a rapidly changing digital environment, evoking uncertainty and unease, it is becoming increasingly important for a person to have strong digital competencies, including programming skills. Studying computer science disciplines in school is a crucial factor for the future development of students and their ability to adapt and succeed. In Bulgaria, this issue is addressed with the subject “Computer Modeling and Information Technologies” (CMIT), which begins to be taught from the 5th grade (MSE, 2020).

The study of CMIT is not just about learning to use computers. This subject aims to provide students with knowledge and skills that are very important for their future career success. It educates students in creativity, critical and problem-solving thinking. Topics related to the effective and ethical use of artificial intelligence (AI) technologies are also covered, both in personal and professional contexts. This subject is extremely important – it prepares students for the future!

The rapid development of AI technologies presents new challenges for educators. They need to fully innovate the learning process, including teaching methods, educational activities and resources, and the ways they communicate with learners. Today, there are many AI-powered software tools that can be used in education. Generative AI provides many opportunities for optimizing teachers' activities, including the creation of educational resources. One interesting possibility is the creation of educational games. This article presents an approach to creating web-based games with the help of ChatGPT.

The use of games in education has a positive impact on learners' intrinsic motivation, leading to increased interest, enthusiasm, and persistence in achieving educational goals and completing assignments (Erylmaz & Boicu, 2023). Experiments have shown that students engage more deeply with the material when they have the opportunity to participate in game-based activities (Hartt, Hosseini & Hartt, 2020). Gamification can serve as a powerful tool to create an emotional connection between the educational content and the students (Hose, 2023). The competitive element in games and the sense of competition motivate learners to accomplish the set goals. This also helps educators identify students who may need additional support (Chandra, 2021).

2. CMIT education in Bulgaria

The education in CMIT is focused on developing and enhancing students' digital competencies. They begin studying computer science in the early grades, and then, in middle and high school, they build upon their knowledge and skills. Students gain fundamental computer skills such as working with operating systems, the Internet, text editors, software applications for spreadsheets, presentations, graphic editors, and more. They are introduced to the basics of programming using appropriate programming environments (IDLE, Edublocks) and programming languages (Scratch, Python). The subject stimulates their creativity through various projects and practical tasks.

Many students encounter difficulties in learning CMIT. The reasons for this are many. Computer modeling and programming require abstract thinking. Working with data structures and understanding and implementing algorithms usually pose challenges for learners. Practical examples and applications are essential. Learning the syntax and semantics of a programming language is also a difficult task. Writing code requires a specific way of thinking, which can be mastered only after extensive practice. The process of identifying and correcting errors in code can also discourage and demotivate learners if they do not receive timely support in their work. Many teachers believe that the time allocated for programming exercises is insufficient. Additionally, in some cases, technical issues can arise, leading to even less time for practice in class.

On the other hand, *teachers also face various challenges.* In the classroom, students usually have different levels of knowledge and skills and it is difficult for teacher to maintain interest and a suitable learning speed for all students. The lack of sufficient suitable teaching resources can limit the opportunities for instruction and practical training. Some students feel insecure in their knowledge, and failures in completing tasks during class can discourage and demotivate them. Evaluating tasks that require writing code is also challenging and time-consuming. Teachers need to develop effective assessment methods that accurately reflect the students' actual skills.

3. Methodology for creating games with ChatGPT

ChatGPT is one of the most popular chatbots (ChatGPT, 2024). It is an advanced language model developed by OpenAI, utilizing AI to understand and generate text in multiple languages. It is based on the GPT (Generative Pre-trained Transformer) architecture and has been trained on vast amounts of textual data. This enables it to perform a wide range of tasks related to text-based information. The chatbot was launched in November 2022 and quickly gained popularity.

ChatGPT is used in various fields, primarily related to:

- *Text generation:* It creates different type of texts, incl. essays, documentation, marketing materials, summaries, instructions, guides, and more.
- *Answering questions:* It answers questions on a wide range of topics using a knowledge base on which it has been trained.
- *Code creation:* It assists developers by generating and debugging code in different programming languages. It can also create complete small applications based on a given task.
- *Dialogue and consultation:* It engages in dialogue, provides advice, and helps solve problems in various fields.
- *Education:* It can be used as an educational tool, both for instructional and administrative tasks. This includes creating educational materials, exercises, methodologies, generating lesson plans and curricula, and more.

Creating a game with the help of ChatGPT is an iterative process. A successful game is not created in a single attempt. Generally, the process goes through several stages, with gradual development and refinement of functionalities. The process involves multiple attempts, tests, and adjustments to achieve the desired quality and functionality. After each iteration, tests are conducted, and improvements are made until the project meets the predefined goals. The main stages are as follows:

3.1 Defining the objectives of the game

Precisely defining the game's objective is essential because it directs the design and content towards specific learning outcomes. A clear objective helps learners understand what is expected of them and increases their engagement. Additionally, the objective allows for measuring the game's effectiveness and ensuring it fulfills its educational purpose. In the initial stage, it is important to decide the following:

- *Educational goals:* The educator should determine what specific knowledge or skills the learners need to acquire or practice. This could include reinforcing knowledge in a particular area, critical thinking, problem-solving tasks, quizzes, and more.

- *Learner profile*: It's important to define the age group, knowledge level, and interests of the learners.
- *Duration*: In some cases, determining the duration of the game is important.

3.2 Designing the game scenario

The design of the game scenario determines the structure and sequence of the game elements that maintain player engagement and interest. It links the educational objectives with the game activities, creating a context and story that make learning more enjoyable and interactive. Therefore, it is important to carefully consider the following:

- *Game concept*: The educator should determine the type of game – flashcards, quiz, puzzle, role-playing game, simulation, etc. It is necessary to specify what actions the players will take.
- *Game structure*: If the game is more complex, levels, stages, or scenarios may be defined. These should follow a logical sequence and adapt according to the player's progress. In many cases, it is appropriate to establish a story or scenario that engages learners and makes the learning process more enjoyable.

3.3 Content development

The educator can provide ChatGPT with specific educational content to be used in the creation of the game or rely on the chatbot's own knowledge base. It is appropriate to specify the following information:

- *Questions and tasks, related to the learning material*: These can vary in complexity and type (for example multiple choice, open-ended questions, drag-and-drop tasks, etc.). For better results, the educator may include feedback for incorrect answers, which helps learners to identify their gaps.
- *Hints*: In many cases, it is advisable to include options for hints in the game, which learners can use if they encounter difficult questions.

3.4 Adding adaptability and personalization

Thanks to AI, ChatGPT can be given more complex requirements when creating the game, including implementing adaptability and personalization based on the learners' knowledge and skills. This makes the learning process more effective, engaging and motivating. It is possible to specify:

- *Adaptability*: Adjust the content according to the player's progress by changing the difficulty level or providing additional assistance when needed.
- *Assessment and feedback*: Analyze players' responses and provide personalized feedback, as well as track their progress.

3.5 Testing and improving the game

Identifying and correcting errors in the game, as well as optimizing the gameplay, are very important, therefore, it is necessary to conduct testing and gather feedback from learners. This allows for assessing whether the game is engaging and effective in achieving the educational goals. This involves the following activities:

- *Test execution:* The game should be tested with real learners to evaluate its complexity and effectiveness and to gather feedback on necessary improvements.
- *Improvements and updates:* Based on the feedback from the tests, corrections and enhancements to the game can be planned and implemented.

3.6 Evaluating the effectiveness and improving the game

To determine whether the game successfully achieves the set educational goals, it is necessary to evaluate its effectiveness. This evaluation analyzes what the learners have gained and whether the teaching methods were effective. This process helps identify the game's strengths and weaknesses, allowing for further enhancement. This requires the following:

- *Data analysis:* It is advisable to collect and analyze various data on the game's usage and the results achieved by the learners to assess its educational effectiveness.
- *Enhancement:* Based on the data analysis and feedback, the game can be improved to increase its educational value and appeal.

4. Creating games to support CMIT Education

When working with generative AI, it is very important to provide a correct prompt. The quality of the prompt largely determines the outcome. Generally, the *prompt should meet the following requirements:*

- *Clarity and specificity:* Prompts should be formulated clearly and specifically so that ChatGPT can accurately understand what type of game needs to be created. More specific prompts lead to more accurate and relevant suggestions for game elements and functionalities.
- *Context:* It is very important to describe the specific game context in details. For example, if the game needs to take place in a certain setting or time period, this context will help ChatGPT generate more appropriate content.
- *Objective:* The game's objective should be clearly defined – whether it is intended for entertainment, education, or training. This will help ChatGPT to structure the game's content in a suitable way.

- *Format*: If the game needs to follow a specific format (e.g., quiz, adventure, puzzle), it is helpful to specify this in the prompt to generate the corresponding game content.
- *Precision in terminology*: The prompt should avoid unclear or ambiguous terms, as this can lead to poor suggestions for the game. Desired elements and techniques should be described with precise and specific terminology.
- *Multi-component prompts*: If the game needs to include several different elements or aspects (e.g., various levels, tasks, or types of interaction), it is useful to formulate these components separately or as clearly defined points within the prompt.

There are *two main approaches to creating different types of games with ChatGPT*. In one approach, the teacher can experiment with a single prompt to create a game, refining it several times until the desired result is achieved. The other approach involves the teacher creating one prompt to generate a game and then submitting additional prompts to improve various aspects of the created game.

In our experiments, many successful attempts at game creation were conducted. Here, we will look at a few examples to demonstrate different possibilities and various types of games, with specific educational content being secondary. Other types of games developed for teaching Databases are presented in (Hadzhikoleva et al., 2024).

One of the popular games suitable for memorizing important terms and concepts is *Flashcards*. Such a game can be created, for example, with the following prompt:

Prompt to ChatGPT: Create an educational game on the topic "Programming Languages" for 6th-grade students. The game should be of the "flashcards" type. Create 8 flashcards, arranged in two rows and four columns. On the front of each card, there should be a term, and on the back, a definition. When a card is clicked, it should flip to show either the front or the back, allowing the player to continuously view the term or the definition, which helps with learning. The game should have a simple design, using light colors. Use HTML, CSS, and JavaScript to create the game.

ChatGPT generates code for three files, which the teacher needs to copy and save into text files with the following names: index.html, styles.css and scripts.js. The application is launched in the browser from the index.html file. Through a series of questions posed by the teacher, students can arrive at the definitions that describe the given programming languages (Figure 1).

The learning material related to different types of algorithms can be challenging for students. The teacher can create a "Grouping" type game where students categorize code fragments according to the different types of algorithms (Figure 2). This can be done in the following way:

Prompt to ChatGPT: Algorithms with Python" for 6th-grade students. The game should be called "Code Classification" and be of the "Grouping" type. Create three groups for different types of algorithms - linear, cyclic, and conditional, each with a different color. Create 9 code snippets that the students need to classify into one of the three algorithm groups. There should be 3 code snippets for each group. Add a "Check" button that allows the students to verify whether they have correctly classified the code snippets. The game should have a simple design. Use HTML, CSS, and JavaScript to create the game.

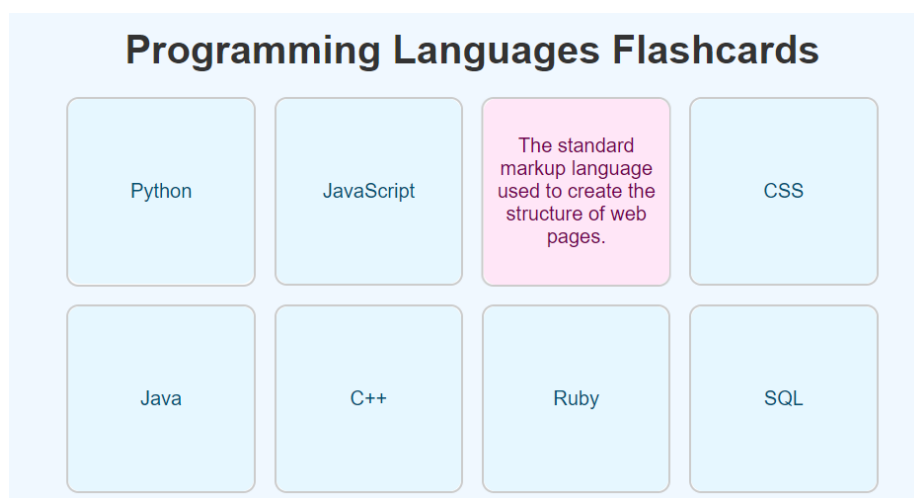


Figure 1. Flashcards for learning information about programming languages

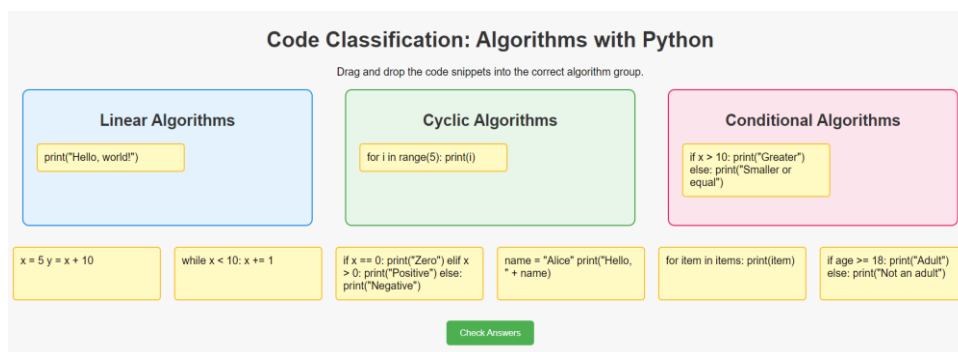


Figure 2. A game for classifying code fragments

Learning functions is another challenging task for 6th-grade students. Therefore, an appropriate game can be created for this as well (Figure 3).

Prompt to ChatGPT: Create an educational game titled 'Functions in Python' suitable for 6th-grade students. The goal of the game is to help students reinforce their knowledge of functions and how they work. Create 10 pairs of function names and their corresponding descriptions. The students should be able to match the functions with their descriptions. Award the user 3 points for each correctly matched pair. Include a button to check the results. Use HTML, CSS, and JavaScript to create the game.

The created game did not look well. The components were unevenly positioned on the left side of the screen. For this reason, we executed the following prompt to modify the game:

Prompt to ChatGPT: Modify the game to center components so that they optimally fill the game space.

Figure 3. A game for learning functions

The games that the teacher can create using the ChatGPT chatbot are an excellent supplement to the materials for a specific lesson. They can be used at the beginning of the class to review knowledge or during the lesson to check the students' understanding and skills.

These games can also be used by students for self-study. With the help of other online applications, the games generated by ChatGPT can be assigned to

students for practice at home. Examples of such software include GitHub, CodePen, and Netlify. In CodePen, it is sufficient for the teacher to copy the information from the three files generated by ChatGPT and paste it into a newly created file in the application. After saving the file, a link is generated, which the teacher can share with students so they can complete the exercise at home.

5. Risks and Limitations

It is undoubtedly that AI can facilitate and optimize the work of educators in preparing and conducting the teaching process, as well as support learners in their study and self-preparation processes. However, for successful and ethical use, certain risks and limitations must be addressed. The most significant ones are as follows:

- *Quality and reliability of the generated content.* It is possible that the educational resources generated by ChatGPT may contain inaccurate or unclear content, and students' answers may be incorrectly evaluated. The reasons for this can be many and varied: limited educational resources provided by the educator as a basis for generating games; the model being trained on outdated data and not updated with current information; unclear or ambiguous prompts, and others. For this reason, educators should carefully review the educational resources before presenting them to learners.

- *Copyright and ethics.* It is possible that when generating its responses, the chatbot may use texts that were used for its training but are subject to copyright, or contain personal or sensitive information. To avoid situations of plagiarism, users should carefully use the information provided by ChatGPT. They should identify the source and cite it according to the established guidelines.

- *Dependence on technology.* The ease of using ChatGPT may lead to dependency. Educators might start to overly rely on the chatbot for various administrative and educational tasks, which can result in a loss of personalization in the learning process. For learners, the risk lies in the excessive use of AI for completing homework and course assignments, which can hinder the development of their cognitive abilities.

- *Privacy and personal data.* Some games may require personal data. Learners should not disclose personal information, as it could potentially be used in unpredictable ways. If the educator wishes to process and analyze data related to learners' academic performance, they can use various methods to anonymize personal data.

Addressing the risks associated with the use of AI in education is a complex task. For trouble-free use, it is necessary for each educational institution to take appropriate measures in this direction. This includes identifying various risks, developing and communicating rules and policies for the use of AI in education, and training both educators and learners on the safe use of AI.

6. Conclusion

The article outlines the opportunities for using games created with the help of ChatGPT in the learning process. By properly formulating prompts for the chatbot, educators can create interactive and engaging games that effectively support the acquisition of knowledge and skills. These games not only enrich classroom materials but also offer opportunities for students' independent study. The ability to easily share and use these games through online platforms makes this approach even more applicable and valuable in modern education.

The experiments presented in the article just demonstrate the rich possibilities for creating educational games with ChatGPT. Our work can be extended in several directions. With the help of the chatbot, more complex and interactive games can be created, implementing dynamic scenarios and differentiated adaptive feedback. Thanks to the OpenAI API, the chatbot's capabilities can be utilized in other applications, and the games can be integrated into Learning Management Systems. It is undoubtedly necessary to study the impact of AI technologies on the learning process, learners' performance, their motivation, and the development of higher-order thinking skills.

In conclusion, the use of AI in education offers many opportunities for innovation in the learning processes. The development and implementation of new technologies will not only enrich educational resources but also improve the quality of education.

Acknowledgment

The work is funded by the SP23-FMI-008 project at the Research Fund of the University of Plovdiv "Paisii Hilendarski".

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