

Flipped dialogic learning method with ChatGPT: A case study

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ABSTRACT

This article presents a case study and ideas to flip classical dialogic learning method. Some possibilities of using ChatGPT to stimulate the active role of the student in the dialogic teaching method are shown. Data from observations of students training to be teachers of mathematics and informatics in their work with artificial intelligence (AI) are presented. A model for the application of the flipped dialogue in the education of students is proposed. An example of dialogue is given. The study concludes that the main advantages of using flipped dialog learning with AI are easy access to the platforms, the lack of stress and stimulating the research qualities of students when searching for specific information or stimulating the system to make mistakes. The ability to ask the right leading questions and to detect the gaps of the “interlocutor” are important competencies applicable in dealing with life’s problems.

Keywords: artificial intelligence, ChatGPT, dialogue, creativity, mistakes

INTRODUCTION

There are many classic methods of training. Dialogue is one of the most valuable methods. This method has different expressions—educational, heuristic, Socratic dialogue. It can be used in teaching different subjects and at different levels of education. Through the dialogue, the learner actively assimilates the learning content, discovers new knowledge and consolidates and improves his skills. This method is also particularly useful in teaching bilingual students. By solving specific tasks, students are stimulated to use a language that is not their native language.

According to Portev and Nikolov (1987),

“dialogue of the student body through which step by step it is resolved the set cognitive task. The teacher guides the search for a solution. All students participate in the search for answers.”

An interesting example of teaching mathematics with Roma students is given by Stefanova (2016). Stefanova (2016) emphasizes that

“this method is also used in training mathematics, as through it the teacher stimulates, directs and guides the students’ independent cognitive activity. This method occupies an important place and in teaching students who must master both mathematical language and symbolism, as well as the Bulgarian language, which is not their mother tongue.”

On the other hand, working with artificial intelligence (AI), in chat form, implies a particular form of dialogue between man and machine. The application of AI in education is a new wave, but the ideas and possibilities are developing at breakneck speed. At this stage, it is important to think about how we can consciously and responsibly use these opportunities. We believe that the available imperfections of AI are the thread that can stimulate students to think independently.

The application of AI has been explored in the teaching of various subjects. For example, serious results have been achieved in the training on the topic “electronic magnetism” (Alneyadi & Wardat, 2023), mathematics (Wardat et al., 2023), etc.

It is also important for teachers to be prepared to follow the latest developments in working with students.

“Teachers should be trained regarding strategies and mechanisms for employing smart applications in education. Finally, parents and teachers should encourage students to use smart applications, given their positive impact on raising the level of scientific concepts acquisition.” (Alneyadi et al., 2023).

THEORETICAL FRAMEWORK

Artificial Intelligence in Education

There is a lot of research focused on the application of AI in education. The easy access to the platforms and the intuitive interface provokes the search for different possibilities. The main role of AI in learning, according to Mike Sharples (Professor Emeritus of Educational Technology, Open University, UK) (Sabzalieva & Valentini, 2023), is as follows:

1. **Possibility engine:** AI generates alternative ways of expressing an idea.
2. **Socratic opponent:** AI acts as an opponent to develop and argument.
3. **Collaboration coach:** AI helps groups to research and solve problems together
4. **Guide on the side:** AI acts as a guide to navigate physical and conceptual spaces
5. **Personal tutor:** AI tutors each student and gives immediate feedback on progress.
6. **Co-designer:** AI assists throughout the design process.
7. **Exploratorium:** AI provides tools to play with, explore and interpret data.
8. **Study buddy:** AI helps the student reflect on learning material.
9. **Motivator:** AI offers games and challenges to extend learning.
10. **Dynamic assessor:** AI provides educators with a profile of each student's current knowledge.

We consider this classification comprehensive and convenient. The method proposed below is based on is based on the definitions of "possibility engine" and "Socratic opponent".

Duggal (2023) describes advantages and disadvantages of AI in different fields. As disadvantages in education is mentioned:

"The potential for ethical and privacy concerns. AI systems collect and analyze a significant amount of data on students, including their performance, behavior, and personal information. There is a need to ensure that this data is handled securely, with appropriate privacy safeguards in place" (Duggal, 2023).

Regardless of some disadvantages of AI, it is clear that education will follow the environment, where students have access to AI and use it regardless of the teacher's wishes. It is important to find a way to make this use useful for the student.

Classic Dialogic Learning Method

As mentioned above, the dialogic teaching method is a classic method used most often by the teacher to guide students in the right direction of reasoning. Shor and Freire (1987) discuss that

"The dialogical method of liberatory education. Dialogue is not a mere technique to achieve some cognitive results; dialogue is a means to transform social relations in the classroom, and to raise awareness about relations in society at large. Dialogue is a way to recreate knowledge as well as the way we learn. It is a mutual learning process, where the teacher poses critical problems for inquiry."

Deliberate Error Method

The method consists in the teacher making the deliberate mistake in order to stimulate the students' attention and critical thinking. This method should be applied carefully because students do not always understand the teacher's original purpose. According to Wong and Lim (2022),

"Notwithstanding deliberate erring's prowess, learners were largely oblivious to its benefits, misjudging the strategy as less effective."

In dialogue with AI, the student does not perceive the mistake made as "intentional" even though in practice he/she is pushed by the teacher into a situation, where he/she has to deal with a mistake.

Flipped Classroom

There are different definitions of the "flipped classroom." We will use the following:

"Flipped instruction or a flipped classroom is a form of blended learning in which students learn new content online by watching video lectures, usually at home, and what used to be homework (assigned problems) is now done in class with teachers offering more personalized guidance and interaction with students, instead of lecturing" (Nwosisi et al., 2016).

Although the concept of the "flipped classroom" gives good results, it should be applied in moderation. Thus, a study conducted in 2016 shows that

"The flipped classroom concept for thirty percent of the course content is a great help for the students. Some students do not grasp the concept in the beginning. The Flipped instruction concept facilitates interaction among students, and between students and their Instructors. Flipped instruction leads to better learning results" (Nwosisi et al., 2016).

The presented idea of flipped dialogue does not follow the student's extensive pre-class preparation, but rather stimulates his heuristic thinking and creativity in asking questions.

A FLIPPED DIALOGUE MODEL

It is quite a different perspective to look at the dialogue when it is generated by a student. Such approaches are used in the "flipped classroom", but even there the student is not expected to construct an instructional dialogue. In this article, we will look at some possibilities of using ChatGPT to stimulate students not only to search for information, but also to ask, "the right questions". This skill is not only an important factor in self-learning, but also an important life competence. According to defined roles of AI (Sabzalieva & Valentini, 2023), we propose a model for flipped dialogue (**Figure 1**).

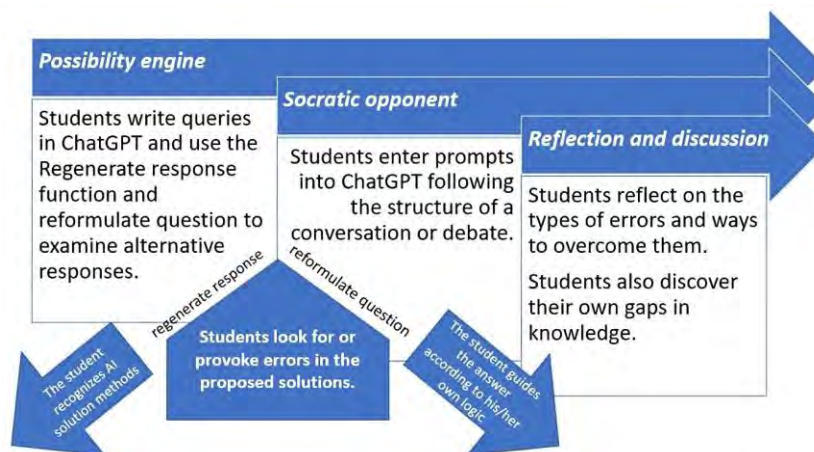


Figure 1. A flipped dialogue model (Source: Author's own elaboration)

The main stages in the proposed method are, as follows:

1. We provide students with examples, where AI makes mistakes or gives solutions that are not clear to the students.
2. We encourage critical review of the resulting solutions.
3. We encourage students to reformulate and direct their questions to obtain a valid and user-friendly result.
4. We encourage students to look for similar examples themselves.

Observations of the students' work show that they hardly manage to generate on their own examples in which AI makes mistakes. In order to save time, it is important at the beginning that the teacher gives ready-made examples or directs the students to topics, where an error is expected, or the resulting solution is in a form that is not clear enough for the students.

Using ChatGPT to teach students how to ask the right questions can offer a lot of benefits:

1. ChatGPT provides an interactive platform for students to practice and refine their question-asking skills. They can engage in real-time conversations and receive immediate feedback, allowing for dynamic learning experiences.
2. ChatGPT encourages students to think critically about their questions and how they are phrased. By observing how ChatGPT responds differently to various question structures, students can develop a deeper understanding of how wording and context impact communication.
3. Students can experiment with different ways of phrasing questions and explore the nuances of language. This helps them become more proficient in expressing themselves effectively and precisely.
4. ChatGPT's responses can help students grasp the importance of providing context when asking questions. They can learn how to include relevant details to make their questions clearer and more informative.
5. As students interact with ChatGPT, they can learn to ask questions strategically to obtain the information they need. This nurtures their problem-solving abilities as they figure out how to elicit accurate and relevant responses.
6. ChatGPT offers instant feedback, allowing students to adjust their questions based on the responses they receive. This iterative process helps them refine their question-asking skills over time.
7. The skills learned from interacting with ChatGPT can be transferred to real-life scenarios, such as interviews, research projects, or discussions. Students can practice effective questioning techniques that enhance their communication in various contexts.
8. ChatGPT can be adjusted to different levels of complexity, making it suitable for various age groups and skill levels. Whether teaching elementary students about basic questioning or guiding high school students in crafting advanced queries, ChatGPT can be tailored to meet educational needs.
9. The interactive nature of ChatGPT can engage students and make the learning process more enjoyable. Students may find it intriguing to engage with an AI model and see how their questions influence the responses.

10. ChatGPT provides a readily available resource for students to practice question-asking at any time. They can explore and experiment with different questions without time constraints.

This method can also be applied in foreign language learning, as well as to overcome difficulties when working with bilingual students. Within tasks from different subject areas, students can be stimulated to conduct a dialogue in a particular language. In this case, in addition to improving logical, numerical, scientific and engineering skills, students will also improve their literacy and multilingual competencies.

MATERIALS & METHODS

This study does not claim to be representative, because it was conducted only with students studying in 2023. These are future teachers of mathematics, informatics and information technology. The total number of students was 21. We plan to continue the study in the future in order to collect enough data.

The study aimed to investigate:

- to what extent students are familiar with the possibilities of AI and in particular with ChatGPT,
- whether students used AI to cheat in coursework preparation,
- whether the students did experiments to find bugs in AI, and
- have they thought about how they can apply AI to teaching students at school.

The main tools of the research were the discussion with the students and the observation of their work. We observed their ChatGPT experiments. We analyzed their coursework in different disciplines, after getting acquainted with ChatGPT

RESULTS & ANALYSES

This section contains an example dialogue with question reformulation and a SWOT analysis.

The difference in approach between using the “REGENERATE” option and reformulating the question is whether the student will have to figure out the logic of the new solution for themselves or guide the answer according to their own logic.

SWOT Analysis

The discussion with the students showed that all future teachers of informatics and information technology were familiar with ChatGPT, unlike the future teachers of mathematics (only one was familiar).

Three of the students admitted to using ChatGPT to do coursework and other assignments.

Students who initially claimed to be unfamiliar with ChatGPT subsequently changed the style of their coursework, but none admitted to using ChatGPT.

When introduced to ChatGPT, most preferred to ask political and frivolous questions. Their main goal was to have fun. When required, the dialogues about their subject matter, computer scientists mainly wanted code, and mathematicians solved equations, expressions and checked precedence of operations. Almost all of them tried to set the topic for their term paper and were very satisfied with the result. After targeting problems that deal with numerical sets, they were very surprised at the errors that were produced. SWOT analysis based on the conducted literature review and student discussions and observations is presented in **Figure 2**. This analysis in **Figure 2** only concerns the flipped dialogue method via ChatGPT. The use of AI in education in general is a much deeper issue and is not the goal of this paper.

S	<ul style="list-style-type: none"> • Easy access to AI at this stage of its development • Ease of use in the chat format • Fun and not stressful for students • Stimulates the skill of asking questions • Stimulates critical thinking • Stimulates creativity 	<ul style="list-style-type: none"> • Some students do not understand the idea of solutions • Some students do not have the necessary preparation to rephrase the question correctly • It is difficult for the teacher to follow the dialogues of the whole class 	W
	<ul style="list-style-type: none"> • Improvements in new versions • Transferring experience to other areas 	<ul style="list-style-type: none"> • Possible commercialization of the technology • Possible loss of interest in case of failure • Possible personality changes when communicating with people. 	T
O			T

Figure 2. Flipped dialogic learning method in education (Source: Author’s own elaboration)

Example of Dialogue With ChatGPT

Observations of the work of students who are introduced to AI for the first time indicate that they initially accept the obtained result as final and do not seek to reformulate the question. We assume that this fact is due to the initial curiosity and the desire to try many different examples in a limited time.

At a later stage, with the help of the teacher, the skill of asking and reformulating questions is developed and refined. We will present one specific example below.

Let's take a look at the solution given in **Figure 3**.

To find the probability that a randomly selected child likes exactly two of these vegetables, we can use the principle of inclusion and exclusion.

Let's define the following events:

A: Likes cabbage
B: Likes carrots
C: Likes peas

We are given the following information:

- $P(A) = 10/25$ (10 children like cabbage)
- $P(B) = 14/25$ (14 children like carrots)
- $P(C) = 15/25$ (15 children like peas)
- $P(A \cap B) = 4/25$ (4 children like both cabbage and carrots)
- $P(A \cap C) = 3/25$ (3 children like both cabbage and peas)
- $P(B \cap C) = 12/25$ (12 children like both carrots and peas)
- $P(A \cap B \cap C) = 2/25$ (2 children like all three vegetables)

Now, we can use the principle of inclusion and exclusion to find the probability that a child likes exactly two of the vegetables:

$$P(\text{exactly two of } A, B, C) = P(A \cap B \cap \neg C) + P(A \cap C \cap \neg B) + P(B \cap C \cap \neg A)$$

Where \neg denotes the complement of an event.

Using the principle of inclusion and exclusion:

$$P(\text{exactly two of } A, B, C) = [P(A \cap B) - P(A \cap B \cap C)] + [P(A \cap C) - P(A \cap B \cap C)] + [P(B \cap C) - P(A \cap B \cap C)]$$

Calculating the values:

$$\begin{aligned} P(\text{exactly two of } A, B, C) &= [(4/25) - (2/25)] + [(3/25) - (2/25)] + [(12/25) - (2/25)] \\ &= (2/25) + (1/25) + (10/25) \\ &= 13/25 \end{aligned}$$

Therefore, the probability that a randomly selected child from the group likes exactly two of the vegetables is $13/25$.

Figure 3. ChatGPT solution by using probabilities (Source: Author's own elaboration, using OpenAI, 2023)

ChatGPT gives to the following task:

"There are 25 children in the first group of kindergarten. 10 of them like cabbage, 14 carrots, 15 like peas, four of them carrots and cabbage, three of them cabbage and peas, 12 of them carrots and peas, and two of these children like everything. Find the probability that a randomly selected child likes exactly two of these vegetables."

The given solution in **Figure 3** is correct, but quite complicated for the student to understand. It is good to think about another matter.

It is challenging for students to ask the question. They need to know different methods of solving tasks of this type in order to get the question "correct". Students can also select the "regenerate response" option. In this case, they will need to recognize the methods by which the solutions are presented. This is also useful for students.

If we ask question "Cannot we count the kids who like exactly two vegetables?", ChatGPT gives us another solution (**Figure 4**).

Certainly, we can also directly count the number of children who like exactly two vegetables.

Let's denote the number of children who like:

- cabbage as "A"
- carrots as "B"
- peas as "C"

Given the information:

- $A = 10$ (children who like cabbage)
- $B = 14$ (children who like carrots)
- $C = 15$ (children who like peas)
- $A \cap B = 4$ (children who like both cabbage and carrots)
- $A \cap C = 3$ (children who like both cabbage and peas)
- $B \cap C = 12$ (children who like both carrots and peas)
- $A \cap B \cap C = 2$ (children who like all three vegetables)

To find the number of children who like exactly two vegetables, we can add the number of children who like two of the vegetables ($A \cap B$, $A \cap C$, $B \cap C$) and subtract the number who like all three ($A \cap B \cap C$):

$$\begin{aligned} \text{Number of children who like exactly two vegetables} &= (A \cap B) + (A \cap C) + (B \cap C) - (A \cap B \cap C) \\ &= 4 + 3 + 12 - 2 \\ &= 17 \end{aligned}$$

There are 17 children who like exactly two of these vegetables. Now, to find the probability, we can divide this number by the total number of children (25):

$$\text{Probability} = \frac{\text{Number of children who like exactly two vegetables}}{\text{Total number of children}} = \frac{17}{25}$$

Therefore, the probability that a randomly selected child from the group likes exactly two of the vegetables is $\frac{17}{25}$.

Figure 4. ChatGPT solution by using sets (Source: Author's own elaboration, using OpenAI, 2023)

We can easily notice that there is a discrepancy, and we should find the error. The error is that the intersection of the three sets is taken only once. This is especially useful for the student who is in the role of the teacher and has to follow AI's "reasoning" and find the error in this case. If we try to help to AI and give it a tip "you have three intersecting sets, and you take out the elements of the section only once," we have again mistake (**Figure 5**).

$$\begin{aligned} \text{Number of children who like exactly two vegetables} &= (A \cap B) + (A \cap C) + (B \cap C) - 2 * (A \cap B \cap C) \\ &= (4) + (3) + (12) - 2 * (2) \\ &= 17 - 4 \\ &= 13 \end{aligned}$$

Figure 5. Part of ChatGPT solution (Source: Author's own elaboration, using OpenAI, 2023)

In this solution, the number of elements in the section is subtracted twice. If the given dialogue with AI is led by the teacher and projected for the students to see, a discussion can be made here to find the error. In case everyone works individually, the discussion can be done at the end of the class.

If we ask for a solution via a Euler-Venn diagram, the variations shown in **Figure 6** follow (via "regenerate"). We can see in parts a, b, c, and d in **Figure 6** that the visualization is not appropriate and could even confuse the students. This confusion drives discovery of the correct solution and modeling through Euler-Venn diagrams.

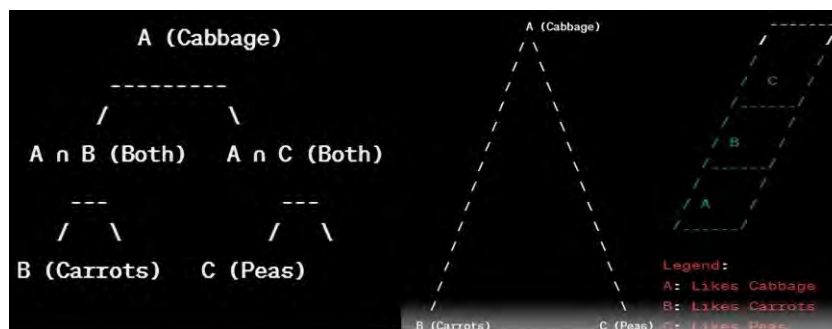


Figure 6. Part of ChatGPT solutions with Euler-Venn diagram (Source: Author's own elaboration, using OpenAI, 2023)

If the teaching takes place in the classroom, the teacher decides when to end the dialogue and conduct the discussion. In the case of independent work at home, students decide how far they are interested in exploring the solutions provided by AI. Examples of interesting dialogues with incorrect solutions in the field of the topic “functions” are shown in the article “ChatGPT: A revolutionary tool for teaching and learning mathematics” (Wardat et al., 2023). These examples are very suitable for stimulating students to check obtained results and to formulate and reformulate guiding questions clarifying the obtained result.

In order to implement this method in practice, it is important that students are motivated to work independently at home. In the classroom and within the constraints of instructional time, it is difficult to implement a quality “flipped dialogue” process. This can be done through assignments involving the targeted search for case studies with errors, or by expecting students to come across such case studies themselves when solving current homework assignments. An interesting connection between mathematics and philosophy can be made with the help of different solutions to problems caused by Bertrand's (1889) paradox with the use of AI.

DISCUSSION

The studies on the given topic were born from the practice of working with future math and ICT teachers. Over the past year, many articles have appeared focusing on the possibilities, problems and solutions in applying AI in education. Some of them support the use of AI.

“There are several advantages in the use of AI in mathematics learning among which is that students become more critical and responsible in facing daily solutions and a better understanding of fundamental problems of geometry, mathematics, and statistics. In addition, students also learn about and improve interpersonal abilities and better social interaction; it also allows effective learning to create a better environment to enhance the acquisition of mathematical concepts” (Mohamed et al., 2022).

A useful application of AI as a tool in the implementation of the STEM approach can be seen as a conclusion:

“Implementing GenAIbots in STEM learning requires weighing benefits and limitations, ensuring accurate information and considering reduced human interaction. Integrating GenAIbots with other educational tools or activities promoting collaborative dialogue among learners may address these concerns” (Vasconcelos & Santos, 2023).

Other authors consider that this is not appropriate at this stage. Gregorcic and Pendrill (2023) in their article “ChatGPT and the frustrated Socrates” mention that ChatGPT is not yet good enough to be used as a cheating tool for physics students or as a physics teacher. However, we have found it quite reliable in generating incorrect answers on which physics teachers can practice evaluating student answers. Their idea of using a wrong answer as a distraction in tests is very useful and fits the idea of looking for errors in AI solutions for a didactic purpose. Moral and ethical norms are also an important factor in the education of students. Working with AI raises a number of questions about when and how chatbots might be used (Jarrah et al., 2023). In the presented method, the end result is not as important as the dialogue to overcome the mistakes and reach the true solution. For the purposes of teaching mathematics, the fact that AI can quickly generate different solutions is very convenient for visualizing different approaches. The fact that AI is still not perfect—it cannot illustrate the examples and makes mistakes - can have a positive effect on the cognitive abilities of students. It is the critical look at the finished material that educates the student. Using a flipped approach with dialogic learning is mentioned by Reed and Chappell (2023).

“We did this by flipping the content, so before class, students would watch mini-lectures and at times prepare to present something to their peers at the start of the seminar.”

In their article, the authors actually implement the “flipped classroom” method. The ability to actively conduct dialogue and participate in discussions is preceded by independent preparation. The article deals only with communication between people.

CONCLUSIONS

In practice, students outpaced teachers in using ChatGPT. Students have used calculators and platforms to solve math problems before, but dialogue with AI has taken this process to a whole other level. Already with its appearance, it became clear that many homeworks are done with the help of AI. Over-reliance on technology has led to quite unpleasant consequences - wrong homework, recognition by the teacher that the work is not the student's, etc.

Students are impressed at the wrong answers of AI. They may be interested in looking for different ways to get exactly the wrong answer to see how it works. Looking for areas and reformulating questions is also a valuable skill for the student.

The limitations of the given method are that students must be motivated and provoked to look for interesting examples and attractive mistakes on their own. Not all students have an interest and desire for independent thinking. One of the options for implementing the method is with the help of appropriate homework and projects. Formulating interesting topics and assignments is a challenge for the teacher.

It is at this point that it is important to teach the student that technology must be used responsibly. The results should be critically reviewed, reworked according to the author's opinion, and the sources indicated. Looking for someone else's mistake and guiding them to find the correct solution with appropriate questions can lead students to a much deeper knowledge and understanding of the problems.

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