

# МЕТОДОЛОГІЧНІ ПРОБЛЕМИ ВПРОВАДЖЕННЯ ЦИФРОВИХ ТЕХНОЛОГІЙ ТА ІННОВАЦІЙНИХ МЕТОДИК НАВЧАННЯ

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## EXPERIENCE IN THE USING OF AI IN THE PROFESSIONAL ACTIVITY OF A TEACHERS OF HIGHER MATHEMATICS

**Abstract.** This paper investigates the problem of discrepancies between the capabilities declared by AI model developers and the actual quality of the corresponding tasks performed by these models. AI developers, especially those working on large language models (such as Gemini), identify several opportunities for creating educational content: generating content for different purposes, adapting to different audiences, personalizing learning, rapid content creation, and continuous improvement. However, a significant problem arises from the lack of publicly available data on the error rate of AI in these tasks.

The issue is particularly critical in the context of creating educational content in higher mathematics. Errors in such materials can have critical consequences for students in higher education who use widely available AI models. This paper analyzes the possibilities of using Gemini AI to develop educational materials for higher mathematics courses. Examples of practical application of AI included its use to generate a solution to a given problem, generate task variants based on a template, and create multiple-choice test tasks. Most of the educational materials developed with the help of AI were related to testing students' knowledge on the topic of the Theory of Functions of a Complex Variable. Real dialogues with AI are shown, which concern the correction of errors made by the model. The paper notes that all the comments made during the study were acknowledged and addressed by the AI model. Thus, at the current moment in time, the effective use of general-purpose AI models for generating educational content in higher mathematics can be carried out exclusively by users with a high level of mathematical training who can critically evaluate the results of the AI model. It is also shown that the lack of the ability to use formulas in Word Equation format when creating tasks for AI and generating its reports significantly reduces the effectiveness of AI in the professional activities of higher mathematics teachers.

**Keywords:** AI, Gemini, higher mathematics, educational materials.

### 1. INTRODUCTION

Among the most popular models of artificial intelligence, which allow the use of mathematical formulas in queries, we name the following: ChatGPT [1], Wolfram Alpha [2], Google Bard [3], Microsoft Bing Chat [4], Mathpix [5]. During 2023-2024, the Gemini artificial

intelligence model [6] was put into use by Google, which also has this capability. This study is devoted to the study of the possibilities of using AI Gemini in the professional activity of a teacher of higher mathematics in a higher education institution.

According to information from official websites [1-6], artificial intelligence models can be used to generate problems, check solutions, create interactive learning tools, create various types of educational materials (lecture notes, presentations, etc.).

This research is devoted to the practical study of the possibilities of using AI Gemini in the professional activity of a higher mathematics teacher in a higher education institution.

**Problem statement.** AI developers, particularly those working on models like Gemini, highlight several capabilities for educational content creation: generating diverse content, adapting to different audiences, personalizing learning, rapid content creation, and continuous improvement.

However, a significant challenge arises from the lack of publicly available data on AI error rates when performing these tasks. This scarcity is attributed to the competitive nature of AI development, the desire to protect proprietary information, and the rapid evolution of machine learning models.

The issue becomes particularly acute when considering the creation of educational content in higher mathematics. Errors in such materials can have critical consequences for students' understanding of complex mathematical concepts. Therefore, researching the actual quality of higher mathematics learning materials generated by large language AI models is a highly relevant task.

**Analysis of recent research and publications.** The emergence of generative artificial intelligence opens up new opportunities for education, but also raises complex ethical issues. On the one hand, such technologies can significantly improve the quality of education, but on the other hand, they pose risks related to academic integrity and accessibility of education. As emphasized by Yang et al. [7], the introduction of generative artificial intelligence requires a balanced approach that will allow to realize its potential while minimizing negative consequences.

Research has also intensified to compare recommendations generated by artificial intelligence with those provided by human teachers [8]. This line of research is crucial for understanding how artificial intelligence can complement and improve traditional teaching methods.

Modern researchers are increasingly focusing on assessing the potential of large AI language models in solving mathematical problems. Although the works [9-11] show some progress in this area, it should be noted that the models still have significant limitations.

AI systems can generate plausible but incorrect answers, which emphasizes the need to critically evaluate the results obtained by such models. According to Schorcht et al. [12], the effectiveness of solving mathematical problems with AI depends largely on the correct formulation of the problem.

Thus, the effective use of AI in education requires joint efforts of teachers, AI developers, and educational policy experts. It is worth noting that before large AI language models can be widely used to generate and solve mathematical problems, it is necessary to solve the problem of improving the accuracy of the algorithms used to perform such tasks.

**The purpose of the article.** The aim of the study is to evaluate the potential of AI Gemini as a tool for automating the process of developing various types of educational materials in higher mathematics in the context of transforming traditional approaches to teaching this subject in higher education institutions.

## 2. RESEARCH RESULTS

### Gemini's AI capabilities for developing educational content

When presenting the capabilities of AI for developing educational content, its developers point out the following:

- **Generating diverse content:** Gemini can generate textual content in a variety of formats: from short explanations to in-depth articles, tests, assignments, presentations, and even scripts for training videos.

- **Adaptation to the audience:** The model is able to adapt the complexity and style of presentation of the material to different levels of knowledge and age categories.
- **Personalization of training:** Gemini can create individualized learning paths for each learner, taking into account their strengths and weaknesses.
- **Speed of content creation:** Gemini’s capabilities make it possible to create large volumes of learning materials much faster.
- **Continuous improvement:** The model is constantly learning from new data, allowing it to become more accurate and efficient.

At the same time, there is no publicly available information on the statistics of errors made by AIs when performing tasks. It is explained by competition between companies developing different AI models and the desire to keep some aspects of their developments secret. It is also emphasized that machine learning models are constantly improving, so error statistics can change rapidly.

Among the typical mistakes that Gemini makes when solving math problems, the AI notes the following:

- **Misinterpretation of the task:** The model may misunderstand what is required of it.
- **Using incorrect formulas:** The model may use incorrect formulas or algorithms to solve the problem.
- **Arithmetic errors:** The model may make mistakes when performing simple arithmetic operations.
- **Logical errors:** The model may make logical leaps or skip important details when solving a problem.

Since math content is particularly error-sensitive, it is important for a teacher of this discipline to have their own practical experience of using AI to really assess its advantages and capabilities.

#### **Basic conditions for the use of AI**

For a teacher of higher mathematics, the usability of any computer application with or without artificial intelligence begins with the convenience of entering formulas and the ability to export/import them in common formats such as MathType or Word Equation.

A test of the ease of entering mathematical formulas in Gemini queries revealed the following limitations that are important for the practical application of AI. Formulas in MathType format are added as a graphic image, and there is no possibility to enter several formulas in this format in one query. The use of formulas in the Word Equation format is not supported. Formulas presented in MathML or LaTeX formats are integrated into the query in the amount necessary for the correct formulation of the problem. Obviously, for an average user, even a teacher of higher mathematics, using formulas in MathML or LaTeX requires special training, which significantly slows down the process of interaction with AI.

#### **An example of testing AI capabilities in solving tasks from a higher math course**

**Experiment 1.** To test the AI’s ability to solve higher math problems, let’s ask it to find a general and particular solution for an ordinary differential equation:

$$(x^2 + y^2)dx + 2xydy = 0 \tag{1}$$

with initial condition:

$$y(1) = 3. \tag{2}$$

Fig. 1 shows examples of the formation of a question and Gemini’s answer to it when the formulas are presented in MathType (Fig. 1a) and LaTeX (Fig. 1b). Given the length of Gemini’s answers, some of the text of answers has been removed. Expressions of general solutions are obtained correctly.

<p><b>T</b> Please find the general solution of the ordinary differential equation</p> $(x^2 - y^2) \cdot dx + 2 \cdot x \cdot y \cdot dy = 0$ <p><b>◆</b> The given differential equation is:</p> $(x^2 - y^2)dx + 2xydy = 0$ $x^2 + y^2 = Cx$ <p>This is the general solution of the given differential equation.</p>	<p><b>T</b> Please find the general solution of the ordinary differential equation <math>(x^2 - y^2) \cdot dx + 2 \cdot x \cdot y \cdot dy = 0</math>.</p> <p><b>◆</b> The given differential equation is:</p> $(x^2 - y^2)dx + 2xydy = 0$ $x^2 + y^2 = Cx$ <p>This is the general solution of the given differential equation.</p>
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a) b)

**Figure 1.** Examples of presenting formulas: a) in MathType format, b) in LaTeX format

However, when finding a particular solution to the same equation, the new Gemini chat tool makes strange mistakes at the step of separating variables. Before the step

Dividing by  $x^2$  and rearranging:

$$(1 + v^2)dx + 2xv dv = 0$$

the solution is correct, but when separating the variables, AI Gemini gets an error:

Separating variables:

$$(1 + v^2)/v dv = -2dx/x$$

Subsequently, this equation is integrated and AI Gemini arrives at a new irregular general solution:

4. **Substitute Back for y/x:**

Substituting back  $v = y/x$ :

$$\ln|y/x| + (1/2)(y/x)^2 = -2\ln|x| + C$$

As a result, the constant C for the above initial conditions already has a value:

Solving for C:

$$C = \ln(3) + (9/2)$$

Later, a dialogue takes place:

- T** You are making a mistake when separating variables. After separating the variables, we should get the equation  $(v(1 + v^2)) dv = -dx/(2x)$ .
- ◆** You're absolutely right! I apologize for the oversight.
- T** The expression of the obtained general solution can be significantly simplified to  $x^2 + y^2 = C \cdot x$ .
- ◆** That's correct!

And finally, we get the correct particular solution:

Rearranging terms:

$$x^2 + y^2 = 10x$$

Now, let's introduce a new constant,  $C = 10$ .

The authors conducted experiments on introducing the same problem of finding a general solution to a differential equation in the same format in new chat rooms. As a result, there were cases when a correctly interpreted equation was perceived as incorrect.

In addition, the following errors were observed. When forming a solution at a certain step, the first term in the equation was attributed by AI to the previous text, and the equation was subsequently solved without this term. It is especially surprising that such errors occurred when working with the text generated by AI, not when interpreting a question asked by the user.

That is, at the current stage of general-purpose AI development, it is a dubious idea to use them to solve higher mathematics problems and verify proposed solutions.

**An example of testing AI capabilities in formation of problem variants by template**

**Experiment 2.** Suppose that a teacher needs to develop 30 variants for organizing student’s independent work to test their knowledge of the topic «Theory of functions of a complex variable». In this case, each variant traditionally includes a certain number of problems from calculating the modulus and principal value of a complex number to calculating integrals of functions of complex variables. Let’s try to use AI to generate the required number of variants of some tasks.

**Task for AI:** Suppose you need to generate 30 variants of 4 tasks each. The task itself is to determine the principal value of the argument of a complex number in the interval  $(-\pi, \pi]$ . It is assumed that each of the four complex numbers should be in a different coordinate quarter. The principal values of the arguments of the complex numbers should be calculated using the table values of the angles. The generated set of tasks should contain types of formulas that can be easily integrated into the Word text editor.

Let’s form a corresponding query to AI. It is worth noting that in all our experiments, AI refuses to generate a large number of variants. This time, it was also reported that instead of generating a table, we are offered a Python program that will randomly select a coordinate quarter and generate a complex number with an angle of multiple.

Let’s reduce the number of options to 5. The AI agrees to generate this number of tasks, but the table shows only a few lines, for example, and not all tasks. After being asked to provide all 5 options for 4 tasks, the AI finally adds all the desired tasks to the table.

Let’s change the requirement that the principal values of the arguments of complex numbers be multiples of the table angles:  $0, \pi/6, \pi/4, \pi/3, \pi/2$ . After that, we get the answer as shown in Fig. 2. Further, there is a lengthy discussion of the identified inaccuracies regarding the signs of the proposed principal values of the arguments of complex numbers in different coordinate quarters and the presence of two numbers from the same coordinate quarter in one variant, absence of the «i» symbol in the representation of complex numbers. The comments refer to all AI-generated task variants, not just the part of them shown in Fig. 2.

Option No.	Problem No.	Complex Number	Principal Argument (radians)
1	1	1 + i	$\pi/4$
1	2	$-\sqrt{3} + 1$	$5\pi/6$
1	3	$-1 - \sqrt{3}$	$5\pi/3$
1	4	$\sqrt{3} - 1$	$\pi/6$
2	1	$\sqrt{3} + 1$	$\pi/6$
2	2	$-1 + \sqrt{3}$	$2\pi/3$

**Figure 2.** Answer from AI for Problem 1

Another problem occurs when exporting tasks to a document: the values from the last two columns are transferred incorrectly. This problem is solved by asking the AI to provide formulas in the answer in LaTeX format. Visually, formulas look normal. They can be copied to the Word Equation formula editor, but each one separately.

**Experiment 3.** Now, let’s assume that you want to check the students’ ability to calculate integrals of functions of a complex argument on a closed contour using the Cauchy integral formula. Recall the statement of the corresponding theorem.

**Theorem.** If  $f(z)$  is an analytic function in a one-connected closed domain  $\bar{D}$  and  $C$  is the boundary of the domain  $\bar{D}$ , then the value of the function  $f(z)$  at any interior point of  $D$  can be calculated by the Cauchy formula:

$$f(a) = \frac{1}{2\pi i} \oint_C \frac{f(z)}{z-a} dz, \tag{3}$$

where the contour  $C$  is traversed in such a way that the region  $D$  remains on the left.

Problems for this theorem are most often formulated in such a way that the expression in the numerator of the integral function and some of the factors in the denominator form an analytic function. Less complex problems assume that the root of only one of the denominator factors is inside a given circle. Let's formulate the problem as follows.

Calculate the integral

$$\oint_C \frac{g(z)}{(z-z_1)(z-z_2)} dz, \quad (4)$$

where  $C: |z-z_0|=R$ ;  $z_0, z_1, z_2$  are complex numbers;  $g(z)$  is analytic function of the form  $\exp(\alpha z), \sin(\alpha z), \cos(\alpha z)$ ;  $\alpha$  is a complex number.

The student needs to determine which root of the denominator is inside the circle. We agree that it is the root  $z_2$ . Label

$$f(z) = \frac{g(z)}{z-z_1}.$$

Apply the Cauchy integral formula (3) to the resulting function  $f(z)$ .

Since it is already clear that entering a formula of the form (4) in a Gemini question will create significant difficulties both at the stage of its input and at the stage of its correct understanding by the AI, we will set a simpler task for the AI.

**Task for AI.** Generate 5 variants of this type of problem. A quadratic equation of the form is given:

$$z^2 + pz + q = 0,$$

where the variable  $z$  can take complex values; the coefficients  $p$  and  $q$  are known complex numbers.

Choose the values of the coefficients  $p$  and  $q$  so that only one root of the equation is inside the circle  $|z-z_0|=R$ , where  $z_0$  is a given complex number (the center of the circle),  $R$  is a positive integer.

Observe the constraints:

- 1) the real and imaginary parts of all complex numbers used in the problem must be integers;
- 2) the roots of the equation and the center of the circle must be in the complex plane in the range from  $-5$  to  $5$  in the  $x$ -direction and from  $-5$  to  $5$  in the  $y$ -direction;
- 3) the radius of the circle  $R$  must not exceed  $5$ .

Write your answer in a table with the following columns: the given equation; the discriminant of the given equation; the first root of the equation (which does not fall inside the circle); the second root of the equation (which falls inside the circle); the center of the circle; the radius of the circle.

Use the Latex format when forming an answer for formulas.

As a result of performing this task, AI generated the answer shown in Fig. 3.

Equation	Discriminant	Root 1 (Outside)	Root 2 (Inside)	Center	Radius
$z^2+z-6=0$	25	2	-3	0	3
$z^2+2z-1=0$	8	$-1 + \sqrt{2}$	$-1 - \sqrt{2}$	-1	1
$z^2-3z+10=0$	-31	$2 + 3i$	$2 - 3i$	2	3
$z^2+4z+5=0$	-4	$-2 + i$	$-2 - i$	-2	1
$z^2-z-12=0$	49	4	-3	0	4

Figure 3. Answer from AI for Problem 2

The task was performed by AI several times. When performing the task, AI made completely unacceptable mistakes in calculating the roots of the equation:

- T Again, errors in calculating the roots of the equation.
- ◆ You're absolutely right. There were errors in the calculations. Let's recalculate the roots based on the given equations and discriminants:

There were also cases of violation of the requirement that one root be inside the circle and the other outside. If an additional requirement was put forward, for example, that the discriminant take negative values and the root of the discriminant be equal to a complex number with an integer imaginary part, then some of the predefined requirements were ignored.

Thus, the quality of the created AI tasks cannot be considered acceptable.

### An example of testing AI capabilities to create tests for a higher math course

Let's test the AI's ability to create tests using the example of developing a multiple-choice test.

**Experiment 4.** Let's return to the task of testing students' ability to correctly determine the principal value of the argument of a complex number [13-14]. Let's instruct AI to develop 5 variants of test tasks. Each variant should contain 4 tasks to determine the principal value of the argument of a given complex number. Each task should have four answers, one of which is correct. All other requirements are the same as in Experiment 2.

The variants of the AI test task were designed correctly (Fig. 4). After an additional reminder, the correct answer marks also appeared.

Variant 1

1. $\arg(1 + i)$	2. $\arg(-1 + i)$	3. $\arg(-1 - i)$	4. $\arg(1 - i)$
<ul style="list-style-type: none"> <li>◦ (a) <math>\frac{\pi}{4}</math></li> <li>◦ (b) <math>-\frac{\pi}{4}</math></li> <li>◦ (c) <math>\frac{\pi}{2}</math></li> <li>◦ (d) <math>\frac{3\pi}{4}</math></li> </ul>	<ul style="list-style-type: none"> <li>◦ (a) <math>\frac{3\pi}{4}</math></li> <li>◦ (b) <math>-\frac{3\pi}{4}</math></li> <li>◦ (c) <math>\frac{\pi}{4}</math></li> <li>◦ (d) <math>-\frac{\pi}{4}</math></li> </ul>	<ul style="list-style-type: none"> <li>◦ (a) <math>-\frac{\pi}{4}</math></li> <li>◦ (b) <math>\frac{\pi}{4}</math></li> <li>◦ (c) <math>-\frac{3\pi}{4}</math></li> <li>◦ (d) <math>\frac{3\pi}{4}</math></li> </ul>	<ul style="list-style-type: none"> <li>◦ (a) <math>-\frac{\pi}{4}</math></li> <li>◦ (b) <math>\frac{\pi}{4}</math></li> <li>◦ (c) <math>-\frac{3\pi}{4}</math></li> <li>◦ (d) <math>\frac{3\pi}{4}</math></li> </ul>

Figure 4. Answer from AI for Task 3

However, an attempt to ask AI to diversify the task by using other table values of angles resulted in incorrectly selected correct answers (Fig. 5).

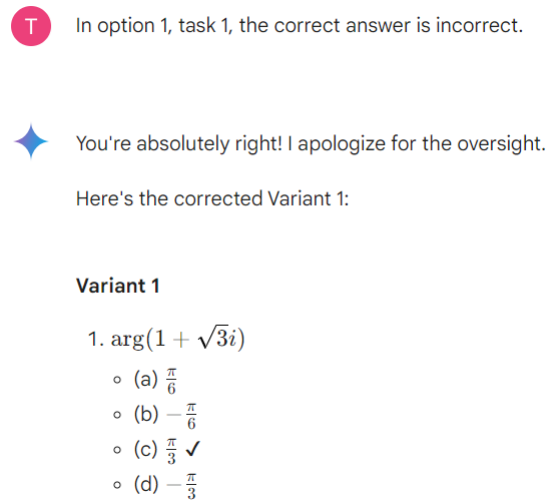
- T In the test, all angles are multiples of  $\pi/4$ . Make the tasks more varied. Also use angles that are multiples of  $\pi/6$ ,  $\pi/3$ ,  $\pi/2$ .
- ◆ Test Variants with More Varied Angles

Variant 1

1. $\arg(1 + \sqrt{3}i)$	2. $\arg(-1 + i)$	3. $\arg(-1 - \sqrt{3}i)$	4. $\arg(1 - i)$
<ul style="list-style-type: none"> <li>◦ (a) <math>\frac{\pi}{6}</math> ✓</li> <li>◦ (b) <math>-\frac{\pi}{6}</math></li> <li>◦ (c) <math>\frac{\pi}{3}</math></li> <li>◦ (d) <math>-\frac{\pi}{3}</math></li> </ul>	<ul style="list-style-type: none"> <li>◦ (a) <math>\frac{3\pi}{4}</math> ✓</li> <li>◦ (b) <math>-\frac{3\pi}{4}</math></li> <li>◦ (c) <math>\frac{\pi}{4}</math></li> <li>◦ (d) <math>-\frac{\pi}{4}</math></li> </ul>	<ul style="list-style-type: none"> <li>◦ (a) <math>-\frac{2\pi}{3}</math> ✓</li> <li>◦ (b) <math>\frac{2\pi}{3}</math></li> <li>◦ (c) <math>\frac{\pi}{3}</math></li> <li>◦ (d) <math>-\frac{\pi}{3}</math></li> </ul>	<ul style="list-style-type: none"> <li>◦ (a) <math>-\frac{\pi}{4}</math> ✓</li> <li>◦ (b) <math>\frac{\pi}{4}</math></li> <li>◦ (c) <math>-\frac{3\pi}{4}</math></li> <li>◦ (d) <math>\frac{3\pi}{4}</math></li> </ul>

Figure 5. The result of diversifying the test content

Figure 6 shows how AI reacts to a comment about a mistake and its correction.



**Figure 6.** The result of diversifying the test content

It is worth noting that during the experiments, AI always recognized the errors pointed out to it and took measures to eliminate them.

**Experiment 5.** We will continue to develop didactic materials to test students' knowledge of the theory of functions of a complex variable. Let's ask the AI to generate 5 variants of the test task of finding the imaginary part  $v(x, y)$  of an analytic function  $f(z)$  given its known real part  $u(x, y)$ . Recall that finding the analytic function by its known real or imaginary part is based on the Cauchy-Riemann conditions [13-14]:

$$\begin{cases} \frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}, \\ \frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}. \end{cases} \quad (5)$$

**Task for AI.** Generate 5 variants of a test task to find the imaginary part  $v(x, y)$  of an analytic function given its known real part of the form

$$u(x, y) = x^2 - y^2 + ay,$$

where  $a \in \mathbb{R}$ .

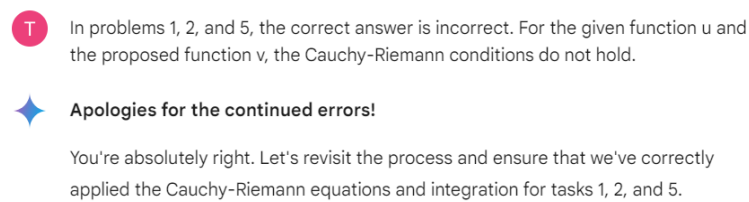
For each task, give four answers, one of which is correct. Write your answers in a list. Mark the correct answers. Use the Cauchy-Riemann conditions to find the correct answer.

Fig. 7 shows the results of generating a test case. It is obvious that in options 1, 2, and 5 the correct imaginary function was chosen incorrectly.

Task 1	Task 2	Task 3	Task 4	Task 5
<ul style="list-style-type: none"> <li>• <math>u(x, y) = x^2 - y^2 + 3y</math></li> <li>◦ a. <math>2xy - 3x + C</math></li> <li>◦ b. <math>2xy + 3x + C</math></li> <li>◦ c. <math>2xy + 3y + C</math></li> <li>◦ d. <math>2xy - 3y + C</math></li> <li>• Correct answer: b.</li> </ul>	<ul style="list-style-type: none"> <li>• <math>u(x, y) = x^2 - y^2 - 5y</math></li> <li>◦ a. <math>2xy + 5x + C</math></li> <li>◦ b. <math>2xy - 5x + C</math></li> <li>◦ c. <math>2xy + 5y + C</math></li> <li>◦ d. <math>2xy - 5y + C</math></li> <li>• Correct answer: b.</li> </ul>	<ul style="list-style-type: none"> <li>• <math>u(x, y) = x^2 - y^2 + y</math></li> <li>◦ a. <math>2xy + x + C</math></li> <li>◦ b. <math>2xy - x + C</math></li> <li>◦ c. <math>2xy + y + C</math></li> <li>◦ d. <math>2xy - y + C</math></li> <li>• Correct answer: b.</li> </ul>	<ul style="list-style-type: none"> <li>• <math>u(x, y) = x^2 - y^2 - 2y</math></li> <li>◦ a. <math>2xy + 2x + C</math></li> <li>◦ b. <math>2xy - 2x + C</math></li> <li>◦ c. <math>2xy + 2y + C</math></li> <li>◦ d. <math>2xy - 2y + C</math></li> <li>• Correct answer: a.</li> </ul>	<ul style="list-style-type: none"> <li>• <math>u(x, y) = x^2 - y^2 + 4y</math></li> <li>◦ a. <math>2xy + 4x + C</math></li> <li>◦ b. <math>2xy - 4x + C</math></li> <li>◦ c. <math>2xy + 4y + C</math></li> <li>◦ d. <math>2xy - 4y + C</math></li> <li>• Correct answer: a.</li> </ul>

**Figure 7.** Results of generating by AI test tasks on finding the imaginary part of an analytical function by a given real part

Later, a dialog with AI takes place, which leads to the correction of mistakes made when forming a test task (Fig. 8).



**Figure 8.** Start a dialog with AI to correct mistakes

### 3. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

Most higher education institutions in Ukraine have long been forced to turn to blended or distance learning. It is logical that such a transformation of the educational process encourages teachers to introduce new teaching methods, develop new types of educational materials, and use new types of tools to create them. The development of educational content using AI is a new tool for teachers. Evaluations of the effectiveness of such a tool will obviously differ depending on the specifics of each academic discipline.

This article analyzes the results of practical application of AI model of Gemini type to the development of educational content in higher mathematics. An attempt was made to prepare tasks for organizing students' independent work and test tasks for the current control of knowledge on the topic «Theory of functions of a complex variable». The ability of AI model of Gemini type to solve problems in higher mathematics was tested on the task on the topic of Differential Equations.

The identified shortcomings in the educational content prepared by AI model of Gemini type resonate with the optimistic statements of developers about the capabilities of this AI model. It is clear that we are talking about the current level of development of AI models. Besides, it is possible to train AI to solve problems on certain topics of the discipline.

Nevertheless, numerous experiments have revealed some drawbacks when working with AI to prepare educational content.

There is **instability in the results**. The same math problem offered by AI model of Gemini type in different chat rooms may have different answers. The order of appearance of correct and incorrect solutions has no regularity.

The solutions to a problem formulated in different languages may be different. And it is not about using different methods, solutions, but about getting the right and wrong answers.

There are **errors in the formation of the response text**. There have been cases when AI incorrectly separates the text of comments and formulas when forming an answer: the first term of the formula is attached to the text of the comment and further transformations are performed without it.

**Errors in calculations.** Similar conversions at the level of using proportion properties, calculating the discriminant, etc. can be performed with errors.

The Gemini interface has a special function for reporting errors. If such a message is received, the model can change the algorithms used to perform mathematical calculations to reduce the likelihood of similar errors in the future.

Thus, given the large number of mistakes made by the Gemini type AI model when solving problems in higher mathematics, an effective alternative to creating educational content is to develop it using computer mathematics systems. The authors have their own positive experience of creating an application in the Maple programming environment for generating tasks on the topic «Ordinary differential equations of the second order with constant coefficients» [15].

**Linguistic mistakes.** When using the Ukrainian language in questions, answers may contain grammatical errors. When pointing them out, AI agrees, but notes that they are trivial and not worthy of attention. For example, there was a discussion about the spelling of the word «корЕні», and AI used «корИні».

One of the key advantages of using artificial intelligence in education is the ability to quickly generate large volumes of various learning tasks. However, a study using the Gemini model revealed certain limitations of this approach. Despite the declared capabilities, the model refused to perform the direct task of creating 30 variants of the same type of task. Instead, Gemini offered several samples and provided general recommendations for further automation of the task generation process.

Among the reasons why the Gemini type AI model refused to generate the requested number of tasks, the model itself mentioned the following:

- **High quality requirements:** test tasks usually have high quality, accuracy, and relevance requirements. The model may not be confident in its ability to provide this level of quality for a large number of tasks.
- **Focus on creativity:** The model is trained to focus on the creative aspect of content generation rather than mass-producing similar tasks.
- **Desire for interaction:** Instead of performing routine work, the model can try to engage the user in the task creation process by providing them with tools and resources for this.

The issue of **converting formulas** from one format to another when working with the Gemini AI model remains far from being resolved. As a result, the share of unproductive work of mathematics teachers on typing texts with formulas is unacceptably high in their professional activities.

In response to the question about the integration of new formula formats into Gemini chat, we received a response from the Gemini AI model itself that there is currently no official information that Gemini developers are working on integrating the Word Equation formula format directly into Gemini chat. So, teachers of higher mathematics will have to wait for the reduction of routine operations.

The analysis of interaction with the Gemini AI model revealed a number of positive characteristics that indicate the presence of a component in its strategy that can be characterized as «desire to interact». The model demonstrates high coherence in dialogue, supporting long and meaningful conversations, as well as the ability to contextualize its responses, taking into account the user's previous statements. In addition, Gemini shows signs of personalizing communication by adapting its style to the user's individual characteristics. These features demonstrate the model's advanced communication abilities and its potential for effective human interaction.

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## ДОСВІД ВИКОРИСТАННЯ ШІ У ПРОФЕСІЙНІЙ ДІЯЛЬНОСТІ ВИКЛАДАЧА ВИЩОЇ МАТЕМАТИКИ

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**Анотація.** У цій статті досліджується проблема розбіжностей між можливостями, які декларують розробники моделей штучного інтелекту, та фактичною якістю виконання відповідних завдань цими моделями. Розробники ШІ, особливо ті, що працюють над великими мовними моделями (такими як Gemini), виділяють кілька можливостей для створення навчального контенту: створення контенту для різних цілей, адаптація до різних аудиторій, персоналізація навчання, швидке створення контенту та постійне вдосконалення. Однак виникає суттєва проблема через відсутність у відкритому доступі даних про рівень помилок, які допускають моделі ШІ при виконанні цих завдань.

Особливо гостро це питання стоїть у контексті створення навчального контенту з вищої математики. Помилки в таких матеріалах можуть мати критичні наслідки для студентів закладів вищої освіти, які використовують широкодоступні моделі ШІ. У цій статті проаналізовано можливості використання моделі ШІ Gemini для розробки навчальних матеріалів для курсу вищої математики. Приклади практичного застосування ШІ включають його використання для генерації розв'язку задачі, генерації варіантів завдань на основі шаблону та створення тестових завдань з множинним вибором. Більшість навчальних матеріалів, розроблених за допомогою ШІ, стосувалися перевірки знань студентів з теми «Теорія функцій комплексного змінного». Наведено реальні діалоги зі ШІ, які стосуються виправлення помилок, допущених моделлю. У статті зазначається, що всі помилки, вказані під час дослідження, були визнані та враховані моделлю ШІ. Таким чином, на поточний момент часу ефективне використання моделей ШІ загального призначення для генерації навчального контенту з вищої математики може здійснюватися виключно користувачами з високим рівнем математичної підготовки, які здатні критично оцінити результати роботи моделі ШІ. Також показано, що відсутність можливості застосування формул у форматі Word Equation при створенні завдань для ШІ та формуванні його звітів суттєво знижує ефективність використання ШІ в професійній діяльності викладачів вищої математики.

**Ключові слова:** ШІ, Gemini, вища математика, навчальні матеріали.

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