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The process of lesson planning using generative artificial intelligence: a study based on the TRACK model and UNESCO's competency framework

Abstract

The article discusses one of the key problems of modern pedagogical practice – the difficulties teachers face when formulating lesson objectives. Based on data from a survey of 300 schools conducted by the I. Altynsarin NAE (2023), in which 22% of teachers indicated difficulties with goal setting, the article explores the potential of large language models (LLMs) as a tool for optimizing this stage of planning. A structured algorithm for using the Google Gemini model to generate lesson objectives, descriptors, and learning tasks is proposed and described. The effectiveness and risks of this approach are analyzed through the lens of the TRASC (Technological Pedagogical Content Knowledge) theoretical framework and the UNESCO Artificial Intelligence Competency Framework for Educators. The article argues that AI can serve as a tool for educators, reducing the cognitive load in routine stages and freeing up resources for creative and analytical aspects of teaching. However, its effective integration requires educators to develop new competencies related to the critical evaluation of generated content and its adaptation to unique pedagogical contexts.

Keywords: lesson planning, learning objectives, generative artificial intelligence, large language models, instructional design, teacher competencies.

Introduction

Lesson planning is a key component of teaching that determines the effectiveness and quality of the educational process. An effectively developed lesson plan guides the teacher in terms of content, methods, and strategies for engaging students [1]. It ensures the systematic nature of teaching by establishing a logical sequence of lesson stages, guaranteeing that the content complies with the curriculum, and selecting appropriate methods and means to achieve the desired educational outcomes.

However, the pedagogical value of planning lies not so much in writing a short-term lesson plan as in the process of developing it. This process is a complex cognitive activity in which the teacher transforms theoretical knowledge and curriculum requirements into specific, practically implementable learning situations [2]. It is at this stage that didactic principles are adapted to the conditions of a particular class, taking into account the age characteristics, individual educational needs, and level of preparation of each student. Thus, lesson planning acts as a key mechanism linking pedagogical theory with teaching practice (methodology), and its quality is directly related to the success of the entire educational process.

Taking into account the recognized importance of each stage of the lesson, scientific research and pedagogical practice consistently indicate that it is the stage of formulating lesson objectives that presents the greatest difficulty. Clearly formulated lesson objectives determine the content of the lesson, the choice of methods, the development of tasks, and the definition of assessment criteria. They give students an understanding of what knowledge and skills are expected of them and guide the teacher's activities toward achieving specific, measurable results [3].

The difficulties associated with goal setting are systemic and international in nature. Numerous studies on the professional development of teachers show that young (novice) teachers experience difficulties in defining and formulating lesson objectives [4, 5, 6].

For example, a study by Zingir Gülten found that 41% of trainee teachers were unable to correctly formulate goals for the lesson plans they had developed. Incorrectly or unclearly formulated goals cause the lesson to lose focus. The specific goal of the lesson should clearly and unambiguously define what needs to be achieved in the lesson.

The results of an online survey conducted by the I. Altynsarin National Academy of Education [7] in 300 secondary education institutions in 2023 showed that 22% of the teachers surveyed consider the most difficult stage of planning to be «formulating lesson objectives based on the objectives of the curriculum». Other difficulties noted by teachers, such as «motivating students to learn» (16.5%), «assessing students (13%), and «finding ways to solve problems» (14%), are largely derived from the initial setting of a clear goal. If students do not understand what they need to learn and why, their motivation decreases. If teachers do not set clear, measurable goals, the assessment process becomes subjective and opaque.

The complexity of goal setting can be explained from the perspective of cognitive science, which essentially states that this process requires teachers to simultaneously synthesize knowledge from several areas, understanding subject matter, mastering teaching strategies, and taking into account the needs and characteristics of learners [2]. This task creates a cognitive load, especially for teachers with little experience.

Today, the technological landscape is changing under the influence of artificial intelligence (AI), in particular large language models (LLMs). This paradigm opens up new horizons for the transformation of professional activities in many areas, and education is no exception [8, 9, 10].

The ability of LLMs to generate structured, contextually appropriate content (resources) makes them a tool for supporting educators in performing routine but cognitively demanding tasks, one of which is lesson planning.

Research shows that AI tools can increase the effectiveness of educators' work. There have been reports of a reduction in the time spent on lesson preparation and administrative tasks by up to 40%, allowing educators to free up time for creative work, such as individual work with students or self-reflection [11, 12, 13].

The introduction of AI into educational design should be seen not as an attempt to replace teachers, but as an opportunity to expand and enhance their professional capabilities [14].

In other words, the goal of using AI is not for it to «write a lesson plan» instead of the teacher, but for it to act as the teacher's assistant. AI can take on tasks such as selecting assignments in line with lesson objectives or structuring objectives in accordance with the SMART format, while teachers remain responsible for higher-order tasks such as «Is this objective really the most relevant and meaningful for this lesson? » and «What method is best suited to achieving this objective in this class?» By adhering to this approach, we can shift the focus from the question «Can AI plan a lesson?» to the question «How can AI improve the planning process?» [15]

Based on the above, this study sets the following goal: to develop and theoretically substantiate a model for using generative AI (using Google Gemini as an example) to optimize the process of setting lesson objectives, developing descriptors, and selecting learning tasks.

To achieve this goal, the following research objectives were identified:

- to analyze and systematize the difficulties faced by teachers when planning lessons, based on data from a survey conducted by the I. Altynsarin National Academy of Education [7] and international scientific literature [4, 5, 6];
- to describe the algorithm for working with the Gemini model to solve the task of setting lesson goals;
- analyze the proposed algorithm through the prism of TRASK [16] and the UNESCO AI Competency Framework for Teachers [17];
- evaluate the advantages [11] as well as the risks and limitations of introducing AI into pedagogical practice [18, 19].

Materials and methods

This study is based on a qualitative, exploratory research methodology implemented in the form of a case study. In this case, the object of the study is the complex cognitive process of pedagogical design (in particular, lesson planning), and the subject is the potential use of large language models (LLMs) to optimize and support it. The case study method allows for a detailed analysis of the proposed algorithm for interaction with AI, identification of its strengths and weaknesses, and formulation of hypotheses for further empirical research.

The study is based on two main types of sources:

1. Data for analyzing the problem. The results of an online survey conducted by the I. Altynsarin National Academy of Education in 300 schools in the Republic of Kazakhstan in 2023 were used as data for identifying the problem under study. The survey included closed-ended questions with multiple-choice options aimed at identifying the stages of lesson planning that cause the most difficulty for practicing teachers. These quantitative data allowed us to empirically confirm the relevance of the problem of goal setting.

2. Tool. The large language model Google Gemini was chosen as the tool for developing the solution model.

The analysis of the proposed AI usage model is based on a theoretical framework that allows for an assessment of its pedagogical validity and the requirements for teacher competencies.

1. The TRACK (Technological Pedagogical Content Knowledge) model [20], developed by P. Mishra and M. Keller, is a widely recognized conceptual framework for analyzing the effective integration of technology into education. It postulates that high-quality teaching using technology requires teachers to have not only separate knowledge in three areas—subject content, pedagogy, and technology—but also a complex synthesis and integration of these areas. In this study, this model is used as a diagnostic tool. It allows us to analyze how the proposed Gemini algorithm develops all components of a teacher's knowledge and to identify why simply mastering technology without integrating it with pedagogy and content can be ineffective or even counterproductive.

2. UNESCO's AI Competency Framework for Teachers [17], which defines the set of knowledge, skills, and values that educators need to work in the age of artificial intelligence. In the study, this framework is used as a prescriptive tool to assess the extent to which the proposed model contributes to the development of the key competencies identified by UNESCO.

The combined use of these two models allows us to describe the proposed technological process and analyze its pedagogical prerequisites and consequences, diagnose potential difficulties, and determine the necessary conditions for its successful implementation.

The study was organized in three stages.

1. Analytical stage (analysis of initial data).

2. Design stage (development of an algorithm for teacher interaction with the Gemini model). The process was iterative: various prompt options were formulated, the results were analyzed, and then the prompts were adjusted to achieve more accurate results.

3. Theoretical stage. At the final stage, the developed algorithm was subjected to theoretical analysis and interpretation.

Results and Discussion

The empirical basis of the study was formed by data from a survey of 300 schools conducted by the I. Altynsarin National Academy of Education [7]. The survey results made it possible to quantitatively assess and rank the difficulties faced by teachers in the process of writing lesson plans. Table 1 shows a detailed breakdown of the respondents' answers.

Table 1.

Distribution of difficulties experienced by teachers at different stages of planning (according to a survey by the I. Altynsarin National Academy of Education, 2023)

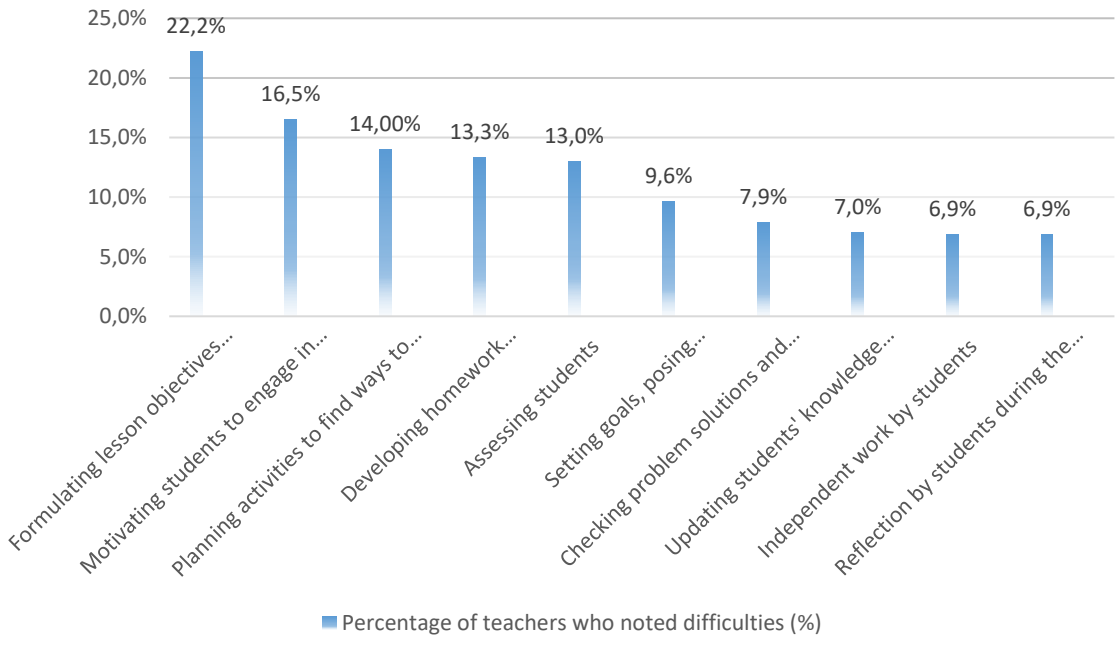
Lesson planning stage	Percentage of teachers who noted the difficulty (%)
Formulating lesson objectives based on the objectives of the curriculum	22.2
Motivating students to engage in learning activities	16.5
Planning activities to find ways to solve problems	14.0

Developing homework assignments of varying levels of difficulty	13.3
Assessing students	13.0
Setting goals, posing questions/problems at the beginning of the lesson	9.6
Checking problem solutions and reinforcing knowledge	7.9
Updating students' knowledge (reviewing material covered)	7.0
Independent work by students	6.9
Reflection by students during the lesson	6.9
Difficult to answer	0.1
No problems with lesson planning	39.7

Source: Results of an online survey conducted by the I. Altynsarin NAE in 300 schools across the republic, 2023.

To clearly demonstrate the key problem areas, a bar chart was constructed (Figure 1), which shows the most frequently encountered difficulties.

Figure 1.
Main difficulties faced by teachers in the lesson planning process



Data analysis shows that formulating lesson objectives is the most significant problem for a large proportion of teachers (22%). This result confirms the central thesis of the study that goal setting is an important and, at the same time, the most difficult stage of pedagogical design. It should be noted that the subsequent difficulties in the ranking (motivation, assessment, problem-based learning) are closely related to the quality of lesson goal setting. A vague and unclear goal makes it difficult to create a motivating learning situation and develop assessment criteria, which confirms the systemic nature of the identified problem.

To solve the identified problem, the potential of the large language model Google Gemini was investigated. This model is trained on huge arrays of multimodal data (text, image, audio) and has a wide range of functional capabilities suitable for instructional design tasks. Table 2 systematizes Gemini's capabilities and provides examples of their application in lesson planning.

Table 2.
Functional capabilities of the Gemini model in lesson planning

Capabilities	Description	Example of pedagogical application
Text generation	Creation of coherent, logical, and contextual text based on a given prompt	Formulation of lesson objectives according to Bloom's taxonomy, creation of learning task descriptions, writing case studies for analysis.
Summarization	Extracting key ideas and condensing large amounts of text information	Creating brief annotations to scientific articles for teachers, preparing notes for students with different levels of perception
Content adaptation	Rewriting text for different target audiences, changing the level of complexity and style.	Differentiation of learning tasks
Answering questions	Providing direct answers to factual or conceptual questions based on one's knowledge	Quick clarification of subject-specific questions by the teacher during the planning process, searching for examples
Logical reasoning	Ability to construct logical chains, analyze relationships, and draw conclusions	Assistance in designing stages of problem-based learning, building a logical sequence of tasks
Creative generation	Creation of original content, such as scripts, dialogues, metaphors	Development of creative tasks, role-playing games, «hooks» to motivate students at the beginning of the lesson

Based on an analysis of the problem and the capabilities of the tool, a detailed algorithm for using Gemini to optimize the most complex stages of planning was developed. The algorithm consists of three consecutive steps.

1. Formulating lesson objectives based on the program's learning objectives (LO).

At this stage, the teacher's task is to transform the general learning objectives (LO) specified in the Standard Curriculum (SC) into specific, measurable, achievable, relevant, and time-bound (SMART) lesson objectives.

Teacher's action. The teacher enters the initial data into the Gemini dialog box: subject, grade, lesson topic, and an exact excerpt from the program's LO. Then they formulate a prompt indicating the use of a specific pedagogical taxonomy (e.g., Bloom's taxonomy) and assessment criteria.

Example prompt: «Act as a teacher. I am preparing a lesson on the subject of Russian language for 6th grade. Lesson topic: Global warming. Learning objectives from the curriculum 6.1.2.1 - identify the main idea based on keywords and phrases; 6.3.5.1 - write a narrative essay, argumentative essay, descriptive essay. Based on these learning objectives, formulate two lesson objectives.»

Analysis of the result. AI generates several options for objectives that correspond to the learning objectives, allowing the teacher and students to clearly understand the expected outcome.

2. Developing descriptors for criterion-based assessment

Once the objectives have been defined, clear criteria for achieving them must be developed – descriptors.

Teacher's action. The teacher copies one of the lesson objectives generated in the previous step and asks Gemini to develop descriptors for it.

Example prompt: «Formulate clear, understandable descriptors for the tasks related to the lesson objective «Master the skill of identifying the main idea of a text based on key words and phrases.»»

Result analysis. The AI generates specific descriptions of what the learner should demonstrate.

3. Selection and generation of learning tasks.

The final step is to develop tasks that will allow students to achieve the set goals and allow the teacher to assess the degree of their achievement based on the descriptors.

Teacher's action. The teacher provides the AI with the developed descriptors and asks it to generate multi-level tasks corresponding to each descriptor and aimed at developing higher-order thinking skills.

Example prompt: «Based on these descriptors, suggest three multi-level assignments for the consolidation stage of the lesson. The assignment for level C should be reproductive. The assignment for level A should require students to apply their analysis and evaluation skills and be creative.»

Analysis of results. AI offers various task options. For example, «Read the text about global warming. Underline 5 key words and phrases» (level C). «Using the keywords you found, summarize the main idea of the text in 1-2 sentences» (level B). «Imagine that you are writing a short article for the school newspaper «Us and Nature». Identify the main idea of the text about global warming. Evaluate its significance for the lives of students. Write a mini-essay (5-6 sentences) using the keywords and suggest one way in which a student can contribute to the protection of nature» (level A).

As shown earlier, the process of formulating goals is a task with a high internal cognitive load, especially for young teachers [5].

The proposed algorithm can be seen as a way to share some of this load, with artificial intelligence taking on routine but precise tasks like setting SMART goals, descriptors, and assignments that fit with the lesson objectives [11].

Thus, AI acts as a tool that helps teachers effectively apply their own professional knowledge.

The successful application of the proposed algorithm requires and simultaneously contributes to the development of a comprehensive system of knowledge in teachers, described by the TRASK model (Table 3).

Table 3.
Analysis of the TRACK model

Technological and content knowledge (TCK)	Technological and content knowledge (TCK) Teachers must have subject knowledge in order to critically evaluate the factual accuracy, completeness, and relevance of the materials proposed by AI. For example, when generating assignments in history or literature, teachers must check whether the AI response contains inaccuracies or «hallucinations».
Technological and pedagogical knowledge (TPK)	It is not enough to simply obtain lesson objectives and assignments from AI. Teachers must have pedagogical knowledge to understand how to integrate these components into the lesson structure, how to organize learning activities based on differentiated assignments, and how to use descriptors to organize formative assessment.
Synthesis of TRACK	The process of iterative «dialogue», constant refinement, and correction of requests can be characterized as «pedagogical prompting» — a new and important competence for teachers in the digital age. Developing this competency means that teachers learn not only to use technology, but also to think alongside technology in order to achieve pedagogical goals.

Working with the proposed algorithm helps teachers develop key competencies, which are also defined by UNESCO in the field of AI (Table 4) [17, 21, 22].

Table 4.
Compliance with the UNESCO Competence Framework

Pedagogy using AI	Teachers learn in practice how to use AI to design individualized and differentiated learning by creating learning materials for different groups of learners.

Fundamentals of AI application	By interacting with AI, educators gain practical experience in understanding the capabilities and limitations of modern LLMs.
AI ethics	The process of working with AI puts educators in the position of critical experts. They need to constantly evaluate content for accuracy, bias, and compliance with ethical and cultural norms.

The process of interacting with AI can develop professional metacognitive reflection in educators. In order to write a good prompt, educators must clearly articulate their goals, their understanding of learners' needs, and their pedagogical rationale. In order to evaluate the AI's response, they must carefully apply professional judgment, which forces educators to reflect on the foundations of their own practice. Thus, the critical use of AI can expand professional self-awareness [15].

However, it is important to note a number of risks associated with the use of artificial intelligence. Large language models tend to generate inaccurate and unreliable information, which is unacceptable in an educational context [18].

Content generated by AI must undergo mandatory and thorough verification and review by a teacher who is an expert in the subject area. Privacy and data protection policies must be strictly adhered to. Teachers must filter the content generated, ensuring fairness and well-being in their classrooms [22].

Conclusion

This study focused on exploring the potential of generative artificial intelligence to address the difficulties experienced by teachers in formulating lesson objectives. Analysis of data from the I. Altynsarin NAE survey and international scientific sources confirmed that goal setting is a systemic and widespread problem in the lesson planning process. As a solution, a model was proposed and described for using Google Gemini's large language model to sequentially generate lesson objectives, assessment descriptors, and differentiated tasks in line with lesson objectives. Theoretical analysis of this model through the lens of the TRACK concept and the UNESCO Competency Framework led to the following conclusions:

1. Generative AI can be used to perform routine tasks in the lesson planning process.

2. The application of AI requires teachers to have technological skills, as well as to synthesize them with pedagogical and subject knowledge (TRASK), forming a new competence – «pedagogical prompting».

3. Critical use of AI contributes to the development of competencies in teachers that meet international standards and can enhance professional metacognitive reflection.

The central thesis of the study is that artificial intelligence in education should be viewed only as a tool that enhances the intellectual and creative

capabilities of teachers, provided that the decisive role in all pedagogical decisions remains with the teacher.

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