

Three-Subject Didactics 2.0 – The Role of Artificial Intelligence in the Modern Concept of Education

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Abstract. The article explores the role of artificial intelligence in the context of three-subject didactics 2.0 – a modern pedagogical concept that redefines the interaction between the learner, the teacher, and the digital educational environment. Based on the three-subject didactics model, the authors analyze the stages of didactics transformation: from a teacher-centered model to an interactive one, and ultimately to the updated three-subject system in format 2.0, where AI becomes an equal participant in the educational process. The article emphasizes the ability of AI to detect logical inconsistencies and analyze dialogues between participants in the educational process to improve the effectiveness of interaction. The paper identifies the levels of interaction between AI and higher education students, analyzes the advantages and challenges of integrating AI into the educational process, and addresses ethical aspects, such as explainability, human involvement, and the risks of reduced social interaction. Special attention is given to the importance of regulatory frameworks and institutional policies, particularly with examples from Ukrainian higher education institutions, such as Kherson State University. In conclusion, it is argued that AI can significantly enhance the effectiveness of learning through adaptive trajectories, real-time feedback, dialogue analytics, and outcome prediction, provided that a human-centered approach is followed in its implementation.

Keywords: Artificial Intelligence, Higher Education, Three-Subject Didactics, Digital Pedagogy, Adaptive Learning, Digital Educational Environment, Information and Communication Technologies, Personalized Education.

1 Introduction

The integration of artificial intelligence into the educational environment is fundamentally transforming the role of technology in learning – from a supportive tool to an active partner. The use of adaptive learning systems, personalization algorithms, automated assessment, and intelligent student support demonstrates significant potential for enhancing the quality of education. At the same time, the intersection of technological

progress and the humanistic dimension of education gives rise to new challenges – preserving ethical principles, interpersonal interaction, and pedagogical autonomy.

Existing models of digital education often consider AI solely as a tool for supporting teaching or monitoring academic performance. However, recent studies [2; 15; 23] emphasize the potential of AI as an agent of interaction – an intellectual interlocutor, tutor, and facilitator of knowledge. Based on this, a rethinking of traditional educational interaction becomes increasingly relevant.

Building on the concept of three-subject didactics developed by Ukrainian researchers [19], we propose its modernized version – three-subject didactics 2.0, in which artificial intelligence acts as a full-fledged subject of the educational process alongside the teacher and the learner. This approach allows for the realization of a new format of interaction – dialogical, flexible, personalized, and based on partnership.

2 The Concept of Three-Subject Didactics 2.0

Given the rapid development of digital technologies and artificial intelligence (AI), the logical next step in the evolution of educational theory is the introduction of three-subject didactics 2.0, where AI plays a key role in the personalization of learning, automation of learning analytics, and expansion of the functions of the information and communication pedagogical environment (ICPE).

In the updated model, AI becomes a kind of «bridge» between the student and the ICPE, providing personalized recommendations, adaptive content, and monitoring learning progress.

Research indicates that ICPE is gradually transforming the classical didactic model. According to the conducted analysis, the role of the teacher is increasingly shifting toward that of a learning coordinator, the student becomes an active participant in the learning process, and ICPE emerges as an equal participant in the educational environment: «ICPE is systematically integrated into the educational process, gradually increasing its role as a new subject, thanks to improved learning outcomes» [19]. The use of ICT is a universal approach to solving educational tasks, as it improves the educational process, provides access to a larger volume of information, and fosters learners' independence and logical thinking [18].

Moreover, ICT stimulates learner engagement, supports individualized and differentiated instruction, diversifies forms of collaboration, and enhances motivation for ongoing professional development.

A team of researchers led by O. Spivakovskiy and L. Petukhova has identified that the development of education is inextricably linked to societal transformation and its needs, and the interaction among all three subjects of the educational process is guided by a common goal – the formation of a competitive professional – and is characterized by a three-dimensional non-linear model [19].

Table 1 reflects the stages of the evolution of didactics that gradually led to the formation of the concept of three-subject didactics 2.0.

Table 1. «Stages of the Development of Didactics»

Stage	Characteristics	Main Learning Subjects	Role of AI / Digital Technologies
Subject-Object Didactics	The teacher is the sole source of knowledge; the student is a passive recipient of instruction	Teacher → Student (one-way transmission of knowledge)	None
Subject-Subject Didactics	Teacher and student interact as equal partners in the learning process	Teacher ↔ Student (two-way interaction, dialogue)	Minimal (multimedia tools)
Three-Subject Didactics	The learning process includes the information and communication pedagogical environment (ICPE)	Teacher ↔ Student ↔ ICPE	Technologies as means of integrating content and resources (e-libraries, encyclopedias, learning platforms, etc.)
Three-Subject Didactics 2.0	AI acts as an «observer» in the learning process as part of the ICPE, and as a teacher's partner	Teacher ↔ Student ↔ AI (ICPE 2.0)	AI as an active partner of the teacher in the learning process

Within the framework of three-subject didactics, which considers the interaction of the learner, teacher, and educational content, AI can play the role of mediator and innovator in content creation. Modern approaches emphasize the importance of such interaction, as AI's adaptive capabilities allow for flexible customization of learning materials according to learners' levels and interests [22].

The further development of general and subject-specific didactics in light of innovative technologies opens new horizons for interdisciplinary collaboration, forming a foundation for the effective implementation of European educational standards [24].

An important aspect is the impact of AI on learners' motivation. Taking into account that «the use of artificial intelligence for the development of sustainable motivation is appropriate in such aspects as: personalization of learning, gamification of the educational process, providing feedback, data analytics, creation of communities/platforms/forums, portfolios, learning plans, etc.» [25], it can be stated that AI promotes increased learning motivation and student engagement.

At the same time, these processes inevitably lead to a metamorphosis of the teacher's role and functions. The teacher – as an educational coach, tutor, or mentor – ceases to be the sole source of knowledge and takes on a new role: coordinator of the learning process. It is the teacher who determines which AI implementation methods will be

most effective in a specific educational situation, how to combine various digital tools, and how to maintain a balance between automated and live instruction.

Thus, the integration of AI into the educational process not only promotes the personalization and effectiveness of learning but also transforms the traditional didactic model.

Considering the above-mentioned possible applications of AI, we conclude that artificial intelligence (AI) falls under the category of an information and communication pedagogical environment (ICPE) for several key reasons:

1. ICPE involves the use of various technologies to optimize the learning process, and AI is one of the most advanced tools within this system. It performs functions such as analyzing learning data, personalizing educational content, and automating knowledge assessment. Thanks to machine learning algorithms, AI can identify knowledge gaps in students, propose adaptive learning pathways, and provide instant feedback, which significantly enhances the effectiveness of learning.
2. One of the key functions of the information and communication pedagogical environment (ICPE) is the processing and exchange of educational information. Artificial intelligence (AI) performs this role effectively, as it is capable of working with large volumes of educational data, analyzing student performance, and predicting potential learning difficulties. Based on the data obtained, the system can automatically adjust learning trajectories, thus ensuring a personalized approach for each student. Moreover, AI can be integrated with knowledge bases and educational platforms, providing access to up-to-date learning resources.
3. The ICPE ensures interaction between students, educators, and learning content, with artificial intelligence acting as an intermediary in this process. Chatbots, virtual tutors, and voice assistants facilitate more efficient communication by providing students with prompt answers to questions, explaining learning materials, and assisting with complex tasks. This approach not only enhances access to knowledge but also promotes student autonomy in learning.
4. Traditionally, the ICPE includes distance learning, digital platforms, and multimedia resources. Artificial intelligence significantly expands the capabilities of this environment, making it more flexible, adaptive, and intelligent. For example, AI can automatically generate educational materials, personalize tasks according to the student's level of preparedness, and create individual recommendations for improving learning outcomes. Additionally, the development of AI contributes to the implementation of new learning formats, such as interactive virtual laboratories and simulations.

Thus, in modern education, the concept of three-subject didactics is gaining prominence. It involves the interaction of three equally important subjects of the educational process: the student, the educator, and the information and communication pedagogical environment (ICPE). In this context, artificial intelligence (AI) serves as the intellectual core of the ICPE, performing functions of observation and optimization of the learning process in cooperation with the other subjects. AI not only analyzes students' knowledge levels, but also independently adapts curricula, generates new educational

materials, and conducts assessments. In this way, AI acts as an active and fully-fledged subject of learning, fundamentally transforming traditional approaches to education.

3 Functions of Artificial Intelligence in the Educational Process

Contemporary trends in educational development are heavily influenced by digital technologies, particularly artificial intelligence (AI), which is evolving from a tool to a partner in enhancing the effectiveness of the learning process. The integration of AI into pedagogy is transforming traditional models of interaction between educators and learners, creating new opportunities for personalized education. In this context, it is relevant to explore the role of AI within the framework of three-subject didactics, which implies the interaction between the learner, the educator, and the educational environment.

In the concept of Three-Subject Didactics 2.0, artificial intelligence becomes a partner to the teacher, impacting various aspects of teaching and learning. Its application ranges from automated assessment to personalized learning pathways, contributing to improved educational quality and increased learner motivation.

Current research demonstrates a shift in the role of AI as it increasingly penetrates different facets of educational activity, changing approaches to teaching, knowledge assessment, and the creation of didactic materials. Specifically, certain studies highlight AI's potential in the development of personalized learning, the automation of administrative functions, and the design of adaptive learning products [2]. AI is actively used for student assessment, particularly in automated and formative evaluation [10], confirming its effectiveness in analytical systems.

Thanks to AI capabilities, educators receive effective tools for automating the assessment of learning outcomes, allowing them to promptly analyze large volumes of data and focus on individual student needs. Educational management also greatly benefits from AI implementation, as modern technologies optimize the administration of student cohorts and enhance communication among participants in the educational process.

In addition to automation, AI supports the creation and adaptation of didactic materials. The generation of texts and educational content helps reduce the workload on educators while ensuring better individualization of the learning process [15]. In the field of didactic games and training, AI algorithms enhance the flexibility of the educational process, increase student engagement, and foster skill development through game-based methods [8].

AI promotes the development of personalized learning paths, enabling the adaptation of educational content to the individual needs of students [23]. This is especially important in large learning groups, where instructors cannot always provide individual attention to each student. Such approaches improve the effectiveness of learning and stimulate creativity [11]. AI also positively influences academic success, particularly in STEM disciplines [9].

AI significantly enhances personalization in education by providing adaptive real-time feedback and adjusting content to individual student needs [14]. Intelligent learning

systems and analytics help identify student behavior patterns and predict academic challenges, allowing for timely interventions to improve outcomes [6].

However, along with the numerous advantages of integrating AI into education, certain challenges arise. Personalized learning, assessment automation, and time savings for teachers are clear benefits [2; 8; 15], but the effective use of AI requires teachers to be specially trained, possessing both theoretical knowledge and practical skills.

Among the most significant challenges are ethical issues related to the use of students' personal data, the risks of excessive automation, and the value-based ambivalence of AI's impact on the educational environment [5; 7]. In this context, it is important to ensure dialogue among all participants in the educational process to harmonize innovation with traditional values.

Despite its many benefits, the implementation of AI in education faces the challenge of adapting educational institutions to new technologies and strategies [17]. One example of regulation is the Concept for the Development of Artificial Intelligence in Ukraine, as well as the policies of individual educational institutions. For instance, Kherson State University has adopted the «General Policies on the Use of Artificial Intelligence in Teaching, Learning, and Research at KSU» [12], which regulate the initiatives of all participants in the educational process. In a paper by KSU authors under the supervision of O. Spivakovskiy, an «institutional policy was developed for students, teachers, and researchers with recommended and non-recommended initiatives for the use of AI in the learning process and research at Kherson State University» [20]. The goal of these institutional policies is to define the framework for the use of AI in education, teaching, and research by all educational stakeholders.

The prospects for the development of educational practice in the AI era are closely linked to the training of a new generation of teachers. Educators need to acquire not only basic knowledge about the capabilities and limitations of AI but also skills in planning and implementing innovative didactic activities [1]. It is also important to adapt curricula with a focus on flexible formats – online, offline, and hybrid models of education.

It should be noted that in the studies, AI is viewed as a tool or a set of tools that support personalization, automation, and innovation. At the same time, we propose the need to transition AI from the role of a tool to that of a full-fledged subject, a partner to the teacher – made possible by expanding the model of three-subject didactics.

Artificial intelligence holds significant potential for transforming education by improving assessment, personalizing learning, and enhancing student success. However, to fully harness its potential, it is necessary to overcome educational and ethical challenges and ensure proper teacher training.

An analysis of AI's functional capabilities suggests that it constitutes a key component of the information and communication pedagogical environment. Its integration into the educational process enhances educational quality, provides a personalized approach to learning, improves communication between students and teachers, and optimizes knowledge assessment.

For example, article [4] explores the creation of a personalized learning assistant using the CrewAI framework, OpenAI's GPT models, and the Serper API. The author demonstrates how to organize the operation of a multi-agent system in which agents

perform various roles: retrieving relevant information, generating educational materials, creating test tasks, and supporting self-assessment. Particular emphasis is placed on the modularity of the system, which allows the solution to be easily scaled and adapted to individual users' needs in education.

Thus, in our view, AI becomes an important subject of three-subject didactics, implying a transformation of traditional educational models. Given these opportunities, we can speak of the emergence of an updated educational model – Three-Subject Didactics 2.0 – where artificial intelligence acts as a full participant in the educational process. In line with this objective, the task is to provide AI tools with autonomy in carrying out their functions as a partner to the educator.

4 ICPE in the Context of the Pedagogical Framework «Three-Subject Didactics 2.0»

Further, the information and communication pedagogical environment (ICPE) will be considered as a multi-agent educational environment that must meet the following key requirements in accordance with the educational framework «Three-Subject Didactics 2.0»:

1. Personalized access to learning content.
2. Adaptive testing and self-assessment of knowledge.
3. The ability to receive individual recommendations for revision or deeper study of the material.
4. Ensuring inclusiveness: support for special educational needs, cognitive, motor, and sensory limitations, as well as personalized modes of interaction with the environment for both students and teachers.
5. The ability to perform emotional analysis of student engagement.
6. A feedback mechanism: evaluation of satisfaction with the content and learning process.
7. Support for various learning formats (text, audio, video, interactive simulations).
8. Tools for creating and updating educational programs.
9. Support for designing tasks and materials with varying levels of difficulty.
10. Student performance analytics based on tests, assignments, and activity.
11. Automatic generation of reports on lesson outcomes and general group trends.
12. Receiving recommendations for adapting instruction to meet students' needs.

We acknowledge that this list can be expanded, but we have highlighted what we consider the key requirements – those that will be implemented in the ICPE through AI agents. The ICPE will be enhanced using the CrewAI framework [3].

CrewAI is an innovative framework for building multi-agent artificial intelligence systems that enables collaboration, planning, and execution of complex tasks by multiple AI agents. In CrewAI, each agent has its own role, objective, background, and the ability to function both independently and as part of a team, combining individual competencies to achieve a common goal.

Figure 1 below illustrates the model of AI agent interaction according to the above-mentioned requirements, including interactions between agents themselves, as well as between the student, teacher, and the ICPE.

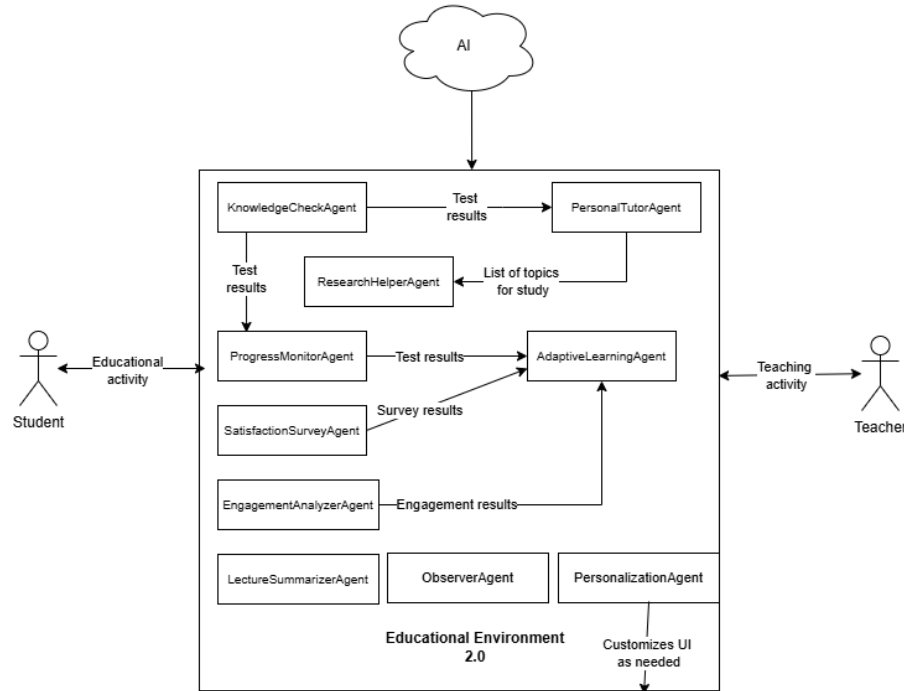


Figure 1. Model of AI Agent Interaction within the ICPE

Let's consider each of these agents and their main functionality. List of AI agents available to the student:

1. KnowledgeCheckAgent – generates mini-tests after each lesson for self-testing.
2. PersonalTutorAgent – suggests which topics need to be repeated based on the student's mistakes.

These two agents work together, since the test results collected by KnowledgeCheckAgent are transmitted to PersonalTutorAgent for analysis, which allows the personal tutor to identify weaknesses in the student's knowledge and form recommendations for re-studying topics.

3. ResearchHelperAgent – selects scientific articles, open courses and materials on a given topic.

This agent works as an optional module for collecting additional educational materials and focusing on the results of the PersonalTutorAgent agent and offers relevant information according to the identified needs of the student.

Let's consider AI agents available to the teacher:

1. SatisfactionSurveyAgent – an agent that analyzes the results of surveys of students' satisfaction with the educational process.

At Kherson State University, this functionality is implemented through a mandatory survey after each pair. The survey is integrated into the corporate educational platform LMS KSU24 [13]. The survey consists of the following questions:

- How clear was the educational material for you?
- How interested were you in the topic and content of the lesson?
- How satisfied are you with the atmosphere in the lesson?
- How effective are the approaches to activating cognitive interest and thinking activity for you?
- How convenient is feedback and communication with the teacher for you?

2. ProgressMonitorAgent – analyzes the results of students and signals the need for additional attention.

This agent cooperates with KnowledgeCheckAgent and SatisfactionSurveyAgent, which, based on the results of tests, surveys and engagement.. The results obtained by KnowledgeCheckAgent serve as a data source for ProgressMonitorAgent.

3. EngagementAnalyzerAgent is an agent that determines the level of student engagement based on their activity during classes, with the possibility of integrating systems such as MorphCast [16] and Zoom.

Kherson State University plans to use the MorphCast application [16]., which integrates with the Zoom platform [27] to analyze students' emotions in real time via a camera during classes. MorphCast uses deep learning technologies to analyze facial expressions, determine the emotional state of participants (such as joy, surprise, sadness, interest, etc.) and build an emotional profile of student engagement during lectures or seminars.

4. AdaptiveLearningAgent – provides recommendations for changing teaching methods depending on student engagement and learning outcomes.

AdaptiveLearningAgent forms its recommendations based on a comprehensive analysis of data received from ProgressMonitorAgent, SatisfactionSurveyAgent, and EngagementAnalyzerAgent. In particular, it takes into account the level of academic success of students, identified difficulties in mastering the material, their level of satisfaction with the educational process, as well as the degree of engagement and activity during training sessions. Combining this data, AdaptiveLearningAgent identifies potential problem areas in learning, detects changes in student motivation and engagement, and also assesses the general emotional background of the group.

Agents available to both sides of the educational process:

1. LectureSummarizerAgent – generates a short summary of the lecture.

At Kherson State University, a similar functionality has already been implemented on the basis of the Zoom platform through the AI Companion module [26], which automatically creates text summaries of lectures, highlighting key points and main ideas.

2. ObserverAgent – an agent that analyzes dialogues, correspondence and other text communications in order to identify structural and logical errors.

It detects violations of logical connections, incorrect arguments, contradictions in statements, as well as inaccuracies in the formulations of the teacher or student.

3. PersonalizationAgent – personalizes the system settings according to the needs of inclusive education of age restrictions. This module is available for both the student and the teacher

An agent that adapts the settings of the educational system according to the individual needs of the teacher or student, taking into account age, level of digital literacy, need for voice control, cognitive features, inclusive requirements. The main tasks of such an agent are as follows:

- Visual accessibility, for example, increasing contrast, increasing text

- Voice accessibility, support for screen readers and voice commands
- Cognitive accessibility
- Support for keyboard navigation without a mouse
- Alternative options for content delivery (text instead of audio, etc.)

Below is a code fragment using the CrewAI framework to implement part of the model in accordance with the 3-subject didactics 2.0 framework.

As part of this experiment, an automated multi-agent system based on the CrewAI framework was implemented to analyze student knowledge. The goal is to demonstrate the capabilities of AI agents in detecting learning errors and forming personalized recommendations for the student's further educational path.

The system works with the student's predefined answers. Among them are both correct and incorrect ones. Based on this data, two AI agents are launched – Analyst and Methodist, each of which performs its own role.

The first agent, Analyst, receives the student's answers. Its task is to analyze each answer, identify incorrect ones and form a structured list of errors. The corresponding agent and its task are presented below:

```
analyst = Agent(
    role=«Analyst»,
    goal=«Analyze the student's answers and identify mistakes»,
    backstory=«An expert in educational testing and concept diagnostics»,
    verbose=True,
    allow_delegation=False,
    llm=llm
)
```

Below is a snippet of code that creates a task for an AI agent (analyst) that acts as an automated student knowledge checker:

```
analysis_task = Task(
    description=(
        «Analyze the list of student answers below. « «Identify which answers are incorrect based on mathematical correctness. « «Return only the incorrect answers as a JSON array in the format:\n» «[{\"question\": \"...\", \"answer\": \"...\"}]\" f»Answers:\n{answer}» ), expected_output=«JSON array of incorrect answers only»,
    agent=analyst
)
```

The second agent, the Methodist, receives the analysis results from the Analyst. Based on them, it forms a list of topics that the student should repeat. For example, if a student made a mistake in the question about the area of a circle, the Methodist will recommend the topic «Geometry: Area of a Circle». Below is the implementation, the corresponding agent and its tasks:

```
methodologist = Agent(
    role=«Methodologist»,
    goal=«Suggest learning topics based on mistakes»,
    backstory=«A teaching methodology specialist focused on curriculum guidance»,
    verbose=True,
```

```
allow_delegation=False,
llm=llm
)
```

```
crew = Crew(
    agents=[analyst, methodologist],
    tasks=[analysis_task, recommendation_task],
    verbose=True
)
```

```
Crew: crew
├── Task: 91d35e47-06a9-4f4c-a467-ddf926859d99
│   ├── Assigned to: Analyst
│   ├── Status: ✓ Completed
│   └── Agent: Analyst
│       ├── Status: ✓ Completed
│       └── Agent: Analyst
├── Task: 2da2a79b-aab6-46e3-8ecf-29d91b0ce09e
│   ├── Assigned to: Methodologist
│   ├── Status: ✓ Completed
│   └── Agent: Methodologist
│       ├── Status: ✓ Completed
│       └── Agent: Methodologist
```

Fig. 3 presents the result of this two-stage system of AI agents within the framework of an educational experiment. The generated topics directly respond to those questions to

which the student gave incorrect answers, and, thus, form the basis for building a personalized route for repetition and assimilation of the material.

```
Final recommendations:
[
  "Geometry: Perimeter of a Triangle",
  "Algebra: Linear Equations",
  "Geometry: Volume of a Rectangular Prism",
  "Math Fundamentals: Fractions",
  "Algebra: Solving Quadratic Equations",
  "Geometry: Circumference of a Circle",
  "Algebra: Graphing Lines",
  "Geometry: Surface Area of a Cube",
  "Algebra: Inequalities",
  "Geometry: Finding the Midpoint of a Line Segment"
]
```

Fig. 3. Result of AI agent topic recommendation

As the experiment showed, CrewAI is a flexible tool that allows integrating AI agents with various artificial intelligence models. This has a positive effect on the accuracy of the results of response analysis, and also opens up the possibility of connecting specialized agents to more specific models.

The application of CrewAI in the field of education demonstrates high potential for creating adaptive, intelligently managed solutions that can improve the quality of learning and provide a more personalized approach to building personalized learning environments.

Conclusions

In modern conditions of deep digital transformation of education, the updated model of three-subject didactics 2.0 appears as a timely and scientifically sound response to the challenges and opportunities generated by the rapid development of artificial intelligence. Rethinking traditional didactic approaches in the direction of three-component interaction, where AI acts not only as a tool, but also as a full-fledged subject of the educational process, means a cardinal change of paradigm in educational science. It is not only about structural changes, but also about a deep rethinking of the roles of all participants in the educational process.

Within the framework of three-subject didactics 2.0, the role of the teacher is also transformed, who from a carrier of knowledge gradually turns into a facilitator and coordinator of interaction between AI and the student. The teacher remains responsible for ethical and methodological leadership, while AI takes on some of the analytical, organizational and diagnostic work. This distribution of functions allows teachers to pay more attention to the development of critical thinking, reflection and value-oriented learning – aspects that remain exclusively human and cannot be algorithmized.

Currently, work is underway to implement the model shown in Fig. 1 for monitoring and personalizing the educational process at the university. Using the CrewAI framework allows you to easily add new agents as needed, which contributes to the scalability of the system and ensures its flexible adaptation to the needs of each specific educational institution.

In our opinion, three-subject didactics 2.0 in combination with the capabilities of a multi-agent educational environment based on CrewAI opens up new horizons for personalized learning. Such a model integrates artificial intelligence into the interaction between a student, a teacher, and digital agents, creating a dynamic, adaptive educational space.

For Ukrainian higher education, the concept of three-subject didactics 2.0 is particularly relevant, as it not only corresponds to global trends, but also contributes to the processes of European integration and modernization of the educational system. The practices implemented at Kherson State University demonstrate the possibility of ethical and effective implementation of AI in the educational process, provided that institutional policies, staff training, and inter-university cooperation are in place. The effectiveness of implementing this paradigm depends not only on pedagogical and technological approaches, but also on management decisions that will ensure the implementation of a flexible individual trajectory for each student.

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