Using artificial intelligence technologies to predict and identify the educational process

Natalia Yevtushenko[1], Natalia Tverdokhliebova[1] and Olga Ponomarenko[1]

[1] National Technical University "Kharkiv Polytechnic Institute", 2 Kirpicheva St., 61002, Kharkiv, Ukraine

Abstract

The article is devoted to the use of simulation modeling technologies for predicting and identifying processes occurring in an educational institution during the transfer and accumulation of knowledge by active elements of the system. A description of the block diagram is introduced in the form of a decomposition of the system for further modeling. A mathematical description of the processes of accumulation of knowledge and assessment of the quality of education is made. A description is given of the use of tools for expanding multi-representative models by building an artificial neural network to improve the accuracy of calculations when conducting experiments with the model. The use of simulation modeling using a mathematical model and artificial intelligence tools makes it possible to reflect the state and dynamics of the process of transferring and accumulating knowledge with the analysis and prediction of the quality of education. The article describes the methods and software implementation of the oriented simulation of the interaction between the student and the teacher, taking into account the psycho-physiological, emotional and cognitive state of intellectual representatives. The simulation results are presented and their analysis is given.

Keywords

Simulation modeling, intellectual representative, multi-representative system, accumulation of knowledge, social modeling

1. Introduction

The professional growth of teachers in the field of new information technologies is considered today as an area requiring intensive rethinking. The teacher is a central actor in the organization of the educational process, therefore the context in which he is trained is crucial for his ability to carry out professional activities in modern technological environments. Today, insufficient attention is paid to the question of the role of the teacher in the use of effective educational technologies, in particular artificial intelligence.

One of the urgent problems of introducing artificial intelligence into the educational environment is that artificial intelligence can lead to a decrease in the importance of a teacher and a decrease in the value of his skills. It is important that the teacher is involved in every step of the process of designing, developing, testing, improving, implementing and managing educational technologies using artificial intelligence [1]. This includes engaging educators in analyzing existing systems, tools and data in universities, implementing proposed new learning tools, working with developers to improve the reliability of assessment tools, and examining the risks of implementing the system. Ukrainian educational policy should provide the necessary support teachers during the war, think over areward system to allow teachers to take an active part in the development of educational systems using artificial intelligence [2].

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natalya0899@ukr.net (N. Yevtushenko); natatv@ukr.net (N. Tverdokhliebova); 21ponomarenko@gmail.com (O. Ponomarenko)

0000-0003-0217-3450 (N. Yevtushenko); 0000-0003-3139-4308 (N. Tverdokhliebova); 0000-0002-3043-4497 (O. Ponomarenko)

Firstly, modern teachers tend to use artificial intelligence for the process of searching, selecting and adapting educational materials. Artificial intelligence can improve the adaptability of learning resources to the strengths and needs of students.

Secondly, there are potential risks of using artificial intelligence in the educational environment. For example, students may be subject to stricter supervision [3]. Some teachers fear that artificial intelligence could replace them. The public thinks of examples of discrimination due to algorithmic bias, such as a voice recognition system that does not work as well with regional dialects, or an exam monitoring system that may unfairly identify certain groups of students for disciplinary action. Artificial intelligence can provide information that appears to be reliable but is actually inaccurate or has no basis in fact [4, 5]. Crucially, AI brings new risks in addition to the well-known privacy and data security risks, such as the risk of scaling pattern detectors and automation that lead to "algorithmic discrimination" (for example, systematic inequities in learning opportunities or resources recommended by some groups of students).

Thirdly, there may be a problem due to the scale of possible unforeseen consequences. When artificial intelligence allows for large-scale automation of learning decisions, educators may discover undesirable consequences. For example, if AI adapts by speeding up the pace of learning for some students and slowing down the pace for other students (based on incomplete data), the achievement gap could widen [6].

Summing up, it can be said that now it is extremely important to address artificial intelligence in education in order to realize key opportunities, prevent and mitigate emerging risks, and eliminate unforeseen consequences.

Artificial intelligence is an umbrella term for a growing set of modeling capabilities (Fig.1)

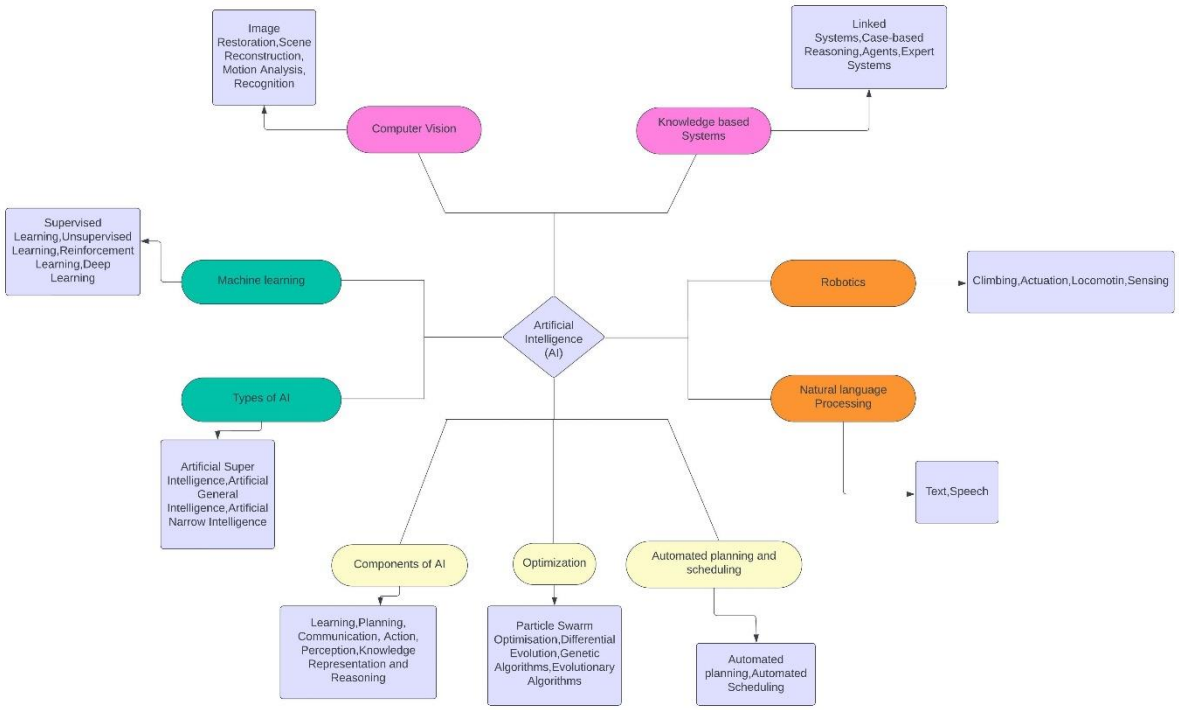


Figure 1. Components, types and subfields of artificial intelligence

At its core, artificial intelligence is a highly developed mathematical toolkit for building and using models. In well-known chat bots, complex essays are written one word at a time [7]. The underlying AI model predicts which next words are most likely to follow the already written

text; AI chatbots use a very large statistical model to add one likely word at a time, thus creating coherent essays.

Artificial intelligence systems and tools identify patterns and choose actions to achieve a given goal. These pattern recognition capabilities and automatic recommendations are used in ways that influence the educational process, including student learning and teacher decision making. For example, current personalized learning systems can recognize signs that a student is having difficulty and recommend an alternative learning sequence [8]. The scope of image recognition and automated recommendations will expand. However, artificial intelligence systems often lack the data and judgment to correctly consider context when they discover patterns and automate decisions. In addition, technology can quickly go from secure to insecure or efficient to inefficient when the context changes even slightly [9]. We want to bring to the fore the idea that every artificial intelligence model is incomplete and it is important to know how the artificial intelligence model corresponds to the reality we are interested in, where the model will break and how.

For this and other reasons, all participants in the learning process should be involved in setting goals, analyzing patterns, and making decisions [10]. Today, artificial intelligence systems and tools already make it possible to adapt the learning sequence to the needs of students, providing them with feedback and tips, for example, while solving mathematical problems or learning a foreign language.

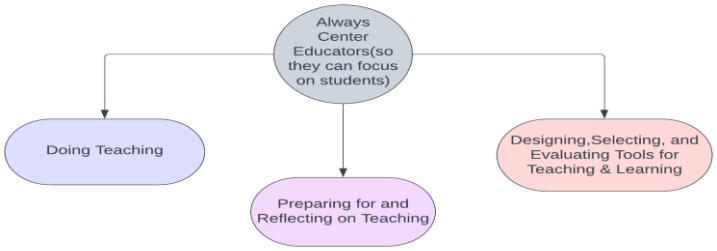


Figure 2. Three cycles of introducing artificial intelligence into the educational process.

On fig. 2 shows examples of three cycles of introducing artificial intelligence into the educational process with the obligatory central role of the teacher.

1. A cycle in which teachers make decisions every second, doing the direct work of teaching.
2. A cycle in which teachers prepare, plan and reflect on teaching, including professional development.
3. A cycle in which educators participate in AI-enabled technology development decisions, participate in technology selection, and shape technology assessment, thereby creating context not only for their audience of students, but also for peers.

Let's give an example of using a chatbot with artificial intelligence in the educational process. First, as students engage in enhanced interactions with AI chatbots, educators need to educate them on the safe use of AI, monitor their use, and provide human assistance when something goes wrong [11].

Secondly, teachers are starting to use chatbots to plan individual student learning; they need to interact with colleagues in order to understand effective cross-disciplinary connections. Third, educators should be involved in the development and evaluation of artificial intelligence systems before they are used in the teaching process and when improvement needs arise [12]. In one example, in order to develop artificial intelligence-generated homework support for students, a teacher needs a deep understanding of the cognitive, motivational, and social support students need.

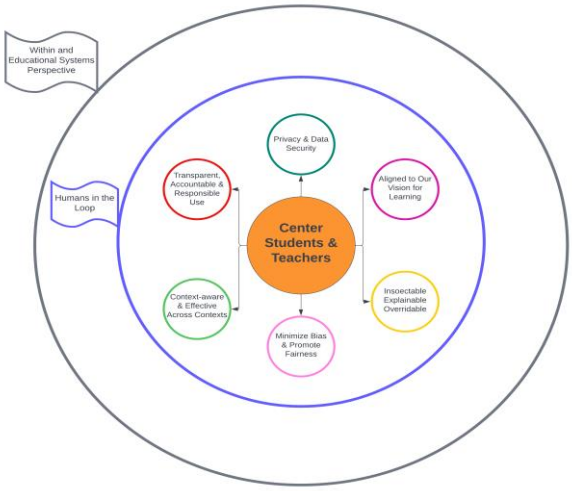


Figure 3. Recommendations on the desired qualities of artificial intelligence tools and systems in education

In Figure 3, we focus on artificial intelligence models for educational use.
Modern personalization tools can automatically adjust the sequence, pace, prompts, or learning path. In addition, an AI-enabled assistant can act as an additional "partner" in a small group of students working together on a common task [13].
The AI-enabled tool can also help educators complete complex tasks in the classroom.
For example, the tool can help educators manage student transitions from general discussion to small groups and ensure that each group has the materials they need to get started [14].
We have identified six characteristics of artificial intelligence models for education, taking into account the specifics of educational systems:
1. Aligning the artificial intelligence model with the vision of teacher training.
2. Data privacy. Ensuring the security and confidentiality of all participants in the educational process in artificial intelligence systems.
3. Notice and explanation. Educators can test educational technologies to determine if artificial intelligence is included in educational technology systems and, if so, in what way. Educators' commitment to AI models can provide a basis for identifying patterns and/or making recommendations.
4. Algorithmic protection against discrimination. Developers and implementers of artificial intelligence in education are taking decisive steps to minimize bias and ensure fairness in artificial intelligence models.
5. Safe and efficient systems. The use of artificial intelligence models in education is based on evidence of effectiveness (using standards already established in education for this purpose) and works for different students and in different educational settings.
6. Human Choices, Consideration and Feedback: AI models that support the transparent, accountable and responsible use of AI in education by involving people in the process to ensure that educational values and principles take precedence.
We will give examples of the use of artificial intelligence in education:
1. Personalized training. Artificial intelligence can be used to adapt content and learning methods to the individual needs and potential of each student. Learning systems can analyze data about student performance, abilities and interests to provide personalized support and guidance. Artificially intelligent systems analyze data on student progress, their abilities and knowledge, and provide individual recommendations and materials that contribute to better learning of the material [15]. In artificially intelligent systems, adaptation algorithms can be used to personalize the learning experience of students.

2. Automatic evaluation of tasks. Artificial intelligence systems can automatically grade student assignments, such as test questions, programming code, or essay writing [16]. They can use machine learning algorithms to automatically grade and provide feedback using criteria set by the teacher.
3. Automatic assessment and feedback. The use of artificial intelligence in automatic grading systems can help teachers.
4. Virtual assistants. Universities are using artificial intelligence-based chatbot virtual assistants to help students and answer their questions about schedules, course registration, library resources and other aspects of university life.
5. Language recognition and automatic translation. AI applications can recognize the language of students during lectures or seminars, and have the ability to automatically translate terms or words that are not understood by the teacher into the language of the student, making learning easier for foreign students or students with limited language skills.
6. Research analyzes and forecasting. Universities can use artificial intelligence to analyze large volumes of data to find statistical relationships, trends and patterns in educational processes or scientific research [17]. This helps university administrators confidently make decisions about improving the educational experience of students.

2. Materials And Research Methodology

Simulation modeling of the process of knowledge accumulation based on initial data and parametric descriptions is a modern approach that provides novelty in the development and analysis of systems for collecting and using knowledge. This approach allows you to create models that take into account various factors and characteristics that influence the accumulation of knowledge.

Simulation models of the knowledge process based on data and parametric descriptions use real or synthetic data to create initial conditions and general context. This makes it possible to realistically reproduce the conditions and factors influencing the accumulation of knowledge.

Simulation modeling uses parametric description to determine the main characteristics and relationships in the process of knowledge accumulation. These parameters take into account factors such as absorption speed, data volume, available resources and other influencing factors.

Based on source data and parametric descriptions, scenarios are created that allow one to reproduce the process of knowledge accumulation in a virtual environment. This allows you to take into account different possible development options and influential factors.

Simulation models allow you to analyze and evaluate the results of the knowledge accumulation process in different conditions and scenarios. This helps identify patterns, evaluate effectiveness, and determine optimal knowledge acquisition strategies.

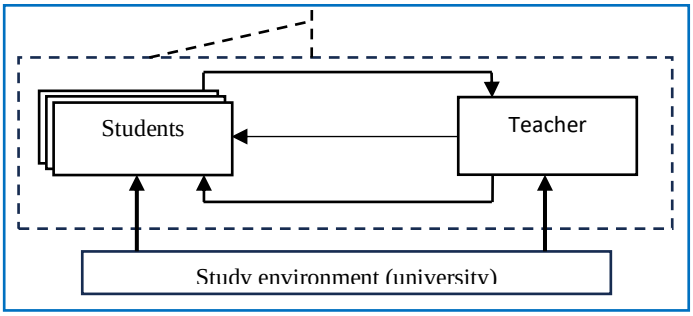
The use of simulation modeling in the process of accumulating knowledge allows for a deeper understanding, prediction and optimization of results.

While many products today are adaptive, some are adaptive in only one or a few dimensions of variability, such as student problem solving accuracy [18]. As teachers know, there are many more important ways to adapt to student strengths and needs. Students are neurodiverse and may have certain impairments. They bring different benefits from their experiences at home, in communities and in their culture. They have different interests and motivations. They learn in a variety of settings [19]. We recommend paying attention to "context" as a means of expressing the many dimensions that need to be taken into account when developing the phrase "for whom and under what conditions." We recognize the role of researchers in undertaking assessments that should consider not only effectiveness but also where harm may occur, as well as systemic issues that may arise from under-reliance or over-reliance on AI systems.

The educational process is an ordered set of situations, events and actions that ensure the transfer and as. The structural components of such a process are: the subject being trained (pupil, student, etc.); teacher (senior lecturer, associate professor, professor); goals and content of training; means of information and methodological interaction; effective level of professional training simulations of educational information with the accumulation of professional knowledge and skills.

The learning process at a university can be represented as a block diagram Fig. 4, which includes three main blocks: a trained intellectual representative RespStud, which simulates the process of knowledge accumulation; intellectual representative RespTeacher, transferring knowledge to the trained agent and evaluating the degree of their accumulation; the object block "Study environment", reflecting the conditions of the process (class schedule, teaching and methodological instructions, classroom equipment, etc.).

Figure 4. Structural diagram of the learning process



Mathematical description of the model. The RespStud representative can be described by the variables and parameters of the cognitive Co, personal Ps, emotional Em and social So state as a tuple of vectors.

$$\text{RespStud} = \{\text{Co}, \text{Ps}, \text{Em}, \text{So}\} \quad (1)$$

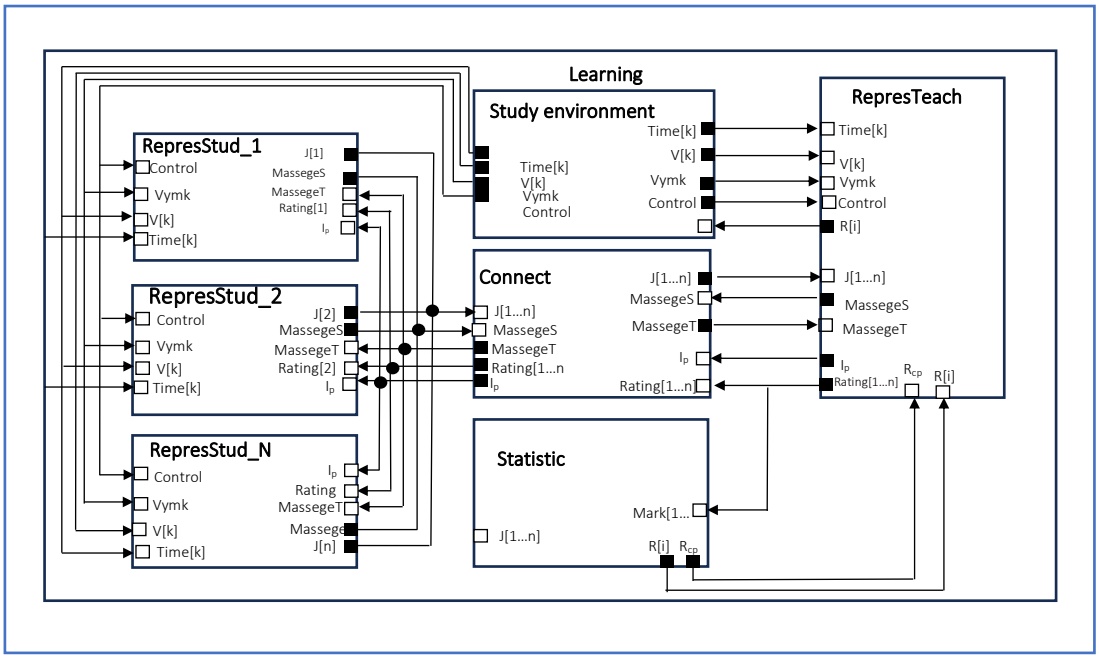


Figure 5. Multi-Representative Simulation Model Learning

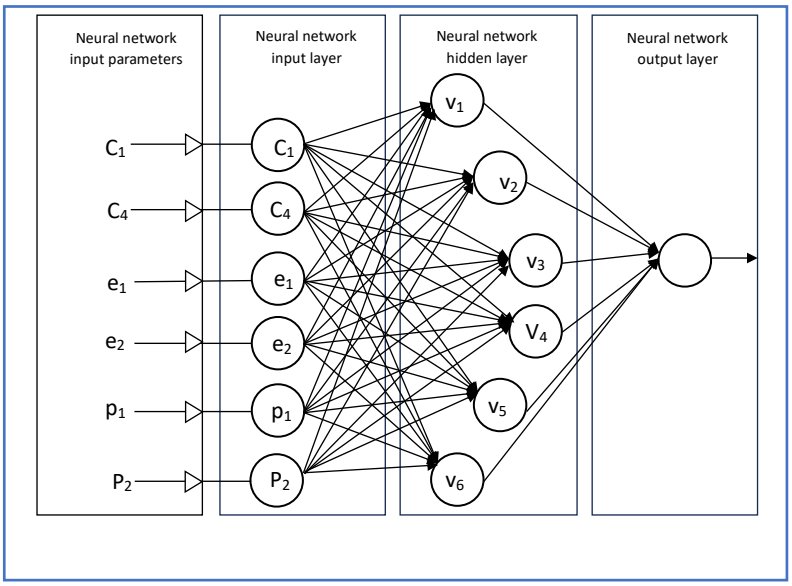


Figure 6. Structure of an artificial neural network to calculate λ

3. Results and discussion

Among the parameters of the state vectors as a result of experimental psychological tests in a group of students with subsequent normalization and reduction to the universal form of the conditional Stan scale [1], the most relevant were identified.

The volume of new accumulation values J (t) representative of RespStud, depending on the volume and redundancy of the information It presented, is determined by the equation

$$J(t) = R \cdot I_t \cdot \left(1 - \frac{J_0}{I_t}\right) + J_0 \qquad (2)$$

where $R = \frac{J}{I_t}$ is the average coefficient of training effectiveness, changing from 1 to 0; J0 - quantitative assessment of a priori knowledge. The process of knowledge accumulation [2] can be generally described by a first-order differential equation

$$T \cdot \frac{\mathrm{d}J(t)}{\mathrm{d}t} = R_t^0 \left(1 - \frac{J_0}{I_t}\right) \cdot I_t - \left(J_{(t)} - J_0\right) \qquad (3)$$

where Rt is the coefficient of information assimilation efficiency at the current time t; T is the time constant of assimilation of a unit of new information, s; the time constant T is inversely proportional to the representative capacity λ (unit of information / unit of time), which determines the time of the transition process and the rate of knowledge accumulation with a single jump of input information at the initial moment of time:

$$T = \frac{1}{\lambda_0} \qquad (4)$$

In accordance with equations (1) - (4) and experimental data, the normalized process of knowledge accumulation is approximated by a function of the form

$$J(t) = I_t \cdot \left(1 - \mathrm{e}^{-\lambda t}\right) \quad (5)$$

Where It is the amount of information presented by the teacher at the set training time t;λ - throughput of a representative (student), due to his psycho-physiological capabilities and states in given conditions A neural network (NN) was used to find λi0 (Fig. 5). For the implemented network, the output signal of the i-th neuron of the hidden layer is represented by the function

$$v_i = f\left(\sum_{j=1}^{4} \beta_{\mathrm{i},j}^{(1)} \cdot c_j + \sum_{k=1}^{2} \beta_{\mathrm{i},j}^{(1)} \cdot e_k + \sum_{I=1}^{2} \beta_{\mathrm{i},j}^{(1)} \cdot \rho_I\right) \mathrm{i} = 1{,}9 \quad (6)$$

where cj, ek, pI;βi,j, βi,k, βi,I, are the input parameters of the neural network and their weight coefficients. Then the output layer, where the value of the throughput of the trainee representatives λ is formed, will take the form

$$\lambda = f\left(\sum_{i=1}^{9} \beta_i^{(2)} \cdot v_i\right) \quad (7)$$

In the course of processing the experimental data, as well as conducting experiments with various types of neural networks, the best activation function of the neuron on both layers was chosen to be the sigmoid unipolar form, which gives the smallest deviation from the desired value λ in the process of network training. The teacher representative is characterized mainly by a state tuple:

RespTeach = {Co, Em}, where Co is the vector of the cognitive state, including Em is the vector of emotional state variables.

Mathematical models (1) - (7) and production rules make it possible to compose a description of the state and behavior of representatives depending on the situation in interaction with other representatives and the environment. Multi-subject model of the educational process. In accordance with the general scheme (Fig. 4), the multi-subject learning model [3, 4]. Study in the universal simulation system Simplex3 [5, 6] includes five basic components (Fig. 5), namely: representatives of the RespStud class, a representative of RespTeach, a component Study environment "learning environment"; the Statistic component "current progress and performance evaluation", the Connection component - for targeted messaging between representatives of RespStud and RespTeach.

Each representative is described in the object-oriented language for describing models Simplex-MDL (Model description Language) by a basic MDL component with the declaration of state variables, sensory connections and a description of dynamic behavior in the form of algebraic and differential equations or a sequence of events. Basic components are combined into a

common multi-representative model of the system with the help of sensor connections and mobile components - for targeted transmission of messages between representatives. From the Study block ("Study environment"), representatives of RespStud ("student") and RespTeach ("teacher") are transmitted through sensory channels organizational information about the start time of lectures, practical and laboratory classes, Time [k], k = 1…3 ; characteristics of the learning environment V[k] (equipment with computers, multimedia, Internet, etc.); plan of lectures, practical and laboratory classes for the Vymk semester; information about the timing and type of control Control accumulated knowledge - Ji. From the RespTeach representative to each RespStud representative through the Connect component, the flow of educational information I, the ActControl control program and the grade assigned by the teacher to the i-th student Rating are received. In turn, the RespTeach representative, through the Connect component, receives from the RespStudi representatives information about the accumulated knowledge Ji of the i-th representative, his social need to work with the teacher, learning goals, and emotional reaction; questions and assessments of the quality of teaching, etc. The model forms a set of events that reflect the real learning process [3]. In the process of learning, in accordance with the mathematical description, the process of accumulation of knowledge takes in accordance with the mathematical description, the process of accumulation of knowledge takes place.

The assessment of the level of knowledge gained in most cases is associated with the negotiation process and the achievement of agreement through an interactive exchange of information in the form of questions and answers, on the basis of which the Ball rating is set. If the student has successfully answered the questions and agrees with the assessment, then the process ends. Otherwise, the dialogue continues with the presentation of additional questions until an agreement is reached or an unsatisfactory mark is given.

Simulation results. As a result of simulation modeling of the process of knowledge accumulation on the basis of initial data and parametric descriptions, curves of changes in the level of knowledge of students in the process of active and independent phases of learning were obtained (Fig. 7).

On the graph (Fig. 7), during the simulation from 0 to 4.5 hours, an increase in the knowledge of representatives in the active phase of learning is observed. On fig. Figure 7 shows how in the cycle of learning independent (4.5-7.5 hours) phases of work, the overall effectiveness of teaching representatives changes, taking into account changes in their cognitive Co, emotional Qi and social So state. Analyzing the data obtained, it can be seen that the method of multi-representative simulation of the interaction of active elements of the system in the conditions of a difficultly formalized task of transferring and accumulating knowledge makes it possible to

identify and predict the state of the system, which is the result of a multi-step interaction of many active elements of the system and among learning based on a functional model of intelligent representatives with a parametric description of the blocks of state and purpose, the dynamics of behavior and interaction with other representatives.

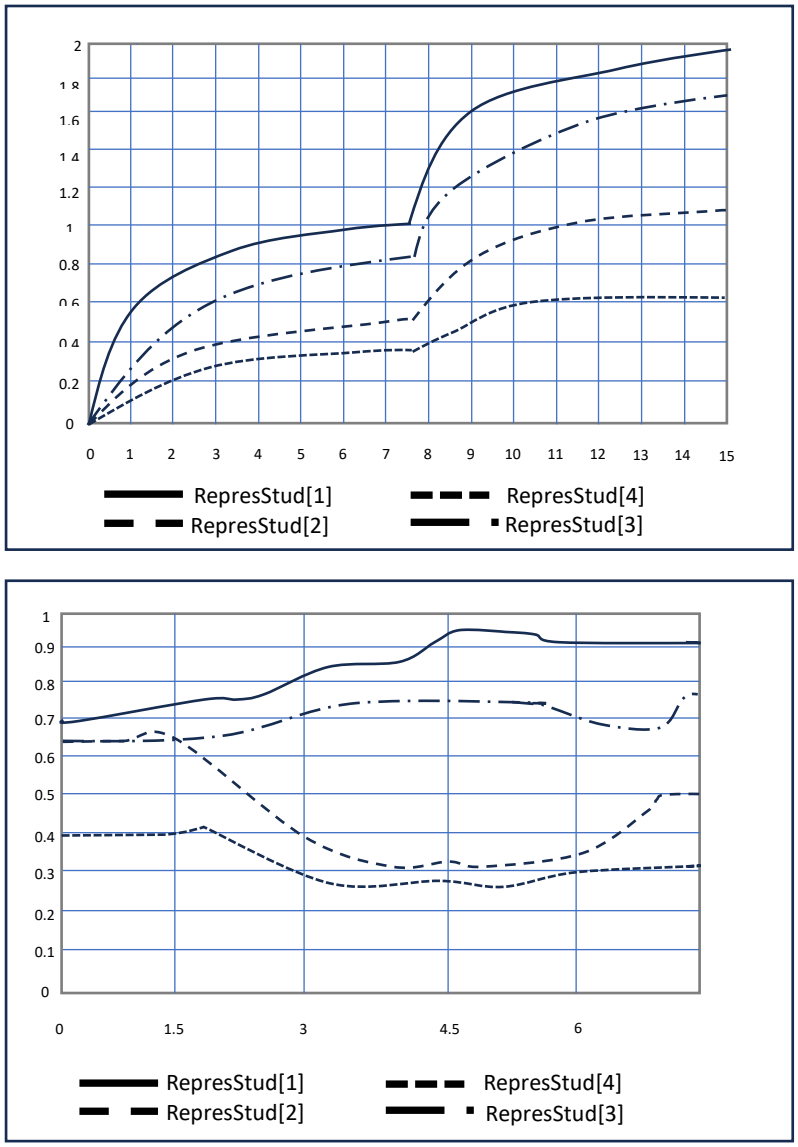


Figure7. Graphs of knowledge accumulation by ReprStud representatives

4. Conclusions

Artificial intelligence assistants improve teaching and provide teachers with the information they need to work closely and empathically with students. Emphasizing the teacher across educational cycles can ensure that AI-enabled classroom technologies keep the teacher

connected with students and help control important learning decisions. It is also important for risk management.

In terms of career trajectories, AI-assisted assessments can provide guidance to students and educators on a broader range of valuable skills, with a focus on providing information that enhances learning. In line with a human-centered approach, we must adopt a systematic approach to assessment that puts all participants in the learning process at the center of learning decisions, use artificial intelligence to support goals that require customization of learning resources, for example, allowing teachers to more easily transform materials to support neurodiverse learners. and increase efficiency. local communities and cultures.

Thus, artificial intelligence seeks to automate the processes of achieving goals, however, artificial intelligence should never set educational goals. Objectives should come from the teachers' vision of teaching and learning, and from the teachers' understanding of the strengths and needs of the students.

How can we understand the models that underlie AI applications and ensure that they have qualities that are appropriate for educational purposes? It is necessary to consider specific principles and rules that will allow teachers to realize the possibilities of artificial intelligence in educational technologies, while minimizing risks.

It remains an open question to develop additional resources and activities to improve understanding of artificial intelligence and to engage those who will be most affected by these new technologies. In addition, scientists need to focus their efforts on the development of artificial intelligence in the conditions of learning variability, where large groups of students are involved and there are many learning settings.

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