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# Development options for artificial intelligence supported intelligent tutoring systems via the integration of the ChatGPT

## Abstract

In the era of the second revolution of intelligent tutoring systems, the integration of artificial intelligence can bring about a learning process adjusted to the personal needs and preferences of students, including language teaching, sinse AI-based systems can assist in identifying and addressing individual language skills and deficiencies. While these systems can be divided into four inherently AI-based components (learner model, domain model, pedagogical model and user interface) facilitating the embedding of cognitive functions, the options hidden in the integration of big language models have not yet been fully utilized. The first step in the integration of ChatGPT developed by OpenAI is the thorough identification of the goals of the education process  followed by the allocation of the appropriate API (Application Programming Interface) service to the given process (question and answer, content summary, sentiment analysis). At the same time it is worthwhile to improve the ITS architecture to maximise the ChatGPT provided options. One result of our research and development effort is a further improved architecture integrating an additional component, the central organizer. This unit is responsible for the matching or allocation of the ChatGPT's API parameters to the given educational content and objective. The integration of ChatGPT into intelligent tutoring systems poses numerous challenges such as the protection of personal information, the related technological problems along with the clarification of ethical issues (Arató–Balázs 2023). Addressing such concerns is necessary for the realization of our original objective guaranteeing that the respective technological achievement would effectively support the implementation of said goals.

**Keywords**: artificial intelligence, language models, human cognition, libraries, linguistic interaction, language theory

## Introduction

Modern and intelligent tutoring systems (ITS) combining the latest results of Artificial Intelligence research with the pedagogical field can revolutionize the education process. The Intelligent Tutoring System is a computer system designed to influence the instruction process and improve learning outcomes in an interactive manner. These systems provide personal mentoring by taking the individual needs and abilities of students into consideration. Intelligent Tutoring Systems rely on artificial intelligence to dynamically adapt the

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methods and content of the instruction process to the learning style and pace of students while immediate context-dependent feedback eventually leads to a personalized learning experience.

While scientific exploration of various dimensions related to the use of ChatGPT for the support of the education process has already begun, its application in Intelligent Tutoring Systems can facilitate a deeper understanding of the given options (Rajcsányi–Molnár et al. 2024b).

The integration of AI achievements creates new opportunities not only globally, but also in the teaching of the Hungarian language. Our study provides a brief overview of the operation and structure of Intelligent Tutoring Systems along with introducing various educational and pedagogical options. Next, we look at the roles the ChatGPT can play in this framework and consider the advantages and potential dangers related to its integration.

## The evolution of Intelligent Tutoring Systems

Intelligent Tutoring Systems already have a significant history as they originate in the 1960s (Carbonell 1970; Wescourt et al. 1977; Nwana 1990; Kulik–Kulik 1991; Guo et al. 2021). At this time such instruction systems exclusively focused on providing a more or less adaptive interactive and customized learning environment for students. This goal was achieved via an *if-then* construction based programming matching the individual knowledge level of the learner. (One such example is the Rule-Based Reasoning paradigm utilizing general information related to the given topic [Anderson et al. 1995]).

After a quarter of a century of spectacular development represented by machine-based learning and the rise of the Case-Based Reasoning (CBR, [Manouselis et al. 2014: 102]), the next generation of these systems offers the option of making conclusions based upon previous experiences, while the preservation of previously deployed methods helps in solving newly emerging challenges (see the Retrieve, Reuse, Revise, and Retain method (Aamodt–Plaza 1994: 8). The given findings are useful in solving the newer problems by taking into consideration the role of memory, piece sequencing, analogue transfer, reasoning and problem solving techniques in the knowledge acquisition process (Koedinger et al. 2012).

After the passage of another 25 years the role of AI surpasses the various automation concerns in the current ITS. Such systems contain four clearly distinguishable AI-based components. The continuously updated ***learner model*** stores information on the student's knowledge, skills and learning methods gained from interaction. The ***module*** facilitating ***domain***

***knowledge*** contains the educational materials and relevant concepts arranged in a structured manner. The ***pedagogical component*** manages the learning process and provides feedback to the learner along with harmonizing the modifications indicated by other components and selecting the optimal learning strategy. The ***user interface module*** guaranteeing interactivity provides a communication channel between the learner and the ITS enabling students to navigate within the system (Balázs L. 2023). Chart 1 describes the schematic structure of the ITS.

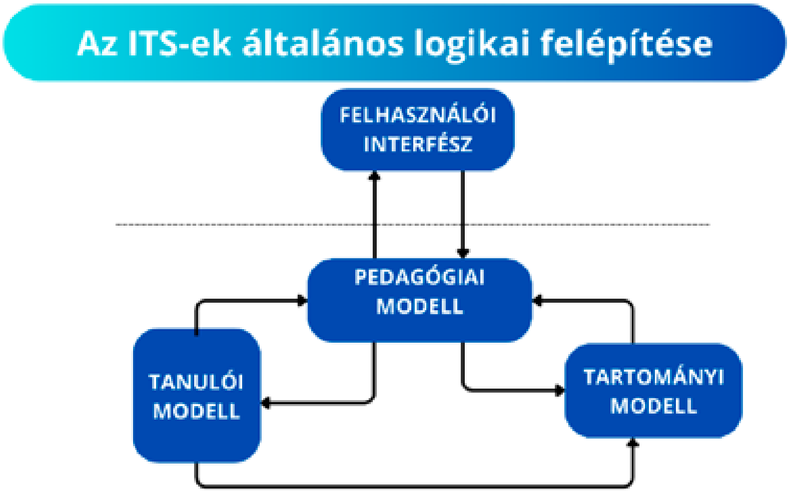


*Chart 1.* (Toldi 2023) The general logical architecture of the ITS
Learner model, Domain model, Pedagogical model, User interface.

The AI-based structure facilitates the integration of such advanced cognitive functions as the big language models, natural language processing, the new generation of machine-based learning technology, and various explainable AI solutions. (XAI – eXplainable Artificial Intelligence). One such example is the sample recognition process facilitating deeper, context-based adaptivity in processing learning materials. The system takes into consideration individual skills along with actual mental and emotional conditions coupled with monitored didactic and methodological autonomy.

Modern ITS, mainly due to the previously introduced XAI methods can provide a more personalized learning environment by accurately identifying and addressing potential learning problems and make predictions concerning difficulties to be encountered during the learning process (Chaturvedi–Ezeife 2017; Gligorea et al. 2023).

The big language models can provide an opportunity to take advantage of most of the new options. While the ChatGPT and similar generative, pre-trained transformers are ready to redefine the world of ITS, their application poses several challenges and requires careful consideration and analyses before their actual use. Below we describe how can the integration of the ChatGPT be harmonized or reconciled with the multidisciplinary expectations related to their use in ITS.

## The significance and role of artificial intelligence in Intelligent Tutoring Systems

As mentioned earlier in the introduction to this section the main attraction of AI-supported ITS is their ability to process and analyse a huge amount of data obtained via machine-based learning including answers by students, learning patterns, and previous performance-related information (Baker–Inventado 2014). Due to such data-driven approach real time learning environments adapted to the needs of the given students can be formed. In such systems the AI is capable of identifying the potential lack of knowledge along with optimizing the learning content and pace accordingly (Gligorea et al. 2023). Consequently, through its natural language processing techniques the ITS can involve students in personalized dialogues while providing explanations, feedback, and guidance adapted to their learning needs and comprehension level. (McNamara et al. 2013). Such a personalized or customized approach not only increases the commitment of students to the learning process, but it facilitates a deeper understanding of various concepts along with promoting the development of critical thinking skills. AI-based systems having processed various learning preferences can generate further simulations and interactive games (Daghestani et al. 2020; Rajcsányi-Molnár et al. 2024; Kőkuti et al. 2023).

## The options provided by the integration of the ChatGTP into Intelligent Tutoring Systems

The OpenAI facilitates the integration of the ChatGTP via an Application Programming Interface developed for this purpose. The API services include a wide variety of options focusing on the comprehension of natural language and text generation. As far as the ITS is concerned, the crucial API functions include *text generation, text classification, mood analysis, content summary, question and answer,* and *problem solving*. These services also cater to the specificities of the Hungarian language, offering extensive opportunities for more effective teaching of grammar, stylistics, and even etymology (Balázs 1997: 25–9).

The primary prerequisite for the integration of the ChatGTP into a given ITS is the clear and comprehensive definition of the respective instructional goals with an awareness of the capability of the actual objectives to function as potential guidelines for future development efforts.

The forthcoming pedagogical objective system contains elements providing a free choice of options in light of the available material and other type resources. Learning adapted to the individual needs, preferences, and learning pace of the students *increases the intensity of customization. Active promotion of persistent student effort* facilitates deeper understanding of the given educational material and its incorporation into the long-term memory. The proper application of the acquired knowledge and the *recognition of potential misinterpretation* of the given information coupled with the provision of *immediate personalized feedback and support* increase the efficiency of learning (Szűts–Szűts-Novák 2023: 566). Equally important feature is the recognition of the learner 'sindividual characteristics in *supporting various learning styles and strategies.* The elaboration of complex tests and the description of problem solving processes promote *critical thinking* and *improve problem solving skills,* while sharing the management of the knowledge acquisition process through dialogue promotes *self-directed learning and self-motivation.*

The allocation of API-provided services to pedagogical objectives requires the detailed analysis of the API service options. Below we introduce a few examples.

*Text generation* can help in meeting student needs related to academic progress based upon the acquisition of the respective educational materials along with providing written feedback or evaluation of the results of various assignments and tests.

The appropriate integration of the *question-answer* feature allows the ITS to simulate personal remedial instruction via offering students immediate, concise and accurate answers As a result of identifying appropriate parameters not only the learner's understanding of the given material can increase, but the generation of lead-in questions can help the improvement of analytical skills, while promoting learning by discovery and critical thinking.

The *content summary* service can be used as a complementary feature to transform longer, even scholarly texts into a concise form while observing appropriate style parameters. This feature can also help students with specific or unique learning styles highlighting and practicing the concepts and essential components of the given learning material even during end of the year reviews.

*Sentiment analysis* enables the ITS to explore the emotional aspects including satisfaction, frustration, or general commitment levels behind student interaction. Such a feedback mechanism facilitates the processing of adaptive answers by modifying the given difficulty level or sending motivational messages. *We must note, however, that in this case especially, but in the context of all other API functions in order to increase the reliability of the given function the ChatGTP has to be fine-tuned according to the needs of the appropriately prepared student groups.*

## The steps of integrating the ChatGTP into Intelligent Tutoring Systems

The first step in the integration of the ChatGTP services is redesigning the ITS architecture in order to assure the continuous cooperation between the respective artificial intelligence components at an optimal level. Thus Chart 2 describes a potential modification of the system.

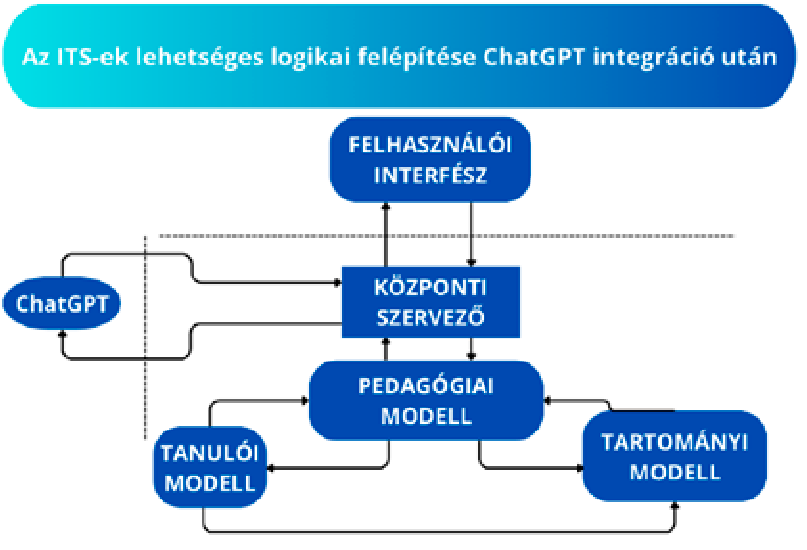


*Chart 2. A potential logical architecture of the ITS following the integration of ChatGTP.*
(author's own compilation)
User interface, Central organizer, Pedagogical model, Learner model, Domain model.

The new component, the module named ***central organizer*** has to fulfill a variety of tasks.

Primarily it has to assure the personalization or customization of the Chat GTP's API parameters to the given educational content and goals. In the same vein it has to guarantee the relevance of the respective interaction, while making sure that despite the dynamic aspects of the specific components such options would always harmonize with prospective pedagogical objectives. In order to provide a continuous real time user experience the algorithms of the module must have predictive and scheduling functionality. Additionally due to the need to protect learner data the given system component must have substantial data processing and handling practice while the parameters influenced by learner data analyses have to be continuously modified and updated for the ChatGTP on the API. Integration design must extend to the definition of how the ChatGTP will cooperate or work together with other components of the ITS not directly connected to the system, such as the user surface, feedback mechanisms, or the respective subject module.

In order to identify, eliminate, or correct unavoidable problems and assure continuous functioning and the protection of user data the system has to be thoroughly tested.

Following the successful testing phase, the final stage includes the installment and the monitoring of the operation of the system. This stage is not only required for the continuous operation of the integrated system, but for the optimalization and further development of the intelligent modules in an iterative manner as well.  System monitoring includes guaranteeing continuous availability of basic services along with the evaluation and analysis of the behaviour patterns of users, the demonstrated and assessed commitment levels, the respective learning outcomes and the interaction with the system.

The central organization unit has to fulfill most of these monitoring tasks in cooperation with the pedagogical module.  During the monitoring process this unit provides indicator numbers for the evaluation of the performance of the given logical components and the specific learning results. Accordingly stakeholders (artificial agents or humans) can evaluate the results in light of the pre-determined objectives. (In order to facilitate human evaluation of the respective indicators specially and purportively incorporated analytical platforms provide fast account or report of the crucial performance indicators in a dashboard-like arrangement [KPIs]. Moreover, they provide a surface for the modification and fine-tuning of the necessary correction parameters).

Besides optimalization the technological, usability-related or potential ergonomic problems hindering the learning process are identified in time via the formulated indicators. (The continuous data collection helps in intensifying the learning process in light of the differing demands of learners, the understanding of learner preferences, thereby supporting the more accurate personalization and customizing of the given educational material. This task however is controlled by the pedagogical model also responsible for the feedback loops integrated via various learning routes facilitating the fast, point-based, or the more detailed questionnaire-oriented direct monitoring of user satisfaction).

## The main challenges related to the integration of the ChatGPT into Intelligent Tutoring Systems

The obvious advantages notwithstanding the integration of the ChatGPT into intelligent tutoring systems implies several challenges. It requires several high level skills along with substantial resources.

The first crucial integration-related challenge is connected with the complexity of the integrated system and the reliability of its operation along with the respective scalability. In addition to the required multidisciplinary (pedagogical and informatics-related) expertise, depending on the number of the actual active users and the capability of accommodating high level user needs, a robust infrastructural background is indispensable. Such equipment is not only essential for appropriately scalable computing capability necessary for the processing and generating of real time answers, but enables flexible handling or solving of technological errors that frustrate the contemporary learning experience. The elaboration and maintenance of such an infrastructure demands a high amount of resources and technological expertise, which can pose a significant challenge for institutions with limited means. This problem can besolved by the acquisition of a cloud-based infrastructure via procurement or government tenders.

The protection of the learners' personal data and the safety of the stored information is a special priority. ITS often store and process sensitive educational data, which requires rigorous observation of data protection regulations and standards in addition to strict and thorough implementation of data protection measures. The unique requirements of the integration of state of the art Artificial Intelligence technologies, i. e. ChatGTP, warrant the elaboration of relevant protocols as well.

Additionally further ethical concerns emerge related to the ChatGPT. Contents or materials provided by generative Artificial Intelligence can include potential bias, or incorrect statements. This gives cause for significant concern as any bias in educational content not only weakens or undermines the effectiveness of the instruction process, but it can promote stereotyping while maintaining and strengthening prejudicial attitudes. A thorough pre-application fine-tuning of the ChatGTP model is indispensable for the elimination of such threat.

Finally, it must be mentioned that in order to guarantee that the respective technological development effectively supports the realization of the set pedagogical objectives the monitoring of performance indicators, continuous pedagogical research and the identification and adaptation of teaching strategies appropriate to the given school environment are necessary. Consequently, teachers and system developers have to work together in finding the potentially most effective ways of integrating the abilities of artificial intelligence into existing instructional framework systems, or redesign the given system if necessary to accommodate new means of learning by Artificial Intelligence (Balázs G. 2023a, b).

## Conclusion

Our research focused on the options implied by the integration of the ChatGPT into Intelligent Tutoring Systems. In light of the previously identified pedagogical objectives we presented an overview of technological skills facilitating its integration into existing ITS. Next we looked at the steps required for successful integration and analyzed the related potential challenges. Our findings indicate that the synergy of the ChatGTP and ITS can open new vistas and lead to the identification of significant problems. Additionally, our research highlighted that the integration of ChatGPT can bring about significant advancements not only globally but also in the teaching of the Hungarian language.

The integration of the ChatGTP into ITS can result in major changes in the education process via promoting the improvement of learning and providing adequate support to meeting the individual needs and preferences of students. While the combination of the ChatGPT and ITS has its challenges, it can lead to further developments in digitally supported education.

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