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MODERN EDUCATION CHALLEGNES AND OPPORTUNITES IN THE ERA OF INTELLIGENT TUTORING SYSTEMS

Abstract: *The landscape of modern education is undergoing a significant transformation, driven by rapid advancements in technology and shifting societal needs. Educational systems have become more personalized with a constant technological development where e-learning has been integrated with artificial intelligence techniques. These complex systems, known as Intelligent Tutoring Systems (ITS), apply the concept of artificial intelligence to the challenging demands of teaching and learning. ITS, recognized as a key driver of successful teaching and learning, enable active and practical teaching and learning experience in a certain educational field, while respecting the individuality of users. The paper provides an overview of existing intelligent tutoring systems with regard to the opportunities and challenges they face in modern leaning process.*

Анотація: *Ландшафт сучасної освіти зазнає суттєвих змін, зумовлених швидким технологічним прогресом і зміною соціальних потреб. Освітні системи стали більш персоналізованими з постійним технологічним розвитком, де електронне навчання було інтегровано з технікою штучного інтелекту. Ці складні системи, відомі як інтелектуальні системи навчання (ITS), застосовують концепцію штучного інтелекту до складних вимог викладання та навчання. ІТС, визнані ключовою рушійною силою успішного викладання та навчання, забезпечують активне та практичне викладання та навчання в певній освітній галузі, поважаючи при цьому індивідуальність користувачів. У документі подано огляд існуючих інтелектуальних систем навчання з огляду на можливості та виклики, з якими вони стикаються в сучасному навчальному процесі.*

1. INTRODUCTION

Educational environment has been changed excessively over the past period. Teaching and learning process has moved from traditional methodology and techniques to incorporating technology as an essential part of curriculum, aiming to develop competences based on creative information and communication technologies.

Traditional education was facing difficulties in accommodating diverse learning styles, level of preparation and prior knowledge degree. Accordingly, students who struggled with a single teacher who was unable to respond to their learning needs, wereoften unsatisfied due to the impossibility to gain learning and academic outcomes.On the other hand, conventional education in big groups of students led to lower individualization considering limitations of a teacher to prepare a personalized study plan in line with needs of each student in a group[1].

Artificial intelligence (AI) technology in last decades, and modern information technology in general, contributed to the establishment of Advanced Learning Technology (ALT). The use of new technology provides to users various benefits, at the same time making them increasingly reliant on application of new software in many fields [2-6].The most commonly used are in programming, languages, information technology, medicine, programming etc. Based on the independent knowledge databases for educational content, ALT examine the learner's strengths and weaknesses, as well as understanding of topic in order to dynamically adapt learning process [7]. Those learners are better in academic achievements compared to learners who rely only on traditional educational system [8, 9].

This paper aims to explore the multifaceted challenges and opportunities presented by the integration of ITS into contemporary educational frameworks. As we delve into this era of intelligent tutoring, it becomes imperative to assess how these systems are shaping educational outcomes, addressing learning disparities, and transforming the roles of educators and learners alike. Moreover, this examination seeks to identify the barriers to the widespread adoption of ITS and propose strategies to leverage their capabilities fully. By navigating the complexities of modern education in the context of ITS, this paper endeavors to offer insights into creating more engaging, efficient, and equitable learning environments for the future.

2. TRADITIONAL VS. MODERN LEARNING

Modern education, with a focus on new technologies, is now widely applied in educational institutions ensuring multi benefits compared to traditional education. Traditional education, as a teacher centered concept is primary focus on traditional literacy and communication skills. Conventional teaching methods rely on memory instructions, isolated learning activities and experience in a controlled learning environment. Focusing on memorization and repetition of learning material, students in traditional education lacked critical thinking and problem-solving skills, as well as ability to take an active participation in decision making process. This system began to change with an advancement of science and technology and their extensive use in learning process. A technology usage enabled lectures to be more interactive and engaging for students. Contrary to theo+retical learning, textbooks and learning by heart, modern education reduced these limitations of traditional education by trial and experience (figure 1).

The new learning process as learner-centered concept in education focuses on students [10; 11]. Surrounded by various learning resources, the learner-centered concept places a student in the center. Learning resources with regard to time, place and learning method refer to organizations, people, multimedia, social media, knowledge, technology, lectures, etc.

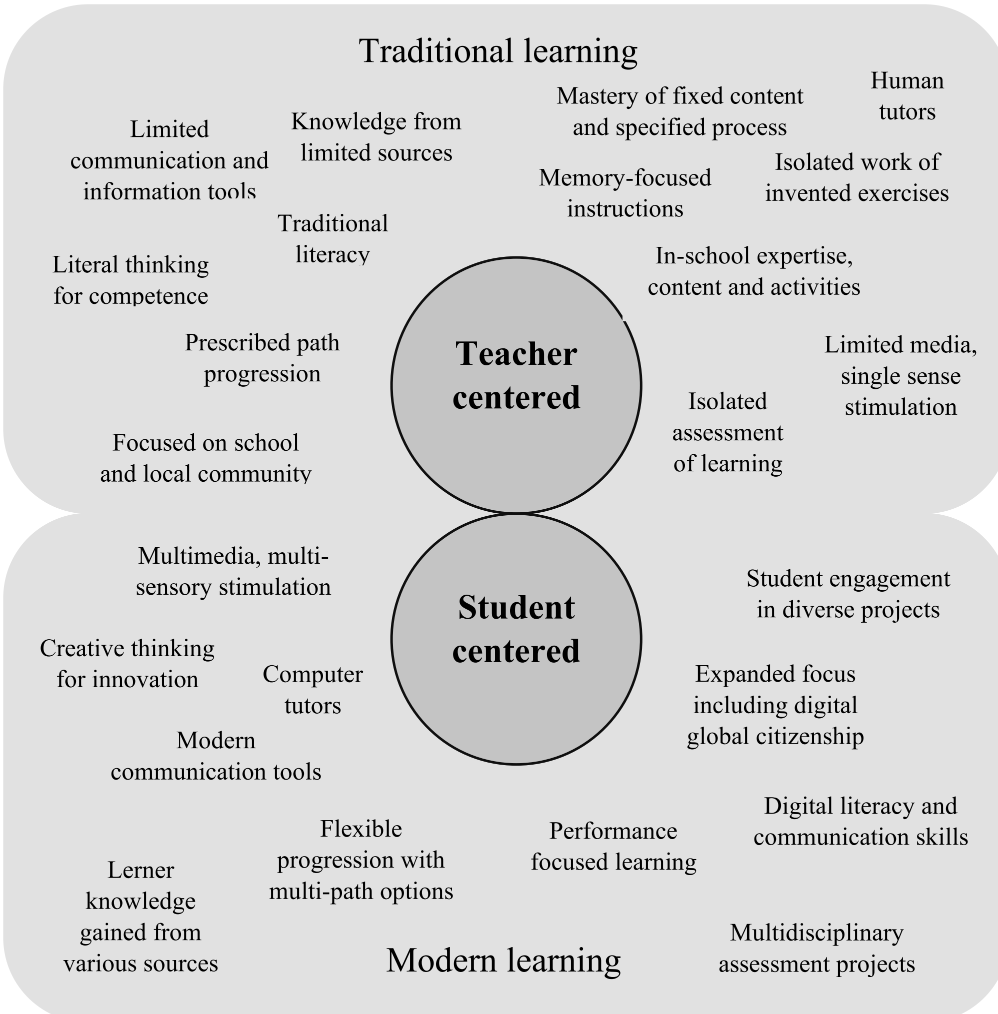

Figure 1. Differences between traditional and modern learning process [12]

One of the crucial differences in these two approaches are in tutoring systems. Human tutors ensure effectiveness in a students' learning process by guiding them to overcome difficulties in understanding theoretical concepts, encouraging them to learn more by searching for new topics and solutions, challenging them with complex problems, provoking curiosity. Therefore, human tutors lead students through the process rather than giving them explicit solutions, providing regular feedback. Even though, students can also study alone and increase their knowledge, skill and competences, this would require much more time and effort than guided learning [13, 14]. In order to ensure computer tutors to be effective as human tutors and provide similar feedback, there is a need of interaction with students in a way that human tutors have. The learning process need to be monitored step by step aiming to detect potential mistakes students make so the system can support students in solving them. Feedback depends on mistakes and their appearance so instructions can be given to help students to proceed [14].

3. INTELLIGENT TUTORING SYSTEM (ITS)

Among various technological innovations, Intelligent Tutoring Systems (ITS) have emerged as a pivotal element, poised to redefine the paradigms of teaching and learning. ITS, with their ability to provide personalized instruction and feedback to learners, represent a leap towards realizing the full potential of dig+ital education. Intelligent tutoring systems (ITS) are complex software systems that apply the main principles of artificial intelligence (AI) and incorporate them with educational methods. These systems customize learning activities based on learner's needs and characteristics [15], supporting the learning process in various fields of knowledge. The most commonly used AI approaches in ITS are computer sciences (36.1%), social sciences (27.7%), medicine (27.7%), engineering (8.3%), mathematics (5.5%), aiming to provide personalized guidelines to learners, develop or update learners model, and cluster learners [1]. Artificial intelligence in ITS simulate human tutors in order to become computer or intelligent tutors.

The research of the use of artificial intelligence has its beginnings in 1970s resulting with ITS as a direct outcome [6]. Respecting individual learner's characteristics such as knowledge, skills, behavior or emotions, ITS provide tutoring or developed guide. Based on the recent research [16], students have achieved 27% higher learning outcomes with personalized ITS. Given the increased productivity and lowered expenses for training instructions, this approach is also welcomed by staff and students since 90% of them are in favor of personalized ITS training method.

Traditional intelligent tutoring systems are focused on the educational field intended to be trained and reworded, using domain as a management technique. On the other hand, modern ITS additionally approach the educational techniques and concepts trying to separate as much as possible architectural, methodological and manipulative disorders from domain [17, 18].

Intelligent tutoring systems focus on: 1) knowledge about the domain, 2) knowledge of the educational principles, 3) methods for modeling a way in which students gain new knowledge and skills. Traditional ITS has been established on ++four interrelated software modules [4, 6, 3]:

1) *Student module* refers to the all-diverse aspects of students' gaining knowledge and skills in the given area of knowledge. Student module is of crucial importance in the student modeling procedure that encompasses student module and determination of student knowledge. Student module provides information on the current level of student knowledge, while the diagnostic process monitors those data using them in the student evaluation process.

2) *Teacher module* (tutorial skills) is related to the control of gained student knowledge and skills. Therefore, teacher module is in charge for teaching and pedagogical knowledge owned by human tutor.

3) *Domain module* (expert knowledge) or expert module is the key point in every intelligent tutoring system, referring to the domain knowledge that is the main communication tool in a learning process with students.

4) *Communication module* (user interface) represents interaction between students and intelligent tutoring systems.

Artificial intelligence (AI) for computer-assisted instruction firstly was mentioned in 1970s [19] with regard to the development of SCHOLAR system. For that reason, Carbonell is considered as creator or "father"of intelligent systems for teaching and learning. In 1982 Sleeman and Brown [20] equalized intelligent tutoring systems (ITS) and intelligent computer-aided instruction (ICAI). However, e-learning was introduced in 1960s when some experts recognized the potential and benefits of computers in education and their wide room for application. Those experts are mainly psychologists, pedagogues and engineers indicating two groups of research: 1) engineering research approach as the applied research which can be considered as the main contributor in establishing the teaching system based on the use of computer or computer-based instruction (CBI) and 2) advanced research of experts that contributed to the development of intelligent tutoring systems (ITS).

A great contribution to ITS has adaptive hypermedia with its application in educational hypermedia, information and online support system, or institutional information system. Adaptive educational hypermedia serves to modify the content that students see into more adjusted material in line with their goals, needs, knowledge, interest.

Modern education as personalized learning with ITS has been proved as more efficient than traditional education. The opportunities of such a system are various and benefits can be reflected in [16]: high accessibility at any time and from any location, instant feedback that increases performance, knowledge and skills-based assessment and grading, analyses of future performance, personalized learning ensuring higher engagement of students due to inspiring learning environment, better time allocation for both teachers and students, better understanding of learning materials using available technologies, etc. However, despite clear opportunities, there are still some challenges of ITS implementation in education that need to be overcome [16]: large number of stakeholders involved in decision-making process in educational institutions, lack of available information and communication technology in some countries or regions, quality of internet connection, lack of skills that teachers and students need in order to use ITS, language barriers, pedagogical processes reflected in rejection to use new technologies, complicated organizational structure in educational institutions, human resources limitation with regard to a lack of awareness about benefits of new technologies.

4. REVIEW OF INTELLIGENT TUTORING SYSTEMS IN EDUCATION

Intelligent tutoring systems have successfully been used in all educational area and their opportunities are opened up by extending a volume of learning material that has been under certain standards and available on internet. ITS benefit from applying extensible knowledge scheme which is also on disposal to other systems.

The following ITS have been developed so far:

Adil (*Automated Debugger in Learning System*) as ITS is a software system for automated error correction based on knowledge. It supports students in upgrading basic debugging skills of their programs. Considering a syntax error program and its specification, Adil identifies program errors, but if there are no errors, the system explains program itself. Adil has been established on the automated program understanding system Conceiver [21].

ADIS (*Animated Data Structure Intelligent Tutoring System*) is Java-based Web-enabled ITS and serves to support teachers in the learning process and challenges regarding students' understanding of diverse data structures (linked-lists, stacks, queues, trees and graphs). ADIS allows data structures to be graphically presented on computer screen, but also to graphically update the created data structures. ADIS provides a guide with necessary instructions and exercises intended for students to learn basic algorithms [22].

BITS (*Bayesian Intelligent Tutoring System*), as a Web-based ITS for computer programming guides a decision-making process by Bayesian network. BITS navigates students while using online learning material, suggesting learning goal and purpose and generating suitable learning sequences. BITS helps to identify the minimum knowledge students need in order to understand some new concept without learning in details previously explained related concepts [23].

DCG (*Dynamic Courseware Generation*) applies AI planning techniques in order to determine content of instruction. Accordingly, following the certain learning goal, the course plan is prepared individually for a student. The main advantage of DCG is reflected in automatically built goal-directed adaptive Computer Assisted Learning (CAL) courses which is not possible with traditional CAL techniques [24].

DM-Tutor is an ITS based on constraints which are incorporated into existing management information system for oil palm plantation. It helps users to apply theoretical concepts of plantation to real-life decision-making process [25].

ELM-ART (*Episodic Learner Model – Adaptive Remote Tutor*) integrates intelligent educational system with e book program in a learning environment that enables upgrading the previously gained knowledge [26].

JITS (*Java Intelligent Tutoring System*) implies the development of designed for students programming tutor in the first programming course in JavaTM at the university level. It is assumed that the developed prototype is sufficient to prove the concept and established JavaTM intelligent tutoring system provides an interactive learning environment for students resulting in their learning achievements [27].

KERMIT (*Knowledge-Based Entity Relationship Modelling Intelligent Tutoring*) is ITS for entity relationship modelling. Designed database is an open—ended task because there is determined outcome but not precise procedure to reach this outcome [28].

MBITS (*Multicriteria Bayesian Intelligent Tutoring System*) is Web-based ITS supported by Bayesian Network, functioning as an interactive Web application easy to be used. It supports students in better understanding the learning process using multicriteria approach for evaluating various solutions and information [29].

ML-Tutor (*Machine Learning Tutor*) is a Web-based client server system established to combine Internet technology with educational hypertext [30].

NORMIT (*Normalization Intelligent Tutor*) is ITS primarily oriented to teach students about database normalization [31].

SQL-Tutor (*Structured Query Language*) is ITS based on knowledge, learning and teaching SQL language database, with an application of modeling based limitation approach to students [32].

SQLT-Webis a software ITS based on knowledge, learning and teaching SQL language database [33].

TEx-Sys (*Tutor-Expert System*) is a software system for learning, representing copyright for building ITS in the chosen field of knowledge [34].

WITS (*Whole-Course Intelligent Tutoring System*) is ITS and expert system that focuses on teaching solid state electronics course without human tutor. Creating inspiring learning environment, it seems to be motivating for learners given useful instant feedback [35].

5. CONCLUSION

In conclusion, the era of Intelligent Tutoring Systems (ITS) presents a transformative landscape for modern education, characterized by both challenges and opportunities. As we have explored throughout this paper, ITS offer unparalleled personalization and efficiency in learning, catering to individual student needs and facilitating a deeper, more interactive educational experience. However, the integration of ITS into mainstream education is not without its hurdles, including issues of accessibility, the digital divide, ethical considerations, and the need for comprehensive teacher training.

The opportunities presented by ITS, from adaptive learning environments to data-driven insights into student performance, herald a promising future for education. These systems can potentially bridge educational gaps, enhance student engagement, and prepare learners more effectively for a rapidly changing world. Nevertheless, for ITS to truly fulfill their potential, stakeholders must address the associated challenges head-on. This involves investing in technological infrastructure, ensuring equitable access, safeguarding data privacy, and fostering a collaborative approach between educators, developers, and policymakers.As we move forward, the role of educators will evolve from disseminators of knowledge to facilitators of learning, guiding students through personalized educational journeys shaped by ITS. The successful integration of ITS into education systems worldwide will require a concerted effort to overcome existing barriers, coupled with a commitment to continuous improvement and innovation.

In well planned and organized learning environment, e-learning as a combination of information and communication technology and education has many benefits. However, a word of caution is necessary since e-learning cannot instantly overcome all the existing challenges in learning process and replace theories, principles and norms. As a new learning paradigm, e-learning is supported by information and communication technology and intelligent tutoring systems in the process of personalized teaching and learning. ITS are viable and advanced technological solutions that using artificial intelligence provide high quality education with a constant intent to overcome limitations of existing not personalized and not enough interactive platforms. Personalized learning would never reach this level of development without ITS considering the ability to perfectly simulate a learning environment, act like a human tutor, provide an interface for information sharing, and provide feedback.

Ultimately, the journey into the era of Intelligent Tutoring Systems is one of both discovery and responsibility. By embracing the opportunities and addressing the challenges, we can unlock the full potential of ITS to revolutionize education, making it more inclusive, effective, and aligned with the needs of the 21st century.

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