DEVELOPMENT OF AN INNOVATIVE E-LEARNING SYSTEM

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ABSTRACT

The rapid evolution of digital technologies is reshaping the landscape of education, introducing e-learning as a prominent and viable way of knowledge delivery. Learning is also a challenge that can be related to information technology and data collection. With the advent of new technologies comes the emergence of new ways of learning that will have interactive training as a basis. These modes of learning are called e-learning and are time and place independent. It can be seen that in recent years, in the field of educational technology and in the field of artificial intelligence, it is expected to provide educational services that will help students. With this in mind, the aim of this paper is to explore e-learning systems and their modules, what is innovative in those systems and to give a suggestion on what needs to be upgraded in order to get an innovative e-learning system. The paper itself also explores how AI tutors can be used in those e-learning systems.

KEYWORDS

e-learning, e-learning systems, innovative systems, AI tutors.

1. INTRODUCTION

Modern e-learning systems represent a significant advancement compared to conventional educational models, offering greater flexibility, accessibility, and continuous learning without spatial or temporal limitations. Unlike traditional approaches, e-learning provides a rich selection of digital resources and personalized content, enabling students to learn at their own pace and according to their individual needs [1].

One of the primary objectives of e-learning is to help students develop relevant skills and deeper understanding, thereby facilitating more effective achievement of their educational outcomes. This aspect represents a crucial advantage of modern e-learning systems and should be emphasized in both the introduction and discussion, as it highlights the transformative role of technology in education [2].

This study aims to identify the requirements and challenges of existing e-learning systems, focusing on factors that influence user interaction with the platforms. Furthermore, it analyzes the application of artificial intelligence as a tool to enhance these systems, through the development of innovative systems and integration of AI tutors, which aim to provide dynamic, adaptive, and personalized learning experiences [3].

Previous research indicates that the integration of artificial intelligence can significantly improve content accessibility, more effectively identify students' learning needs, and enhance the quality

of interaction between students and instructors. In doing so, it lays the foundation for a new generation of educational platforms that not only support the learning process but also actively contribute to the development of competencies essential for contemporary society [3].

2. E-LEARNING

Learning is the process where information is obtained. Many people learn from instructors or through the use of informative sources such as guides, menus, newspapers, etc. [4]. E-learning can be said to be a type of learning that is part of the Internet network [5]. E-learning has been defined as computer assisted learning since the 1960s, but its adoption and popularity began with the popularization of the Internet. Since its introduction, e-learning has rapidly evolved in the field of technology and the methods it uses. E-learning is the practice of using information and communication technology to create a learning experience that can be formal, organized, and created with sufficient freedom without any boundaries [6]. E-learning is a process where a set of lessons are provided on digital devices such as computers, tablets or any memory devices that support it. It is an interactive learning experience in which content is available online and provides feedback on the student's learning activities [7]. One of the main goals of e-learning is to develop skills and understanding to help students achieve their learning goals [8].

3. E-LEARNING SYSTEMS

Traditional e-learning systems are first appearing on the University Network and on the Internet to support and invest in schools and companies. Such systems contain six parts in their intelligence network infrastructure, such as IP, application usage and development, content creation, content management, learning management, delivery, and development [9]. Also available are the integration of data, video and voice, multicast technology, security, handling, storage, distribution of content in intelligent infrastructure facilities.

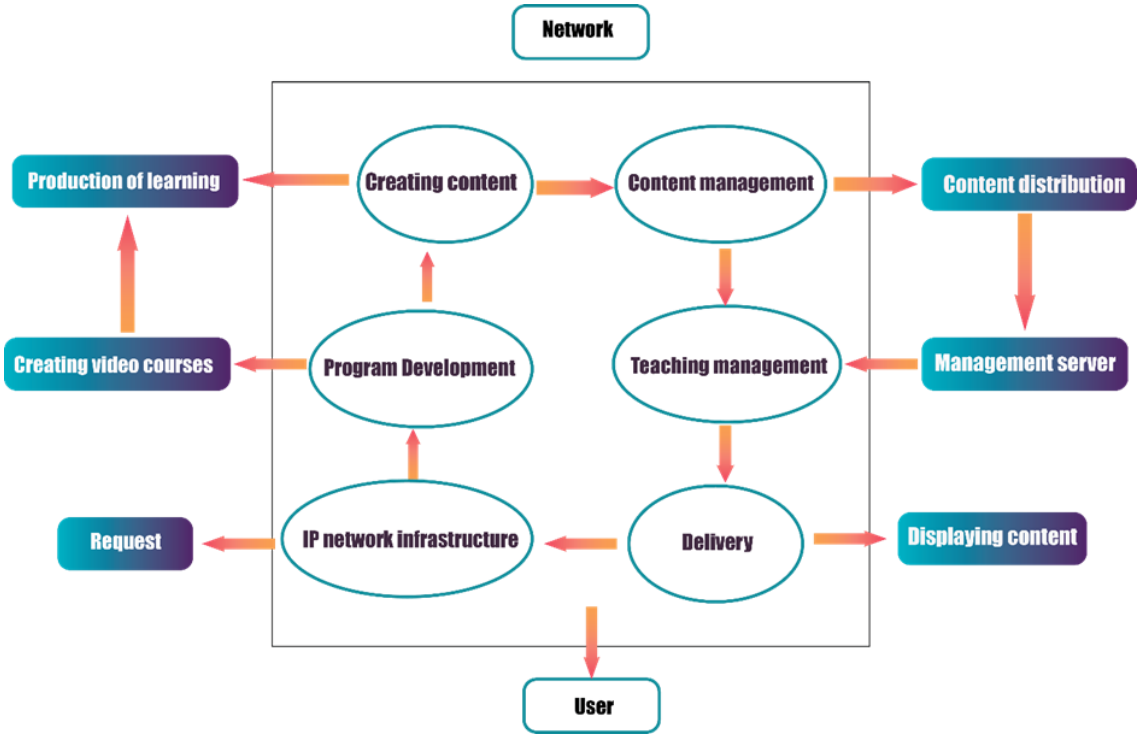

Figure 1. Framework of a traditional e-learning system

4. E-LEARNING SYSTEMS

E-learning systems based on artificial intelligence (AI) techniques allow appropriate content for the user to be determined according to Level 7 user understanding. Developing an AI-based e-learning system requires a holistic approach and a thorough analysis of data and data sources. Such requests should be available in the databases of the system itself. Murtaza proposes a model of an e-learning system that contains a set of requirements and then presents a holistic framework for e-learning. Their setup framework is designed to be an example of an intelligent e-learning system that integrates components in order to first determine the user's level of learning and then propose materials [10].

As a subset of AI, machine learning (ML) is also emerging as a powerful tool in e-learning systems. In such systems, MU is used as a conventional approach to monitoring user performance. There are several MU techniques used to create such systems. Such techniques are Bayesian Knowledge Tracing (BCT), which uses a technique called the Markov process that is equipped for each skill so that future performance can be predicted based on the user's response history [11].

MU's algorithms along with AI techniques enable the creation of e-learning systems that can accurately predict and display materials to users. Such application of these technologies not only in e-learning systems, but also in other systems is a major innovation that offers an improved user experience in different usage circumstances.

5. LIMITATIONS OF E-LEARNING SYSTEMS

Despite the considerable advantages offered by contemporary e-learning systems, several limitations hinder their full potential. Traditional platforms often provide a uniform learning experience that does not adapt to individual students' abilities, learning styles, and preferences. Content accessibility can be inconsistent, making it difficult to locate relevant materials or receive timely and actionable feedback. Interaction with instructors is frequently limited, reducing opportunities for engagement, guidance, and personalized support. Moreover, existing systems may inadequately monitor learners' progress or fail to provide insights that help close learning gaps.

The proposed innovative system, enhanced with an AI tutor, directly addresses these shortcomings. By delivering personalized learning pathways and adapting content in real-time based on individual performance, the system ensures that students engage with relevant resources at the right moment. The AI tutor facilitates continuous interaction, providing guidance, monitoring progress, and suggesting targeted interventions to close learning gaps. This approach transforms the educational experience from a static, one-size-fits-all model into a dynamic, adaptive, and learner-centered environment. Consequently, integrating artificial intelligence tools within e-learning systems not only mitigates existing limitations but also enhances the overall quality and effectiveness of online education.

6. CURRENT RESEARCH IN THE FIELD

According to the research and interest of researchers on this topic, we can see different types of e-learning systems that are based on different technologies.

Murtaza and others. In their research, they created an e-learning framework based on 5 modules where they expect an answer to their 4 research questions that are related to the key factors of e-

learning and the benefits of AI in the same. They set a set of requirements and challenges, and then present a holistic framework for learning. The results they receive meet their requirement and expectation that the proposed framework answers the research questions that were asked at the outset [11].

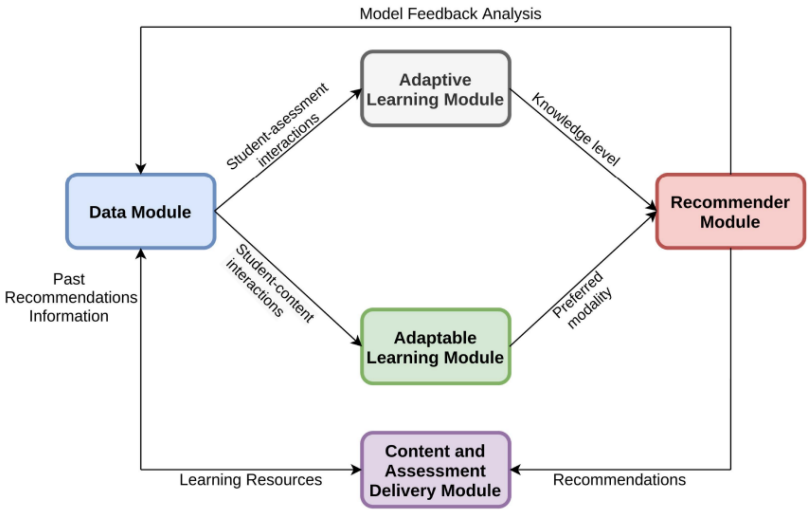

Figure 2. Proposed architecture [11]

Alexandra and others analyze the different techniques for applying tag based recommendations to e-learning systems. They use the ranking method as the most appropriate model based on tensor factorization techniques to obtain efficient results from the recommendations. The authors present an intelligent tutoring system used for programming and present it as a recommendation for learning resources. Their research focuses on choosing a tagging technique that can lead to better recommendations. They create an architecture of a system called Protus that has five components. To analyze the results, they use the algorithms PageRank and FolkRank where they compare the results and note that their system has contributed to e-learning [12].

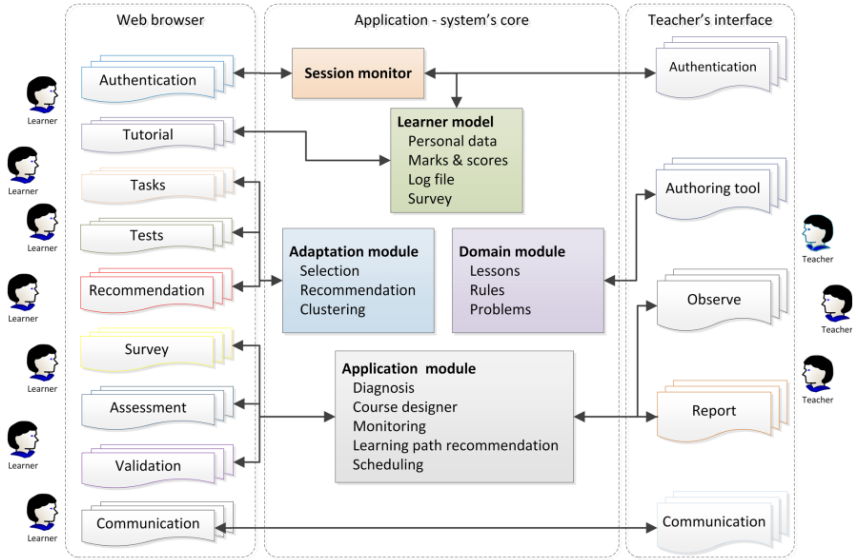

Figure 3. Protus system architecture [12]

Mustafa and others find the most appropriate learning path and content for a given student that aligns with their profile and learning achievement. Their paper suggests several methods with varying levels of performance in terms of accuracy and quality of adaptation. The authors differ from others in that they combine a content based filtering technique and a machine learning algorithm based on the student's motivation. They create a system that consists of several modules and test them using mathematical formulas. They used a specific database of 400 students to test them and the results obtained indicate that the level of motivation during the adaptation process has a high potential for improving performance and quality in e-learning systems [13].

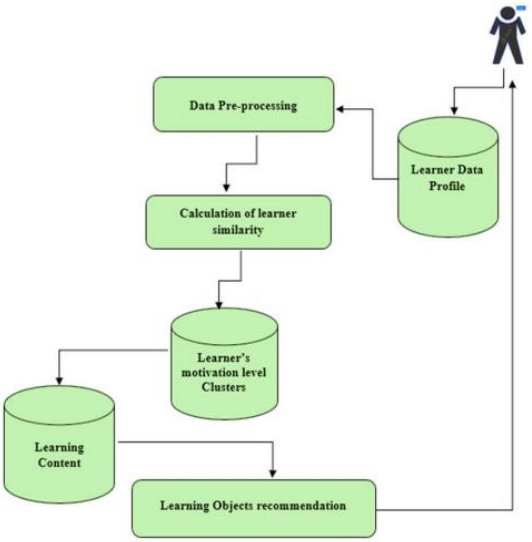

Figure 4. Adaptation System Process [13]

Nikola and others in their research, created an e-learning platform that aims to provide a solution for creating and maintaining courses called Dira. The e-learning platform is an online platform that aims to help Roma adults learn to use IT tools. To achieve this goal, they use a variety of technologies to develop it. The backend is built using Flask, MySQL and Phusion Passenger is used as the application server. The platform consists of several core modules [14].

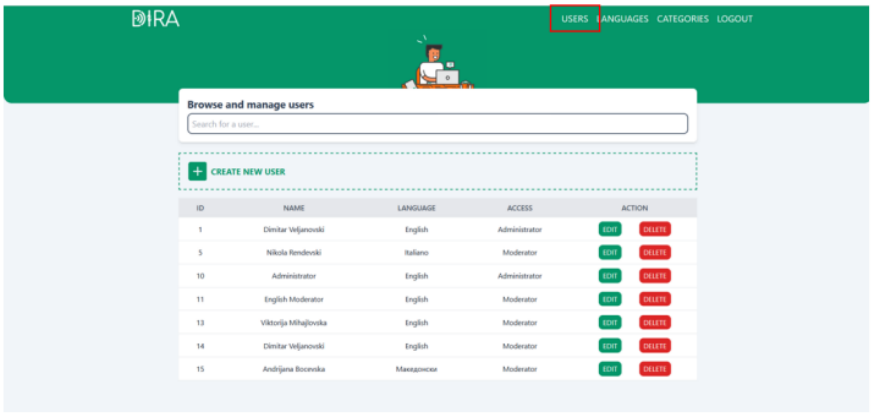

Figure 5. Dira Platform [14]

Baradari, D. and others proposed a neuroadaptive AI tutor that uses real-time EEG signals to adjust difficulty, style, and pace of learning. Pilot testing (n=24) showed increased engagement, although learning gains were not yet significant [15].

Wang, R. and others developed an AI tool for supporting human tutors. In a randomized controlled trial (900 tutors, 1 800 students), students taught with Tutor CoPilot achieved significantly higher mastery (+4 percentage points overall; +9 pp for lower-achieving students) [16].

Thomas, D. and others proposed three quasi-experiments in real classrooms. Hybrid human-AI tutoring significantly improved learning outcomes, especially among students with lower prior achievement [17].

7. PROPOSE AN INNOVATIVE E-LEARNING SYSTEM

In this part of the study, we will develop a proposed model for an innovative e-learning system. Our model contains four standard modules, three innovative ones and a new module that will feature AI technology.

The standard modules in the innovative system are: the User Management Module, the Category Management Module, the Language Management Module and the User Management Module. The user management module has the functionality for each user to create their own account, edit that account in courses and delete user accounts. The category management module is tasked with creating lists of course categories, adding, editing, deleting if one is not needed. The language management module will allow you to create a language, edit the language and allow archiving in the appropriate language. The course management module is tasked with creating an appropriate course and enabling its editing.

The innovative modules in our system are: a data module, an adaptive learning module and an adaptive module. The data module is responsible for storing the student's profile and assessment data. It also stores learning content and assessment questions. The results of the assessments are used by the adaptive module to calculate the level of adaptability of the student. The adaptive module is tasked with determining the user's level of knowledge that is announced to the system itself. This module will use a sequential machine learning algorithm that will be trained for student interaction to first assess the student's latent states of knowledge and determine what level of knowledge the learner is [11]. The adaptive module determines the learning mode for the student. First, the level of knowledge of the student himself is assessed and therefore this module will be able to determine the level of difficulty at which the student needs to learn through the e-learning system.

An AI tutor module offers more functionality but will also connect to other modules. It provides an enhancement of the user experience for e-learning. An AI-assisted module can assess the user's current level of understanding and skills and make a suggestion of a course that the user should or wants to use. This module can also be linked to an adaptive module where they will adjust the weight and content based on the user's progress and learning style. This module will provide a quick way to retrieve customized information that will be obtained based on the user's responses, where they will receive advice or additional resources to improve the user's knowledge. Users can ask questions to the AI tutor at any time, where the AI provides an answer or solution to the appropriate question. If a user makes a mistake no matter what part, this module can guide them and help them correct the error step by step. With the help of AI, the module can also give multimodal responses, i.e. using various resources such as images, videos, text. Based on the user's choice, this module can provide customized suggested learning resources, and focus

the user on a particular course. This module may also have functionality such as giving interactive instructions, i.e. step by step explanations in the areas of coding, mathematical problems, or language learning. Users will be able to interact with an AI tutor/teacher in natural language in the form of dialogue, and the AI can also translate into different languages. One very important feature of this module is accessibility, i.e. the main commands where users who have physical or visual impairments can interact with the system using voice. The options offered by this module can allow users with disabilities to fully engage in listening to the courses.

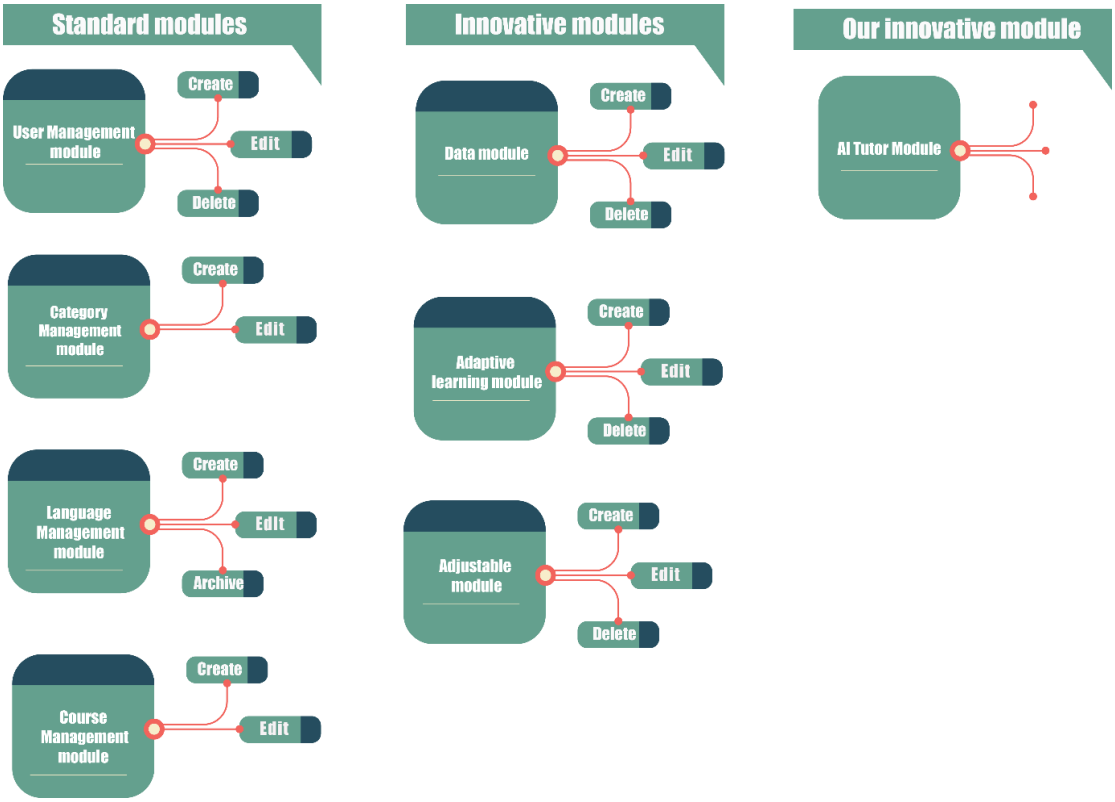

Figure 6. Proposed Innovative E-Learning System

8. CONCLUSIONS

This study highlights the significant role of e-learning systems and the application of artificial intelligence, with a particular focus on the development of an innovative module. The key finding demonstrates that the integration of an AI tutor enables personalized and adaptive learning pathways, enhances interaction between users and the platform, and optimizes the efficiency of knowledge acquisition. By leveraging AI-driven adaptability, the system not only tailors learning materials to the individual needs of learners but also provides timely feedback and guidance that are critical for maintaining learner motivation and progress.

The novelty of the proposed approach lies in combining existing modules with the AI tutor, which dynamically adapts content and provides recommendations based on individual user performance. This integration creates an intelligent and learner-centered environment that overcomes the limitations of traditional e-learning platforms, which often rely on static content delivery and generalized learning trajectories. Unlike conventional systems, the proposed framework emphasizes interactivity, personalization, and inclusivity, thereby fostering a more

engaging and supportive learning experience for diverse learners, including those with specific needs or disabilities.

Moreover, the AI tutor enriches the learning process by offering multimodal feedback, interactive problem-solving assistance, and accessibility features such as natural language interaction and voice-based commands. These capabilities have the potential to significantly reduce barriers in education and democratize access to knowledge on a global scale. From a pedagogical perspective, this represents a paradigm shift—from passive content consumption to active, guided, and adaptive learning where students are empowered to take ownership of their educational journey.

Future steps include rigorous testing of the system in real-world environments, both with and without the AI tutor module, to quantitatively assess its contribution to learning performance, motivation, and user satisfaction. Expanding the pilot to include diverse learner populations will enable a deeper understanding of how cultural, linguistic, and cognitive factors influence system effectiveness. Opportunities also exist for scaling the system to larger user bases by integrating it into existing Learning Management Systems (LMS) and Virtual Learning Environments (VLE). Such integration could pave the way for hybrid educational models that blend adaptive AI-driven personalization with traditional instructional practices.

In addition, future research should examine the ethical and practical considerations of deploying AI tutors, including data privacy, algorithmic transparency, and potential biases in adaptive recommendations. Establishing clear evaluation frameworks and benchmarks will ensure that the system not only enhances academic outcomes but also aligns with ethical principles and promotes fairness.

In conclusion, the proposed innovative e-learning system provides a robust foundation for the next generation of digital education platforms. Its emphasis on adaptability, interactivity, and inclusivity demonstrates how the integration of artificial intelligence can transform learning into a more effective, equitable, and personalized process. With continued development and evaluation, such systems hold the promise of reshaping education in the digital era and contributing significantly to lifelong learning and global knowledge accessibility.

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