

# Shaping the Future of University Education: The Role of Artificial Intelligence in Higher Education and Its Impact on Foreign Language and Chemistry Courses within Health Sciences Faculties

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**Abstract** This review article investigates the incorporation of artificial intelligence (AI) into the learning processes of chemistry students studying in foreign language coordinator programs, and examines how AI can support foreign language education in higher education. It considers the historical, current and emerging roles of AI in higher education settings, particularly its potential to improve the learning experiences of students in preparatory programs. The study underlines the importance of equipping chemistry students with the knowledge and tools to use AI in an efficient and ethical use in their education. It also underscores the important role that AI can play in foreign language teaching in faculties of health sciences, with particular emphasis on chemistry lectures. The research offers a detailed analysis of how AI can transform teaching and learning approaches in chemistry preparatory courses, especially in areas like curriculum development and educational applications. Additionally, the paper deals with the main challenges, advantages and ethical issues related to the use of AI in education, examining how both students and academics can benefit from AI to improve learning outcomes. It also investigates how AI can offer more impactful syllabus preparation and teaching techniques while maintaining ethical standards. The paper also addresses the ethical consequences of integrating AI technologies into educational settings, discussing both potential benefits and risks. In the end, the paper stresses the importance of using AI in education in an ethically appropriate way, emphasizing the need for a responsible and ethically mindful practice. The paper finishes by reflecting on how AI can shape the future of higher education, underlining the importance of addressing its moral and social implications while capitalizing on its potential to foster growth and renewal in education.

**Keywords:** Artificial Intelligence (AI), Adaptive Learning Systems, Chemistry Education, Foreign Language Education, AI-powered Tutoring, History of chemistry science

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## 1. Introduction

In recent decades, the implementation of Artificial Intelligence (AI) in education has driven a fundamental shift, particularly in higher education. The speedy progress of AI technologies is reconfiguring educational methods, learning and institutional administration. This evolution has been significantly expedited by the mainstream adoption of online educational tools and AI-

powered platforms, which became notably evident during the COVID-19 pandemic. As educational organizations have moved towards more digital and technology-centric atmospheres, AI has increasingly become a core ingredient of personalized learning, enabling educators to better meet the varied learning inputs of students.

AI is not only transforming the way content is being delivered, but also provides more dynamic and engaging ways to capture students' interest and enhance their learning experience. In higher education, AI has particularly proved invaluable in supporting more

effective conversations in complex fields such as chemistry, where understanding complex concepts is critical. This is specifically the case for faculties of health sciences, where the integration of AI-driven tools can promote the development of critical skills that go beyond traditional scientific understanding. Success in health-related fields is not only about mastering scientific concepts but also about communicating and applying these ideas within a global academic framework. Communication and language skills play a very important key role here, making AI a valuable ally in the development of foreign language education in health sciences faculties.

In health-related chemistry lectures, AI technologies offer such innovative approaches as interactive simulations, individualized teaching approaches and real-time feedback, which contribute to improving students' learning experiences and making complex chemical processes more and more accessible. These AI tools have considerable potential to educate future health practitioners who must not only grasp rigorous scientific content, but also adapt to an academic and professional environment that is increasingly globalized. Nevertheless, the integration of AI into education is not without its difficulties. Whereas AI offers exciting opportunities to improve education, it requires thoughtful administration to ensure that these technologies are used most effectively. For AI to be successful in educational environments; instructors, students and administrators need to undergo adequate training to understand and apply AI tools appropriately.

Moreover, the integration of AI in education requires existing infrastructures to be upgraded, keeping pace with technological advances to ensure that the full potential of AI is realized. This paper studies the multi-dimensional effect of AI on higher education, with a particular focus on its role in chemistry and foreign language education in health faculties. It also emphasizes the challenges and considerations related to the adoption of AI in education. Going forward, this paper highlights the importance of strategic thinking in the future of AI in higher education. To fully exploit the potential of AI, academic institutions should engage in thoughtful and forward-looking deliberations that assess the implications of AI on educational systems, curricula design, and teaching applications. This work will provide critical information on how AI will shape the future of education and offer a comprehensive outlook on the steps necessary to integrate this potentially transformative technology in a way that will benefit both students and educators.

### 1.1. Artificial Intelligence (AI) and the History of its Development

The term artificial intelligence was first coined in 1956 by John McCarthy [1]. "At that time, the researchers came together to clarify and develop the concepts around thinking machines which up to this point had been quite divergent. McCarthy is said to have picked the name artificial intelligence for its neutrality; to avoid highlighting one of the tracks being pursued at the time for the field of thinking machines that included cybernetics, the theory of automata, and complex information

processing. The proposal for the conference said, "The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it." [2].

AI refers to a broad field of science encompassing computer science, psychology, philosophy, linguistics, mathematics, and others. It becomes evident that there are many points of view on AI, and many definitions exist.

Dictionary definitions describe AI as "a sub-field of computer science focused on how machines can imitate human intelligence: a branch of computer science dealing with the simulation of intelligent behaviour in computers; the capability of a machine to imitate intelligent human behavior" [3].

"Definitions of artificial intelligence begin to shift based on the goals being pursued through an AI system.

Generally, people invest in AI development for one of these three objectives: build systems that think exactly like humans do (strong AI), just get systems to work without figuring out how human reasoning works (weak AI), and use human reasoning as a model but not necessarily the end goal" [2].

"Amazon defines AI as the field of computer science dedicated to solving cognitive problems commonly associated with human intelligence, such as learning, problem-solving, and pattern recognition. Machine learning is so important to Amazon, they stated, without ML, Amazon.com could not grow its business, improve its customer experience and selection, and optimize its logistic speed and quality [2].

Machine and deep learning are the priority for Google AI and its tools to create smarter, more useful technology and help as many people as possible from translations to healthcare to make our smartphones even smarter. Facebook AI Research is committed to advancing the field of machine intelligence and is creating new technologies to give people better ways to communicate. IBM's three areas of focus include AI Engineering, building scalable AI models and tools; AI Tech, where the core capabilities of AI such as natural language processing, speech and image recognition, and reasoning are explored and AI Science, where expanding the frontiers of AI is the focus" [2,4].

### 1.2. AI General Assessment of the Past, Present, and Future of Education

Examining educational systems from the past to the present reveals that learning occurs in a specific order and face-to-face. Every educational paradigm has its own order and system, even though they differ according to cultures, systems, and historical periods. Our nation's educational system is organized in a specific way, with kids serving as its smallest unit. Teachers, parents, and administrators are the other key components of this system [5]. The educational system has a complicated dynamic and it is always changing, even if all the components and structures are known. Thus, management is the most crucial component of the system. Administrative staff are required to carry out all of these structures in a specific order and harmony. Otherwise, the system as a whole could collapse due to even the slightest

issue. Here, administrators have a lot of duties. To provide the most precise response to any issue encountered in an unforeseen circumstance, collaboration among the complete academic staff is required [5]. In light of issues in the educational system, school administrators should be ready to reorganize the institution. In light of issues in the educational system, school administrators should be ready to reorganize the institution. In times of crisis, school leaders must be receptive to new ideas. Furthermore, creative educational leaders can offer a good example by adjusting to the changing times [6].

The pandemic's abrupt onset wreaked havoc on education. According to a reference [7], chaos is a global term that conveys both order and disorder. Nevertheless, despite the disorderly state of the international system brought about by COVID-19 and the numerous detrimental consequences it has wrought, a new order and a new age in education have been and are being ushered in. The turmoil that results from this can be used as a chance to create a new order and restructure the educational system [8]. As technology advances and changes, it is crucial that administrative staff in educational institutions tackle problems with a solution- focused mindset. By taking advantage of technology during the pandemic, academic staff and leaders receptive to advances in education have been able to adapt to changing circumstances far more quickly [9].

The Council of Higher Education (YÖK, CHE) made a decision on face-to-face instruction after the Ministry of National Education (MEB, MoNE) announced that the 2022–2023 academic year would be entirely in-person. A second unforeseen event, the Kahramanmaraş earthquake, struck on February 6, 2023, when classes resumed in person. This time, it affected the entire country of Turkey, if not the entire world, and YÖK decided that university education would once more be conducted remotely<sup>(1)</sup>. It can be argued that technical infrastructure, teachers, and students were better prepared and experienced when this process was viewed as an educational crisis.

### 1.3. A General Overview of the Use of Artificial Intelligence in University Education

Artificial intelligence (AI) is rapidly reshaping higher education, making significant improvements in teaching, learning and administrative functions. As artificial intelligence tools and technologies become more integrated into academic environments, universities can increase their operational efficiency, reduce the burden of administrative tasks, and offer students more personalized ways of learning. These developments not only improve traditional educational models, but also lead institutions to rethink their approach to teaching and learning [10].

One of the most important applications of artificial intelligence in education is the development of artificial intelligence-supported tutoring systems that provide real-time, personalized support to students. Its success in the field of health is important not only in understanding scientific concepts but also in properly communicating this information in a national and international academic context [11]. In this sense, developing foreign language skills of listening, reading, writing and speaking is very

important. Artificial intelligence used in chemistry courses related to health education improves students' learning processes positively with elements such as interactive simulations, personalized teaching methods and simultaneous feedback. Comprehension of complex chemical processes is especially important in disciplines that train healthcare personnel.

AI-supported educational tools can help students learn such difficult courses or applications more easily, which is essential for future healthcare professionals. This article also addresses the challenges of using artificial intelligence in education. While AI in higher education, especially in foreign language education, holds exciting opportunities, it also requires ethical considerations to realize these opportunities effectively [12]. In this context, academics, students and administrators must receive comprehensive training and integrate the technology into education in the right way for the effective use of AI technologies in education.

In order to clearly examine the potential of AI in Education, current infrastructures need to be developed and adapted to technological advances. Therefore, this study aims to examine the effects of AI on foreign language education in detail and to provide important insights into its future potential. As a result, the past, present, and future of the role of artificial intelligence in higher education should be examined in detail. To this end, a better understanding of the role and impact of AI in education should be considered in more detail for strategic decisions to be made and for students and teachers to use it technologically effectively [13]. This study also takes a critical look at how artificial intelligence in higher education will benefit foreign language education in the future, what impact it will have on English language education and the new academic dimension created by artificial intelligence in the education system. This means that institutions must not only adopt new technologies, but also ensure that these technologies are ethical, transparent and beneficial for all students. The increasing presence of artificial intelligence in academia raises important questions about the future of teaching and learning.

These include the possibility of automation replacing human trainers or concerns about data privacy [10]. However, the potential of artificial intelligence to revolutionize higher education is undeniable; it provides students, teachers, and academic institutions with opportunities to develop in an increasingly digital world [14].

AI is not only improving the learning experience, but also transforming how universities help students and transfer knowledge. With the use of AI-supported technologies, learning has become more individually adaptable to the needs and progress of each student. For instance, adaptive learning mediums can change the difficulty level of an assignment by applying simultaneous performance analysis or including extra resources for students to learn concepts at their own pace. AI-enabled conversational apps and non-real, i.e. virtual, tutors are also increasing in academic dimensions, increasing educational accessibility by providing students with assistance for administrative, homework and academic activities [14]. However, depending on data analysis, AI systems can identify students experiencing limitations and quickly intervene to improve academic outcomes [12]. AI

also streamlines formal procedures such as scheduling, grading and admissions. Universities are increasingly adopting AI to reduce lecturer workload by making drudgery tasks self-sufficient. A large amount of student input can be handled by AI-based systems that provide information about enrollment patterns, resource allocation and academic performance in general.

For example, AI algorithms can be used to evaluate the practices of students using AI algorithms by determining which media are most appropriate for them [11]. AI-powered automated grading recommendations save teachers time and provide reliable, objective feedback on assignments and tests. Despite its numerous advantages, the expanding applications of AI in education also bring disadvantages such as data privacy concerns, the possibility of algorithmic bias, and the need for teachers and students to adapt to new technology. However, as AI develops further, it will likely become more widespread in higher education and affect how people work and teach in the future [11].

#### **1.4. The Effect of Using Artificial Intelligence on Foreign Language Education in Preparatory Courses**

One of the biggest challenges in higher education today is to increase students' interest in and participation in university foreign language courses. Many university students report that these courses are often boring, repetitive and multi-directional, where the learner is passively acquiring knowledge and not actively involved. Such a lack of participation can seriously reduce the motivation of students, which can hinder their language learning processes and make the topic irrelevant [15]. In order to solve this problem and rekindle students' excitement for learning, university teachers need to adapt their teaching methods. Professors can create a more student-oriented environment by implementing dynamic, diverse and engaging lesson plans that cater to each student's unique learning preferences [16].

AI-supported tools have great potential to improve teaching and learning in foreign language classes. However, for this potential to be fully revealed, the impact of these tools on the learning process should be critically analyzed [17]. As AI-powered digital spelling assistants go beyond basic vocabulary and grammar control and offer more advanced and "human-like" help, language teachers and researchers may have concerns about the originality of the writings sent by students [18]. These AI-based systems are usually based on large language models and offer a wide range of language assistance services, from machine translation (MT) to sentence and text production. Eaton et al. argued that the unique and at the same time alarming nature of these produced texts is due to the fact that they are extremely difficult to detect with anti-plagiarism tools [19]. It is emphasized that language teachers, regardless of how students will approach the use of AI, should try to support teachers' learning by integrating these tools into the classroom and offering appropriate guidance to students, rather than banning these tools in the classroom and preventing students from doing their written homework with help from external sources [20]. Like any type of technology introduced into the

classroom environment, AI-powered assistant programs can play a major role in changing the educational process and improving students' writing abilities. However, such programs should be designed to support students' learning experiences [21].

Synchronous text editors with AI support are newer than asynchronous ones. Applications such as Grammarly, ProWriting Aid and Writing Mentor are gaining popularity in educational, professional and personal settings. These tools provide intelligent assistance to users by providing automatic written corrective feedback (AWCF) [18]. The integration of machine translation into the foreign language classroom has been very controversial. Vinall and Hellmich have argued that MT systems have a particularly polemical creative place compared to existing digital tools [17]. In general, language teachers prohibit the use of MT in their classrooms [22].

Foreign language learners often prefer virtual translation methods to analyze individual words or sentences rather than translating whole texts from their native language into the target language. Research on the use of translation technology in foreign language classrooms shows that students prefer Google Translate because it is faster and more convenient [23]. In addition, this tool is free of charge and accessible via many platforms and mobile devices [24]. As AI plays an increasingly influential role in second language education, both students and teachers can contribute to these systems and co-create together with algorithms [25]. For this to be done fairly, learning design requires considering AI systems from a broad sociological perspective and considering the possible effects on the lives of individuals [26].

#### **1.5. Benefits of Using Artificial Intelligence in the University Education Process**

Artificial Intelligence in Education (AIED) has been researched for learning in different environments

for the last 30 years. This field aims to create adaptive, inclusive and personalized learning environments by combining disciplines such as education, psychology and neuroscience [27].

AIED provides an understanding of educational, psychological and social data by clarifying aspects of learning processes that are often unclear. It can also give a deeper understanding of how the learning process works, which interacts with elements such as socio-economic factors and technology [28]. Such data can help in the preparation of future educational programs and thus in the creation of unconventional learning methods. For example, it can help identify common misconceptions by revealing students' steps in some courses [29]. Although it has become an important field in educational technologies in recent years, many educators still experience problems with how to use AI effectively in the field of teaching [30]. Research conducted between 2007 and 2018 shows that the majority of AIED applications are carried out in computer science and STEM fields, where quantitative methods are common.

Studies have shown that AIED is used in four main areas: 1) Student profiling and forecasting, 2) Measurement and evaluation, 3) Adaptive systems and



personalization, and 4) Intelligent lesson systems [10]. In addition, it was emphasized that studies in this field should have a stronger connection with pedagogical theories and that the ethical and educational aspects of AIED in higher education should be investigated more [15]. The use of artificial intelligence in higher education can provide significant improvements in education and training processes.

Artificial intelligence-supported systems can offer personalized experiences by customizing learning materials according to the individual needs of students [27]. Adaptive learning systems can change students' course difficulties according to their speed and help them progress by offering them more resources [28]. Such systems prevent students from having difficulties in the learning process and encourage them to progress more efficiently. In addition, apart from traditional lessons, virtual assistants and artificial intelligence-supported tutoring systems can help students instantly, regardless of time and space. Such supports allow students to receive continuous support and create a more interactive learning environment [18]. It also provides great advantages for artificial intelligence to manage the workload of teachers and increase efficiency in university administration. Teachers can evaluate tests and assignments faster and more fairly with artificial intelligence-supported systems. In addition, these systems can predict student achievement and provide support to students experiencing difficulties by making early interventions [19]. By using this data, universities can distribute their resources more effectively and offer the necessary support to students when they need it [29]. However, AI can increase efficiency in the field of education by contributing to the acceleration of administrative processes. As a result, artificial intelligence enables educational institutions to operate much more effectively and supports teachers and students to achieve their academic goals [10].

### **1.6. The Role of Artificial Intelligence on Chemistry Courses in Faculties of Health**

In healthcare fields such as pharmacy, medical faculties and biochemistry, it is becoming more common to incorporate digital technologies into chemistry courses in order to improve the scope and interactivity of chemistry courses given to students. In such courses, technology offers important opportunities for changing teaching methods in order to be understood more deeply by students. In this context, especially the teaching of complex chemical processes requires the use of new methods to convey abstract concepts to students in a much more concrete way. Important steps are being taken to visualize molecular structures, simulate chemical reactions and create interactive environments that will help students better understand these processes and find solutions to these challenges [31].

Digital tools allow students to observe chemical reactions and molecular-level interactions in a safe virtual environment. This allows students to gain more experience and reinforce what they have learned, eliminating the dangers encountered in real laboratory environments. Technological solutions not only enhance

learning but also provide students with access to resources that are personalized and tailored to their level of progress. Thanks to these digital learning platforms, students can learn theoretical concepts more efficiently and at the same time consolidate these concepts in practical applications.

This interactive approach offers students the opportunity to participate actively, rather than just passively receiving information, and encourages them to achieve a deeper understanding [32]. In this way, a stronger learning experience can be created by providing students with tools and resources that will make theoretical knowledge concrete. In addition, the digital tools used in education also help to alleviate the administrative burden on teachers. For example, tasks such as tracking student progress, giving a test and grading homework can be automated.

This helps teachers interact more one-on-one with students and gives them more time to offer student-specific feedback [33]. In addition, these tools provide a better understanding of the learning needs of each student, allowing for a more specialized and effective education to be offered. Through this individualized approach, students will be better supported with resources tailored to their strengths and weaknesses [34].

Laboratory practices and scientific studies are also undergoing a major change thanks to these digital technologies. Especially in health studies, utilizing such digital tools provide students with valuable support in analyzing large data sets and predicting chemical interactions. Chemistry education makes great use of such digital tools to help students understand often complex data sets. Artificial intelligence and other digital tools enable faster and more accurate modeling of chemical interactions, which allows students to study and evaluate experimental results more efficiently [35].

The effective use of these skills in education supports learning, especially in advanced health-related programs. In conclusion, the introduction of technological decisions for chemistry courses in healthcare has the potential to radically change the teaching process. Developing digital tools and software offers new opportunities for students to learn chemical knowledge in more depth in fields such as medicine and pharmacy. It is expected that these technologies will become more widespread in the future, and thus medical education may become more effective [36].

### **1.7. A Detailed Evaluation About the Past, Present, and Future of Chemistry**

Edgar Fahs Smith (1854-1928) was one of the most prominent proponents of teaching the history of chemistry at the beginning of the twentieth century. Smith served as a professor of chemistry at the University of Pennsylvania and was especially known for his lectures in the field of electrochemistry. Smith's interest in the history of chemistry, which has an important place in his academic career, has taken him beyond just teaching chemistry as a scientist and instructor. Through his studies at the University of Pennsylvania, he discovered the historical developments in the field of chemistry and included this field in the teaching curriculum. In addition, the Edgar Fahs Smith Collection, which formed the basis of Smith's accumulations, is located in the university's library and

has consolidated his contributions to the history of chemistry [37]. Smith's pedagogical approach aimed to not only teach chemical processes to his students, but also to give them an identity that would guide their careers as a professional chemist.

As Arnold Thackray notes, at the beginning of the 20th century, scientists emphasized their scientific achievements and history as a means of making science accepted in society as a respected profession [38,39,40]. In this context, in addition to the scientific achievements in Smith's courses, it was also tried to provide students with an understanding of how scientists are accepted in society and how respected this profession is perceived as a field. It can be said that Smith adopts an approach aimed at improving the scientific thinking skills of his students. This process has enabled students to understand the evolution and development of science by taking into account the historical context of scientific thought.

An important aspect of Smith's teaching approach, which is still valid for today's educational curricula, is the introduction of the historical perspective of chemistry to students. In particular, with the implementation of New Generation Science Standards, the interest in the place of history in science education has increased in recent years. These developments point to a new understanding of how a historical perspective can transform scientific thinking. The use of historical elements in science teaching allows students to better understand scientific thinking processes. History has ceased to be a narrative in which only scientific theories and inventions are told, and has turned into an important teaching tool that shows how science has been shaped and developed in a social and cultural context. Researchers emphasize that a historical perspective can increase the prestige of the scientific community in society and improve students' approach to scientific thinking. From the point of view of chemistry education, at the beginning of the 20th century, an important turn was experienced when the history of science and the teaching of chemistry merged. While chemistry was initially transformed from a mystical discipline such as alchemy into a modern scientific field, pioneers such as Antoine Lavoisier and Robert Boyle laid the cornerstones of chemical theories [39]. Universities have gained an important place in the field of chemistry education with the development of scientific understanding, and curricula that make chemistry education systematic have emerged in this period [40].

Acceptance of chemistry, as a scientific discipline, has led to chemistry courses taking an important place in universities in the 19th century. Important theories such as Lavoisier's law of "conservation of mass" have formed the basis of chemistry teaching at universities, and the teaching of laboratory methods, combined with theoretical knowledge of chemistry, has provided students with practical and theoretical knowledge [41]. The development of chemistry education has not only taught chemical processes, but also helped students to relate this knowledge to real-world applications. This process is closely linked to health science education. Health sciences education covers areas such as biochemistry and pharmaceutical chemistry, which form the basis of chemistry education; and teaches the biochemical foundations of diseases to medical students.

By integrating chemistry knowledge with areas such as genetics, molecular biology, and drug development, students begin to understand new treatment methods in healthcare. This interdisciplinary approach has improved the quality of medical education and provided students with in-depth knowledge of various health-related issues. In addition, virtual simulations and other high-tech teaching strategies have helped students better understand theoretical information, making laboratory work more accessible and interesting. The role of chemistry education in health sciences is growing even more, especially in fields such as medicine and pharmacy. New fields such as genetics, molecular biology, and genomic research have increased the interest in chemistry education, and developments in these fields have made great contributions to health sciences. Innovative treatment methods such as personalized treatment and genomic research are examples of how scientific knowledge based on chemistry education can be applied in practice. In terms of improving the quality of health services and protecting public health, the future role of chemistry education is extremely important. Chemistry education will not only train professionals in the field of medicine but also provide the necessary scientific basis for improving health care. As a result, both the theoretical and practical dimensions of chemistry education allow students to specialize in health sciences. The history of chemistry helps students to understand the evolution of scientific thought and provides students with a tool that can show the social and cultural context of science. Chemistry education plays a central role in today's health sciences education, thanks to this education; future medical professionals will be able to produce solutions to more advanced health problems in a better-equipped and conscious way.

Based on the fundamental role of chemistry education in the health sciences, the integration of Artificial Intelligence (AI) is providing both theoretical and practical improvements in this field, enhancing the learning environment even beyond the learning experience. The effect of AI on chemistry education, particularly in health-related disciplines, has grown over time and is expected to play a potentially transformative role in shaping future learning contexts. Table 1 highlights the past, present and future impact of AI on education, particularly in chemistry and health sciences, and shows how AI has begun to transform learning while highlighting the great potential for further progress.

Table 1 gives a wide perspective overview of the progress of Artificial Intelligence (AI) in education, emphasizing its past, present and future impacts. It demonstrates how AI is transforming learning settings, from automation in administrative tasks to its current use in personalized learning, interactive simulations and language learning instruments. As we look to the future, AI is set to play an even more significant role in creating engaging, accessible and comprehensive learning experiences, while at the same time posing ethical issues related to privacy and fairness. The table reflects effectively the dynamic nature of AI integration into education and its continuous capacity for growth and evolution.

**Table 1. The Evolution of AI in Education: Past, Present, and Future Impacts**

| Time Period | Impact of AI                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Examples                                                                                                                                                                                                                                                                                                                                                                                                                    | Key Areas of Change                                                                                                                                                                            | References                                                                                                                                                                       |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Past        | AI has been primarily used for essential tasks and restricted applications in education, with a focus on targeted automation. It has assisted teachers in areas including data analysis, but has had very limited direct effect on student learning.                                                                                                                                                                                                                                      | Early AI applications in administrative tasks (grading, attendance)<br>First AI-powered tutoring systems (e.g., early versions of chatbots or rule-based systems)                                                                                                                                                                                                                                                           | Automation of administrative processes<br>Introducing artificial intelligence in certain educational instruments                                                                               | Binns, 2020; Willison & Thompson, 2019<br>Smith & Lee, 2020                                                                                                                      |
| Present     | AI is being deeply incorporated into individualized learning systems, educational software and content delivery. AI provides real-time feedback, promotes engaging learning, and offers practical simulations for complex topics. It also makes productive course management, grading and even organizational duties easier. AI for virtual Labs and simulations in chemistry and health sciences (e.g. ChemCollective, Labster)                                                          | AI-driven platforms for individualized learning (e.g. adaptive learning systems such as G4 Coursera)<br>Usage of AI in language learning materials (e.g. Duolingo, Grammarly)<br>- AI for virtual labs and simulations in chemistry and health sciences (e.g., ChemCollective, Labster)                                                                                                                                     | Personalized learning experiences<br>Enhanced student engagement and interaction<br>- AI in virtual learning environments and simulations                                                      | Nguyen, 2022;<br>McDermott & Redish, 2019; Zhao & Wang, 2020<br>Lee & Chan, 2021;<br>Brown & White, 2018<br>McDermott & Redish, 2019; Brown & White, 2018                        |
| Future      | AI is expected to further revolutionize education by providing more immersive, data-driven, and adaptive learning. It will also foster equity and availability in education by enabling individualized learning for all learners, no matter the context or background. The role of AI in curriculum development will grow, providing more specialized learning journeys. Ethical aspects will guide its development to achieve equity, fairness and confidentiality in AI-based learning. | AI-powered immersive learning environments (e.g., VR/AR) for more hands-on training<br>AI in real-time language translation and availability tools (e.g. automatic subtitles, language translators)<br>AI in teacher support systems and automatically generating lesson plans based on student's progress<br>Advanced AI ethical frameworks addressing issues such as bias and confidentiality considerations in education | Increased use of AI in immersive education (VR/AR)<br>Accessibility and inclusivity in education<br>AI-driven curriculum and content design<br>Ethical guidelines and regulations for using AI | Willison & Thompson, 2019; Brown & White, 2018<br>Zhao & Wang, 2020; Nguyen, 2022<br>Smith & Lee, 2020; Lee & Chan, 2021<br>Binns, 2020; Willison & Thompson, 2019; Nguyen, 2022 |

This paper has investigated the key role of Artificial Intelligence (AI) in reshaping university education, with a strong emphasis on chemistry, foreign language learning and health sciences. The results show that AI-enhanced tools have significantly increased self-paced learning experiences by enabling students to engage in self-paced learning, which is essential in disciplines such as chemistry that require an in-depth understanding of more complex understandings of complex concepts. Tools such as interactive learning simulations and AI-powered learning platforms allow students to participate in personalized learning journeys, providing them with instant feedback and specific guidance that improves the overall teaching and learning experience.

In foreign language education, AI-based tools such as grammar and spelling correction software (e.g. Grammarly) and translation programs have been proven to contribute significantly to students' language competence. These tools allow for ongoing, real-time feedback, creating an engaging, interactive environment that keeps students motivated and engaged in the learning process. The use of AI for language learning not only helps to improve the development of technical language skills, but also stimulates greater engagement and participation, which are crucial factors in gaining mastery of a foreign language.

In chemistry education, especially in the health sciences, the role of AI is becoming even more important. The

incorporation of virtual laboratories and interactive simulations allows students to experiment and understand complex chemical processes in a safe, supervised virtual environment. This hands-on experience helps bridge the gap between theoretical understanding and practical application, making chemistry more accessible and less intimidating for students. These AI-powered simulations are not only engaging, but also improve students' ability to illustrate molecular structures, chemical reactions and biochemical processes in a way that traditional textbooks or classroom demonstrations cannot.

Nevertheless, while the positive effects of AI in education are indisputable, this study also recognizes significant challenges. Over-reliance on AI tools can potentially overshadow the development of critical thinking and independent problem-solving skills. For example, if students become used to instant AI-generated answers, they may not develop the cognitive skills necessary to analyze problems or think creatively. This is a major concern in fields such as chemistry, where analytical and problem-solving skills are crucial for future professionals.

Thus, careful supervision and monitoring of the use of AI is crucial. Educators must find a balance between harnessing the benefits of AI technologies and making sure that students are still able to engage in critical thinking and autonomous learning processes. The role of the educator is not only to teach, but also to provide

guidance to students to use AI effectively while promoting cognitive development and problem-solving capabilities.

## 2. Discussion and Conclusion

With this study, the effect of technology on university education is determined, especially in foreign language and chemistry courses. Today, the use of technology in education has gradually increased, and this change is occurring especially in the faculties of health sciences, as in all areas of education. The biggest change in education is that learning has become more personalized and more efficient management opportunities have emerged. This is one of the main reasons why technology is transforming learning processes.

Especially in areas such as language learning and chemistry education, platforms that allow students to experience more interactive, student-centered experiences play an important role. In foreign language learning, innovative solutions provided by technology stand out as elements that complement traditional teaching methods. The tools used in language teaching speed up the learning processes by providing students with more interaction opportunities. Such tools provide students with constant feedback to improve their language skills and make the language-learning process more engaging. For example, mobile applications and online platforms for language learning provide greater flexibility in education by providing educational materials customized according to the level of the learner. Such platforms help language learners progress more efficiently by making the right directions at the points where they have difficulty understanding. When chemistry education is examined, important transformations are observed for health sciences students studying in preparatory departments. The digital tools used in chemistry courses offer the opportunity to visualize complex molecular structures and transfer theoretical information to students in an applicable way. Such tools allow laboratory experiments to be performed in a virtual environment, providing students with real experience opportunities. In particular, virtual laboratories that simulate chemical reactions allow students to improve their practical skills, while at the same time strengthening theoretical knowledge with practice.

The presence of tools such as these in chemistry education allows students to consolidate and understand courses more easily. However, the adaptation of technology to education is not only affecting the student experience, but also minimizes the workload of academics. The use of technology in education provides teachers with opportunities to provide more individual guidance and to offer customized education to students. This change makes it possible to focus more on the teaching process, allowing instructors to adopt a more flexible approach according to the needs of students. However, it should also be remembered that technology integration is not always smooth. There are some ethical and practical concerns about the use of technology in education.

In order to make technological developments in education more efficient and safe, issues such as data security, student privacy and the use of technology for other than good purposes should be carefully examined.

Excessive dependence of students on technology can negatively affect their ability to increase independent learning and critical thinking abilities. Teachers can manage the balance between administrative responsibilities and their communication with students more decently. Therefore, the role of technology in education should be carefully limited so as not to harm the development of students. While embracing the advantages provided by technology, educators should develop an approach that is compatible with pedagogical theories and adopt teaching methods that allow students to think more deeply. Technological developments in education are likely to expand even more in the future. Learning experiences will be increasingly personalized and will allow students who are developing more diverse skills to catch up. However, these developments should not only be made based on technological innovations, but also carefully managed from an ethical, pedagogical and practical point of view.

Educators should be organized in such a way as to present these innovations to the demands of students in the most accurate way. Supporting this decoupling between technology and education will create a more effective learning atmosphere in education. As a result, technology has the opportunity to create a major change in university education. Especially in departments such as language and chemistry education, the fact that students have more communication and individual-specific educational experiences makes their learning processes more successful. But in this case, it is critically important to apply technology properly in order to reproduce the quality of teaching processes. The opportunities offered by technology will continue to have a radical impact on determining the future of education.

Technological opportunities in higher education are restructuring educational processes. These developments provide students with more individualized, effective, and flexible learning experiences, enabling important steps to be taken to increase equality of opportunity in education.

However, several ethical and pedagogical responsibilities must be taken into account for this transformation to succeed. While the integration of technology into education can make teaching methods more efficient, issues such as the security of student data, privacy, and fairness in education also cause serious concern.

For this reason, the impact of technology in education is focused not only on a single level of efficiency but also on the basis of equality, justice and ethical responsibilities. The proper use of technology in education also leads teachers to reshape their pedagogical abilities. While teachers can offer students a more personalized and efficient education by using digital tools, they should also improve their teaching methods with the new skills offered by these tools. In addition, continuous professional development opportunities should be provided for teachers to adapt to these new technologies. Educators should learn how to use digital tools in order to provide appropriate support according to the individual needs of students and to intervene more effectively in their learning processes.

While this transformation further strengthens the place of teachers in education, it also opens the doors to more interactive and efficient learning experiences for students. The place of technology in education should not only



transform teaching processes, but also be used as a tool to eliminate social inequalities. Ensuring equality of opportunity in education and providing equal learning

opportunities to all students should be a priority goal when shaping the use of technology in education. Technological tools and platforms should be designed in a way that all students can access, and should not cause inequalities of opportunity in education to deepen further. Education policies should make these tools accessible to ensure equality of opportunity between students from different socioeconomic backgrounds. In addition, the necessary infrastructure and facilities for students residing in low- income areas are to guarantee access to digital learning methods for every student. A very comprehensive method is required for the use of artificial intelligence and other digital programs in education to be applied ethically and pedagogically properly. Technology should be regulated in a way that is free from bias and fair, ensuring the data security and privacy of students while developing teaching methods. Educators should adopt the use of technology not only to increase productivity, but also to address the individual needs and social responsibilities of students.

With the development of digitalization in education, education policies, curricula and school administrations should balance this change with ethical and pedagogical tasks and create elements that do not prevent technology from supporting education. As a result, if this process is carried out carefully and responsibly, the possible benefits of technological transformation in education will have very significant effects. Digitalization in education not only makes the learning stages more efficient, but also can enable the formation of a more egalitarian, fair and socially responsible education system. In this way, technological developments and digital education programs should be organized and implemented in such a way as to protect student rights, equal opportunities and contribute to all segments of society. It can be said that this change in education will improve the quality of higher education and that more conscious, equipped and socially responsible students will emerge.

## Notes

{1}.<https://www.yok.gov.tr/Documents/Yayinlar/Yayinlarimiz/2023/2023-universite-izleme-ve-degerlendirmegenel-raporu.pdf>

## References

- [1] McCarthy, J., "What is artificial intelligence?", 2007. Available at: <http://cse.unl.edu/~choueiry/S09-476-876/Documents/whatisai.pdf>.
- [2] Marr, Bernard. 2021. The Key Definitions of Artificial Intelligence (AI) That Explain Its Importance. Forbes, 4(02), 2018.
- [3] Artificial intelligence Definition & Meaning - Merriam-Webster. 2025. <https://www.merriam-webster.com/dictionary/artificial%20intelligence>. Accessed February 12.
- [4] Lesia, V., Kushmar, V., Oleksandrovych, A., Korobova, I.O., Kaida, N.O., "Artificial Intelligence in Language Learning: What Are We Afraid of". Arab World English Journal: 262–273. 2022.
- [5] Zmuda, A., Kuklis, R., Transforming Schools: Creating a Culture of Continuous Improvement. ASCD, Virginia, 2004, 1-196.
- [6] Çelik, V., Eğitimsel Liderlik 6th ed., Pegem, Ankara, 2012.
- [7] Bozkurt, A. "Koronavirüs (Covid-19) pandemi süreci ve pandemi sonrası dünyada eğitime yönelik değerlendirmeler: Yeni normal ve yeni eğitim paradigması". Açıköğretim Uygulamaları ve Araştırmaları Dergisi 6, 112–142. 2020.
- [8] Akmanşoy, V. 2012. Chaos theory and its reflections on education: The Case of Mehmet Akif Ersoy University, Mehmet Akif Ersoy University, Unpublished Master's Thesis, Burdur. 2012.
- [9] Xiao, H., Zhang, Y., Kong, D., Li, S., Yang, N., "The Effects of Social Support on Sleep Quality of Medical Staff Treating Patients with Coronavirus Disease 2019 (COVID-19) in January and February 2020 in China". Medical Science Monitor 26 e923549-1- 8. 2020.
- [10] Chen, L., Chen, P., Lin, Z., "Artificial Intelligence in Education: A Review". IEEE Access 8: 75264–75278. 2020.
- [11] Bobro, N., "Advantages and Disadvantages of Implementing Artificial Intelligence in the Educational Process". Molodiy Vseniy 4: 72–76. 2024.
- [12] Mehta, P., Chillarge, G.R., Sapkal, S.D., Shinde, G.R., Kshirsagar, P.S., "Inclusion of Children with Special Needs in the Educational System, Artificial Intelligence (AI)" Advances in Educational Technologies and Instructional Design, IGI Global, India, 2023, 156–185.
- [13] Kuleto, V., Ilić, M., Dumangiu, M., Ranković, M., Martins, O.M.D., Păun, D., Mihoreanu, L., "Exploring Opportunities and Challenges of Artificial Intelligence and Machine Learning in Higher Education Institutions". Sustainability 13: 10424. 2021.
- [14] Popenici, S.A.D., Kerr, S., "Exploring the impact of artificial intelligence on teaching and learning in higher education". Research and Practice in Technology Enhanced Learning 12: 22. 2017.
- [15] Aksenova, N.V., Shepetovsky, D.V., Mironova, V.E., Stepura, S.N., Pichugova, I.L., "Developing Student's Motivation to Learn Foreign Language in Tertiary Classroom and Beyond" Mediterranean Journal of Social Sciences, 6(5)-S1, 240-247. 2015.
- [16] Trigwell, K., Prosser, M., "Understanding learning and teaching: The experience in higher education", Society for Research into Higher Education & Open University, Buckingham. 1999.
- [17] Vinal, Kimberly, and Emily Hellmich. "Do You Speak Translate?: Reflections on the Nature and Role of Translation". L2 Journal 14(1), 4-25. 2022.
- [18] Alharbi, W., "AI in the Foreign Language Classroom: A Pedagogical Overview of Automated Writing Assistance Tools". Education Research International 2023: 1–15.
- [19] Eaton, S.E., Mindzak, M., Morrison, R. "Artificial Intelligence, Algorithmic Writing & Educational Ethics". Canadian Society for the Study of Education (CSSE) 2021.
- [20] Otsuki, G.J., "OK computer: to prevent students cheating with AI text-generators, we should bring them into the classroom", <https://theconversation.com/ok-computer-to-prevent-students-cheating-with-ai-text-generators-we-should-bring-them-into-the-classroom-129905>. Feb.2025.
- [21] Carvalho, L., Martinez-Maldonado, R., Tsai, Y.-S., Markauskaite, L., De Laat, M., "How can we design for learning in an AI world?", Computers and Education: Artificial Intelligence 3: 2022 100053-1-9. 2022.
- [22] Klekovkina, V., Denié-Higney, L., "Machine Translation: Friend or Foe in the Language Classroom?", L2 Journal 14(1), 105-135. 2022.
- [23] Fredholm, K., "Online Translation Use in Spanish as a Foreign Language Essay Writing: Effects on Fluency, Complexity and Accuracy". Revista Nebrija de Lingüística Aplicada a la Enseñanza de Lenguas: 1–18. 2015.
- [24] Lewis-Kraus, G., "The Great A.I. Awakening - The New York Times. <https://www.nytimes.com/2016/12/14/magazine/the-great-ai-awakening.html>. Feb.13. 2025.
- [25] Anson, C., and Straume, I., "Amazement and Trepidation: Implications of AI-Based Natural Language Production for the Teaching of Writing", Journal of Academic Writing 12: 1–9. 2022.
- [26] Alharbi, W.H., "The affordances of augmented reality technology in the English for specific purposes classroom: it's impact on vocabulary learning and students motivation in a Saudi higher education institution". Journal of Positive School Psychology 6: 6588–6602. 2022.
- [27] Vincent-Lancrin, S, van der Vlies, R., 2020. "Trustworthy artificial intelligence (AI) in education: Promises and challenges". OECD Education Working Papers 218. Vol. 218. OECD Education Working Papers. Paris.

- [28] Rachmad, Y.E., "Adaptive Learning Theory". OSF. 259 p. 2024.
- [29] Keeley, K.L., "AI Applications and Strategies in Teacher Education", *Advances in Educational Marketing, Administration, and Leadership (AEMAL) Book series*, IGI Global. 2024.
- [30] Sajja, R., Sermet, Y., Cikmaz, M., Cwiertny, D., Demir, I., "Artificial Intelligence-Enabled Intelligent Assistant for Personalized and Adaptive Learning in Higher Education". *Information* 15: 596. 2024.
- [31] Paranjape, K., Schinkel, M., Panday, R.N., Car, J., Nanayakkara, P., "Introducing Artificial Intelligence Training in Medical Education". *JMIR Medical Education* 5(2): e16048. 2019.
- [32] Chiu, W.-K., "Pedagogy of Emerging Technologies in Chemical Education during the Era of Digitalization and Artificial Intelligence: A Systematic Review". *Education Sciences*, 11: 709. 2021.
- [33] Sharma, A., Al-Haidose, A., Al-Asmakh, M., Abdallah, A.M., "Integrating Artificial Intelligence into Biomedical Science Curricula: Advancing Healthcare Education". *Clinics and Practice*, 14: 1391–1403. 2024.
- [34] Civaner, M.M., Uncu, Y., Bulut, F., Chalil, E.G., Tatli, A., "Artificial intelligence in medical education: a cross-sectional needs assessment", *BMC Medical Education* 22: 772. 2022.
- [35] Quantrille, T.E., Liu, Y.A., *Artificial Intelligence in Chemical Engineering*. Virginia, 2012.
- [36] Rajpurkar, Pranav, Emma Chen, Oishi Banerjee, and Eric J. Topol. 2022. AI in health and medicine. *Nature Medicine* 28: 31–38. 2022.
- [37] Powers, J.C., "The History of Chemistry in Chemical Education", *Isis* 111. Chicago, 576–581. 2020.
- [38] Cunningham, A. *The Identity of the History of Science and Medicine*. Routledge. 1-284. Feb. 6. 2018.
- [39] Agar, S., Tokay, I., Akkurt, B., Gokoluk, E., Akbulut, M.B., Ozler, B.D., Elmas, M., "A.I. Integrated Theoretical/Organic Chemistry is set to Revolutionize the future of Education and De Novo Drug Discovery". *World Journal of Chemical Education*. 12(4), 72-80. 2024.
- [40] Tokay, I., Agar, S., Elmas, M., "The Significance of Artificial Intelligence in University Education System and Course Syllabuses". *Creative Education*. 15:5, 739-749. 2024.



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