

Artificial Intelligence and Adaptive learning for Learners with Hearing Impairments: Exploring Opportunities and Impacts

الذكاء الاصطناعي والتعليم التكيفي للمتعلمين ذوي الإعاقات السمعية: استكشاف الفرص والتأثيرات

L'intelligence artificielle et l'enseignement adaptatif pour les apprenants ayant des
déficiences auditives : exploration des opportunités et des impacts

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ملخص

تسعى هذه الورقة البحثية إلى تسليط الضوء على إسهام تطبيقات الذكاء الاصطناعي في تعزيز العدالة التعليمية، من خلال توفير بيئات تعليمية ذكية تناسب احتياجات المتعلمين من ذوي الإعاقة السمعية. وتُعدّ هذه الفئة من المتعلمين من بين الفئات التي تواجه تحديات في المسار التعليمي، خاصةً على الصعدين اللغوي والمعرفي، والتي تتفاوت حدّتها بحسب درجة الإعاقة. وتهدف الورقة إلى تحليل طبيعة الإعاقة السمعية وأشكالها وتأثيراتها المتعددة، إلى جانب استعراض السمات الأساسية لهذه الفئة واحتياجاتها التعليمية. كما تناقش الدراسة الإمكانيات التي توفرها تطبيقات الذكاء الاصطناعي في تصميم أنظمة تعلم مرنة وتفاعلية، قادرة على تكيف المحتوى التعليمي وتقديم الدعم المناسب، بما يساهم في تحسين فرص التعلم لدى المتعلمين ذوي الإعاقة السمعية.

الكلمات المفتاحية: تطبيقات الذكاء الاصطناعي؛ التعليم التكيفي؛ ذوو الإعاقة السمعية.

Abstract :

This research paper aims to highlight the contributions of artificial intelligence (AI) applications in promoting educational equity by creating intelligent learning environments tailored to the needs of students with hearing impairments. These learners often face substantial educational challenges, particularly in language development and cognitive skills, which vary based on the degree of hearing loss. The paper analyzes the nature and types of hearing impairments, their diverse impacts, and the core characteristics and educational needs of this group. It also explores the potential of AI technologies in designing flexible and interactive learning systems capable of adapting educational content and providing appropriate support ultimately enhancing learning opportunities for students with hearing impairments

Keywords: Artificial Intelligence Applications; Adaptive Learning; Learners with Hearing Impairment.

Résumé

Cet article de recherche vise à mettre en évidence la contribution des applications de l'intelligence artificielle à l'amélioration de l'équité éducative, en fournissant des environnements d'apprentissage intelligents adaptés aux besoins des apprenants ayant un handicap auditif. Cette catégorie d'apprenants fait partie de celles qui rencontrent des difficultés dans leur parcours éducatif, notamment sur les plans linguistique et cognitif, dont l'intensité varie en fonction du degré de la déficience. L'article a pour objectif d'analyser la nature de l'handicap auditif, ses formes et ses impacts divers, ainsi que de présenter les caractéristiques fondamentales de cette catégorie et ses besoins éducatifs. L'étude discute également des potentialités offertes par les applications de l'intelligence artificielle dans la conception de systèmes d'apprentissage flexibles et interactifs,

capables d'adapter le contenu éducatif et de fournir le soutien approprié, contribuant ainsi à améliorer les opportunités d'apprentissage des apprenants ayant un handicap auditif.

Mots clés : Applications de l'intelligence artificielle; éducation adaptative; les handicapé auditif.

Introduction

Artificial intelligence (AI) has become increasingly present in various domains of life, such as commerce, industry, economics, and many other sectors. The rapid advancement of AI technologies has enabled them to penetrate all fields, positioning AI as a serious competitor to human capabilities. It is now capable of performing complex tasks with high efficiency, which has encouraged its adoption in new fields, most notably education. AI is being used to enhance educational practices, not only for typical learners but also for those with special needs, with the aim of promoting educational inclusion, ensuring equal learning opportunities, and responding to the pressing need for adaptive educational models for these groups—especially students with hearing impairments. This particular group has long suffered from marginalization and a lack of access to their educational rights due to the impairment of one of the most vital senses in human life in general, and learning in particular: hearing. Hearing plays a crucial role in interacting with the world and communicating with others.

Learners with hearing impairments face dual challenges: limited auditory interaction and difficulty accessing educational content that is often not designed in a way that suits their needs. Hearing loss presents a significant obstacle in the educational context, as it deprives learners of one of the primary channels of interaction with teachers and learning materials. According to the study by (ABEDEL WAFI, 2022) on hearing impairment and its characteristics, such impairments have a noticeable and negative impact on language development, cognitive growth, and social-emotional development. However, these challenges do not necessarily constitute an insurmountable barrier to the integration and education of deaf and hard-of-hearing individuals provided that they receive appropriate support and accommodation.

Studies by (Al-Qahtani, 2024) and Helwan (2021) also indicated that students with hearing impairments face difficulties in reading comprehension and perform at lower levels compared to their hearing peers.

In this context, artificial intelligence applications have emerged as a promising solution to bridge this gap, offering a more equitable, adaptive, and visually-oriented form of education that respects the unique needs of this population. Studies by (Al-Qahtani, 2024) and (Hussein, 2025) demonstrated that AI can now deliver visual and interactive educational content specifically tailored for deaf and hard-of-hearing learners, through features such as automatic translation, sign language instruction, and real-time learner performance analysis. Numerous studies, including those by Alonzo (2023) and Issa (2020), have shown the success of strategies that integrate AI applications in overcoming many of the challenges imposed by hearing impairment.

AI offers a second chance for individuals with hearing impairments to succeed and achieve their goals, through intelligent learning programs that make the learning process more engaging and

responsive to each individual's abilities. These technologies respect the specific needs and nature of learners with disabilities, as well as the educational and instructional challenges they face.

AI aims to overcome these difficulties and support learners with hearing impairments in surmounting the obstacles posed by their condition, social environment, and surrounding circumstances. It does so by developing intelligent educational systems that diagnose and assess the performance of learners with hearing impairments, then design or adapt appropriate educational content based on the diagnostic results. This includes offering visual content, sign language-based materials, and other accessible formats.

Based on the foregoing, this research paper seeks to highlight the role of artificial intelligence applications in supporting adaptive education for students with hearing impairments, through addressing the following questions:

1. What is the role of AI in developing adaptive learning for learners with hearing impairments?
2. What are the most prominent AI applications that support adaptive learning for this category?
3. What challenges hinder the effective use of these applications?

1-Previous Studies

(Saleh, 2024) **conducted a study titled "The Role of Artificial Intelligence Applications in Adapting University Curricula for Students with Disabilities in Light of Sustainable Development Goals."**

The study aimed to explore the role of AI applications in adapting university curricula for students with disabilities, within the framework of sustainable development goals. A qualitative approach was adopted, and semi-structured interviews were used as a data collection tool. The sample included 10 faculty members and 10 students with disabilities at Taibah University. The findings revealed that the use of AI in adapting course content and aligning teaching methods was at a moderate level, while its role in modifying support services was relatively low. Nevertheless, AI played a significant role in adapting curricula for students with special needs, contributing to the delivery of content in innovative and diverse ways, and enhancing learner engagement. The study also emphasized the need to train both faculty and students in the effective use of AI applications.

(Al-Mansouri, 2024) **conducted a study titled "The Role of Artificial Intelligence in Educational Motivation for Deaf Students from the Perspective of Teachers."**

This study aimed to identify the role of AI in enhancing the educational motivation of deaf students, as perceived by teachers, by exploring the opportunities and challenges presented by AI technological developments. A descriptive approach was followed, with a sample of 45 teachers from Zayed Higher Organization. The results showed that AI plays an important role in motivating deaf students in the United Arab Emirates. The findings also revealed statistically significant differences based on gender regarding the evaluation of AI's role in this domain.

(Ahmed Abdel-Fattouh, 2024) **carried out a study titled "*The Effectiveness of a Program to Improve Reading Comprehension Skills in Children with Hearing Impairment Using Artificial Intelligence.*"**

The study aimed to highlight the effectiveness of AI in enhancing reading comprehension skills among children with hearing impairments. It was conducted on a sample of 7 sixth-grade students aged between 11 and 13 years. The researcher developed a custom reading comprehension test and implemented an AI-based educational program specifically designed for the study. The results confirmed the significance of AI in improving reading comprehension skills and highlighted the importance of training teachers in using such technologies, along with the need to provide the necessary tools and technological resources.

(Abeer & Sultan, 2024) **presented a study titled "*Artificial Intelligence Applications and Their Role in Achieving Cognitive Communication for Students with Disabilities at Assiut University.*"**

The study aimed to identify the importance of AI applications and the role of educational process components in supporting cognitive communication for students with disabilities at Assiut University, from the perspective of faculty members. The researchers adopted a descriptive methodology and used two tools for data collection: a questionnaire distributed to 315 faculty members from the colleges of Education, Arts, Social Work, Specific Education, and Law, and individual interviews with students with disabilities from the same colleges to understand their actual use of AI in enhancing cognitive communication. The results indicated a lack of availability and usage of AI tools among this group and stressed the importance of employing AI to improve their cognitive interaction.

From the review of previous studies, it is evident that there is growing interest in the role of AI in supporting the education of students with hearing impairments—particularly through curriculum adaptation, enhanced learning motivation, and improved reading skills. Saleh's study (2024) focused on adapting university curricula using AI technologies in alignment with sustainable development goals, showing that these technologies offer flexible and engaging educational content. Al-Mansouri's study (2024) demonstrated that AI significantly contributes to the educational motivation of deaf students by creating a more interactive and equitable learning environment, despite some challenges related to individual differences.

Maghawry's study (2024) confirmed the effectiveness of AI in improving reading comprehension skills through a specially designed smart training program. Meanwhile, the study by Al-Tawil and Sultan (2024) addressed the importance of AI applications in achieving cognitive communication among students with disabilities at Assiut University, highlighting the lack of available tools and thus emphasizing a gap in actual AI deployment within university settings.

Based on the above, it can be concluded that most previous studies relied on descriptive or experimental methodologies and focused either on academic aspects (such as curriculum adaptation or comprehension improvement) or on motivational and cognitive elements. However, there remains a need for comprehensive studies that integrate various dimensions of the educational process through AI within the framework of adaptive learning, particularly for students with hearing impairments who

face complex challenges in linguistic and cognitive interaction. This is where the importance of the current study lies—in exploring the true potential of AI applications in providing effective adaptive education for this group and analyzing the key challenges that hinder the educational implementation of such technologies.

2 - Hearing Impairment

2-1 Definition of Hearing Impairment:

Hearing impairment encompasses varying degrees rather than a single level. Individuals may be classified as having *limited hearing* or as experiencing *deafness*. A person with limited hearing typically suffers from hearing loss ranging between **35 to 69 decibels (dB)**, which makes it difficult for them to comprehend speech relying solely on auditory input. In contrast, a *deaf* person is defined as someone with a hearing loss of **70 dB or more**, which prevents them from depending on their sense of hearing to understand speech, even with the use of hearing aids (Kawafha, 2003)

Accordingly, a hearing-impaired individual is someone who suffers from either partial or total loss of hearing—in other words, a person who is unable, either fully or partially, to hear, comprehend, and interpret sounds naturally through the use of their ears.

2-2 Educational Classification of Hearing Impairment:

The educational classification of hearing impairment links hearing loss to the development of speech and language, and it is categorized as follows:

- **Prelingual Deafness:** This type of deafness occurs before the acquisition of language and speech. It is often congenital, but may also be acquired in early childhood. Children in this category are affected in their ability to speak and articulate language because they have not been exposed to spoken language in a way that facilitates its natural acquisition.
- **Postlingual Deafness:** This refers to hearing loss that occurs after the individual has already acquired language and speech. It is known as acquired deafness or deafness occurring after language acquisition (Al-Qamash, 2007)

2-3 Types of Hearing Impairment:

There are four main types of hearing impairment, as outlined below:

Conductive Hearing Loss: This occurs due to repeated ear infections or blockages in the air conduction pathway of the external ear canal or the outer and middle ear. Such blockages—often caused by wax or other substances—result in conductive hearing loss . (Al-Zureikat, 2003)

Sensorineural Hearing Loss: This type of hearing loss arises from a dysfunction in the inner ear or the area between the inner ear and the brain, despite the external and middle ear being intact. It impedes the transmission of sound waves to the inner ear, regardless of their intensity or direction. (Al-Hawamdeh, 2019)

Mixed Hearing Loss: This occurs when both the outer/middle ear and the inner ear are affected, and is referred to as *mixed sensorineural hearing loss*. The severity of this type ranges from mild to moderate to severe, depending on the nature and extent of the damage .(Abdel-Hay, 2001)

Central Hearing Loss: This type results from dysfunction that prevents sound signals from being transmitted from the brainstem to the auditory cortex, or from damage to the brain areas responsible for hearing. Causes may include tumors, strokes, or congenital/acquired neurological conditions (Al-Samadi, 2018)

2-4 Characteristics of Individuals with Hearing Impairments:

Linguistic Characteristics:

Hearing impairment significantly affects an individual's language development and has a negative impact on the acquisition of spoken language. Hearing-impaired individuals often perform poorly on verbal intelligence tests, and the severity of their language difficulties is closely linked to the degree of hearing loss—the more severe the impairment, the greater the linguistic challenges. This can be attributed to several factors, including:

- The absence of appropriate verbal reinforcement for the sounds produced by the hearing-impaired individual.
- The inability to imitate sounds due to the lack of access to auditory models. (Ali, 2010)

Academic Characteristics:

Hearing impairment frequently influences the individual's cognitive and educational development, often resulting in lower academic achievement compared to their non-disabled peers—even when their intelligence level is average or above average (Al-Otaibi, 2018) . (Malkawi, 2008) also points out that the academic performance of children with hearing impairments is negatively affected in areas such as reading, science, and mathematics due to delayed language development, reduced motivation, and unsuitable teaching methods.

Cognitive Characteristics:

Non-verbal intelligence tests have shown no significant differences between hearing-impaired individuals and their typically developing peers. However, the intellectual performance of deaf individuals varies when verbal tests are used. Key cognitive traits of this group include:

- The ability to learn and engage in abstract thinking, provided the hearing impairment is not accompanied by brain damage.
- Deaf individuals' conceptual understanding is generally similar to that of hearing individuals, except in the area of language-based concepts.
- They tend to learn more effectively through the use of other senses such as vision and touch (Mohamed, 2011)

5-2 Needs of Individuals with Hearing Impairments:

Due to their unique nature and characteristics, individuals with hearing impairments require a range of specialized services and training programs, including:

- Preserving residual hearing abilities through training that enhances sound discrimination skills.
- Learning sign language, practicing speech articulation, and developing lip-reading and phonetic skills.
- Providing psychological support to reduce anxiety and promote social, educational, and cultural inclusion with hearing peers.
- Adapting curricula according to the nature of the impairment and incorporating visual aids.
- Modifying the classroom environment physically, including aspects such as lighting, ventilation, and class size. (Abdul Jawad, 2012)
- Simplifying information and linking it to examples from the learner's immediate environment.
- Expanding the learner's vocabulary before school enrollment.
- Diversifying instructional methods with a focus on visual materials such as drawings and mind maps.
- Promoting hands-on activities to enhance practical skills and encourage application-based learning. (Al-Hassani, 2020)
- Accordingly, individuals with hearing impairments require numerous modifications to both the educational and social environments in order to help them adapt effectively and gain access to appropriate and impactful learning experiences.

3- Artificial Intelligence

3-1 Definition of Artificial Intelligence:

Liu (2021) defined Artificial Intelligence (AI) as a branch of technology that relies on advanced techniques from various fields such as mathematics, computer science, statistics, data science, and intelligent computing. AI aims to enable systems to simulate human capabilities such as acquiring knowledge, learning, thinking, planning, perception, communication, and decision-making. Liu also noted that AI possesses several advantages in areas like intelligent decision-making, deep learning, and rapid and accurate data analysis, making it an effective tool for processing large volumes of information and identifying valuable patterns. (Al-Balawi, 2024)

Accordingly, Artificial Intelligence can be understood as a collection of systems and software designed to perform tasks that typically require human intelligence, such as analysis and decision-making. These systems are programmed to emulate human cognitive abilities and execute complex functions autonomously and intelligently.

3-2 The Importance of Artificial Intelligence for People with Special Needs:

AI applications are no longer confined to the field of information technology; they now play a pivotal role in various sectors, particularly in education. These applications are especially important for individuals with special needs and their families, as they offer advanced educational and rehabilitative solutions that help overcome many of the challenges they face. The key areas of importance can be summarized as follows:

- **Designing Individualized Educational Programs:**

AI systems can prepare personalized educational plans tailored to each student's abilities and specific needs.

- **Providing Specialized Support Services:**

These applications can deliver individualized support appropriate to each type of disability, thereby enhancing the quality of services offered.

- **Supporting Inclusive Education Environments:**

AI tools facilitate inclusion within schools—whether at the level of school management or classroom activities and curriculum delivery—by simulating the role of the teacher in conveying content to students.

- **Enhancing Psychological and Social Integration:**

AI-based applications contribute to fostering positive interaction and integration of individuals with special needs in personal, academic, and social contexts.

- **Contributing to Rehabilitation Programs:**

Several AI-supported applications have been employed to support various groups. For example, for the hearing impaired, applications such as *StorySign*, *Live Transcribe*, and *Listen at Home* have proven helpful. For individuals with visual impairments, specialized apps like *Be My Eyes* enable greater independence in performing daily tasks . (Makari, 2023)

3-3 The Integration of Artificial Intelligence in the Teaching-Learning Process:

Thomas et al. (2023) indicated that the use of Artificial Intelligence (AI) in education is expanding significantly and is still considered a relatively new domain for both academics and practitioners. AI in education can be categorized into four main areas: learning, teaching, assessment, and educational administration.

A. AI in the Field of Learning:

- Customizing learning tasks based on each student's individual abilities and competencies.
- Facilitating interaction through intelligent human-machine conversations.
- Analyzing student performance to provide immediate and effective feedback.
- Supporting dynamic adaptation to digital environments and interactions.

B. AI in the Field of Teaching:

- Offering adaptive instructional strategies tailored to the diverse capabilities of learners.
- Assisting teachers in enhancing instructional methods and improving their competencies.
- Supporting ongoing professional development for educational staff.

C. AI in the Field of Assessment:

- Implementing accurate and rapid electronic grading mechanisms.
- Predicting students' future performance levels.

D. AI in Educational Administration:

- Enhancing administrative performance and improving the efficiency of digital management platforms.
- Providing customized academic and non-academic services to meet students' individual needs.

Supporting decision-makers in making more accurate and effective educational decisions. (Makari, 2023)

3-4 The Role of Artificial Intelligence in Assisting Students with Hearing Impairments to Adapt to Educational Content:

Artificial Intelligence plays a vital role in helping learners with disabilities adapt to and comprehend educational content through the use of instructional media that respects the sequencing of lessons within the curriculum. This approach emphasizes learning through action, includes learner assessment, and identifies progress and acquisition levels.

- AI-based tools offer learners opportunities for interaction and active participation.
- They provide practice and training on skill performance, which helps reinforce acquired knowledge.
- These tools stimulate learner interest and motivation by simplifying and clarifying information in ways not possible through traditional teaching methods.
- They are easily accessible at any time and place, and for all learner groups.

What distinguishes intelligent multimedia educational programs designed for students with hearing impairments is their silent nature. These programs rely on still/moving images, static/animated graphics, written text, and sign language. Such tools allow deaf learners to interact with the content in ways that develop their skills and abilities. Moreover, they generate detailed reports on learners' strengths to further enhance them and identify weaknesses for targeted remediation. They can also provide feedback about the challenges learners face during the learning process and offer guidance to overcome these challenges and improve performance . (Al-Hassani, 2020)

3-5 AI Mechanisms in Supporting Adaptive Education for the Deaf and Hard of Hearing:

Artificial Intelligence technologies assist individuals with hearing impairments in overcoming the challenges they face by adapting educational curricula to suit learners' specific needs through the following:

- **Personalized Learning:**

AI systems analyze each learner's individual abilities—including strengths and weaknesses, type of impairment, and learning pace—to deliver educational content specifically tailored to their characteristics. This includes the use of multimedia such as audio texts, visual illustrations, and interactive clips. The difficulty level of educational tasks and activities is also adjusted based on learners' capacities, which enhances their active engagement.

- **Enhancing Communication and Interaction:**

AI technologies facilitate the development of tools that improve communication between learners with disabilities and their teachers. For example, sign language can be translated into written text and vice versa, thus enhancing interaction with deaf learners. Additionally, virtual assistants offer interactive features allowing students to ask questions and receive immediate explanations.

- **Assessment and Feedback:**

AI-based systems continuously evaluate learners' performance and provide real-time feedback, helping them identify their strengths and work on areas needing improvement. These systems also contribute to the early detection of learning difficulties, enabling prompt intervention and appropriate support.

- **Psychological and Social Support:**

AI applications contribute effectively to the psychological and social well-being of students with disabilities. They can interact with intelligent chat programs that allow them to express emotions, receive advice, and access support when needed. Furthermore, AI facilitates the creation of virtual support groups where students can share experiences and communicate with peers facing similar circumstances, thereby fostering a sense of belonging and appreciation.

- **Expanded Learning Opportunities:**

AI increases learning opportunities by providing students with disabilities equal chances for academic growth.

- **High-Quality Personalized Instruction:**

It delivers tailored, high-quality education that respects individual differences.

- **Increased Learner Autonomy:**

AI enables more flexible, independent learning, reducing the constant need for direct assistance.

- **Time and Effort Efficiency:**

It reduces the teacher's workload, allowing greater focus on pedagogical aspects. (Saleh, 2024)

3 -6 AI Applications Supporting Adaptive Learning and Interaction for Individuals with Hearing Disabilities:

Artificial intelligence technologies have brought about a significant transformation in supporting individuals with hearing impairments, particularly in enhancing communication and interaction with society. This has been achieved through a range of smart applications that utilize speech recognition, real-time translation, and text conversion. Among the most prominent applications are:

- **Ava:** Ava is a leading application for real-time conversation transcription, enabling deaf or hard-of-hearing individuals to actively participate in group discussions by converting spoken speech into written text in real time. It is highly accurate in distinguishing between different speakers and automatically adds punctuation. Users can also customize the dictionary according to commonly used terminology. Ava supports integration with presentation tools and virtual conferencing platforms.
- **RogerVoice:** Developed in France, RogerVoice offers real-time transcription of phone calls and daily conversations in over 90 languages. It allows users to read what is being said on the screen during conversations, eliminating the need for lip-reading. Additionally, users can reply using typed text, which the app then converts to speech for the listener.
- **StorySign:** This app supports deaf children in acquiring reading skills by using AI and a smartphone camera to translate the text in children's books into sign language via a 3D animated character. Developed in collaboration with the European Union of the Deaf, StorySign is an interactive educational tool that motivates children to comprehend and engage.
- **Microsoft Translator:** Offered by Microsoft, this application provides real-time translation in over 70 languages. It converts speech directly into written text and, when integrated with other applications, can translate into sign language. It also supports live translation during meetings and lectures, fostering a more inclusive and integrated learning environment. (Abeer & Sultan, 2024)
- **Dragon NaturallySpeaking (Dragon Speech Recognition):** One of the most powerful speech recognition applications, it uses precise algorithms to convert speech into written text quickly and accurately. It can be used for writing, lecture note-taking, or replying to messages without the need for a keyboard—particularly useful for hard-of-hearing individuals who struggle with fast written communication.

These applications help to:

- Break the barriers of silence and improve communication in classroom environments.
- Provide flexible learning that adapts to students' abilities.
- Enhance understanding and interaction between students and teachers.
- Strengthen independence and self-confidence among students with hearing impairments.

Furthermore, (Abeer & Sultan, 2024) indicated that AI applications can help individuals with hearing impairments overcome their learning challenges by adapting educational content to suit their needs through the following mechanisms:

- **Automatic Transcription and Captioning:** AI-supported transcription and captioning services have revolutionized access to audio content for individuals with hearing impairments by automatically converting spoken words into written text. For example, platforms like YouTube offer auto-generated captions using AI algorithms, making content more accessible.

- **Real-Time Translation:** Real-time translation is among the leading AI applications in improving access to conversations and events, especially when provided in multiple languages. Using speech recognition and machine learning algorithms, spoken words can be instantly translated into written text or sign language, enabling active participation for the hard of hearing in educational settings.
- **Audio Visualization and Tactile Feedback:** AI technologies convert audio content into visual or tactile formats, allowing the hard of hearing to perceive sounds in alternative ways. For example, the company “NewSensation” developed a smart bracelet worn on the wrist that transforms sounds into vibrations, enabling users to "feel" their surrounding sounds.
- **Personalized Sound Enhancement:** AI algorithms allow for the customization and improvement of sound quality according to individual needs. By analyzing a user's auditory profile, frequencies that require amplification or adjustment are identified, enhancing the listening experience. An example is the “Sound Amplifier” app, which amplifies necessary frequencies to help individuals with hearing loss understand conversations more clearly.
- **Audio Description and Visual Recognition:** Computer vision algorithms are used to identify visual content and provide real-time audio descriptions. This is particularly helpful in multimedia-rich educational environments, allowing students with hearing impairments to follow explanations and visual scenes interactively through a combination of images and descriptive narration.

3-7 Challenges Associated with the Use of Artificial Intelligence in the Educational Field

Despite the significant advancement of artificial intelligence (AI) and its expanding applications, its implementation in the educational context still faces several obstacles that hinder its optimal utilization. The most prominent challenges include:

-Lack of qualified personnel: There is a clear shortage of specialists and trained individuals capable of handling AI systems, which limits their effective application within educational institutions.

-Weak technological infrastructure: Some educational environments still lack essential components, such as modern computers, high-speed internet, and suitable educational software.

-Need to develop teachers' skills: Integrating AI requires training teachers and enhancing their skills so they can keep pace with digital developments and incorporate computer technologies into their teaching methods.

-Complexity of converting human knowledge into programmed data: Translating human expertise into codes or algorithms used in smart systems is a complex technical challenge, as it is sometimes difficult to express tacit knowledge in precise digital form.

-Weak natural language processing in Arabic: AI technologies face difficulties dealing with Modern Standard Arabic due to the presence of foreign terms, abbreviations, and diverse linguistic styles, which affects the language performance of these systems.

-Lack of awareness: Both teachers and students often lack awareness of the benefits of AI applications, leading to hesitation or reluctance to adopt them.

-Absence of motivation among some faculty members: Some educators lack conviction regarding the positive impact of AI on improving their educational practices.

-Lack of specialized training programs: There is a shortage of training programs focused on integrating AI into classrooms, creating a significant gap between technological potential and educational needs.

-Insufficient maintenance and updating services: The lack of technical support and software updates reduces the effectiveness of educational technologies and discourages users from relying on them. (Makari, 2023)

Conclusion

Based on the above, it can be affirmed that artificial intelligence, through its various applications, serves as an effective tool for achieving educational equity. It is not limited to a particular group but rather opens learning opportunities for marginalized populations. As education is a fundamental right for every individual, employing these technologies in the education of individuals with hearing impairments contributes to improving their performance, academic level, and skills—thus enhancing the overall effectiveness of the educational process directed toward the

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