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THE EVOLUTION OF DIGITAL INTELLIGENCE IN EDUCATION

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Abstract

In recent years, digital intelligence has developed significantly and plays an important role in the transformation of education. The research method conducted in this study is literature. The results show that advances in educational technology such as AI, VR, and the use of big data have provided innovative instruments to facilitate a learning process that is more of being split into autonomous and specialised. The adoption of these new tools seems to increase interaction and personalization in learning, providing opportunities for students to learn at their own time and pace. However, the literature also notes the challenges faced, including unequal access to technology, the need for infrastructure adaptation, and the demand for teacher capacity building. The results show that students who have complete and supportive access to digital intelligence show improvements in academic engagement and achievement.

Keywords: Evolution, Digital Intelligence, Education

Introduction

In the era of globalization and industrial revolution 5.0, advances in information and communication technology (ICT) have changed various aspects of human life, including education. The integration of technology into education not only allows the teaching and learning process to be more interactive and engaging, but also opens access to unlimited learning resources, enabling personalized learning tailored to the needs and learning pace of each individual (Sitepu et al., 2022); (Hairiyanto et al., 2024). Furthermore, these changes support the development of essential skills such as digital literacy, critical thinking, and teamwork, all of which are indispensable for competition in the 21st century (Ali, 2023). Therefore, adapting to technological developments in education is not only a step to improve the quality of learning, but also an important investment in preparing future generations to succeed and adapt in an ever-changing environment.

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Digital transformation introduces the concept of digital intelligence, which includes the ability to understand and use digital technologies effectively. Digital intelligence refers to a person's ability to access, manage, understand and communicate information through digital technology (Anele, 2024). The influence of ICT can be seen in the way learning is increasingly easy and accessible from anywhere, allowing students and educators to access various learning resources and online learning platforms. This provides opportunities for more flexible and adaptive learning, where students can learn according to their personal rhythm and needs, as well as allowing educators to customize learning materials to meet the individual needs of each student (Bakar, 2024).

In addition, information and communication technologies also encourage wider knowledge exchange and collaboration without geographical boundaries. Digital intelligence is not only limited to the ability to use devices or software, but also involves critical skills in assessing the reliability of information sources and using data ethically (Bickley, 2023). Through online forums, social media and other digital collaboration tools, students and educators can expand their networks and collaborate on a global scale, fostering innovation and creativity. This, in turn, has a positive impact on the formation of adequate digital intelligence, paving the way for a generation that is better equipped to face the challenges of an ever-changing world at the pace demanded by the times (Biswas, 2023).

The impact of the evolution of digital intelligence on education is significant, affecting the way teachers teach, the way students learn, and the structure of the curriculum offered by educational institutions (Bramantyo, 2023).

These changes encourage educators and learners to adopt new methods that are more interactive, adaptive and flexible. Computer-based learning, e-learning, collaborative learning through social media, and the use of games and simulations are concrete examples of technology utilization in education. Through the implementation of digital intelligence, educational goals such as increasing student engagement, personalizing the learning process, and improving learning effectiveness can be achieved more efficiently (Briganti, 2023).

However, the transition to digital education also poses new challenges, such as the digital divide between students from different economic and geographical backgrounds, resistance to change on the part of educators, and the need for adequate technological infrastructure. In addition, the digital capabilities of teachers and students are critical in determining the successful integration of digital intelligence in education (Buday et al., 2023); (Chattopadhyay & Das, 2022).

Seeing the great potential and challenges that exist, there is a need for an in-depth study of the evolution of digital intelligence in education. Tracing the development of technology, exploring the application of technology in learning, and identifying the supporting and inhibiting factors for the effectiveness of digital intelligence in education is important. This research will provide insights into how the world of education can

optimally utilize digital intelligence and what strategies can be applied to overcome the challenges that arise.

Research Methods

The study conducted in this research uses the literature research method. The literature research method is a systematic approach in reviewing and analyzing written publications or source documents related to a research topic (Abdussamad, 2022); (Adlini et al., 2022). The aim is to gain an in-depth understanding, identify trends, and assess gaps in existing research on an issue. This process involves several key steps, including the formulation of research questions, collection of relevant literature sources, evaluation of the quality and relevance of sources, and synthesis and analysis of findings (Afiyanti, 2008); (Ainiyah, 2021).

Results and Discussion

Digital Intelligence

Digital Intelligence, also often referred to as Digital Intelligence, is a set of social, emotional, and cognitive competencies that enable individuals to face challenges and adapt to the demands of living, working, and learning in a digital-based society (Chen, 2024). Digital Intelligence encapsulates the technical knowledge as well as the practical skills required to use digital devices, applications, and networks in an ethical, safe and effective manner. It includes the ability to recognize and manage information, create digital content, communicate with other users, understand digital ethics and exercise good citizenship in the online world (Dai et al., 2020).

The components of Digital Intelligence can be divided into several key domains, including information and IT literacy, communication and collaboration, digital citizenship, online ethics, personal safety and problem-solving, digital leadership, and digital life balance. It also emphasizes the importance of a critical and reflective attitude towards digital media, including awareness of privacy rights and the impact of technology on social and personal life (Dawson, 2020). This combination of skills forms the foundation for individuals to be able to adapt to the rapid and constantly changing technological developments, and participate productively and responsibly in a digital society (Dayathilake, 2023).

Several models of digital intelligence have been developed to summarize and systematize the components incorporated in this concept. One well-known model is the "Digital Intelligence Quotient" (DQ) developed by the DQ Institute in collaboration with the Organization for Economic Cooperation and Development (OECD) and various other global entities (Dedaj, 2024). The DQ model categorizes digital intelligence into eight key areas: digital identity, digital usage, digital security, digital communication, digital literacy, digital content, digital rights and responsibilities, and digital health. The model aims to guide individuals of all ages in developing their digital competencies and navigating the challenges that arise in an increasingly connected world (Delnevo, 2023).

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Both "Digital Intelligence Quotient" (DQ) and "Nine Elements of Digital Citizenship" offer comprehensive frameworks for individuals and educational institutions to develop and assess digital competencies (Rodrigues, 2023). The importance of these models lies in their ability to assist individuals not only in honing technical skills, but also in understanding the ethical and social responsibilities that come along with the use of technology. This creates the basis for the establishment of a responsible, inclusive and dynamic digital culture that is essential for the well-being of individuals and society at large (Fowler, 2023).

The ever-changing advancement of digital technologies requires individuals to constantly update and develop their digital competencies. Digital intelligence education from an early age lays the foundation for skills that will be required for a lifetime of interacting with new technologies and unimagined challenges (G & Vijayakumar, 2021). Schools, universities and other organizations are urged to integrate digital intelligence models in their curricula and professional development programs. In this way, they not only provide tools for academic and professional success but also promote digital health, online safety, and responsible digital citizenship. Digital intelligence, therefore, becomes a key essential in navigating the complexities of today's and tomorrow's digital world (Tubagus et al., 2023); (Aslan & Shiong, 2023).

Evolution of Technology in Education

The integration of technology in education has become a crucial element in developing effective teaching and learning in this digital age. The use of innovative technological tools and applications not only supports deeper student engagement, but also enriches the learning experience by providing access to unlimited resources and information (Gallon, 2024). Educational technology, or EdTech, enables personalization of learning, where students can learn according to their own pace, style and learning needs. Tools such as learning management platforms (LMS), educational apps and adaptive technologies facilitate the creation of inclusive and dynamic learning environments. Communication and collaboration among students as well as between students and teachers can be strengthened through the use of forums, virtual group problem solving, and collaborative projects, allowing learning to be more interactive and meaningful (Garai-Fodor & Csercsa, 2022).

Furthermore, the integration of technology in education also supports the development of digital intelligence which is important for students. By being exposed to digital and online tools from an early age, students learn about online safety, digital ethics and digital citizenship while honing their technical skills and digital literacy (Gayoso-Cabada, 2024). Teachers play a critical role in guiding students in using technology responsibly and effectively, integrating best practices into the curriculum, and preparing students for life and careers in this constantly connected and changing world (Gazzawe, 2023). Therefore, ongoing teacher training and professional development in technology and innovative teaching methods are essential to ensure that education remains relevant, responsive and able to meet future challenges.

One of the latest technology trends that has had a significant impact on education is the adoption and implementation of artificial intelligence (AI) and machine learning. These two technologies open up new opportunities in personalization of learning, automation of assessment, and identification of individual learning needs (Gervais, 2023). With AI, education systems can offer course recommendations and materials tailored to each student's learning style and pace, enabling a more flexible and adaptive approach to education. In addition, AI helps in the development of learning tools that can adjust the difficulty level of learning materials in real-time based on students' abilities, support language teaching through chatbots, and even help researchers gain valuable insights from large educational data sets (Goroshko, 2024). Thus, artificial intelligence not only drives efficiency in education operations but also contributes to the creation of learning experiences that are more inclusive, interactive, and support the achievement of better learning outcomes for all students.

Learning Approaches in the Digital Age

Computer-based learning and e-learning are two aspects of educational technology that have reshaped the way material is taught and learned in modern educational environments. Computer-based learning uses software, applications and programs to deliver learning materials, allowing students to interact with content directly through their devices (Grinschgl, 2023). It facilitates independent and self-paced learning, where students can control the pace and sequence of their learning, making it a highly flexible and customized method. In addition, computer-based learning often comes with instant feedback and assessment, which helps students in understanding concepts better and teachers in monitoring learning progress. Simulation tools and educational games also provide an engaging and interactive method to understand complex concepts, making learning more interesting and facilitating knowledge absorption (Hanji, 2021).

Meanwhile, e-learning extends the concept of computer-based learning by utilizing the internet to provide access to learning resources from anywhere at any time. Through e-learning platforms, students can access learning videos, online courses, webinars and other digital resources, enabling learning that is not limited by geographical boundaries (Healy & Walshe, 2020). This is particularly advantageous in today's global context, where

resources and expertise can be widely shared among educational institutions around the world. E-learning also supports hybrid and flipped learning approaches, where learning materials can be accessed before class meetings to maximize the time of direct interaction with the instructor (Hörmann, 2024). Thus, computer-based learning and e-learning not only increase the flexibility and accessibility of education but also enrich the learning experience with diverse technologies and teaching methods.

Furthermore, social media has emerged as a powerful tool in supporting collaborative and interactive teaching, remodeling the way students and teachers communicate and collaborate. Platforms such as Twitter, Facebook, and LinkedIn, as well as education-specific tools such as Edmodo and Google Classroom, enable the creation of online learning communities where students and teachers can share resources, discussions, and real-time feedback (Iddagoda, 2024). The use of social media in teaching allows for a more open and inclusive dialog, breaking down walls between teachers and students as well as between the students themselves. Peer-to-peer collaboration through social media supports social learning and constructivism, where students are active in constructing new knowledge through interaction with their peers and context. This initiative emphasizes the importance of collaborative learning and strengthens communication and cooperation skills, which are crucial in the 21st century (Ivanova, 2023).

Furthermore, social media has facilitated the development of student-centered interactive teaching approaches, where the two-way flow of information between teachers and students and among students provides a more dynamic and responsive learning experience. Teaching techniques such as project-based learning, online brainstorming and virtual debates using social media can stimulate students' active participation and encourage deeper engagement with learning materials (Jalbani, 2024). The power of interactivity is also amplified by the ability to combine different types of media, such as text, images, videos and links, making the material more engaging and accessible for different learning styles. Through the strategic use of social media in education, the learning process becomes more adaptive, inclusive and fun, preparing students not only with academic knowledge but also with the digital skills required in the modern world (Jianu, 2024).

Furthermore, games and simulations have become increasingly popular learning tools, offering an innovative and engaging approach to teaching complex concepts. Through the use of educational games and realistic simulations, students can engage in an interactive and immersive learning experience, where they can apply theory in a real context virtually (Kaltenborn, 2023). The advantage of this method is that it allows students to conduct experiments and make decisions in a safe and controlled environment, providing immediate feedback that helps in understanding the consequences of their actions without the risk of fatal errors. This learning experience not only improves understanding of the material but also develops important skills such as problem solving, critical thinking, and decision-making ability (Karangara, 2024). In addition, games and simulations are usually highly engaging, increasing student

motivation and engagement, which often leads to better learning outcomes (Khan & Nayab, 2021).

Finally, Technology has revolutionized the field of education, providing new methods and tools that enrich the learning and teaching experience. Computer-based learning and e-learning have increased the flexibility and accessibility of education, allowing students to learn at their own pace and from any location. Social media and collaborative teaching approaches strengthen connectedness and cooperation among students and teachers, paving the way for more inclusive and interactive teaching (Kitsantas, 2024). While games and simulations introduce an engaging and effective way to understand complex concepts through hands-on and interactive experiences. All these aspects demonstrate the great potential of technology in supporting more adaptive, inclusive and engaging teaching and learning. We are on the threshold of a new era in education, where learning is personalized, student-driven and driven by innovative technologies, promising to improve the quality of education for all (Krajcer, 2023).

The Impact of Digital Intelligence on Education

Changes in teacher and student roles

Technological changes in education have shifted the traditional role of teachers from knowledge delivery to learning facilitators. In this digital age, teachers are no longer the only source of information; they are now tasked with directing students in navigating and integrating the vast and easily accessible information from the internet. This requires teachers to acquire new skills, such as digital literacy, and develop more collaborative and adaptive approaches to teaching (Kuka, 2024). Teachers are required to design supportive learning environments, provide resources, guide student research, and encourage critical analysis and independent learning, facilitating students to become active researchers and lifelong learners (Laczi & Póser, 2024).

On the other hand, students are now expected to take a more active role in their learning process. With access to various technological tools and online learning resources, students have the opportunity to explore their own interests, ask questions, and develop solutions (Dayathilake, 2023). Their role changes to be more initiative, participating in project-based learning, peer-to-peer collaboration, and critical discussions. This not only demands more independence from students but also skills such as time management, problem solving, and effective collaboration. This approach aims to equip students with the skills and knowledge they need to succeed in an ever-evolving society and knowledge-based economy (Machová et al., 2023).

Effectiveness of adaptive learning and personalized education

Adaptive learning and personalized education utilizing technology have been proven effective in improving student learning outcomes by providing experiences tailored to each individual's learning pace and style. These technologies enable more flexible and responsive teaching, where learning materials can be automatically adjusted

based on student progress and needs (Mamede, 2024). With this kind of support system, students who may struggle to keep up with lessons in a traditional classroom setting can receive additional material that suits their level of understanding, while those who are more advanced can be given more challenges to expand their knowledge. As a result, the use of adaptive learning in the classroom can assist in reducing the performance gap between students, allowing each student to reach their full potential (Manaswi & Sharma, 2024).

In addition, personalized education also supports the development of a more relevant and engaging curriculum for students. By integrating individual interests and career goals into the learning experience, education becomes more meaningful and student motivation to learn can increase (Marengo, 2024). This success is also supported by the use of data analytics to track students' learning progress and personality, which allows teachers to provide timely and appropriate feedback. The introduction of these technologies supports different learning styles and facilitates a more holistic approach to education, which focuses not only on learning outcomes but also on developing competencies and work readiness that are crucial for students in the modern world. As such, adaptive learning and personalized education continue to have a positive impact on transforming the global education scene (Masters, 2023).

Digital literacy and digital character building

Digital literacy is the ability to find, utilize and create content using information and communication technologies. It involves critical skills such as searching for information online, evaluating the credibility of sources, managing digital privacy and security, and understanding and respecting copyright (Memon, 2023). In an increasingly digitized world, building digital literacy is becoming an important aspect of education, ensuring that individuals can not only use technology, but also act as knowledgeable and ethical media consumers. Digitally literate students are better able to access and utilize diverse learning resources, respond adaptively to rapid technological change, and participate in a sustainable and inclusive digital economy (Messaoudi, 2024).

Digital character building includes aspects of ethical awareness and responsible online behavior. This includes understanding the consequences of performing actions in the digital realm such as the sharing of personal or other people's information, netiquette, and avoiding harmful behaviors such as cyberbullying (Mittal, 2023). As more interactions occur online, it is important for individuals to develop good digital character, where they act with integrity and respect towards others, no matter what environment they operate in - be it personal, educational or professional. By having a solid digital character, individuals not only protect themselves and others from engaging with digital risks, but also help create a safe and inclusive digital community for all (Mohapatra, 2023).

Challenges and Barriers to Digital Intelligence Adoption

The adoption of digital intelligence, which refers to the use of digital capabilities and tools to transform ways of working and lifestyles, faces various challenges and barriers. One of the main challenges is the digital skills gap, which arises from differences in access to technology education resources between different layers of society (Nakshabandi, 2024). This can be influenced by economic factors, geographical location, as well as educational background. This gap limits the ability of individuals and organizations to adopt advanced digital tools that can increase efficiency and innovation. As a result, those who lack relevant skills may become increasingly left behind in a technology-driven economy (Novik, 2023).

In addition, significant barriers to the adoption of digital intelligence are security and privacy concerns. As the reliance on digital systems to store and process personal and business data increases, the vulnerability to cyber-attacks and data breaches also increases (Palazzo, 2024). Hedging against these risks implies the need for investment in cybersecurity and ongoing training to maintain system and data integrity. For many individuals and organizations, being proactive in this aspect of security feels complex and intimidating, often beyond their capabilities and resources (Pham, 2024).

People with low levels of digital literacy or resistance to change can face difficulties in adapting to the digital age. This creates a 'psychological barrier', where individuals feel anxious or uncertain about utilizing new technologies (Ploumis, 2023). Let alone leveraging digital intelligence to optimize operations or learning processes, even basic technology utilization can be a source of concern. To overcome this barrier, a patient mentoring approach and gradual training are needed to build trust and help individuals internalize the value of digital adaptation by clarifying the benefits they can derive from the change (Pottosina & Lambrechts, 2023).

Infrastructural barriers also play an important role in limiting the spread and acceptance of digital intelligence. In many regions, especially in rural or less developed areas, technological infrastructure such as high-quality internet connectivity and modern technological devices are unevenly distributed. This makes the implementation of digital-based solutions limited (Quaresma, 2022). While governments and organizations attempt to democratize technology access through various initiatives, the process is often slow and uneven, leaving some groups without access to essential tools that enable full participation in the digital economy (Reddy, 2023).

Moreover, regulatory challenges often follow the evolution of technology. Outdated regulations or the absence of policies that encourage innovation in addition to rapidly adapting to digital civilization can hinder progress (Reier, 2023). Policies must be constantly updated to accommodate technological advancements while protecting users and businesses from potential associated risks. The sooner these regulations can be adjusted, the greater the opportunity to optimally utilize digital intelligence within the public and private sectors (Rejeleene, 2023).

In conclusion, despite its great potential to improve efficiency and support economic and social development, the adoption of digital intelligence faces various

hurdles ranging from skills, security, infrastructure to regulation. Overcoming these barriers requires collaboration between individuals, organizations, and governments to develop inclusive and sustainable policies, invest in education and infrastructure, and protect citizens' data and privacy. With a structured and adaptive approach, progress in the adoption of digital intelligence can be accelerated, allowing for broader benefits across all sectors of society.

Conclusion

The evolution of digital intelligence in education has changed the way we teach and learn around the world. The implementation of technologies such as e-learning platforms, virtual reality (VR), and artificial intelligence (AI) has opened up new opportunities in personalizing the learning process. These technologies allow students to learn according to their own pace and learning style, offering a more flexible and interactive approach than traditional methods. In addition, the use of big data has enabled educators to analyze and optimize their teaching methods, thus improving learning effectiveness.

However, the transition to digital education is not free from challenges. Issues such as gaps in access to digital tools and internet connectivity are significant barriers, especially in less developed areas. This absence or limited access can deepen educational inequalities, separating students who have access from those who do not. It is therefore important for education policy to prioritize equitable access as part of a digital intelligence integration strategy, ensuring that every student has an equal opportunity to take advantage of educational technology.

Digital intelligence is also triggering changes in the role of educators. Teachers are no longer just conveyors of information, but also guides in the technology-guided learning process. It requires continuous training and professional development for teachers to keep their skills relevant to technological advancements. Successful implementation of digital intelligence in the education sector depends on the ability of educators to adapt and integrate these new technologies into their curriculum and teaching methodologies. This demands consistent support from educational institutions and improved infrastructure to support technology-rich learning environments.

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