Technium
Education and Humanities

Technium Education and Humanities
Vol. 10, pp.115-126 (2024)
ISSN: 2821-5079
www.techniumscience.com

The Impact of Digital Technologies on Formative Assessment and the Learning Experience

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Vol. 10, pp.115-126 (2024)
ISSN: 2821-5079
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Abstract: *The integration of digital technologies into formative assessment has revolutionized modern education by enhancing the learning experience and transforming how educators evaluate student progress. Digital tools such as Learning Management Systems, Artificial Intelligence-driven platforms, and immersive technologies like Virtual Reality (VR) and Augmented Reality (AR) provide real-time feedback, personalized learning pathways, and increased engagement. These innovations support diverse learning styles and foster deeper understanding through interactive and multimedia-rich environments. However, challenges such as the digital divide, lack of teacher training, ethical concerns surrounding data privacy, and biases in AI-driven systems pose significant barriers to equitable implementation. Future trends, including predictive analytics, blockchain for secure data management, and gamified assessment strategies, offer promising avenues for further development. Addressing these challenges while leveraging technological advancements can lead to a more inclusive, engaging, and effective educational landscape, preparing students for the demands of a rapidly evolving world.*

Key Words: *Digital technologies, Formative assessment Learning Management Systems (LMS), Artificial Intelligence (AI), Virtual Reality (VR), Personalized learning*

Introduction

Formative assessment plays a vital role in education by providing ongoing feedback that helps students identify their strengths and weaknesses while enabling educators to adjust instruction to meet learners' needs. Unlike summative assessments, which evaluate learning at the end of a course, formative assessment is continuous and focuses on guiding the learning process. It fosters a collaborative environment where students are actively involved in their learning journey, allowing for reflection, self-assessment, and goal setting. In this context, digital technologies have emerged as transformative tools, reshaping the way formative assessment is designed and implemented in modern education [1].

Learning Management Systems (LMS) such as Moodle and Google Classroom have become integral to education, providing platforms where educators can create assignments, deliver assessments, and offer feedback in real time. Artificial Intelligence (AI)-powered tools, including adaptive learning platforms like DreamBox and Smart Sparrow, tailor educational content to individual student needs, ensuring a personalized learning experience. These systems analyze data from student interactions to provide instant feedback and insights, enabling both students and teachers to track progress effectively. Gamification platforms further enhance engagement by integrating game-like elements such as points, badges, and leaderboards into the learning process, motivating students to participate actively and enjoy their educational journey [2].

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These technologies are revolutionizing formative assessment by making it more interactive, efficient, and responsive. They enable educators to gather detailed data on student performance, identify learning gaps, and provide targeted interventions. At the same time, students benefit from immersive, personalized, and engaging learning environments that cater to diverse learning styles. The alignment of digital technologies with the principles of formative assessment lies in their ability to support real-time feedback, foster collaboration, and empower learners to take ownership of their education. These tools are paving the way for a more inclusive and adaptive approach to teaching and learning [3].

1. Enhancing Formative Assessment through Digital Tools

Digital tools have transformed the way formative assessment is conducted, offering unprecedented opportunities for real-time feedback and effective monitoring of student progress. By leveraging digital platforms, educators can provide immediate responses to student work, allowing learners to understand their mistakes and improve their understanding without delays. These platforms enable teachers to gather and analyze detailed data on student performance, identifying areas of strength and weakness with precision and tailoring their instruction accordingly. Real-time feedback not only accelerates the learning process but also fosters a more interactive and engaging educational environment where students are empowered to take an active role in their development [4].

AI-based adaptive learning platforms such as DreamBox and Khan Academy have revolutionized personalized education by analyzing individual student responses and adjusting the level of difficulty or type of content accordingly. These tools ensure that each student receives a tailored learning experience suited to their needs, helping to close gaps in knowledge and reinforce key concepts. Quizzing tools like Google Forms allow educators to design assessments that provide instant feedback to students, highlighting errors and offering explanations for correct answers. Peer-assessment platforms like Peergrade facilitate collaborative learning by enabling students to evaluate each other's work, promoting critical thinking and reflection while fostering a sense of shared responsibility in the learning process.

Digital tools also make formative assessment more scalable and accessible by removing traditional barriers such as time, location, and resource limitations. Online platforms allow for large-scale implementation of assessments, making it possible to manage diverse classrooms with varying learning paces and styles. Accessibility is enhanced as students can engage with digital assessments from any location with an internet connection, while features like automated grading save educators valuable time and reduce administrative burdens [5].

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ISSN: 2821-5079
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The key benefits of digital tools in formative assessment include personalization, which ensures that learning activities align with individual needs and capabilities; efficiency, as automated systems streamline the process of assessment and feedback; and immediate feedback, which reinforces learning in real-time and keeps students motivated. These benefits collectively contribute to a more dynamic and responsive educational system where both students and educators can thrive. By integrating digital tools into formative assessment, education systems can create more inclusive and effective learning environments that cater to the diverse needs of learners in the modern age [6].

2. Transforming the Learning Experience

Digital technologies have revolutionized the learning experience by creating more interactive and engaging environments that cater to the diverse needs of students. By leveraging these technologies, educators can provide dynamic and immersive learning opportunities that foster deeper understanding and encourage active participation [7]. One of the most transformative aspects of digital learning is the integration of multimedia-rich content, including videos, interactive simulations, and gamified elements. These tools not only capture students' attention but also present complex information in visually appealing and easily digestible formats, making learning more accessible and enjoyable [8].

Multimedia content allows for the combination of auditory, visual, and kinesthetic elements, which can accommodate a variety of learning styles. For example, videos can explain abstract concepts through animation and storytelling, while interactive simulations enable students to experiment with ideas in a risk-free, hands-on environment. Gamification further enhances engagement by incorporating elements of challenge, reward, and competition into educational tasks [9]. By transforming traditional lessons into interactive games or challenges, students are more likely to stay motivated and persist through difficult topics. These gamified experiences also promote critical thinking, problem-solving, and collaboration, essential skills for success in the 21st century [10].

Virtual Reality (VR) and Augmented Reality (AR) represent another leap forward in transforming the learning experience. These technologies provide experiential learning opportunities that were previously unimaginable [11]. With VR, students can explore historical landmarks, dive into the depths of the ocean, or even travel through space, all from the classroom. AR enhances real-world environments by overlaying digital information, allowing students to interact with 3D models or view scientific phenomena in real-time. These immersive experiences deepen understanding by providing a tangible connection to abstract ideas and concepts, fostering a sense of curiosity and wonder that inspires lifelong learning [12].

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Digital technologies also support active participation by enabling students to take ownership of their education. Interactive platforms encourage learners to engage with content at their own pace, revisit challenging topics, and explore areas of personal interest. Features such as discussion forums and collaborative tools empower students to share ideas, ask questions, and work together on projects, creating a vibrant and inclusive learning community [13]. The personalization offered by digital tools ensures that every student has access to resources and strategies tailored to their unique abilities and learning preferences, reducing barriers to success [14].

By making learning more engaging, accessible, and personalized, digital technologies significantly enhance student motivation and encourage deeper learning. When students are actively involved in their education and can see the real-world applications of their knowledge, they are more likely to develop a genuine love for learning [15]. This not only improves academic outcomes but also cultivates essential skills such as creativity, critical thinking, and adaptability, preparing students to thrive in a rapidly changing world. As digital tools continue to evolve, their potential to transform education and empower learners grows, paving the way for more innovative and effective teaching practices that meet the needs of all students [16].

3. Challenges and Ethical Considerations

Integrating digital tools into formative assessment presents numerous opportunities, but it also brings significant challenges and ethical considerations that educators and policymakers must address to ensure equity, fairness, and effectiveness [17]. One of the primary barriers is the digital divide, which creates unequal access to technology among students [18]. Many learners, especially those from low-income or rural areas, lack reliable internet connections, devices, or both. This inequality can exacerbate existing disparities in education, leaving marginalized students at a disadvantage compared to their peers who have access to advanced digital tools and resources. Bridging this gap requires targeted investments in infrastructure and initiatives to provide affordable access to technology for underserved communities [19].

Another challenge is the lack of teacher training and preparedness for effectively using digital platforms in formative assessment. Many educators may not have the technical skills or familiarity with these tools to implement them confidently and efficiently in their teaching [20]. This can lead to inconsistent or ineffective use of digital resources, undermining their potential benefits. Comprehensive professional development programs are essential to equip teachers with the skills and knowledge needed to integrate digital technologies meaningfully into their assessment practices [21].

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Over-reliance on automated tools is another issue, as these tools may lack the ability to capture the nuances of student learning and performance [22]. Automated grading systems, for instance, can efficiently evaluate objective answers but may struggle to assess subjective or creative responses, such as essays or projects, with the same level of depth and accuracy as a human educator [23]. This limitation can result in a narrow view of student capabilities and reduce the richness of feedback provided to learners. Balancing automated and human assessment methods is crucial to ensure a holistic evaluation of student progress [24].

Ethical concerns also play a significant role in the adoption of digital tools for formative assessment. Data privacy and security are critical, as these tools often collect vast amounts of student data, including performance metrics, learning behaviors, and personal information [25]. Ensuring that this data is stored securely and used responsibly is paramount to protecting students' rights and preventing potential misuse. Schools and technology providers must implement robust data protection policies and practices to safeguard student information and comply with privacy regulations [26].

Bias in AI algorithms is another ethical issue that can affect the fairness of assessments. AI-driven tools may unintentionally reinforce existing biases, leading to unequal treatment or outcomes for certain groups of students [27]. For example, language-processing algorithms may disadvantage non-native speakers, or predictive analytics could perpetuate stereotypes based on historical data. Addressing these biases requires continuous evaluation and improvement of algorithms, as well as transparency in how these tools operate and make decisions [28].

To overcome these challenges, educators and policymakers must work collaboratively to implement effective solutions [29]. Bridging the digital divide should be a top priority through investments in infrastructure, affordable devices, and internet access. Comprehensive teacher training programs can ensure that educators are well-prepared to use digital tools effectively and equitably [30]. Ethical guidelines and regulations should be established to protect student data and ensure fairness in AI applications. By addressing these barriers and concerns, digital tools can be harnessed to enhance formative assessment while promoting an inclusive and equitable learning environment for all students [31].

4. Future Trends in Digital Formative Assessment

The evolution of digital technologies continues to shape the future of formative assessment, offering even more advanced and innovative solutions. Artificial Intelligence (AI) and machine learning are at the forefront, enabling predictive analytics that can anticipate student learning gaps and suggest tailored interventions [32]. These technologies have the potential to transform formative assessment from

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Vol. 10, pp.115-126 (2024)
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reactive to proactive, allowing educators to address issues before they become significant challenges. Tools leveraging Natural Language Processing (NLP) are also enhancing the assessment of open-ended responses, providing nuanced feedback on written or verbal work [33].

Another emerging trend is the integration of Virtual Reality (VR) and Augmented Reality (AR) in formative assessment [34]. These immersive tools create environments where students can demonstrate skills or solve problems in real-world scenarios, providing immediate feedback in a highly engaging and interactive manner[35]. Blockchain technology also shows promise in education, ensuring secure and transparent records of student progress, which could streamline formative assessment and feedback processes [36].

Furthermore, gamification and serious games are gaining traction as effective methods for engaging students while assessing their understanding in a less formal and more enjoyable way [37]. This trend highlights the potential of integrating entertainment with education to make learning experiences more effective and motivating. As these trends develop, research must continue to examine their effectiveness, ensuring that new tools align with pedagogical goals and promote equitable access [38].

CONCLUSIONS

The integration of digital technologies in formative assessment and learning has brought transformative changes to the education landscape, reshaping how educators and students engage with the learning process. Digital tools offer unparalleled opportunities for real-time feedback, personalized learning, and active student participation, making education more dynamic, inclusive, and effective. Platforms powered by artificial intelligence, gamified learning environments, and immersive tools such as virtual and augmented reality have elevated the potential for educators to tailor instruction to the needs of individual learners while fostering engagement and curiosity.

Despite these advancements, challenges remain. The digital divide highlights the urgent need to address unequal access to technology, which limits opportunities for students in underserved communities. Equally pressing is the necessity for comprehensive teacher training programs that enable educators to leverage digital tools effectively. Concerns over data privacy and security, coupled with the potential biases in AI-driven assessment tools, underscore the ethical considerations that must guide the implementation of these technologies. Policymakers and education leaders must work collaboratively to establish regulations and frameworks that address these issues, ensuring that digital innovations serve all learners equitably.

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Vol. 10, pp.115-126 (2024)
ISSN: 2821-5079
www.techniumscience.com

Looking to the future, the possibilities for further evolution in digital formative assessment are immense. Emerging technologies like predictive analytics, blockchain for secure data management, and increasingly sophisticated AI systems promise to refine and expand the ways assessments are conducted. These innovations must be carefully integrated into pedagogical strategies, keeping equity and accessibility at the forefront. Gamified assessments and experiential learning through VR and AR are set to make learning not only more engaging but also more relevant to real-world applications.

The success of these digital interventions depends on a balanced approach that combines technological efficiency with the human touch of educators. By addressing current challenges and embracing emerging trends, the integration of digital tools in formative assessment can lead to a more inclusive, engaging, and effective education system. Such a system has the potential to empower all learners, equipping them with the skills and knowledge necessary to thrive in an increasingly interconnected and technology-driven world.

References

[1] Cosi, A., Voltas, N., Lázaro-Cantabrana, J. L., Morales, P., Calvo, M., Molina, S., & Quiroga, M. Á. (2020). Formative assessment at university through digital technology tools. Profesorado, revista de currículum y formación del profesorado, 24(1), 164-183

[2] Kalogeratos, G., Anastasopoulou, E., Tsagri, A., Tseremegklis, C., & Kriparopoulou, A. (2024). Adverse Adolescent Experiences, Psychological Trauma, and the Impact on Management of Educational Learning. Technium Business and Management, 7, 9-23.

[3] See, B. H., Gorard, S., Lu, B., Dong, L., & Siddiqui, N. (2022). Is technology always helpful?: A critical review of the impact on learning outcomes of education technology in supporting formative assessment in schools. Research Papers in Education, 37(6), 1064-1096.

[4] Cusi, A., Aldon, G., Barzel, B., & Olsher, S. (2024). Rethinking teachers' formative assessment practices within technology-enhanced classrooms. In Handbook of Digital Resources in Mathematics Education (pp. 1-31). Cham: Springer International Publishing.

[5] Kalogeratos, G., Anastasopoulou, E., Tsagri, A., Tseremegklis, C., Tsogka, D., Lourida, K., & Drongitis, A. (2024). Adolescent Trauma and Impact of the COVID-19 Pandemic in the School Context. Technium Social Sciences Journal, 55, 262-276

Technium Education and Humanities
Vol. 10, pp.115-126 (2024)
ISSN: 2821-5079
www.techniumscience.com

[6] Grimalt-Álvaro, C., & Usart, M. (2024). Sentiment analysis for formative assessment in higher education: a systematic literature review. Journal of computing in higher education, 36(3), 647-682.

[7] Haugen, H. J., & de Lange, T. (2024). Multiple choice as formative assessment in dental education. European Journal of Dental Education.

[8] Kalogeratos, G., & Pierrakeas, C. (2024). Use of learning theories and visual programming (scratch) in education. Technium Education and Humanities, 10, 41-54.

[9] Awidi, I. T., & Paynter, M. (2024). An evaluation of the impact of digital technology innovations on students' learning: Participatory research using a student-centred approach. Technology, Knowledge and Learning, 29(1), 65-89.

[10] Atjonen, P., Kontkanen, S., Ruotsalainen, P., & Pöntinen, S. (2024). Pre-service teachers as learners of formative assessment in teaching practice. European Journal of Teacher Education, 1-18.

[11] Kalogeratos, G., Anastasopoulou, E., Tseremegklis, C., & Avramidi, E. (2024). Enhancing Quality of Life for Caregivers of Adolescents with Emotional Disorders through Digital Skills. Technium Education and Humanities, 8, 58-77.

[12] Halkiopoulos, C., Papadopoulos, A., Stamatiou, Y. C., Theodorakopoulos, L., & Vlachos, V. (2024). A Digital Service for Citizens: Multi-Parameter Optimization Model for Cost-Benefit Analysis of Cybercrime and Cyberdefense. Emerging Science Journal, 8(4), 1320-1344.

[13] Theodorakopoulos, L., Theodoropoulou, A., & Stamatiou, Y. (2024). A State-of-the-Art Review in Big Data Management Engineering: Real-Life Case Studies, Challenges, and Future Research Directions. Eng, 5(3), 1266-1297.

[14] Antonopoulou, H., Theodorakopoulos, L., Halkiopoulos, C., & Mamalougkou, V. (2023). Utilizing machine learning to reassess the predictability of bank stocks. Emerging Science Journal, 7(3), 724-732.

[15] Theodorakopoulos, L., Thanasas, G., & Halkiopoulos, C. (2024). Implications of Big Data in Accounting: Challenges and Opportunities. Emerging Science Journal, 8(3), 1201-1214.

[16] Karras, A., Giannaros, A., Theodorakopoulos, L., Krimpas, G. A., Kalogeratos, G., Karras, C., & Sioutas, S. (2023). FLIBD: A federated learning-based IoT big data management

Technium Education and Humanities
Vol. 10, pp.115-126 (2024)
ISSN: 2821-5079
www.techniumscience.com

approach for privacy-preserving over Apache Spark with FATE. Electronics, 12(22), 4633.

[17] Kalogeratos, G., Anastasopoulou, E., Tsagri, A., Tseremegklis, C., Tsogka, D., Lourida, K., ... & Drongitis, A. (2024). PTSD in Children and Adolescents in the Educational Context. A Conceptual Approach. Technium Social Sciences Journal, 55, 226-247.

[18] Thanasas, G. L., Theodorakopoulos, L., & Lampropoulos, S. (2022). A Big Data Analysis with Machine Learning techniques in Accounting dataset from the Greek banking system. European Journal of Accounting, Auditing and Finance Research.

[19] Karras, C., Karras, A., Theodorakopoulos, L., Giannoukou, I., & Sioutas, S. (2022, August). Expanding queries with maximum likelihood estimators and language models. In The International Conference on Innovations in Computing Research (pp. 201-213). Cham: Springer International Publishing.

[20] Theodorakopoulos, L., Antonopoulou, H., Mamalougou, V., & Giotopoulos, K. (2022). The drivers of volume volatility: A big data analysis based on economic uncertainty measures for the Greek banking system. Available at SSRN 4306619.

[21] Antonopoulou, H., Mamalougou, V., & Theodorakopoulos, L. (2022). The role of economic policy uncertainty in predicting stock return volatility in the banking industry: A big data analysis. Emerging Science Journal, 6(3), 569-577.

[22] Vasilopoulos, C., Theodorakopoulos, L., & Giotopoulos, K. (2023). Big Data and Consumer Behavior: The Power and Pitfalls of Analytics in the Digital Age. Technium Soc. Sci. J., 45, 469.Becken, S. (2019). Virtual reality and tourism: An environmental sustainability perspective. Journal of Sustainable Tourism, 27(4), 551-566.

[23] Theodorakopoulos, L., Theodoropoulou, A., & Halkiopoulos, C. (2024). Enhancing Decentralized Decision-Making with Big Data and Blockchain Technology: A Comprehensive Review. Applied Sciences, 14(16), 7007.

[24] Vasilopoulos, C., Theodorakopoulos, L., & Giotopoulos, K. (2023). The Promise and Peril of Big Data in Driving Consumer Engagement. Technium Soc. Sci. J., 45, 489.

[25] Karras, C., Theodorakopoulos, L., Karras, A., & Krimpas, G. A. (2024). Efficient Algorithms for Range Mode Queries in the Big Data Era. Information, 15(8), 450.

Technium Education and Humanities
Vol. 10, pp.115-126 (2024)
ISSN: 2821-5079
www.techniumscience.com

[26] Vasilopoulou, C., Theodorakopoulos, L., & Giotopoulos, K. (2023). Big Data Analytics: A Catalyst for Digital Transformation in e-Government. Technium Social Sciences Journal, 45, 449-459.

[27] Igoumenakis, G., Theodoropoulou, A., & Halkiopoulos, C. (2023, August). Tourism and Developing Countries. Conditions and Prospects for Tourism Development. In International Conference of the International Association of Cultural and Digital Tourism (pp. 721-748). Cham: Springer Nature Switzerland.

[28] Halkiopoulos, C., Igoumenakis, G., & Theodoropoulou, A. (2023, August). Evaluation of Hotel Services Utilizing Digital Marketing Strategies in Less Developed Countries Within the Hospitality Industry. In International Conference of the International Association of Cultural and Digital Tourism (pp. 323-346). Cham: Springer Nature Switzerland.

[29] Kalogeratos, G., Anastasopoulou, E., Tsagri, A., Tseremegklis, C., & Kriparopoulou, A. (2024). Psychotraumatic Childhood Experiences and Anxiety in Educational Setting. Technium Education and Humanities, 7, 29-41.

[30] Kalogeratos, G., Anastasopoulou, E., & Pierrakeas, C. (2024). Myschool: the key role of the information system in the greek public school. a case study on the prefecture of achaia. In EDULEARN24 Proceedings (pp. 9700-9706). IATED.

[31] Kalogeratos, G. (2023). Personality's Influence on Mood Variability and Leading Behavior. A Narrative Review. Technium Social Sciences Journal, 51, 102-111.

[32] García-Bravo, C., de los Ángeles Martínez-Rodríguez, M., Llamas-Salguero, F., García-Peñalvo, F. J., & Conde, M. Á. (2020). Virtual reality learning environments in engineering education: A review. Frontiers in Education, 5, 110. https://doi.org/10.3389/feduc.2020.00110

[33] Cheng, K. H., & Tsai, C. C. (2019). A case study of immersive virtual field trips in an elementary classroom: Students' learning experience and teacher-student interaction behaviors. *Computers & Education*, 140, 103600. https://doi.org/10.1016/j.compedu.2019.103600

[34] Krokos, E., Plaisant, C., & Varshney, A. (2019). Virtual memory palaces: Immersion aids recall. *Virtual Reality*, 23, 1-15. https://doi.org/10.1007/s10055-018-0346-3

[35] Huang, H. M., Rauch, U., & Liaw, S. S. (2010). Investigating learners' attitudes toward virtual reality learning environments: Based on a constructivist approach. *Computers &*

Technium Education and Humanities
Vol. 10, pp.115-126 (2024)
ISSN: 2821-5079
www.techniumscience.com

Education, 55(3), 1171-1182. https://doi.org/10.1016/j.compedu.2010.05.014

[36] Ketelhut, D. J., Nelson, B., Clarke, J., & Dede, C. (2010). A multi-user virtual environment for building and assessing higher order inquiry skills in science. *British Journal of Educational Technology*, 41(1), 56-68. https://doi.org/10.1111/j.1467-8535.2009.00966.x

[37] Kalogeratos, G., Anastasopoulou, E., Stavrogiannopoulos, A., Tsagri, A., Tsogka, D., & Lourida, K. (2023). Personality Types and Leadership Characteristics. A Mini Review. Technium Business and Management, 5, 69-78.

[38] Theodorakopoulos, L., Karras, A., Theodoropoulou, A., & Kampiotis, G. (2024). Benchmarking Big Data Systems: Performance and Decision-Making Implications in Emerging Technologies. Technologies, 12(11), 217. https://doi.org/10.3390/technologies12110217