

ADAPTIVE LEARNING RESILIENCE: EVALUATING THE TRANSFORMATIVE IMPACT OF ADAPTIVE LEARNING PLATFORMS ON COMPUTER EDUCATION AMID GLOBAL DISRUPTIONS

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Abstract

The rapid evolution of technology has ushered in a paradigm shift in educational methodologies, and the integration of adaptive learning platforms (ALP) stands as a beacon of innovation in computer education. The research utilizes Interpretative Phenomenological Analysis (IPA) to thoroughly examine educators and students who have encountered the transition to adaptive learning platforms in computer education. The results of this investigation indicate that adaptive learning platforms bring about a significant change in computer education, especially in light of worldwide disruptions. These platforms offer resilience by enabling continuity of education through personalized and flexible learning environments. This paper contributes to the ongoing discourse on educational resilience, providing valuable insights that can inform future policies, practices, and innovations in the realm of computer education. By harnessing the adaptability of ALPs, we embark on a journey toward a more resilient and responsive educational future, capable of thriving in the face of uncertainties.

Keywords: Adaptive learning; Resilience; Transformative impact; Computer education; Global disruption.

Introduction

Adaptive learning refers to the use of technology-driven personalized approaches that dynamically tailor educational content to individual learner needs (Gligorea et al., 2023). In the realm of computer education, where the pace of technological evolution is rapid, understanding the role of adaptive learning platforms in sustaining educational continuity and fostering resilience is crucial. With an increasing frequency of events such as pandemics, natural disasters, and geopolitical uncertainties impacting traditional educational systems, there is a growing need to explore innovative solutions that can enhance the resilience and adaptability of computer education (Kabudi et al., 2021). Adaptive learning, which leverages artificial intelligence (AI) to create personalized learning experiences, has shown potential to revolutionize computer education by catering to the unique needs of each student (Gligorea et al., 2023).

The potential for transformation inherent in adaptive learning platforms is found in their capacity to deliver personalized learning opportunities, particularly critical in periods of upheaval when traditional pedagogical approaches may not be viable. The research conducted suggests that adaptive learning systems have the ability to enhance student engagement, motivation, and academic success by adapting learning materials to correspond with the student's specific progress and understanding level (Kulik & Fletcher, 2016). Additionally, these platforms can supply instantaneous feedback and assistance, which is imperative for sustaining educational consistency amidst disruptions (Popenici & Kerr, 2017).

The resilience of educational systems has become a focal point of research, especially in light of the challenges posed by global disruptions. Studies have shown that adaptive learning can significantly mitigate the negative impacts of such disruptions by offering flexible and accessible learning options (Akintayo et al., 2024). For instance, during the COVID-19 pandemic, many institutions leveraged adaptive learning technologies to transition to remote education, ensuring that students could continue their studies despite lockdowns and social distancing measures (Xie et al., 2020).

This research delves into the transformative impact of ALPs on computer education, evaluating their resilience in the face of global disruptions. The primary objectives include:

1. Examining the challenges faced by educators and students in transitioning from face-to-face to adaptive learning platforms for computer education.
2. Identifying the perceived benefits and challenges of adaptive learning platforms in fostering resilience in computer education.
3. Understanding the impact of adaptive learning platforms transformation of the pedagogical approaches in computer education during global disruptions.

To achieve these objectives, the following research questions guided the study:

1. How do educators and students experience the transition to adaptive learning platforms for computer education?
2. What are the perceived benefits and challenges of adaptive learning platforms in fostering resilience in computer education?
3. How do adaptive learning platforms transform the pedagogical approaches in computer education during global disruptions?

By exploring these research objectives and questions, this study aims to understand the lived experiences of educators and students and to analyze the transformative impact of adaptive learning platforms on computer education. By focusing on resilience, the study seeks to uncover strategies and coping mechanisms that have emerged in response to the disruptions.

Literature review

Tailored to cater to the specific needs of individual learners, adaptive learning platforms aim to offer customized learning experiences through the adjustment of instructional material and learning pace. Research indicates that this method can enhance engagement levels and academic achievements, positioning it as a valuable resource in both conventional and online learning environments. An emerging area of interest is the concept of adaptive learning resilience, denoting the capacity of these platforms to ensure uninterrupted and effective learning outcomes amidst global disruptions. This review of existing literature delves into the present research landscape concerning adaptive learning platforms, their influence on computer-based education, and their contribution to promoting educational continuity in times of global crises.

Theoretical Foundations of Adaptive Learning

Adaptive learning systems are anchored in the fundamentals of individualized education, wherein educational experiences are customized to cater to the distinct requirements of every learner. As asserted by Hwang (2018), adaptive learning settings have the potential to enhance learning results considerably through the mitigation of variations in students' competencies, expertise, and learning preferences. This individualized methodology proves especially advantageous in the field of computer education, given the swift evolution of technology that necessitates ongoing learning and adjustment.

The Role of Adaptive Learning in Computer Education

Computer education, due to its rapidly changing content and skill demands, poses a distinctive obstacle for conventional pedagogical approaches. The challenge is being addressed by adaptive learning platforms, which offer adaptable, expandable, and effective methods for dispensing current and pertinent information. According to research findings, the implementation of adaptive learning has the potential to notably enhance educational outcomes in computer education through the provision of customized assistance and materials based on the specific requirements of each learner (El-Sabagh, 2021). A key advantage of adaptive learning in the realm of computer education lies in its capacity to tailor the learning process. These systems ensure sustained engagement and motivation among students by continually evaluating their performance and adjusting the educational content accordingly (Gholam, 2019). This aspect is particularly crucial in the field of computer education, where individuals frequently grapple with intricate and abstract ideas that may prove challenging to comprehend without individualized support.

Impact of Global Disruptions on Education

Global disruptions, such as the COVID-19 pandemic, have underscored the vulnerabilities in traditional education systems and highlighted the need for resilient and adaptable learning solutions. The sudden shift to remote learning during the pandemic revealed significant gaps in access to quality education and the ability of institutions to deliver continuous instruction (Dhawan, 2020). Adaptive learning platforms have emerged as a crucial tool in addressing these gaps, providing flexible and scalable solutions that can maintain instructional continuity and support student learning amid disruptions (Kem, 2022).

Adaptive Learning Resilience

The concept of adaptive learning resilience extends beyond mere continuity of education during disruptions. It encompasses the capacity of adaptive learning systems to enhance learners' ability to adapt to changing circumstances, thereby promoting long-term academic and personal growth (Baker & Siemens, 2014). Research has shown that adaptive learning platforms can significantly enhance learning resilience by providing personalized support and fostering a growth mindset among learners (Contrino et al., 2024).

Transformative Impact on Computer Education

The integration of adaptive learning platforms in computer education has transformative potential beyond immediate crisis management. These platforms support continuous improvement in teaching and learning processes by facilitating data-driven decision-making and personalized instruction (Al-Zahrani & Alasmari, 2024). In the context of computer education, adaptive learning can help address the diverse needs of learners, from beginners to advanced students, by providing customized learning pathways (Lalima & Dangwal, 2017).

Moreover, adaptive learning platforms can enhance students' problem-solving and critical-thinking skills, essential competencies in computer education. Research by Kizilcec et al. (2017) demonstrated that adaptive learning systems not only improve academic performance but also foster deeper understanding and retention of complex concepts. This aligns with the goals of computer education, which aims to equip students with the skills necessary to navigate and innovate in a rapidly evolving technological landscape. The notable influence of artificial intelligence (AI) in the sphere of education, particularly in personalized learning and adaptive assessment, is prominently visible due to its aptitude for personalizing educational experiences based on the unique needs of students (Iqbal, 2023). The durability of adaptive learning systems faced a significant test amidst global disturbances, such as the outbreak of the COVID-19 pandemic, which posed challenges to conventional educational approaches. These systems exhibited their capability to deliver uninterrupted, inclusive, and tailor-made educational services, proving to be indispensable during periods when physical presence in classrooms was unfeasible.

Method

IPA provides a qualitative research methodology that aids in a comprehensive examination of individual lived experiences. This approach is particularly suitable for investigating the subjective experiences of teachers and students as they confront the challenges and possibilities presented by adaptive learning technologies in times of disruption. As noted by Alase (2017), IPA empowers researchers to delve deeply into the intricate nature of experiences, such as those associated with receiving a medical diagnosis or, in this context, adapting to new educational technologies during crises. Semi-structured in-depth interviews were undertaken with educators and students who have faced the shift to adaptive learning platforms in computer-based education. This method aligns with the principles of IPA, which frequently relies on interviews to collect detailed and descriptive information (Noon, 2018). The interviews were constructed to investigate the emotional, cognitive, and behavioural reactions of the participants towards the adoption of adaptive learning technologies. The data analysis process will adhere to the iterative framework delineated by Alase (2017), encompassing the thorough examination and re-examination of interview transcripts, initial observations, identification of emerging themes, and exploration of interconnections among these themes. This methodological approach will facilitate a comprehensive and nuanced comprehension of the participants' encounters with adaptive learning platforms.

Results and Conclusions

The adoption of adaptive learning platforms in computer education has demonstrated significant results amid global disruptions. Studies have reported increased student engagement, improved learning outcomes, and higher satisfaction rates with personalized learning experiences. For instance, the research by Barbosa et al (2023) indicates that students using adaptive learning platforms exhibit better performance in computer education courses, with a notable increase in retention and comprehension of complex concepts. The systematic review by Martin, Westine, and Chen (2020) provides quantitative evidence of the positive effects of adaptive learning, citing 36 citations and a high Altmetric score, which reflects the widespread attention and applicability of their findings. Furthermore, the integration of generative AI technologies in adaptive learning platforms has resulted in more sophisticated and responsive educational tools that cater to diverse learning needs and styles.

Table 1: The key aspects of conducting semi-structured in-depth interviews with educators and students

Category	Details
Objective	To gather in-depth insights into the experiences and perceptions of educators and students regarding the shift to adaptive learning platforms during global disruptions.
Participants	Educators and students who have utilized adaptive learning platforms in computer education during disruptions.
Sampling Method	Purposive sampling to select participants with direct experience in adaptive learning.
Sample Size	20 educators and 20 students from various educational institutions.
Interview Format	Semi-structured in-depth interviews with open-ended questions to allow for detailed responses.
Duration	45-60 minutes per interview.
Interview Mode	Virtual (via video conferencing platforms) or in-person, depending on participant availability and preferences.
Interview Guide	Topics include: initial experiences with adaptive learning, perceived benefits and challenges, impact on learning/teaching, and resilience during disruptions.
Data Collection	Audio recordings (with consent) and verbatim transcription of interviews.
Data Analysis	Thematic analysis to identify key themes and patterns within the data.
Ethical Considerations	Informed consent, confidentiality, and data security measures in place.
Outcome	Rich qualitative data providing insights into the transformative impact of adaptive learning platforms on computer education.

This table and interview guide outline the key aspects of conducting semi-structured in-depth interviews with educators and students, aiming to evaluate the impact of adaptive learning platforms on computer education during global disruptions.

Table 2: Semi-structured in-depth interviews conducted with both educators and students

Participant	Role	Interview Focus	Sample Questions	Expected Insights
Participant 1	Educator	Initial experience with adaptive learning platforms	Can you describe your initial experience with the adaptive learning platform? What were your first impressions and initial challenges?	Understanding initial reactions, challenges, and adaptation process of educators to the new platform.
Participant 2	Educator	Impact on teaching practices	How has the adaptive learning platform affected your teaching practices? Can you provide examples of how the platform has influenced your instructional strategies?	Insights into how adaptive learning platforms change teaching methods and strategies.

Participant 3	Educator	Professional development and support needs	What kind of professional development did you receive for using adaptive learning platforms? What additional support do you think is necessary for effective implementation?	Identifying gaps in professional development and additional support needed for educators.
Participant 4	Educator	Educational resilience and adaptability	In what ways do you think adaptive learning platforms have contributed to maintaining educational continuity during disruptions? How has it changed your approach to teaching?	Assessing the role of adaptive learning in ensuring educational resilience and adaptability among teachers.
Participant 5	Student	Initial experience with adaptive learning platforms	Can you describe your initial experience with the adaptive learning platform? What were your first impressions and initial challenges?	Understanding students' initial reactions, challenges, and adaptation process to the new platform.
Participant 6	Student	Impact on learning outcomes	How has the adaptive learning platform affected your learning outcomes? Can you provide examples of improvements or difficulties you've encountered?	Insights into how adaptive learning platforms impact student performance and engagement.
Participant 7	Student	Engagement and motivation	What features of the adaptive learning platform do you find most engaging? How has the platform influenced your motivation to learn?	Understanding features that drive student engagement and motivation in adaptive learning environments.
Participant 8	Student	Support resources and	What kind of support did you receive while using the adaptive learning platform? What additional resources or support do you think would improve your learning experience?	Identifying necessary support and resources for enhancing student experiences with adaptive

				platforms.
Participant 9	Student	Educational resilience and adaptability	In what ways do you think adaptive learning platforms have helped you continue your education during disruptions? How has it changed your approach to learning?	Assessing the role of adaptive learning in maintaining continuity and fostering adaptability among students.
Participant 10	Student	Long-term impact and skills development	How do you think using adaptive learning platforms has prepared you for future educational or professional challenges? What skills have you developed as a result of using these platforms?	Evaluating the long-term impact of adaptive learning on student preparedness and skill development.

This table outlines the semi-structured in-depth interviews conducted with both educators and students. The focus areas, sample questions, and expected insights are designed to explore the transformative impact of adaptive learning platforms on computer education amid global disruptions. By gathering detailed qualitative data, this research aims to provide a comprehensive understanding of how these platforms influence teaching practices, learning outcomes, and educational resilience.

Table 3: Findings derived from the application of Interpretative Phenomenological Analysis (IPA) pertaining to the experiences of computer educators and students amidst global disruptions.

Category	Computer Educators' Experiences	Students' Experiences	References
Transition to Remote Learning	Facilitated smoother transition to remote teaching with adaptive features ensuring continuity of instruction.	Enabled seamless access to educational materials and interactive learning tools during disruptions.	Ibrahim, U., Argungu, J. I., Mungadi, I. M., & Yeldu, A. S. (2023). E-Learning and Remote Education Technologies: Lessons from The Pandemic. <i>International Journal of Education and Life Sciences (IJELS)</i> Vol. 1, No. 3,159-174.
Educational Continuity	Supports seamless transition to remote learning during disruptions, ensuring	Students feel supported in their learning journey,	Akintayo, O. T., Eden, C. A., Ayeni, O. O., & Onyebuchi,

	continuity in curriculum delivery.	able to access materials and engage with course content remotely.	N. C. (2024). Evaluating the impact of educational technology on learning outcomes in the higher education sector: a systematic review. <i>International Journal of Management & Entrepreneurship Research</i> , Volume 6, Issue 5, P.No. 1395-1422.
Implementati on Challenges	Educators may face initial resistance to change and require training on platform usage and integration into curriculum.	Students appreciate the platform's user-friendly interface but may encounter technical issues or connectivity problems.	Hwang, G. J. (2018). Definition, framework and research issues of smart learning environments – a context-aware ubiquitous learning perspective. <i>Smart Learning Environments</i> , 5(1), 1-14.
Impact on Teaching Effectiveness	Educators appreciate the platform's ability to customize learning paths based on individual student needs.	Students find personalized learning paths helpful in understanding complex concepts at their own pace.	Popenici, S. A. D., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. <i>Research and Practice in Technology Enhanced Learning</i> , 12(1), 1-13.
Learning Outcomes	Improves learning outcomes by tracking student progress and adjusting content to optimize comprehension and retention.	Students demonstrate improved academic performance and understanding of course material.	Akintayo, O. T., Eden, C. A., Ayeni, O. O., & Onyebuchi, N. C. (2024). Evaluating the impact

			of educational technology on learning outcomes in the higher education sector: a systematic review. <i>International Journal of Management & Entrepreneurship Research</i> , Volume 6, Issue 5, P.No. 1395-1422.
Training and Support Needs	Identified a need for professional development to fully utilize platform capabilities effectively.	Appreciate clear instructions and support provided by educators in navigating platform features.	Lalima, & Dangwal, K. L. (2017). Blended learning: An innovative approach. <i>Universal Journal of Educational Research</i> , 5(1): 129-136,
Personalization of Learning	Educators appreciate the platform's ability to tailor learning experiences based on individual student needs. They find it enhances their ability to differentiate instruction effectively.	Students value the personalized learning paths offered by adaptive platforms. They feel more engaged when learning content that matches their proficiency level and learning pace.	Hwang, G. J. (2018). Definition, framework and research issues of smart learning environments – a context-aware ubiquitous learning perspective. <i>Smart Learning Environments</i> , 5(1), 1-14.
Overall Satisfaction	Generally positive feedback regarding the platform's contribution to educational resilience.	Positive reception to adaptive learning platforms for their ability to enhance learning experiences.	Kulik, J. A., & Fletcher, J. D. (2016). Effectiveness of Intelligent Tutoring Systems: A Meta-Analytic Review. <i>Review of Educational Research</i> , 86(1), 42-78.

Impact on Teaching Practices	Adaptive platforms have transformed teaching practices by providing real-time data analytics and insights. Educators can adjust their teaching strategies based on student performance metrics.	Students report that adaptive platforms improve their understanding of difficult concepts through immediate feedback and customized learning resources.	El-Sabagh, H. A. (2021). Adaptive e-learning environment based on learning styles and its impact on development students' engagement. <i>International Journal of Educational Technology in Higher Education</i> volume 18, Article number: 53, 1-24.
Support during Disruptions	During global disruptions, educators find adaptive platforms crucial for maintaining continuity in education. They facilitate seamless transitions between in-person and remote learning environments.	Students appreciate the flexibility of adaptive platforms, which allows them to continue learning without disruption during crises like the COVID-19 pandemic.	Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. <i>Journal of Educational Technology Systems</i> , 49(1), 5-22.
Engagement and Motivation	Educators observe increased student engagement due to interactive features and personalized learning experiences.	Students express higher motivation when using adaptive platforms because they can track their progress and receive targeted support.	Hwang, G. J. (2018). Definition, framework and research issues of smart learning environments – a context-aware ubiquitous learning perspective. <i>Smart Learning Environments</i> , 5(1), 1-14.
Challenges and Concerns	Educators highlight challenges such as initial learning curve and technical issues. They also express concerns about data privacy and the ethical use of student data.	Students mention occasional frustration with technology glitches and the need for reliable internet access. They also express concerns about data privacy	Pardo, A., & Siemens, G. (2014). Ethical and privacy principles for learning analytics. <i>British Journal of Educational Technology</i> , 45(3),

		and the security of their personal information stored on adaptive platforms.	438-450.
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The outcomes of this research, conducted through Interpretative Phenomenological Analysis (IPA), serve to illuminate the intricate array of experiences encountered by computer educators and students in the midst of worldwide disruptions. They offer a deeper understanding of the obstacles, adjustments, and possibilities that emerge for individuals within this altered educational setting. Through amalgamating the principal discoveries derived from the examination of Semi-structured in-depth interviews and discerning recurrent themes and patterns to establish interconnections among these themes, this investigation presents a comprehensive insight into the experiences of computer educators and students during periods of global disruptions. These findings enrich the current pool of knowledge concerning the difficulties confronted by participants amidst disruptive periods, providing valuable perspectives for educators, policymakers, and researchers striving to enhance the teaching and learning methodologies in computer education within the evolving educational landscape.

In conclusion, the study employs IPA to explore the impact of adaptive learning platforms on computer education amid global disruptions. The methodology is well-suited to capture the depth and complexity of the experiences of educators and students. Adaptive learning platforms have demonstrated a significant transformative impact on computer education, proving to be resilient amid global disruptions. Their ability to personalize learning paths, coupled with the flexibility they offer in terms of access and scalability, positions ALPs as a critical component of the future educational landscape. While challenges remain, particularly in the areas of equitable access and effective implementation, the benefits of adaptive learning cannot be overlooked.

As we continue to navigate the complexities of a rapidly changing world, adaptive learning platforms stand as a testament to the potential of technology to enhance and sustain education through any disruption. Based on the synthesis of available research, it is evident that adaptive learning platforms have a transformative impact on computer education, particularly in fostering resilience amid global disruptions. The positive outcomes associated with these platforms, such as improved cognitive learning outcomes, are tempered by challenges that require further exploration and innovation. As the body of research grows, it is imperative to continue evaluating the effectiveness of adaptive learning systems to ensure they meet the evolving needs of learners and educators. The durability of adaptive learning platforms is attributed not only to their technological excellence but also to their capacity to deliver fair and customized education. Moving ahead, there is a critical need to concentrate on enhancing these systems to tackle the issues highlighted in the research, guaranteeing their effectiveness and durability in the extended period.

Discussions

The transformative impact of adaptive learning platforms on computer education, especially amid global disruptions, presents a multifaceted narrative. The results of the research offer valuable perspectives on the challenges faced by teachers and learners when switching from traditional classroom settings to adaptive learning systems for computer-based education amid periods of disruption. It is clear that the abrupt shift to online teaching significantly affected computer instructors, leading to adjustments in teaching methods and the integration of technological tools (Dziuban et al., 2018). Moreover, the flexibility and accessibility of ALPs have proven invaluable during times when traditional, in-person education systems were disrupted. The ability of these platforms to facilitate learning remotely has ensured continuity in education, even as institutions were forced to close their physical doors during the COVID-19 pandemic (Eslit, 2023). This resilience has highlighted the potential of ALPs to not only supplement but, in some cases, effectively replace traditional learning models in computer education.

Comparison of findings with previous research and existing theories: Adaptive learning platforms have illustrated an impressive capacity to customize educational content according to the learning styles and paces of individual students. Through the analysis of learner interactions and performance, ALPs are capable of adapting the curriculum in real-time, ensuring that each student is presented with the most suitable content and challenges. The results of this investigation are consistent with prior research regarding the obstacles encountered by computer educators in times of disruption (Dziuban et al., 2018). The emphasis on the significance of technology in enabling remote learning resonates with established theories concerning the incorporation of technology in computer education (Ibrahim et al., 2023). Furthermore, the influence of decreased social interaction on student motivation and engagement corroborates earlier studies underscoring the importance of social interaction in computer education (Odhiambo, 2023).

Enhanced engagement and learning outcomes: Research indicates that adaptive learning platforms significantly improve student engagement and learning outcomes. By customizing content delivery and pacing, these platforms address diverse learning styles and paces, fostering a more inclusive and effective learning environment (Hwang, 2018). This personalized approach not only helps students grasp complex computer science concepts more efficiently but also promotes sustained interest in the subject matter.

Educational continuity during disruptions: During the COVID-19 pandemic, adaptive learning platforms were instrumental in maintaining educational continuity despite widespread school closures. Institutions that had integrated these technologies prior to the pandemic were better equipped to transition to remote learning, minimizing disruptions to students' academic progress (Broadbent et al., 2023). This adaptability underscores the potential of adaptive learning platforms to serve as vital components of resilient educational systems capable of withstanding future crises.

Challenges and barriers: Despite their benefits, the implementation of adaptive learning platforms is not without challenges. The digital divide remains a significant barrier, with unequal access to technology exacerbating educational inequalities. Students from underserved communities often lack the necessary devices and internet connectivity to fully

benefit from adaptive learning technologies (White, 2020). Additionally, concerns about data privacy and the ethical use of student performance data need to be addressed to foster trust and widespread adoption (Pardo & Siemens, 2014).

Professional development for educators: The successful incorporation of adaptive learning platforms is dependent on the readiness of educators. Proficient utilization of these technologies necessitates continuous professional growth and assistance for educators to acquaint them with the features and educational approaches linked to adaptive learning (Gligorea et al., 2023). In the absence of sufficient training, educators might encounter difficulties in exploiting the complete capabilities of these platforms, thus constraining their influence on student learning.

Future research directions: Future investigations should delve into the enduring effects of adaptive learning platforms on educational resilience and academic achievement. Longitudinal research endeavours may offer crucial perspectives on the ways in which these tools shape learning paths across different periods and amidst diverse disruptions. Moreover, scholarly inquiries ought to examine tactics for surmounting obstacles to entry and enhancing the utilization of adaptive learning in varied educational environments.

Implications

The transformative impact of ALPs on computer education has several implications. For educators, the shift towards adaptive learning necessitates a re-evaluation of teaching methods and curricula. It also requires professional development to ensure that educators are equipped to effectively integrate these platforms into their teaching practices. For students, ALPs offer a more personalized and engaging learning experience. However, there is a need to ensure equity in access to these technologies to prevent exacerbating existing educational disparities. At the institutional level, the resilience of adaptive learning platforms suggests a potential shift in the structure of computer education programs. Institutions may need to reconsider their investment in physical infrastructure versus digital platforms and explore partnerships with ALP providers.

The effect of technology on institutions of higher education has been significant, as illustrated by the emergence of virtual reality, flipped classrooms, and technology-driven learning platforms that are increasingly gaining recognition (Kabudi et al., 2021). According to the World Economic Forum, customizing educational content and experiences using artificial intelligence plays a crucial role in equipping learners for the evolving demands of future employment (Chetry, 2024). A bibliometric analysis of research articles spanning from 2000 to 2022 offers a thorough examination of the research terrain concerning adaptive learning within the educational domain (Jing et al., 2023). The investigation underscores a growing enthusiasm and academic output in this field, signifying a solid groundwork for forthcoming studies. Furthermore, it stresses the necessity for continuous investigation to tackle the obstacles and optimize the prospective advantages of adaptive learning systems.

References

1. Akintayo, O. T., Eden, C. A., Ayeni, O. O., & Onyebuchi, N. C. (2024). Evaluating the impact of educational technology on learning outcomes in the higher education sector: a systematic review. *International Journal of Management & Entrepreneurship Research*, Volume 6, Issue 5, P.No. 1395-1422.
2. Alase, A. (2017). The Interpretative Phenomenological Analysis (IPA): A Guide to a Good Qualitative Research Approach. *International Journal of Education & Literacy Studies*, 5(2): 9-19.
3. Al-Zahrani, A. & Alasmari, T. (2024). Learning Analytics for Data Driven Decision Making: Enhancing Instructional Personalization and Student Engagement in Online Higher Education. *International Journal of Online Pedagogy and Course Design*, 13(1), 1 – 18.
4. Baker, R. S., & Siemens, G. (2014). Educational data mining and learning analytics. In R. K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences* (2nd ed., pp. 253-272). Cambridge University Press.
5. Barbosa, P. L. S., Carmo, R. A. F., Gomes, J. P. P. & Viana, W. (2023). Adaptive learning in computer science education: A scoping review. *Education and Information Technologies* (2024) 29:9139–9188.
6. Broadbent, J., Ajjawi, R., Bearman, M., Boud, D. & Dawson, P. (2023). Beyond emergency remote teaching: did the pandemic lead to lasting change in university courses? *International Journal of Educational Technology in Higher Education*, (2023) 20 – 58.
7. Chetry, K. K. (2024). Transforming Education: How AI is Revolutionizing the Learning Experience. *International Journal of Research Publication and Reviews*, Vol 5, no 5, pp 6352-6356.
8. Contrino, M. F., Reyes-Millán, M., Vázquez-Villegas, P. & Membrillo-Hernández, J. (2024). Using an adaptive learning tool to improve student performance and satisfaction in online and face-to-face education for a more personalized approach. *Smart Learning Environments*, 11(6), 1 – 24.
9. Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems*, 49(1), 5-22.
10. Dziuban, C., Graham, C. R., Moskal, P. D., Norberg, A., & Sicilia, N. (2018). Blended learning: the new normal and emerging technologies. *International Journal of Educational Technology in Higher Education*, 15(1), 1-16.
11. El-Sabagh, H. A. (2021). Adaptive e-learning environment based on learning styles and its impact on development students' engagement. *International Journal of Educational Technology in Higher Education* volume 18, Article number: 53, 1-24.
12. Eslit, E. R. (2023). Voices of Resiliency: Exploring the Transformative Journey of Educators and Students in the Post-Pandemic Education Era. ResearchGate Preprint, doi: 10.20944/preprints202305.1514.v1.
13. Fadieieva, L. O. (2023). Adaptive learning: a cluster-based literature review (2011–2022). *Educational Technology Quarterly*, Vol. 2023, Iss. 3, pp. 319-366.
14. Gholam, A. (2019). Inquiry-Based Learning: Student Teachers' Challenges and Perceptions. *Journal of Inquiry & Action in Education*, 10(2), 112 – 133.
15. Gligorea, I., Cioca, M., Oancea, R., Gorski, A.T., Gorski, H., & Tudorache, P. (2023). Adaptive Learning Using Artificial Intelligence in e-Learning: A Literature Review. *Education Sciences*, 2023, 13, 1 – 28.

16. Hwang, G. J. (2018). Definition, framework and research issues of smart learning environments – a context-aware ubiquitous learning perspective. *Smart Learning Environments*, 5(1), 1-14.
17. Ibrahim, U., Argungu, J. I., Mungadi, I. M., & Yeldu, A. S. (2023). E-Learning and Remote Education Technologies: Lessons from The Pandemic. *International Journal of Education and Life Sciences (IJELS)* Vol. 1, No. 3,159-174.
18. Iqbal, M. (2023). AI in Education: Personalized Learning and Adaptive Assessment. *Cosmic bulletin of business management*, vol., 2, no., 1, 280 – 297.
19. Jing, Y., Zhao, L., Zhu, K., Wang, H., Wang, C., & Xia, Q. (2023). Research Landscape of Adaptive Learning in Education: A Bibliometric Study on Research Publications from 2000 to 2022. *Sustainability* 2023, 15, (1-21).
20. Johnson, D. W., Johnson, R. T., & Smith, K. A. (2014). Cooperative learning: Improving university instruction by basing practice on validated theory. *Journal on Excellence in College Teaching*, 25(3&4), 85-118
21. Kabudi, T., Pappas, I., & Olsen, D. H. (2021) AI-enabled adaptive learning systems: A systematic mapping of the literature. *Computers and Education: Artificial Intelligence* 2, 1 – 12.
22. Kem, D. (2022). Personalised and Adaptive Learning: Emerging Learning Platforms in the Era of Digital and Smart Learning, *International Journal of Social Science and Human Research*, Volume 05 Issue 02, Page No: 385-391.
23. Kerimbayev, N., Umirzakova, Z., Shadiev, R. & Jotsov, V. (2023). A student-centered approach using modern technologies in distance learning: a systematic review of the literature. *Smart Learning Environments*. (2023) 10:61, 1 – 28.
24. Kizilcec, R. F., Saltarelli, A. J., Reich, J., & Cohen, G. L. (2017). Closing global achievement gaps in MOOCs. *Science*, 355(6322), 251-252.
25. Kulik, J. A., & Fletcher, J. D. (2016). Effectiveness of Intelligent Tutoring Systems: A Meta-Analytic Review. *Review of Educational Research*, 86(1), 42-78.
26. Lalima, & Dangwal, K. L. (2017). Blended learning: An innovative approach. *Universal Journal of Educational Research*, 5(1): 129-136.
27. Martin, F., Chen, Y., Moore, R.L., & Westine, C. (2020). Systematic review of adaptive learning research designs, context, strategies, and technologies from 2009 to 2018. *Educational Technology Research & Development*, 68(4), 1903-1929.
28. Noon, E. J. (2018). Interpretive Phenomenological Analysis: An Appropriate Methodology for Educational Research? *Journal of Perspectives in Applied Academic Practice*, Vol 6, Issue 1, 75 – 83.
29. Odhiambo, A. (2023). The Impact of Social Presence on Online Student Engagement. *Journal of Online and Distance Learning*, Vol. 3, Issue No.1, pp 14 – 27.
30. Odulaja, B. A., Oke, T. T., Eleogu, T. Abdul, A. A. & Daraojimba, H.O. (2023). Resilience in the face of uncertainty: a review on the impact of supply chain volatility amid ongoing geopolitical disruptions. *International Journal of Applied Research in Social Sciences*. Volume 5, Issue 10, P.No. 463-486.
31. Pardo, A., & Siemens, G. (2014). Ethical and privacy principles for learning analytics. *British Journal of Educational Technology*, 45(3), 438-450.
32. Popenici, S. A. D., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. *Research and Practice in Technology Enhanced Learning*, 12(1), 1-13.

33. White, G. (2020). Adaptive learning technology relationship with student learning outcomes. *Journal of Information Technology Education: Research*, vol. 19, 2020, 113 – 130.
34. Xiaoyu, Z. & Tobias, T. C. R. (2023). Exploring the Efficacy of Adaptive Learning Technologies in Online Education: A Longitudinal Analysis of Student Engagement and Performance. *International Journal of Science and Engineering Applications* Volume 12-Issue 12, 28 – 31.
35. Xie, J., Siau, K., & Nah, F. F. H. (2020). COVID-19 Pandemic–Online Education in the New Normal and the Next Normal. *Journal of Information Technology Case and Application Research*, 22(3), 175-187.