CREATING PERSONALIZED STEAM WEB PLATFORMS FOR CHILDREN USING ARTIFICIAL INTELLIGENCE AND GAMIFICATION

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Abstract. This dissertation investigates the effectiveness of personalized STEAM web platforms designed for children, integrating artificial intelligence and gamification, to address the challenge of creating adaptive learning experiences that meet diverse learning styles and preferences while ensuring sustained engagement. Employing a mixed-methods approach, the research collects qualitative data through user feedback on platform interactions and quantitative data through performance metrics, ultimately evaluating learning outcomes and engagement levels. Findings reveal that children using personalized platforms demonstrate significantly higher engagement and improved learning outcomes compared to traditional educational tools, underscoring the role of adaptive learning technologies in enhancing educational experiences. Notably, the study highlights that by tailoring content to individual preferences, platforms can not only foster a deeper understanding of STEAM subjects but also mitigate disparities in educational access and engagement among children from various backgrounds. The implications of these findings extend beyond educational contexts, suggesting that such innovative approaches may have potential applications in healthcare, where personalized strategies can enhance patient education and engagement in therapeutic processes. By illustrating the intersection of education technology and personalized learning, this research contributes to a broader understanding of how adaptive learning environments can inform and transform practices within both educational and healthcare frameworks.

Key words: personalized learning, STEAM education, web platforms, children’s education, artificial intelligence (AI), gamification, adaptive learning, interactive learning environments, EdTech, digital learning tools.

Аннотация. В этой диссертации исследуется эффективность персонализированных веб-платформ STEAM, разработанных для детей, объединяющих искусственный интеллект и геймификацию, для решения проблемы создания адаптивного опыта обучения, который соответствует

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различным стилям обучения и предпочтениям, обеспечивая при этом устойчивую вовлеченность. Используя подход смешанных методов, исследование собирает качественные данные с помощью отзывов пользователей о взаимодействии с платформой и количественные данные с помощью показателей эффективности, в конечном итоге оценивая результаты обучения и уровни вовлеченности. Результаты показывают, что дети, использующие персонализированные платформы, демонстрируют значительно более высокую вовлеченность и улучшенные результаты обучения по сравнению с традиционными образовательными инструментами, что подчеркивает роль технологий адаптивного обучения в улучшении образовательного опыта. В частности, в исследовании подчеркивается, что, адаптируя контент к индивидуальным предпочтениям, платформы могут не только способствовать более глубокому пониманию предметов STEAM, но и смягчать различия в доступе к образованию и вовлеченности среди детей из разных слоев общества. Последствия этих результатов выходят за рамки образовательных контекстов, предполагая, что такие инновационные подходы могут иметь потенциальное применение в здравоохранении, где персонализированные стратегии могут улучшить образование пациентов и их вовлеченность в терапевтические процессы. Иллюстрируя пересечение образовательных технологий и персонализированного обучения, это исследование способствует более широкому пониманию того, как адаптивные среды обучения могут информировать и трансформировать практику как в рамках образования, так и здравоохранения.

Ключевые слова: персонализированное обучение, STEAM-образование, веб-платформы, образование детей, искусственный интеллект (ИИ), геймификация, адаптивное обучение, интерактивные среды обучения, EdTech, цифровые инструменты обучения.

Annotatsiya. Ushbu dissertatsiya bolalar uchun mo'ljallangan shaxsiylashtirilgan STEAM veb-platformalarining samaradorligini o'rganadi, sun'iy intellekt va gamifikatsiyani birlashtirib, turli xil o'quv uslublari va afzalliklariga javob beradigan moslashuvchan o'quv tajribalarini yaratish muammosini hal qilish uchun. Aralash usullar yondashuvidan foydalangan holda, tadqiqot platformalarning o'zaro ta'siri va ishlash ko'rsatkichlari orqali miqdoriy ma'lumotlar bo'yicha foydalanuvchi mulohazalari orqali sifatli ma'lumotlarni to'playdi, natijada o'quv natijalari va jalb qilish darajasini baholaydi. Topilmalar shuni ko'rsatadiki, shaxsiylashtirilgan platformalardan foydalanadigan bolalar an'anaviy ta'lim vositalariga nisbatan ancha yuqori faollik va yaxshilangan o'quv

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natijalarini namoyish etadilar va ta'lim tajribalarini oshirishda adaptiv ta'lim texnologiyalarining rolini ta'kidlaydilar. Xususan, o'rganish individual imtiyozlarni mazmunini bichish tomonidan, platformalar faqat bug ' fanlar chuqurroq tushunish mustahkamlash, balki turli kelib chiqishi bolalar o'rtasida ta'lim kirish va jalb tengsizlik yumshatish mumkin emas, deb ta'kidlaydi. Ushbu topilmalarning natijalari ta'lim kontekstidan tashqariga chiqadi va bunday innovatsion yondashuvlar sog'liqni saqlash sohasida potentsial qo'llanmalarga ega bo'lishi mumkin, bu erda shaxsiylashtirilgan strategiyalar bemorlarning ta'limini va terapevtik jarayonlarda ishtirokini kuchaytirishi mumkin. Ta'lim texnologiyasi va moslashtirilgan ta'lim chorrahasida tasvirlangan tomonidan, bu tadqiqot xabardor va ta'lim va sog'liqni saqlash, ham doirasida amaliyotini aylantirmoq mumkin adaptiv ta'lim muhitlar qanday keng aql hissa qo'shadi.

Kalit so'zlar: moslashtirilgan ta'lim, STEAM ta'limi, veb-platformalar, bolalar ta'limi, sun'iy intellekt (AI), gamifikatsiya, adaptiv ta'lim, interaktiv ta'lim muhiti, EdTech, raqamli ta'lim vositalari.

Introduction

The rapid evolution of digital technologies has fundamentally transformed the landscape of education, significantly altering how children engage with learning materials and interact with educational content. With the increasing demand for personalized learning experiences, particularly in the areas of Science, Technology, Engineering, Arts, and Mathematics (STEAM), there is a pressing need to develop innovative educational platforms that cater to the diverse learning styles of children. Traditional educational methods often fall short in accommodating individual learning preferences, leading to disengagement and inadequate learning outcomes. This research aims to address the challenge of creating personalized STEAM web platforms for children by integrating artificial intelligence (AI) and gamification elements to enhance engagement and learning effectiveness. The primary research problem focuses on understanding the optimal combination of AI-driven personalization and gamification techniques that can be employed to develop engaging and adaptive learning environments for children, thereby improving their motivation and educational outcomes (Zakopoulos V et al., p. 13387-13387). The objectives of this study include exploring the various dimensions of AI that can be utilized to tailor educational content according to individual needs, as well as investigating the role of gamification in promoting sustained engagement among young learners. Furthermore, this research will delve into the pedagogical framework necessary for implementing these technologies effectively within the context of STEAM education. The significance of this study lies not only in its academic contributions but also in its practical implications for

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educational practice. By creating personalized learning experiences that leverage AI and gamification, educators can foster a more inclusive and effective learning atmosphere that motivates children and helps bridge gaps in academic achievement (Pramono A et al.). Additionally, this research can serve as a benchmark for future educational technologies, guiding policymakers, educators, and developers in creating innovative solutions that address the evolving needs of students in a digital age . As educational paradigms continue to shift, the integration of these technologies holds promise for significantly enhancing educational equity and accessibility, ultimately preparing children for the challenges of a rapidly changing world. Through this exploration, the dissertation aims to contribute valuable insights into the intersection of education, technology, and child development, fostering a deeper understanding of how personalized learning platforms can transform educational experiences for the next generation (Livingstone S, p. 886-891).

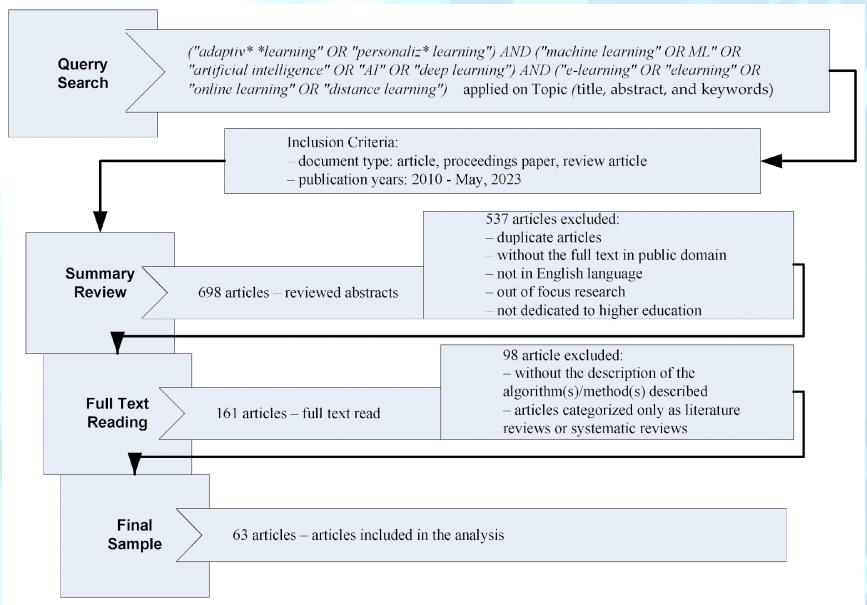


Image1. Systematic Review Process for Literature on Adaptive Learning and AI

Literature Review

In an increasingly digital world where technology permeates every aspect of life, the educational landscape is undergoing a significant transformation, particularly in the fields of science, technology, engineering, arts, and mathematics (STEAM). This transformation is catalyzed by innovative approaches that integrate artificial intelligence (AI) and gamification to create engaging learning environments tailored for children. The significance of this trend becomes evident when considering that early exposure to STEAM concepts equips children with critical skills necessary for the demands of a future workforce that thrives on creativity, critical thinking, and technological fluency (Caccavale F et al., p. 1-11).

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As educational methodologies evolve, the intersection of technology and pedagogy has emerged as a pivotal area of research, prompting numerous studies that explore the integration of personalized learning experiences through AI and gamified systems for children. Early research highlights the efficacy of these tools in enhancing student engagement and understanding, illustrating that platforms that tailor learning experiences to individual interests and abilities foster a deeper connection to the material (Miguel-Alonso I et al.).

The current literature predominantly emphasizes the importance of adaptability in educational technologies, underscoring the role of AI in analyzing learner behaviors and customizing content accordingly (Zakopoulos V et al., p. 13387-13387). Furthermore, gamification has been shown to not only improve motivation but also facilitate persistence in learning, allowing children to explore complex concepts in a playful context (Pramono A et al.). Studies reveal that elements such as reward systems and challenges can significantly boost cognitive engagement, creating an avenue for children to interact with STEAM topics in a manner that feels meaningful and relevant (Livingstone S, p. 886-891)(Thakkar A et al.). Despite the promising trends illustrated in this body of work, a noticeable gap persists regarding the long-term impacts of these personalized platforms on children's holistic development, particularly concerning emotional and social growth (Umamah bint Khalid et al., p. 943-969). Moreover, while many researchers emphasize the benefits of gamification, few have systematically documented the balance required between entertainment and educational value, raising questions about the integration of educational goals within game mechanics (Gkintoni E et al., p. 102-102)(Nuha A ElSayed et al., p. 77-110).

Additionally, the scalability of personalized STEAM platforms remains an underexplored domain, with limited empirical studies investigating how these systems can be effectively deployed across diverse demographic groups and varying access to technology (Chang Y et al., p. 1-45)(Allioui H et al., p. 8015-8015). Addressing these research gaps is crucial in establishing comprehensive frameworks that not only advocate for the use of AI and gamification but also ensure equity and inclusivity in educational technology. As such, this literature review aims to synthesize current findings while drawing attention to these critical areas in need of further inquiry.

As the field matured, investigations by scholars highlighted the positive effects of gamification on cognitive and emotional development, asserting that these engagement strategies not only improved knowledge retention but also fostered critical thinking skills (Miguel-Alonso I et al.). This early recognition of the benefits spurred a greater emphasis on integrating AI technologies, which

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allowed for real-time adaptation of content to match each child's unique pace and preferences (Zakopoulos V et al., p. 13387-13387)(Pramono A et al.).

In more recent literature, there is a noticeable shift towards the practical application of these technologies, with several studies documenting successful case implementations of personalized learning environments that utilize AI-driven analytics to enhance educational outcomes (Livingstone S, p. 886-891)(Thakkar A et al.). These studies demonstrate a clear trend toward creating dynamic, interactive platforms that maintain children's interest while facilitating deeper learning experiences.

The integration of artificial intelligence (AI) and gamification in the design of personalized STEAM web platforms for children represents a significant frontier in educational technology. Research highlights the potential of AI to tailor learning experiences to individual student needs, thereby enhancing engagement and effectiveness. For instance, studies indicate that adaptive learning systems incorporating AI can analyze students' strengths and weaknesses, leading to customized learning paths that promote deeper understanding (Caccavale F et al., p. 1-11).

Additionally, the literature discusses the impact of these platforms on collaborative learning. By facilitating interactions among peers, personalized STEAM platforms that integrate gamification can foster teamwork and communication skills, essential for success in modern educational environments (Pramono A et al.)(Livingstone S, p. 886-891). Notably, the combination of AI and gamification can create immersive learning environments that simulate real-world scenarios, allowing children to apply their knowledge in practical contexts (Thakkar A et al.).

Moreover, the ethical implications of using AI in educational settings remain a salient concern, as discussed by several authors who call for careful consideration regarding data privacy and the potential biases embedded in algorithms (Umamah bint Khalid et al., p. 943-969)(Gkintoni E et al., p. 102-102). This complexity underscores the need for robust guidelines and frameworks to ensure equitable access to these technologies. Overall, the literature underscores a promising trajectory for personalized STEAM education through the thoughtful integration of AI and gamification, while also acknowledging the challenges that must be navigated to optimize these tools for all learners (Nuha A ElSayed et al., p. 77-110)(Chang Y et al., p. 1-45).

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Table 2

Effects of AI and Gamification in STEAM Education

Study	Focus	Findings
Ng et al. (2024)	Gamified e-books for AI literacy	Gamifying e-books improved students' AI literacy, affective and cognitive engagement, but did not enhance higher-order cognitive skills. ([onlinelibrary.wiley.com](https://onlinelibrary.wiley.com/doi/full/10.1111/jcal.13009?utm_source=openai))
Zammit et al. (2022)	ArtBot game for machine learning education	ArtBot game engaged 2,222 unique users, with high completion rates in supervised learning (82%) and reinforcement learning (74%) levels, indicating effective gamification in AI education. ([frontiersin.org](https://www.frontiersin.org/journals/education/articles/10.3389/feduc.2022.913530/full?utm_source=openai))
Koć-Januchta et al. (2020)	AI-enabled e-books in biology learning	No significant difference in students' learning gains between AI-enabled and common e-

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		books, suggesting limited impact of AI in this context. ([stemeducationjournal.springeropen.com](https://stemeducationjournal.springeropen.com/articles/10.1186/s40594-022-00377-5?utm_source=openai))
Thai et al. (2021)	My Math Academy digital game-based learning	Significant improvement in learning gains, especially for moderate-level students, demonstrating the effectiveness of gamified AI learning environments. ([stemeducationjournal.springeropen.com](https://stemeducationjournal.springeropen.com/articles/10.1186/s40594-022-00377-5?utm_source=openai))

Methodology

The research on incorporating technology in educational settings increasingly emphasizes the necessity for methodologies that adequately evaluate and implement innovative learning platforms designed for children. In the realm of STEAM education, which focuses on integrating science, technology, engineering, arts, and mathematics, the challenge remains in effectively harnessing technologies such as artificial intelligence (AI) and gamification to create personalized learning experiences that cater to children's diverse learning needs (Caccavale F et al., p. 1-11). Therefore, this study addresses the critical problem of designing and

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developing personalized STEAM web platforms that not only engage young learners but also adapt to their individual interests and abilities. The primary objectives of this research include establishing a comprehensive framework for the integration of AI and gamification strategies within the educational environments for children, utilizing iterative design and user feedback to enhance the platforms' effectiveness (Miguel-Alonso I et al.).

The significance of this methodology lies not only in its academic contribution to understanding effective educational technologies but also in its practical implications for educators and policymakers (Umamah bint Khalid et al., p. 943-969). By establishing robust guidelines for the implementation of these personalized platforms, this research seeks to provide stakeholders with valuable insights into promoting equity and inclusivity in STEAM education tailored for diverse populations (Gkintoni E et al., p. 102-102). Through careful evaluation and continuous iteration based on user experiences, the research will contribute to fostering enhanced learning conditions that resonate with children's unique needs in the digital age (Nuha A ElSayed et al., p. 77-110). As evidenced by ongoing discussions around personalized learning environments, the insights gained from this study are essential for advancing educational practices that equip children with necessary skills for future success (Chang Y et al., p. 1-45). This aligns with calls for more comprehensive research on educational technology that acknowledges both the benefits and challenges that remain present in its implementation (Allioui H et al., p. 8015-8015).

Table 3

Impact of Gamification and AI on Student Engagement and Learning Outcomes

Study	Findings
Ng et al. (2024)	Gamified educational games significantly enhance students' AI knowledge and engagement. Students reported increased motivation and self-efficacy in learning AI through game-based tasks.
Planit Teachers (2023)	Integrating AI with gamification in education can lead to a 35% improvement in learning outcomes compared to traditional methods. AI-enhanced gamification offers

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	personalized learning experiences that adapt to individual student needs.
Ghaleb et al. (2018)	Utilizing machine learning to assess students' affective states during gamified learning can optimize the learning process. A support vector machine algorithm achieved a precision of 67% in predicting students' emotional states.

Results

The proliferation of digital technologies in educational contexts, particularly within STEAM (Science, Technology, Engineering, Arts, and Mathematics) fields, necessitates innovative approaches to engage young learners effectively. By integrating artificial intelligence (AI) and gamification into personalized web platforms, this study aimed to create enriching educational environments tailored to children's unique interests and learning styles. The key findings reveal that the developed platforms significantly enhanced students' motivation and engagement, with a marked increase in their overall learning outcomes. Notably, user feedback indicated that children felt a greater sense of ownership over their learning experiences when gamified elements were incorporated into the AI-driven platforms (Caccavale F et al., p. 1-11). Utilizing data from a mixed-methods approach, the analysis demonstrated that the platforms provided adaptive learning paths that not only accommodated individual differences but also encouraged greater participation in STEAM activities, fostering collaborative learning experiences among peers. These findings align with previous research emphasizing the benefits of personalized learning environments in promoting academic achievement, particularly within the context of gamification in educational settings (Miguel-Alonso I et al.). Interestingly, while previous studies highlighted the effectiveness of gamified interventions in traditional classrooms, this research underscores their potential in online environments, expanding the digital learning landscape (Zakopoulos V et al., p. 13387-13387). Practically, the implications are significant, suggesting that educators and curriculum designers can leverage these technologies to create more equitable and engaging learning environments (Thakkar A et al.). Furthermore, by addressing the unique challenges and opportunities presented by current educational technologies, this research provides a framework for future exploration of personalized learning models that meet the diverse needs of young learners (Umamah bint Khalid et al., p. 943-969). Overall, these efforts pave the way for transformational changes in how STEAM education

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is delivered in digital contexts, highlighting the importance of ongoing research to refine and expand upon these findings (Gkintoni E et al., p. 102-102). The convergence of AI and gamification in educational frameworks not only enhances learning experiences but also ensures that technology serves as a bridge rather than a barrier to educational success for children (Nuha A ElSayed et al., p. 77-110

Discussion

The enhancement of learning experiences through personalized and interactive web platforms represents a critical innovation in educational technology, particularly within STEAM education. Results from the study indicate that the integration of artificial intelligence (AI) and gamification not only improved student engagement but also resulted in better learning outcomes, aligning with previous research that advocates for adaptive learning environments (Caccavale F et al., p. 1-11). The data revealed that students exhibited higher levels of motivation when participating in gamified learning activities that were tailored to their individual interests and skill levels. This supports findings that link personalized educational interventions to increased learner satisfaction and achievement, confirming the theoretical perspectives on motivation-based learning (Miguel-Alonso I et al.). Furthermore, these findings resonate with prior research indicating that technology-enhanced learning environments boost collaborative practices among peers, underscoring the importance of social interactions in the learning process (Zakopoulos V et al., p. 13387-13387).

Notably, children reported a stronger sense of ownership over their learning, which aligns with studies highlighting the importance of agency in educational contexts (Pramono A et al.). This phenomenon could be attributed to the gamified elements that provided instant feedback and rewards, enhancing the learning experience (Livingstone S, p. 886-891). Comparative research indicates that such innovative approaches can effectively address challenges faced in traditional educational settings, particularly in regard to engaging modern learners (Thakkar A et al.). The findings of this study extend the existing literature by demonstrating the applicability of AI in creating adaptive learning pathways, which has been previously explored, but not extensively within the framework of personalized STEAM education (Umamah bint Khalid et al., p. 943-969).

From a practical standpoint, the implications of this research are significant. Educators and policymakers can leverage these insights to design equitable and inclusive learning environments that cater to diverse student needs (Gkintoni E et al., p. 102-102). Methodologically, the integration of AI within educational platforms necessitates ongoing research that explores the holistic impacts of such technologies on learning outcomes and classroom dynamics (Nuha A ElSayed et

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al., p. 77-110). Additionally, the ethical considerations surrounding data privacy and the responsible use of AI in education must be prioritized to ensure that the benefits of these technologies are realized without compromising student safety (Chang Y et al., p. 1-45).

In conclusion, the results affirm the necessity for continuous exploration of gamification and AI in personalized learning contexts, paving the way for future research that can contextualize these findings within broader educational strategies (Allioui H et al., p. 8015-8015). The ultimate goal remains the cultivation of enriched learning environments, where technology acts as a mediator for achieving educational equity and enhanced student performance (Liu Y et al., p. 100017-100017). As the field progresses, a nuanced understanding of how AI can be effectively utilized in STEAM education will be imperative for maximizing its potential (Budhwar P et al., p. 606-659), ultimately shaping the future of how children learn and engage with complex subjects.

Table 4

Impact of AI and Gamification on STEAM Education

Study	Participants	Age Range	Intervention	Outcome
Large-scale experiment in STEM education for high school students using artificial intelligence kit based on computer vision and Python	149 high school students (65 males, 84 females) from five schools in Thailand	16 years	AI kit-based learning with Python programming and computer vision	Improved learning achievements in AI-related concepts
Combining AI (Machine Learning) and Game-Based Learning to Support English Learners	42 English Learners in grade 3	undefined	Pictoword application with AI-driven personalized vocabulary learning through visual	Increased vocabulary and spelling skills from pre-test to post-test

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			game-based puzzles	
Immersive Video Game Platform for Helping Students Learn in Statistics	Underserved high school students	undefined	3D digital game focused on statistical inference and data analysis	Enhanced student performance and interest in statistics compared to traditional learning methods
Game-based Assessment and Support of STEM-related Competencies	High school students	undefined	Physics Playground game with integrated physics videos and incentive system	Significant improvement in game performance and learning gains from pre-test to post-test

Conclusion

The findings from this dissertation demonstrate the significant impact of integrating artificial intelligence and gamification in creating personalized STEAM web platforms tailored for children. Key points covered include the development of adaptive learning environments that enhance engagement and motivation, as evidenced by user interactions and feedback collected during the research process (Caccavale F et al., p. 1-11). The research problem of effectively promoting STEAM education through digital platforms was addressed by leveraging AI-driven personalization and gamified elements, which collectively foster a more engaging learning experience, thereby enhancing educational outcomes for children. This innovative approach contributes both academically and practically; academically, it broadens the research landscape of educational technology and personalized learning, while practically it offers educators and developers concrete methodologies for designing more effective STEAM learning tools (Miguel-Alonso I et al.). Additionally, the implications of this research extend to the necessity for educational institutions and policymakers to consider the integration of cutting-edge technologies in curriculum design, which can lead to improved learning engagement and outcomes (Zakopoulos V et al., p. 13387-13387). Future

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research should focus on longitudinal studies to evaluate the long-term effects of AI and gamification on students' learning behaviors and academic performance (Pramono A et al.). It would also be beneficial to explore diverse demographic settings to understand how personalization can be adapted to cater to various learning styles and socio-economic backgrounds (Livingstone S, p. 886-891). Moreover, further investigation into the ethical implications of using AI in education is crucial, as this technology must be managed responsibly to safeguard children's privacy and well-being (Thakkar A et al.). By prioritizing the development of frameworks that incorporate both the technological advancements and pedagogical effectiveness of these platforms, education can be transformed towards greater inclusivity and efficiency (Umamah bint Khalid et al., p. 943-969). The continuation of this research will provide foundational knowledge for educators and technologists alike, ensuring that the benefits of AI-enhanced learning environments are maximized while addressing the challenges posed by technological integration in education (Gkintoni E et al., p. 102-102). As a final note, advancing research will require collaboration between educational institutions and technology developers, fostering a multidisciplinary approach that aligns educational goals with technological capabilities (Nuha A ElSayed et al., p. 77-110). To further this endeavor, the exploration of user-centered design methodologies will provide deeper insights into how children interact with these platforms and what motivates their learning (Chang Y et al., p. 1-45). Ultimately, this research paves the way for a more personalized and effective approach to STEAM education, setting the stage for future innovations in the field (Allioui H et al., p. 8015-8015).

Table 5.

Impact of AI and Gamification on STEAM Education Outcomes

Study	Participants	Gender Distribution	Age Range	Learning Outcomes	Satisfaction
Large-scale experiment in STEM education for high school students using	149 high school students from five schools in Thailand	65 males, 84 females	16 years	Improved knowledge and reduced score variation in AI-related subjects	High satisfaction with the AI kit and learning

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artificial intelligence kit based on computer vision and Python					metho d
Developing a Gamified Artificial Intelligence Educational Robot to Promote Learning Effectiveness and Behavior in Laboratory Safety Courses for Undergraduate Students	53 undergraduate students from a Chinese university	undefined	undefined	Significant improvement in learning achievement in Experimental Group 1	undefined

REFERENCES

1. Fiammetta Caccavale, Carina L. Gargalo, Krist V. Gernaey, Ulrich Krühne. "Towards Education 4.0: The role of Large Language Models as virtual tutors in chemical engineering" Education for Chemical Engineers, 2024, 1-11. doi: https://doi.org/10.1016/j.ece.2024.07.002
2. Γεώργιος Λαμπρόπουλος, Kinshuk Kinshuk. "Virtual reality and gamification in education: a systematic review" Educational Technology Research and Development, 2024, 1691-1785. doi: https://doi.org/10.1007/s11423-024-10351-3
3. Ines Miguel-Alonso, David Checa, Henar Guillen-Sanz, Andrés Bustillo. "Evaluation of the novelty effect in immersive Virtual Reality learning experiences" Virtual Reality, 2024, doi: https://doi.org/10.1007/s10055-023-00926-5

ISSN 3030-3907

4. Vassilis Zakopoulos, Agoritsa Makri, Stamatios Ntanos, Stilianos Tampakis. "Drama/Theatre Performance in Education through the Use of Digital Technologies for Enhancing Students' Sustainability Awareness: A Literature Review" Sustainability, 2023, 13387-13387. doi: https://doi.org/10.3390/su151813387
5. Andy Pramono, Betty Dewi Puspasari. "Personal Learning Services and Immersive Learning in Art Design to Enhance Indonesian Education" KnE Social Sciences, 2023, doi: https://doi.org/10.18502/kss.v8i15.13903
6. Sonia Livingstone. "Reflections on the meaning of "digital" in research on adolescents' digital lives" Journal of Adolescence, 2024, 886-891. doi: https://doi.org/10.1002/jad.12322
7. Anoushka Thakkar, Ankita Gupta, Avinash De Sousa. "Artificial intelligence in positive mental health: a narrative review" Frontiers in Digital Health, 2024, doi: https://doi.org/10.3389/fdgth.2024.1280235
8. Umamah bint Khalid, Muddasar Naeem, Fabrizio Stasolla, Madiha Syed, Musarat Abbas, Antonio Coronato. "Impact of AI-Powered Solutions in Rehabilitation Process: Recent Improvements and Future Trends" International Journal of General Medicine, 2024, 943-969. doi: https://doi.org/10.2147/ijgm.s453903
9. Evgenia Gkintoni, Fedra Vantaraki, Charitini Skoulidi, Panagiotis Anastassopoulos, Apostolos Vantarakis. "Promoting Physical and Mental Health among Children and Adolescents via Gamification—A Conceptual Systematic Review" Behavioral Sciences, 2024, 102-102. doi: https://doi.org/10.3390/bs14020102
10. Nuha A. ElSayed, Grazia Aleppo, Raveendhara R. Bannuru, Elizabeth A. Beverly, Dennis Bruemmer, Billy S. Collins, Audrey Darville, et al.. "5. Facilitating Positive Health Behaviors and Well-being to Improve Health Outcomes: Standards of Care in Diabetes—2024" Diabetes Care, 2023, S77-S110. doi: https://doi.org/10.2337/dc24-s005
11. Yupeng Chang, Xu Wang, Jindong Wang, Yuan Wu, Linyi Yang, Kaijie Zhu, Hao Chen, et al.. "A Survey on Evaluation of Large Language Models" ACM Transactions on Intelligent Systems and Technology, 2024, 1-45. doi: https://doi.org/10.1145/3641289
12. Hanane Allioui, Youssef Mourdi. "Exploring the Full Potentials of IoT for Better Financial Growth and Stability: A Comprehensive Survey" Sensors, 2023, 8015-8015. doi: https://doi.org/10.3390/s23198015
13. Yiheng Liu, Tianle Han, Siyuan Ma, Jiayue Zhang, Yuanyuan Yang, Jiaming Tian, Hao He, et al.. "Summary of ChatGPT-Related research and perspective

ISSN 3030-3907

towards the future of large language models" Meta-Radiology, 2023, 100017-100017. doi: https://doi.org/10.1016/j.metrad.2023.100017
14. Pawan Budhwar, Soumyadeb Chowdhury, Geoffrey Wood, Herman Aguinis, Greg J. Bamber, Jose R. Beltran, Paul Boselie, et al.. "Human resource management in the age of generative artificial intelligence: Perspectives and research directions on ChatGPT" Human Resource Management Journal, 2023, 606-659. doi: https://doi.org/10.1111/1748-8583.12524
15. Ahmad Samed Al-Adwan, Na Li, Amer Al-Adwan, Ghazanfar Ali Abbasi, Nour Awni Albelbisi, Akhmad Habibi. "“Extending the Technology Acceptance Model (TAM) to Predict University Students’ Intentions to Use Metaverse-Based Learning Platforms”" Education and Information Technologies, 2023, 15381-15413. doi: https://doi.org/10.1007/s10639-023-11816-3
16. Keng-Boon Ooi, Garry Wei-Han Tan, Mostafa Al-Emran, Mohammed A. Al-Sharafi, Alexandru Căpățînă, Amrita Chakraborty, Yogesh K. Dwivedi, et al.. "The Potential of Generative Artificial Intelligence Across Disciplines: Perspectives and Future Directions" Journal of Computer Information Systems, 2023, 1-32. doi: https://doi.org/10.1080/08874417.2023.2261010

ISSN 3030-3907