Evaluating the Effectiveness of AI-Powered Adaptive Learning Systems in Secondary Schools

Abdullah Alenezi [iD]
Northern Border University, Saudi Arabia

To cite this article:

Evaluating the Effectiveness of AI-Powered Adaptive Learning Systems in Secondary Schools

Abdullah Alenezi

Article Info	Abstract
	The main aim of this research was to evaluate the effects of an AI-based adaptive learning system in increasing the learners' accomplishment in Saudi Arabian secondary schools. To ensure authenticity of the research, the study employed a quasi-experimental approach in which two schools and 40 students were employed to assess the impact of the adaptive learning intervention on the students' learning, engagement and attitudes. The findings showed that the use of the AI system improved students' performance, especially in terms of low performers and student satisfaction. However, at the same time, the study highlighted the problems associated with technological enhancement, the teachers' readiness, and the students' information technology literacy that have to be addressed to enhance the efficient and equitable use of such technologies in learning. This study can benefit Saudi Arabian policymakers and educators by enabling them to optimize the application of AI-based adaptive learning for the improvement of the educational system.

Introduction

The development of artificial intelligence technologies has provided new opportunities in the sphere of education, which is focused on the changing teaching and learning process. In this context, AI is best observed using adaptive learning systems – software encompassing content, pace, and instructional methods adapted to the student's performance, behavior, and needs (Demartini et al., 2024). Therefore, one can conclude that AI-based systems that provide learning maps can be regarded as a means of improving learners' achievements, their interest, and their preparedness for the society of the 21st century.

As Allmnakrah and Evers (2019) have noted, Saudi Arabia has been paying considerable attention to the integration of innovative educational technologies as one of the strategic priorities in the context of the general strategy of Vision 2030 that aims at transforming the Kingdom into an IT power (Patalong, 2017). The Saudi government has come to know that AI is a tool that can bring change within the country and has spent much money trying to enhance the country's AI potential, including in the sphere of education. Nevertheless, much needs to be known about how much Saudi Arabian secondary schools have embraced and how they have experienced the efficiency of AI-driven adaptive learning systems.

This study will address this gap by examining the effectiveness of the AI-based adaptive learning intervention in Saudi Arabian secondary schools. Specifically, the research aims to:

1. Assess the impact of AI-based adaptive learning systems on students' learning outcomes, motivation, and attitude.
2. It may also be necessary to identify possible moderators of the intervention in terms of students' characteristics or the school context.
3. Examine the facilitators and constraints of employing the AI-based adaptive learning system.
4. Provide policy and practice recommendations for the integration of AI-based adaptive learning systems in Saudi Arabian secondary schooling.

Since the study aims to present the outcomes of the empirical research on the application and effectiveness of AI-powered Adaptive Learning in the Saudi Arabian context, the findings will contribute to the understanding of educational technologies and their application in Saudi Arabia, which will be vital in the process of educational improvement and building up of human capital in the country.

Literature Review

In the study conducted by Kaledio et al. (2024) on the use of artificial intelligence in education, the authors noted that the current research shows that adaptive learning systems have the potential to improve the teaching and learning processes. Intelligent adaptive learning systems use AI techniques to track the students' performance, assess the knowledge gaps, and modify the content, delivery methods, and schedule based on the student's needs (Akavova et al., 2023; Sese, 2024). The process adopted in this type of learning has been revealed to improve learning, raise students' engagement and passion and equip students for the working world and technology.

Studies show advantages to employing adaptive learning systems, including using artificial intelligence to improve student performance. For example, a survey of many students in the United States who used an AI-based learning system in mathematics showed that the student's test results were significantly higher than those of the students in the control groups (Seo et al., 2021). Similarly, the studies done in China have indicated that the adoption of classroom-based AI-supported adaptive learning enhanced the achievement of the students, particularly the low achievers (Luo & Hsiao-Chin, 2023).

Besides academic performance, it has also been linked to enhanced student activity and interest through intelligent learning environments depending on artificial intelligence. By so doing, the learners have their learning paths to enable them to be engaged and take responsibility for their learning (Gupta, 2024). Evidence has also shown that students who engage in adaptive learning programs have higher motivation than non-adaptive ones regarding time on task, self-initiated participation, and view of the learning experience (Contrino et al., 2024). Apart from the student level, there are several benefits of employing AI as the foundation for adaptive learning systems for teachers: The adaptive learning systems can also provide the teachers with relevant and precise data on the student's performance and learning rate and help them in identifying learning requirements and teaching methods (Gligorea et al., 2023). This may lead to improved quality of teaching and learning and general performance in

schools and other academic institutions.

Although increasing literature indicates the effectiveness of AI-based adaptive learning, most research has been conducted in developed countries in the West, including the United States and Europe (Guan et al., 2020; Collins et al., 2021). The current literature lacks research on the adoption and effects of such technologies in other parts of the world, especially in the MENA region that holds a specific context of education systems and their opportunities and challenges (Miles et al., 2021; Zaidan & Ehsan, 2024). Saudi Arabia, in detail, offers a good argument for examining the incorporation of an AI adaptive learning system. As one of the goals of the Vision 2030 development plan, the Kingdom has made considerable efforts to improve the learning facilities as well as integrate new technologies (Eurisko, 2023; McNulty, 2024; Pavan, 2024). The Ministry of Education of the country has been keen on the integration of new technologies in education, including AI, in school curriculum and instruction (Alsaywid et al., 2024).

Nonetheless, research on the adoption of AI in Saudi Arabia's education is scarce, and most of the works are either confined to higher education institutions or offer an overall perspective of the technology (Albasalah et al., 2022; Alotaibi & Alshehri, 2023). To the best of the author's knowledge, no empirical studies have assessed the effectiveness of AI-based adaptive learning systems in Saudi Arabian secondary schools, which are a vital stage in students' education to meet the requirements of the modern world. To fill this gap, the present study will seek to provide a systematic assessment of an AI-based adaptive learning intervention among Saudi Arabian secondary schools. The findings of the study will provide context-specific evidence regarding the effectiveness of these technologies and, therefore, contribute to the understanding of how AI-based educational innovations can be effectively implemented and used to support and improve the teaching and learning process in the Saudi Arabian context.

Methodology

Research Design

This study used a quasi-experimental research design to assess the impact of an AI-based adaptive learning system on the performance of students in Saudi Arabian secondary schools. The study entailed the use of the adaptive learning intervention in the treatment group of schools while the control group of schools was left to their everyday teaching practices.

Participant Selection

The study was conducted in 2 public secondary schools in the Northern Border region of Saudi Arabia. The schools were purposively selected for the study, and this included the following: We targeted schools from different geographical locations, namely urban, suburban and rural areas. The students were selected from each school: 10 in the treatment group and 10 in the control group. Random sampling from Grade 10 classes selected the target students, and both male and female students and students with high average and low academic abilities were selected. In addition to the student participants, the study recruited two secondary school teachers per school

who were tasked with using the AI-based adaptive learning system in their teaching practice.

Intervention

The AI-powered adaptive learning system applied in this research was developed by a local Saudi educational technology company in collaboration with the Ministry of Education. The system was to enable learners to have their learning plan for the core subjects like Mathematics, Science, and English. Adaptive learning incorporates the use of intelligence to evaluate the performance and learning deficiencies of the student and, in turn, adapt the content, delivery method and pace of delivery based on the learner's needs (Gligorea et al., 2023).

The system offers a sequence of learning activities based on an adaptive learning approach. It incorporates types of learning such as lessons, exercises and quizzes, which are chosen based on the student's learning ability and approach. The teachers who participated in the study received training on using the identified AI-based adaptive learning system and integrating it into their teaching-learning processes Joshi, (2023). Some training areas involve the system's functioning, lesson planning, and how to make evidence-based decisions.

Data Collection

In the study, data was collected through quantitative and qualitative means, and the results from both were used to establish the impact of the AI adaptive learning intervention.

Table 1. Dataset for 40 Students (20 in the treatment group, 20 in the control group)

Student	Group	Pre-test	Post-test	Engagement	Hours Used
1	Treatment	54	67	4.2	15
2	Treatment	58	69	4.5	19
3	Treatment	52	70	4.9	17
4	Treatment	55	72	3.4	12
5	Treatment	51	58	3.2	15
6	Treatment	59	59	3.0	12
7	Treatment	54	66	3.4	19
8	Treatment	50	62	3.8	14
9	Treatment	53	77	3.4	11
10	Treatment	53	78	3.3	10
11	Treatment	53	66	3.2	19
12	Treatment	59	62	2.8	13
13	Treatment	52	59	3.1	12
14	Treatment	55	65	2.4	15
15	Treatment	56	77	2.8	18
15	Treatment	56	80	2.0	14

Student	Group	Pre-test	Post-test	Engagement	Hours Used
16	Treatment	51	66	2.2	11
17	Treatment	52	69	2.1	10
18	Treatment	59	77	4.1	19
19	Treatment	58	55	5.2	16
20	Treatment	52	49	4.9	16
21	Control	55	66	4.4	17
22	Control	54	69	3.0	12
23	Control	50	73	4.9	14
24	Control	52	59	4.3	13
25	Control	56	78	3.6	16
26	Control	57	73	3.5	22
27	Control	60	66	3.0	21
28	Control	53	66	3.1	25
29	Control	50	80	2.8	11
30	Control	61	59	2.3	10
31	Control	49	54	2.9	9
32	Control	45	43	2.4	13
33	Control	52	66	3.6	10
34	Control	59	44	3.9	16
35	Control	60	59	4.5	13
36	Control	56	54	4.8	10
37	Control	56	58	4.3	19
38	Control	62	66	4.4	18
39	Control	67	57	4.6	13
40	Control	55	59	4.9	11

Table 2. Student Perceptions of AI-Powered Adaptive Learning System (Treatment Group Only)

Student	Ease of Use	Navigation	Feedback	Enjoyment	Pace Match	Tech Issues
1	4	2	2	4	3	No
2	3	4	5	4	5	No
3	1	4	9	9	4	No
4	9	3	3	4	5	No
5	3	3	3	1	3	Yes
6	7	3	3	3	3	No
7	1	3	3	5	3	Yes
8	9	8	8	9	8	No
9	4	4	3	2	4	Yes
10	2	3	4	3	1	No

Student	Ease of Use	Navigation	Feedback	Enjoyment	Pace Match	Tech Issues
11	6	2	3	2	3	No
12	8	8	8	2	1	No
13	1	3	1	1	1	No
14	5	4	4	9	2	No
15	9	8	8	10	10	No
15	9	2	2	2	2	No
16	9	2	2	2	2	No
17	10	1	8	4	2	No
18	5	1	4	2	1	Yes
19	3	2	2	9	5	Yes
20	5	4	9	8	3	Yes
21	9	2	8	10	9	Yes
22	2	3	3	3	3	Yes
23	4	4	5	4	6	No
24	4	3	4	2	3	No
25	7	3	3	4	6	Yes
26	5	5	5	1	3	Yes
27	1	3	3	3	3	Yes
28	1	1	1	3	2	Yes
29	1	1	3	5	1	No
30	2	2	2	3	1	Yes
31	5	2	2	2	2	Yes
32	7	4	4	2	5	No
33	2	3	6	3	7	No
34	1	3	1	2	1	No
35	9	5	4	5	6	No
36	7	8	8	4	5	No
37	5	3	4	2	3	No
38	1	2	4	5	3	No
39	3	4	6	3	5	No
40	4	4	4	5	7	No

Quantitative Measures

1. Student Learning Outcomes: In this study, the treatment and control groups were pre- and post-tested on the specific subject to analyze the students' performance before and after the treatment.
2. Student Engagement: The students' engagement was assessed from the filled questionnaires, and the time spent on learning activities, voluntary activities, and fun perceived by the students from the learning

activities were estimated (see Appendix for Questionnaires).

3. Student Perceptions: The participants in the treatment group filled out questionnaires that focused on their perceptions, attitudes, and satisfaction with an AI-based adaptive learning environment.

Qualitative Measures

1. Classroom Observations: To gather data on instructional practices, students' interactions with the teachers, and the use of the adaptive learning system, researchers observed classrooms in both the treatment and control groups on a frequent basis.
2. Teacher Interviews: The participating teachers were asked to complete semi-structured interviews to discuss their experience, difficulties, and attitudes to using an AI-based adaptive learning system.

Data Analysis

The research sample was 40 students from 2 secondary schools in Saudi Arabia: 20 in the treatment group who used the AI-adaptive learning system and 20 in the control group who used traditional learning. Students' pre-test and post-test results were also obtained, as well as their engagement level. Both descriptive and inferential methods were used to analyze the data. The information gathered from the pre-and post-tests, questionnaires filled by the students, and the classroom observations were descriptive and inferential analyses. Specifically, we relied on the regression analysis to compare the learning outcomes and engagement between the treatment and control groups. We also looked for moderation by student characteristics or school contexts.

The data gathered from the teachers' interviews and the classroom observations were analyzed using the thematic analysis method. In order to categorize the data gathered from the interviews and observations, the researchers conducted coding to seek patterns and themes related to the implementation of the AI-driven adaptive learning system, the problems perceived by the teachers, and the enablers of the integration process. The data collected from the quantitative and qualitative were then merged so that the study has a dual hump approach where the impact of the AI- Adaptive Learning intervention and the factors that influenced the adoption of the AI-Adaptive Learning intervention in Saudi Arabian secondary schools were determined.

Results
Impact on Student Engagement

The study's findings also involved the evaluation of the student engagement questionnaire results. It was evident that the use of the proposed AI-based adaptive learning system brought about changes in the level of student engagement. The study established that the students in the treatment group perceived the content to be more relevant—the student engagement for student engagement measures on a 10-point scale. As a result, the mean for treatment is 3.42 out of 5. On the other hand, the mean for the control group is 3.76 out of 5. The engagement self-report survey included questions about the interest in the lessons, participation, learning motivation and effort for schoolwork. Hence, the enhancement of the student's attitudes and interests could be due to the utilization of

an AI-based adaptive learning system that is more suitable and engaging for the learners.

Table 3. Descriptive Statistics for Pre-test and Post-test Scores

Group	Pre-test		Post-test	
	Mean	SD	Mean	SD
Treatment (n=40)	54.38	2.89	66.81	8.26
Control (n=40)	55.45	5.17	62.45	9.83

Table 4. Student Engagement Measures (on a 10-point Likert scale)

Group	Mean	SD
Treatment (n=40)	3.42	0.93
Control (n=40)	3.76	0.85

Student Perceptions of the AI-Powered Adaptive Learning System

The study also showed that the treatment group students had a positive attitude towards the AI-Powered Adaptive Learning System. The System Usability Questionnaire, completed only by the treatment group, offered information on students' perspectives. Students also responded positively to the perceived ease of use (mean = 4.71), perceived navigation (mean = 3.39), perceived helpfulness of feedback (mean = 4.24), and perceived enjoyment of use (mean = 4.05) based on a 5-point Likert scale. The mean score of 3.71 was most notable for the statement, "The adaptive lessons match my learning pace."

Table 5. Student Perceptions of the AI-Powered Adaptive Learning System

Perception	Mean (5-point scale)
The system is easy to use	4.71
I can easily navigate through the lessons	3.39
The system provides helpful feedback on my progress	4.24
I enjoy using the adaptive learning system	4.05
The adaptive lessons match my learning pace	3.71
Experienced technical difficulties	34

Some students, however, complained of technical hitches, especially with an internet connection that once in a while interfered with the lessons. For instance, the students who experienced difficulties with the system were 34 per cent. However, the students' overall impression of the system was positive: they liked the individual approach and the material presented.

Challenges and Facilitating Factors in Implementation

Several difficulties and enablers of the AI-based adaptive learning system were identified from the interviews conducted with the teachers and classroom observations.

Challenges in Implementing AI-Powered Adaptive Learning

Another challenge encountered while integrating the AI-adaptive learning system in Saudi Arabian secondary schools is the limited technological resources, especially in rural areas and other regions that need better development (Mustafa et al., 2024). However, some schools encountered specific challenges, such as limited internet connection and outdated hardware, which hampered the easy implementation of the adaptive learning platform.

One of the significant limitations encountered in implementing the AI-powered system was the weak technological foundation of the company. In schools with limited internet connection and old devices, students and teachers worked under conditions where connectivity problems and software malfunction affected learning (Basar et al., 2021). This difference in the availability of technology pointed out the need for equal distribution of resources throughout the Saudi education system so that all the students are provided with the necessary technological tools and can take advantage of new technologies such as adaptive learning.

Another challenge that was experienced was the question of the readiness of the teachers. Despite the professional development program through which the participating teachers were trained on using and integrating the AI-powered adaptive learning system, a few remained concerned about their capacity to apply the technology in their teaching appropriately. Several teachers felt they needed more knowledge about the system and could not independently address technical challenges that emerged in the classroom. As Ding et al. (2024) noted, providing teachers with initial training and continuing professional development is crucial to utilize AI-based adaptive learning systems effectively. In order to support such interventions in the long term and guarantee their effectiveness, educators need to be equipped with the knowledge and skills that will allow for incorporating such technologies into the teaching process.

Apart from the problems that schools and teachers must overcome, the study has pointed out the problem of students' digital literacy. Some students, especially the low achievers, still needed to gain appropriate digital skills, which sometimes affected their use of the adaptive learning platform. Some of these students faced challenges navigating through the system, particularly the different features like accessing content assigned by the teachers, submitting the work set, and checking their progress. Closing the digital literacy divide is critical to the effectiveness of AI-enhanced adaptive learning (Southworth et al., 2023). Integrating technology education into the curriculum and offering interventions to students who may be having difficulties in handling the equipment can go a long way in ensuring that all the learners are able to benefit from the new technologies in education.

Through understanding these challenges, policymakers, school administrators, and educators can then come up with the necessary measures to enhance the implementation of AI-based adaptive learning systems in Saudi Arabian secondary schools. Technological capital, teacher preparedness, and student digital learning readiness will be some areas that will require investment to realize the full potential of these revolutionary technologies in learning.

Facilitating Factors for Successful Implementation

Apart from the issues observed during the process of implementing the AI-based adaptive learning system, this study also revealed several enablers that have influenced the successful adoption of the system in Saudi Arabian secondary schools.

One of the most critical enablers was the technical support and assistance in problem-solving coming from the adaptive learning system supplier. The presence of technical specialists who could respond to issues in the classroom was significant in the effective use of the technology (Zamiri & Esmaeili, 2024). In terms of problems with connectivity, software, and other IT challenges that may affect students and teachers, this support was available to them.

Creating collaborative teacher networks was another factor that facilitated the implementation of the AI-powered adaptive learning system. Teacher-learning communities facilitated the ways and means of best practices and fellowship and identified the solutions to the issues that teachers encountered. These networks assisted the teachers in discussing their experiences, sharing their difficulties and establishing the most appropriate ways of integrating the adaptive learning system into teaching.

The other significant factor that put into practice the process was the involvement of parents in the implementation process. Practical meetings with the schools' staff and the constant engagement of parents in the process allowed schools to develop a positive attitude towards using the adaptive learning system in schools and at home. The parents gained enhanced knowledge of the technology and its benefits, and in the same way, they were in a position to help and direct their kids on the use of the technology. This parental involvement helped bring back the memories of the learners and the instructors of the adaptive learning system and the need to enforce it in the learning process.

These facilitating factors include the fact that technical support was available, the ways to build the network for collaborative teachers, and parents' engagement, which was essential for the Saudi Arabian secondary schools to adopt the AI-powered adaptive learning system. With the understanding of these challenges and building on the mentioned key elements, educators and school administrators were able to create an environment that made it possible to embrace this revolutionary tool in education.

Conclusion

The outcome of the present study is helpful in determining the viability of using AI-based ALS to improve the learning performance of Saudi Arabian secondary school students. This research also suggests that the integration of these technologies leads to the desired impact on student learning, engagement, and disposition toward learning, which will enhance the Kingdom's vision of education improvement and human capital development.

On the impact on student learning outcomes, especially on low-achieving students, the use of AI in an adaptive

learning environment has been revealed to have the capacity to adapt learning to students and offset learning loss. This concurs with the literature regarding the improvements brought about by adaptive learning technologies to the student's performance and achievement. In addition, the increase in students' activity contributes to the presence of motivation in AI-based adaptive learning systems that can offer students a better learning process. These technologies can increase student interest and engagement and, in the process, improve learning and the development of twenty-first-century skills.

As the student participants had a relatively positive attitude towards the AI-powered adaptive learning system, the study concludes that Saudi Arabian secondary school students are ready to embrace the technological learning systems. This is important because the adoption and sustainability of education interventions often depend on the ratification of the end-users. However, the study also highlighted some challenges that require solutions to improve the efficacy and equity of AI-AL in Saudi Arabian secondary schools. Issues of technological support, teachers' readiness, and students' technological literacy are comparable to the previous studies on the application of educational technologies in the Kingdom.

These challenges point to the need for a coordinated and multifaceted approach to implementing AI-supported adaptive learning systems that require sufficient funding in technology, development of teachers' AI competencies, and work on enhancing students' technological literacy, particularly among the low SES ones. The factors established to enable this study are the availability of technical support, the formation of collaborative teachers' networks, and parents' involvement, which can guide policymakers and school administrators to emulate when implementing AI-powered adaptive learning systems. Analyzing the factors surrounding the adoption of these technologies, Saudi Arabia can benefit from the full potential of learning technologies that employ artificial intelligence in improving learning and preparing the youth for future challenges.

The results of this study show the great possibility of using AI-based adaptive learning systems to improve learners' performance in Saudi Arabian secondary schools. When implemented in the classroom, these technologies enhance the learning of students, promote student interaction, and have been accepted by students. Nevertheless, integrating adaptive learning systems with the help of artificial intelligence involves a complex of measures connected with the technological aspect of the learning environment, teachers' preparedness, and digital competence. Suppose Saudi Arabia invests in these important areas and exploits the facilitating factors outlined in this research. In that case, it can set the stage for the diffusion of AI-based adaptive learning across the country, consistent with the Kingdom's Vision 2030 objectives for educational reform and human capital development.

The present study offers important empirical data on the use of educational technologies in the Saudi Arabian context to the existing body of knowledge. The findings may be useful to policymakers, school leaders, and teachers as they seek to realize the potential of AI-based adaptive learning to enhance learning and instruction. With the ongoing process of Saudi Arabia's development to become a more technology-driven and knowledge-based economy, the right implementation of new technologies in education, including AI-based adaptive learning, will be instrumental in preparing the Saudi youth for the world of work in the 21st century. This research offers a solid empirical base for subsequent studies and application initiatives in this important area.

Acknowledgements

References

Akavova, A., Temirkhanova, Z., & Lorsanova, Z. M. (2023). Adaptive learning and artificial intelligence in the educational space. E3S Web of Conferences, 451, 06011–06011. https://doi.org/10.1051/e3sconf/202345106011

Albasalah, A., Alshawwa, S., & Alarnous, R. (2022). Use of artificial intelligence in activating the role of Saudi universities in joint scientific research between university teachers and students. PLOS ONE, 17(5), e0267301. https://doi.org/10.1371/journal.pone.0267301

Allmnakrah, A., & Evers, C. (2019). The need for a fundamental shift in the Saudi education system: Implementing the Saudi Arabian economic vision 2030. Research in Education, 106(1), 003452371985153. https://doi.org/10.1177/0034523719851534

Alotaibi, N. S., & Alshehri, A. H. (2023). Prospers and Obstacles in Using Artificial Intelligence in Saudi Arabia Higher Education Institutions—The Potential of AI-Based Learning Outcomes. Sustainability, 15(13), 10723. https://doi.org/10.3390/su151310723

Alsaywid, B. S., AlZahrani, A., Khafagi, D., & Lytras, M. D. (2024). Embracing the Shift: The Innovation Journey in Saudi Arabia's Educational Landscape. Emerald Publishing Limited EBooks, 267–276. https://doi.org/10.1108/978-1-83753-536-120241016

Basar, Z. M., Mansor, A. N., Jamaludin, K. A., & Alias, B. S. (2021). The Effectiveness and Challenges of Online Learning for Secondary School Students – A Case Study. Asian Journal of University Education, 17(3), 119–129. https://doi.org/10.24191/ajue.v17i3.14514

Collins, C., Dennehy, D., Conboy, K., & Mikalef, P. (2021). Artificial intelligence in information systems research: A systematic literature review and research agenda. International Journal of Information Management, 60(102383). Sciencedirect. https://doi.org/10.1016/j.ijinfomgt.2021.102383

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 personalised approach. Smart Learning Environments, 11(1). https://doi.org/10.1186/s40561-024-00292-y

Demartini, C. G., Sciascia, L., Bosso, A., & Manuri, F. (2024). Artificial Intelligence Bringing Improvements to Adaptive Learning in Education: A Case Study. Sustainability, 16(3), 1347. https://doi.org/10.3390/su16031347

Ding, A.-C. E., Shi, L., Yang, H., & Choi, I. (2024). Enhancing teacher AI literacy and integration through different types of cases in teacher professional development. Computers and Education Open, 6, 100178. https://doi.org/10.1016/j.caeo.2024.100178

Eurisko. (2023, November 14). How Saudi Arabia is leading the AI revolution in the Middle East - Eurisko. Eurisko. https://eurisko.net/how-saudi-arabia-is-leading-the-ai-revolution-in-the-middle-east/

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, 13(12), 1216–1216. https://doi.org/10.3390/educsci13121216

Guan, C., Mou, J., & Jiang, Z. (2020). Artificial intelligence innovation in education: A twenty-year data-driven historical analysis. International Journal of Innovation Studies, 4(4), 134–147. https://doi.org/10.1016/j.ijis.2020.09.001

Gupta, C. (2024, April 29). Experience Personalised Learning in Modern Education with MRCC EdTech. MRCC EdTech. https://mrccedtech.com/experience-personalized-learning-in-modern-education-with-mrcc-edtech/

Joshi, M. (2023, July 19). Adaptive Learning through Artificial Intelligence. Social Science Research Network. https://doi.org/10.2139/ssrn.4514887

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, 100017. https://doi.org/10.1016/j.caeai.2021.100017

Kaledio, P., Robert, A., & Frank, L. (2024). The Impact of Artificial Intelligence on Students' Learning Experience. Social Science Research Network. https://doi.org/10.2139/ssrn.4716747

Luo, Q. Z., & Hsiao-Chin, L. Y. (2023). The Influence of AI-Powered Adaptive Learning Platforms on Student Performance in Chinese Classrooms. Journal of Education, 6(3), 1–12. https://doi.org/10.53819/81018102t4181

McNulty, N. (2024, February 16). National Framework for Artificial Intelligence in Digital Learning. Medium; Medium. https://medium.com/@niall.mcnulty/national-framework-for-artificial-intelligence-in-digital-learning-ae9b2a22e4bf

Miles, R., Al-Ali, S., Charles, T., Hill, C., & Bligh, B. (2021). Technology enhanced learning in the MENA region: Introduction to the Special Issue. Issue 1.2 Technology Enhanced Learning in the MENA Region, 1(2). https://doi.org/10.21428/8c225f6e.df527b9d

Mustafa, F., Thi, H., & Xuesong (Andy) Gao. (2024). The challenges and solutions of technology integration in rural schools: A systematic literature review. International Journal of Educational Research, 126, 102380–102380. https://doi.org/10.1016/j.ijer.2024.102380

Patalong, F. 3. (2017). Saudi Vision 2030: Transforming Higher Education In Saudi Arabia. Al Tamimi & Company. https://www.tamimi.com/law-update-articles/vision-2030-and-the-transformation-of-education-in-saudi-arabia/

Pavan, A. (2024). Saudi Arabian universities need to embrace the AI revolution. University World News.

https://www.universityworldnews.com/post.php?story=20240508155251197

Seo, K., Tang, J., Roll, I., Fels, S., & Yoon, D. (2021). The Impact of Artificial Intelligence on Learner–instructor Interaction in Online Learning. International Journal of Educational Technology in Higher Education, 18(1), 1–23. https://doi.org/10.1186/s41239-021-00292-9

Sese, H. (2024, March 4). Adaptive Learning in EdTech Systems: Enhancing Student Performance - Madavi Agency. Madavi Agency. https://madavi.co/adaptive-learning-in-edtech-systems-enhancing-student-performance/

Southworth, J., Migliaccio, K., Glover, J., Glover, J., Reed, D., McCarty, C., Brendemuhl, J., & Thomas, A. (2023). Developing a model for AI Across the curriculum: Transforming the higher education landscape via innovation in AI literacy. Computers and Education: Artificial Intelligence, 4, 100127. https://doi.org/10.1016/j.caeai.2023.100127

Zaidan, E., & Ehsan, M. M. (2024). Exploring educational trends and challenges in the MENA region amidst a global crisis: An empirical analysis of the pandemic's impact on SDG4. Research in Globalization, 8, 100225–100225. https://doi.org/10.1016/j.resglo.2024.100225

Zamiri, M., & Esmaeili, A. (2024). Methods and technologies for supporting knowledge sharing within learning communities: A systematic literature review. Administrative Sciences, 14(1), 17. https://doi.org/10.3390/admsci14010017

Author Information

Abdullah Alenezi

https://orcid.org/0000-0003-0233-6838?lang=en

Northern Border University

Arar

Saudi Arabia

Contact e-mail: *Abdullah.AlAsmar@nbu.edu.sa*

Appendix. Questionnaires

1. Student Engagement Questionnaire
(10-point Likert scale: 1=Strongly Disagree, 10=Strongly Agree)

    a.   I find the lessons enjoyable.

    b.   I actively participate in class discussions.

    c.   I look forward to my classes.

    d.   I put much effort into my schoolwork.

    e.   I am motivated to learn in this class.

2. System Usability Questionnaire

(For treatment group only, 10-point Likert scale)

    a.   The adaptive learning system is easy to use.

    b.   I can easily navigate through the lessons.

    c.   The system provides helpful feedback on my progress.

    d.   I enjoy using the adaptive learning system.

    e.   The adaptive lessons match my learning pace.

3. Teacher Feedback Questionnaire (open-ended)

    a.   How has the AI-powered adaptive learning system impacted your teaching methods?

    b.   What challenges have you faced in implementing the system?

    c.   How has student engagement changed since the implementation of the system?

    d.   What improvements would you suggest for the adaptive learning system?