

Evaluating the effectiveness of e-learning implementation in Saudi schools using machine learning



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ABSTRACT

The adoption of e-learning methods in Saudi schools has gained increasing importance in recent years, particularly due to the global impact of the COVID-19 pandemic. While e-learning offers several advantages, such as enhanced accessibility and flexibility, it also presents various challenges that require careful consideration. This study aims to identify the primary challenges Saudi schools face when implementing e-learning methods and to suggest potential solutions to address these challenges. The study employs a literature review approach for both data collection and analysis. Additionally, it aims to highlight various models and frameworks proposed in the literature that address e-learning challenges using machine learning (ML) techniques. The findings indicate that Saudi schools encounter several issues, including infrastructure problems, technological challenges, inadequate teacher training and support, low student engagement and motivation, and concerns related to academic integrity and assessment.

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1. Introduction

E-learning methods have become an essential component of modern education, and Saudi Arabia is recognizing their significance in transforming its educational landscape (Alharbi and Lally, 2017). The advantages of e-learning, including increased accessibility, flexibility, engaging learning experiences, collaboration opportunities, teacher support, and continuous learning, make it an invaluable tool for Saudi schools. By embracing e-learning methods, Saudi Arabia can provide quality education to all its students, regardless of geographical barriers or external circumstances. This investment in e-learning is undoubtedly contributing to the nation's progress and development in the digital age. However, there are many challenges and issues facing the implementation of e-learning methods in Saudi schools. In the context of e-learning environments, one of the main sources of data growth is generated using online learning websites and learning management systems as part of the e-learning process. Statistics from the authors in Alfallaj (2020)

indicate that online course websites such as Coursera, EdX, and Udacity have over 78 million students combined, and they are offering over ten thousand courses each of which is affiliated with over 600 universities all around the world. Additionally, according to estimates, online courses have almost a thousand entries in event logs per student every month and around 60,000 course visits a month (Eichhorn and Matkin, 2016). As the amount and variety of data collected increases, it becomes increasingly important to analyze and extract useful information. Thus, ML is proposed as a method for completing the tasks. The term machine learning refers to a subset of artificial intelligence in which a machine can automatically learn from experience and improve its performance because of that experience (Rane et al., 2024). It is based on algorithms, rather than explicitly coding, that analyze large amounts of data, produce insights based on those insights, and then make informed decisions based on the insights. Fig. 1 displays the overview of the e-learning methods.

Therefore, this study aims to highlight the challenges and issues of implementing e-learning in Saudi schools. In addition, the suggested solutions to overcome these challenges and issues are included. The design science method is applied in this study to identify the drawbacks and issues of implementing e-learning methods in Saudi schools and suggest solutions. This article is organized as follows, the methodology and findings are presented

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in Section 2 whereas the conclusion and future works are introduced in Section 3.

2. Methodology and finding

Using the literature review methodology (Snyder, 2019), this study examined a variety of models and frameworks proposed in the literature as solutions to problems and challenges related to implementing e-learning methods. A literature review is a process

in which you research, read, analyze, evaluate, and summarize scholarly literature (typically journals, articles, and books) about a specific subject (Snyder, 2019). Literature reviews can be published as an entire report or article, or they can become part of an article, thesis, dissertation, or grant proposal that provides a comprehensive analysis of the literature. Fig. 2 displays the adapted methodology.

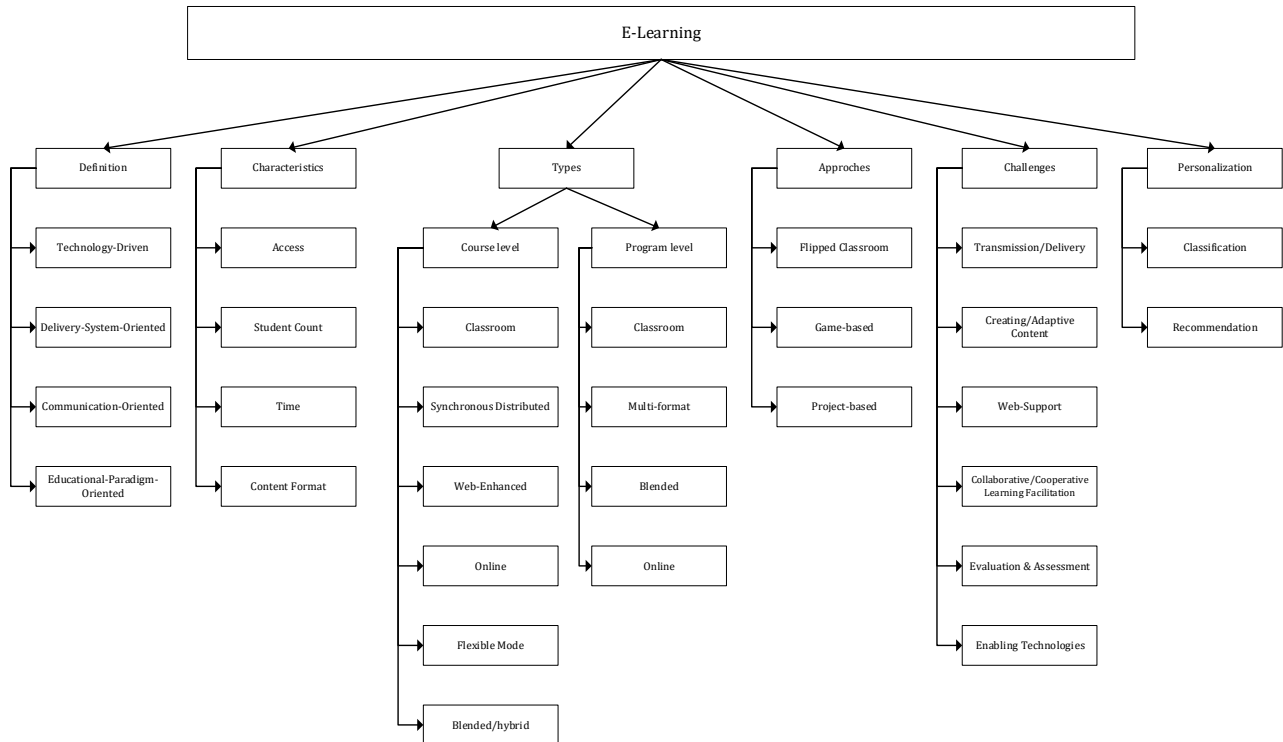


Fig. 1: Overview of e-learning (Alfallaj, 2020)

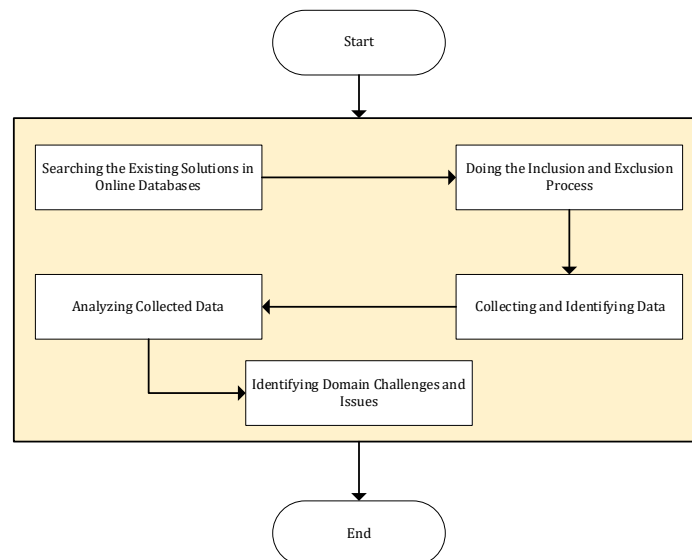


Fig. 2: Adapted methodology (Al-Shehri, 2023)

1. Searching the current results in the online databases: As part of this step, the author will discover the widely used online digital databases (Springer, IEEE Xplore, Scopus, ACM, Science Direct, Web of Science, and Google Scholar) for the related studies to find relevant information. The

keywords that are used in this study are "E-learning Methods, Saudi School, and Machine Learning." According to the search criteria, research on the topic was to be published in the period between January 2015 and January 2024. This paper concentrates on conference articles,

articles, theses, online books, and online book chapters that have been published over the years as opposed to other works. Finally, 25 out of 2472 papers in this field were found to provide a detailed view of processes and technology perspectives.

2. Executing the inclusion and exclusion process: In this phase, results from the search are compiled and eliminated based on the following criteria:

i. Inclusion criteria:

- a) Studies that have been published in relevant, peer-reviewed journals.
- b) Studies that have been conducted in the last five years.
- c) Studies that discuss ML models specifically designed for e-learning.
- d) Studies that provide evidence of the success or failure of ML models for e-learning.
- e) Studies that include detailed descriptions of the data and AI models used.

ii. Exclusion criteria:

- a) Studies that have not been published in relevant, peer-reviewed journals.
- b) Studies that were conducted more than five years ago.
- c) Studies that focus on general AI models, and do not specifically design for e-learning.
- d) Studies that provide only theoretical insights without empirical evidence.
- e) Studies that lack detailed descriptions of the data and ML models used.

To categorize the search methods, the following study questions were used:

- What studies have been conducted on e-learning methods in Saudi schools?
- Are there any challenges or issues with current studies?

3. Gathering and recognizing data: During this phase, authors are collecting data based on stages 1 and 2, and then adding enhancements based on the journal year, relevance, and quality of papers published in the journal. It should also be noted that only articles that discuss challenges and issues related to e-learning in Saudi schools have been selected for this study. Another manual categorization method uses the title and author names for a second round of manual categorization, helping to prevent duplicate content from being created from multiple sources at the same time. Accordingly, out of 2472 articles, 25 articles were suitable for use in this study based on the criteria listed above.

4. Analyzing collected data and identifying domain challenges and issues: As a result of this survey, the authors of the papers addressed the problem of e-learning methods in Saudi schools from

several perspectives. For example, the authors (Hooshyar et al., 2019) attempted to determine what factors were influencing academic performance by analyzing the data. Consequently, they analyzed two different types of data sets to arrive at their findings. According to the first data set, a student's performance in a course's required courses has a significant impact on his or her ability to do well in the current course. According to the second set of data, the student's grade in any course has been demonstrated to be related to their performance throughout the semester until the midterm test after the semester has ended. According to Hai-tao et al. (2021), authors found that the primary contributing factors to predicting academic performance are interviews, tasks, questionnaires, and age as the factors that have a substantial contribution to the estimation of academic performance. Students are graded on the access factor based on how easily they will be able to access the module, which includes forums and glossaries. As indicated in the questionnaire, there are variables related to the visit and attempts that are summarized in the questionnaire factors. A student's age is considered when calculating the age factor. As discussed in Abu Saa et al. (2019), the authors investigated the factors that affect school performance by examining several variables. After reviewing, they determined that the student's performance in earlier classes and results, his e-learning activities, and his or her demographic characteristics had an impact on the student's academic performance, academically speaking. As a result of an analysis of the same data set, researchers were able to determine whether students' learning behaviors were important (Pandey and Taruna, 2018). The three methods were combined using the voting technique to achieve the best results. There were no significant differences in accuracy between the proposed model and the naive Bayes model in most scenarios. As well as the community of inquiry framework that was developed by authors in Wertz (2022), other noteworthy frameworks can be cited. Community of inquiry models emphasize the importance of social, cognitive, and teaching presences to facilitate learning in an online environment. The purpose of this study is to provide a framework for the design and evaluation of online courses that incorporate these three crucial factors. Additionally, the ADDIE model has been identified as a successful instructional design tool for improving e-learning for many years (Spatioti et al., 2022). A simple step-by-step approach is used in this systematic model to give your organization a leg up in developing and implementing effective e-learning courses. Moreover, the SAM (Successive Approximation Model) is a design and development model that employs iterative processes, highlighting rapid prototyping and continuous feedback to enhance the design and development of software applications (Allen and Sites, 2012). During the

entire e-learning development process, this framework aims to include stakeholders and incorporate their input throughout the entire process to expedite e-learning development. In addition, the ARCS model (Attention, Relevance, Confidence, and Satisfaction) recognizes the importance of motivational factors when designing e-learning environments. Several key factors are considered in the design of engaging and

motivating online learning experiences to achieve this goal.

Consequently, and because of the analysis above, the author found several issues and challenges which are associated with the implementation of e-learning methods in Saudi schools as illustrated in Fig. 3 and Table 1 of this study.

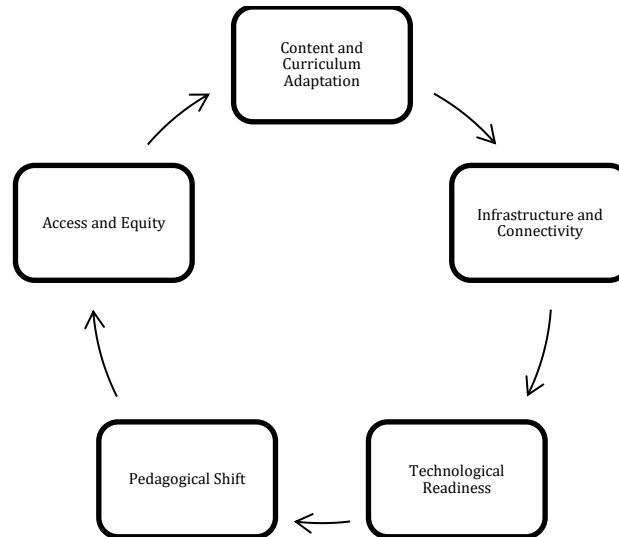


Fig. 3: Challenges and issues of implementing the e-learning methods in the Saudi schools

Table 1: Challenges and issues of implementing the e-learning methods in the Saudi schools

ID	Challenge and Issue	Description
1	Infrastructure and connectivity	Inadequate infrastructure and internet connectivity limit access to online resources and classes. Enhanced digital infrastructure and equal access are required.
2	Technological readiness	Limited experience with digital tools among educators and students necessitates training and digital literacy resources.
3	Content and curriculum adaptation	Transitioning from traditional methods to E-Learning requires redesigning content to be interactive and engaging, along with modified assessment methods.
4	Pedagogical shift	Requires changes in teaching strategies, focusing on student-centered approaches and the redesign of learning activities.
5	Access and equity	Ensuring equitable access to technology and internet for all students, with a focus on providing resources to underserved populations.

On the other hand, this study suggests several solutions for the challenges and issues identified during the discovery process as shown in Fig. 4, and Table 2. Considering the above-mentioned

challenges and issues, the following steps in Fig. 4 and Table 2 are suggested points to overcome these challenges and issues.

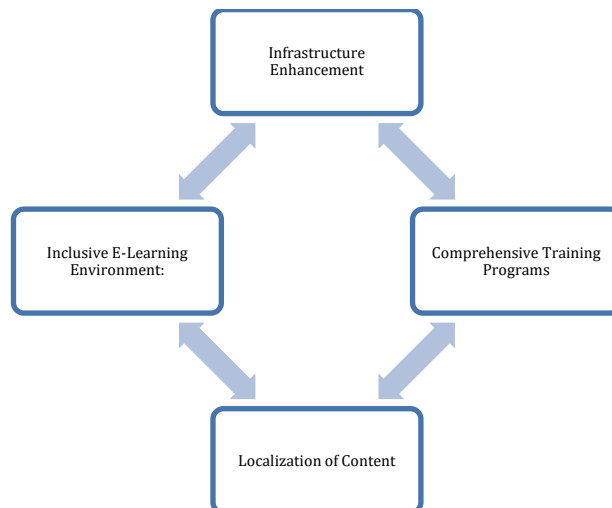


Fig. 4: Suggested solutions for the problems and challenges identified during the discovery process

Table 2: Suggested solutions for the problems and challenges identified during the discovery process

ID	Suggested solution	Description
1	Infrastructure enhancement	Improve infrastructure and connectivity by partnering with telecommunications companies to enhance internet access and technological resources in schools.
2	Comprehensive training programs	Implement training programs to improve digital literacy skills for teachers and students, enabling effective use of E-Learning platforms and continuous professional development opportunities.
3	Localization of content	Address content localization challenges by developing and curating locally relevant e-learning content that aligns with the Saudi curriculum, making it more accessible to learners.
4	Inclusive e-learning environment	Create an inclusive E-Learning environment by providing resources and support for students with disabilities, ensuring accessibility, and removing barriers to participation.

The use of machine learning (ML) in e-learning has become more and more prevalent in recent years, making it easier to access, personalize, and

make learning more efficient. Table 3 provides some successful case studies illustrating the applications of this technology.

Table 3: Successful case studies illustrating the applications of this technology

Case Study	Description
Duolingo	Duolingo is a popular e-learning platform focused on language learning. It employs machine learning algorithms to personalize lessons for users, adapting content to their individual pace and proficiency. This personalized approach has notably enhanced user engagement.
DreamBox learning	DreamBox Learning offers mathematics education for K-8 students, utilizing machine learning to provide personalized learning experiences. It analyzes student responses in real time and adjusts the curriculum to address specific mathematics problems, enhancing student performance and engagement.
Carnegie learning	Carnegie Learning implements AI-driven math education solutions that harness machine learning to adapt lessons to student needs. The platform assesses student performance and learning habits to offer tailored feedback and recommendations, significantly increasing student achievement in mathematics.

These case studies underscore the transformative impact of machine learning on e-learning. They highlight its ability to create responsive, effective, and engaging educational experiences tailored to individual learners' needs. By continuing to refine these technologies, educational platforms can further enhance learning quality and accessibility worldwide. Machine learning has been integrated into various educational settings around the world,

including in Saudi Arabia, to enhance learning experiences and educational outcomes. While specific case studies from Saudi schools might be less documented in international literature compared to Western settings, several initiatives and comparable implementations reflect a growing trend in utilizing AI and machine learning in education within the region. Table 4 displays the real-world implementations of ML in Saudi schools.

Table 4: Real-world implementations of ML in Saudi schools

Real-world Implementations of ML	Descriptions
Tatweer company for educational services	This initiative aims to modernize the education system in Saudi Arabia by developing smart platforms and systems that tailor educational content to the needs of individual students, thereby promoting personalized learning.
Mawhiba (King Abdulaziz and the Companions Foundation for Giftedness and Creativity)	Mawhiba utilizes technology-enhanced learning environments to support gifted students in Saudi Arabia. The foundation actively invests in developing learning programs that identify and meet individual learning requirements for talent development.
Online platforms and EdTech startups	Several ed-tech startups in the region are leveraging machine learning to personalize learning materials and enhance student engagement. These platforms often adapt language learning, coding, or mathematics exercises based on individual student performance.
University research and development	Universities in Saudi Arabia, such as King Abdulaziz University of Science and Technology (KAUST), are conducting research aimed at integrating machine learning applications in classrooms. These initiatives explore the effectiveness of various ML techniques in improving learning outcomes.

3. Conclusion

Over the past few years, there has been an increase in the importance of e-learning methods in Saudi schools, especially considering the global COVID-19 pandemic that has been ravaging the globe. E-learning offers a variety of benefits, such as increased accessibility and flexibility, and there is no doubt that it can contribute to the enhancement of learning, but it also poses several challenges and issues that need to be addressed as well. This study aims to explore the major challenges and issues encountered by Saudi schools when trying to implement e-learning methods using ML and to provide potential solutions to solve these challenges

and issues to implement e-learning methods successfully. As a method of analysis, the present study is based on the design science method. Furthermore, this study highlighted the various models and frameworks that have been proposed in the literature to solve the challenges and issues that have been associated with implementing e-learning methods using ML to address those challenges and issues. Several challenges and issues are faced by Saudi schools such as infrastructure and technological challenges, these challenges also include teacher training and support, student engagement and motivation, academic integrity, and the assessment of students' performance. In the future, the main objective of this study will be to

implement the suggested solution that is highlighted in this study and explain how effective the machine learning system is in real-world conditions.

Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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