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PAPER

Systematic Literature Review for Smart Mobile Learning in Programming Courses

Ghaliya Al Farsi[1](✉), Ragad M. Tawafak[1], Ibrahim Yaussef Alyoussef[2], Waleed Mugahed Al-Rahmi[3,4]

[1]Information Technology Department, Al Buraimi University College, Buraimi, Oman

[2]Education Technology Department, King Faisal University, Alahsa, Saudi Arabia

[3]Computer Science Department, Community College, King Saud University, Riyadh, Saudi Arabia

[4]Faculty of Social Sciences and Humanities, School of Education, Universiti Teknologi Malaysia, Skudai, Malaysia

galfarsi@buc.edu.om

ABSTRACT

Advancements in technology are currently expediting the learning process for students, prompting an investigation into the integration of technology into student education. This study explores the impact of technological evolution on education. E-learning, a method of education that delivers information to students through modern communication platforms such as computers, networks, and multimedia audio components, is being examined. Whether utilized remotely or in traditional classroom settings, this revolution has made the world increasingly dependent on electronic screens in an era marked by the convergence of media technologies, information, culture, and technology. This paper outlines the development of an e-learning system customized for mobile devices, aimed at improving learning within the university environment. With mobile phones now ubiquitous among students, e-learning has become a potent tool for advancing educational objectives. Furthermore, e-learning aids in elevating student proficiency levels. The research conducted involved implementing and evaluating an application, which produced satisfactory results. As this application becomes integrated into university curricula to support learning, it is anticipated to substantially enhance students' learning processes and performance, as evidenced by survey results following its implementation.

KEYWORDS

smart learning, technology enhancement, programming course, mobile development

1 INTRODUCTION

Considering the evolution of data, the continuous change, and the rapid advancement of learning resulting from the data transformation we are witnessing, the world is undergoing a significant scientific and technological transformation that has impacted various aspects of life. Education needs to explore new methods and models of teaching to tackle numerous challenges at the global level, such as the growing demand for education and the shortage of educational institutions. Furthermore, there is a need to increase the amount of information in all areas of education and

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take advantage of technological advancements in the field of education. This will help in implementing the e-learning model to support students in learning at the right place and time through interactive content based on multimedia [1].

E-learning is a learning strategy that involves delivering information to students through modern communication tools such as computers, networks, and multimedia, including audio. Regardless of whether remotely or in the study hall, the insurgency has made the world increasingly such as a small electronic screen in the era of integrated media technology, information, culture, and technology [2] [34]. Electronic correspondence and the exchange of news and data between computer systems have become an absolute reality, enabling quick access to scientific and information centers, libraries, and the latest minute-by-minute [35]. The best advantage is to convey data to the student in the shortest time and with less effort [3].

The problem in this study is integrating mobile learning advancements into programming courses, which presents both opportunities and challenges for teachers and learners. Be that as it may, with the rapid advancement of mobile technology and the increasing demand for software skills, barriers and best practices related to this integration are crucial [4]. Despite the potential benefits, such as increased transparency, flexibility, and interactivity, there remains a need for a comprehensive investigation into addressing the following critical questions:

1. How successful are mobile learning interventions in enhancing the activation and retention of programming concepts and skills among learners?
2. What are the primary challenges and barriers faced by teachers in implementing diverse learning methods in programming courses?
3. What academic approaches, guidelines, and curriculum standards are most compelling for leveraging mobile technology to promote programming instruction?
4. What are the impacts of socio-economic, social, and innovative variables on the adoption and implementation of smart mobile learning in programming education?

Tending to these questions is essential for optimizing the integration of mobile learning into programming courses, ensuring equal access to high-quality programming instruction, and preparing learners for the evolving demands of the modern workforce [5].

This study reviews the literature related to teaching programming languages in a manner that meets the modern requirements of scientific courses, ensures student satisfaction, and enhances academic standards [6]. This study also highlights the significance of utilizing smart education via modern mobile phones and simplified applications to facilitate programming tasks [7]. This study also includes a literature review of 23 research papers related to the advancement of programming education using software technologies on smartphones. Some of these studies were also utilized through computer applications to assist students in gaining scientific benefits and foster students' alignment with scientific values [3, 6]. This study also highlights the gap concerning the weak connection between educational technology and the frequent use of phone applications. Phones were primarily used for visual and entertainment purposes, neglecting the potential for utilizing these smart devices for educational software applications in scientific universities [8].

The significance of this study lies in the fact that an audit contributes to a compressive understanding of the current landscape of research in the field of smart mobile learning in programming courses [5]. This understanding can provide insights into the current trends, challenges, and opportunities in integrating mobile technology innovation into software education. Furthermore, analysts can identify

gaps in existing information by thoroughly examining the literature. These crevices can indicate areas where further investigation is needed or where industrial activity can have a significant impact. Additionally, it can offer assistance in recognizing potential opportunities for development or improvement in existing practices [2]. The discoveries of the writing audit can also shed light on decision-making processes related to contemporary operations. It can provide guidance on selecting the core areas, strategies, and methods to be adopted in effectively integrating mobile learning into software courses. In addition, understanding the leading trends and effective methodologies detailed within the writing can guide teachers and curriculum developers in creating more effective educational approaches for teaching programming using mobile devices [9]. This may lead to improved learning outcomes and student engagement. Finally, this study supports evidence-based research; a systematic literature review validates evidence-based research findings, strengthening the methodology and theoretical framework of contemporary practices. This could increase the validity and legitimacy of the initiative's objectives.

This study is being constructed despite the growing interest in integrating smart mobile learning into programming courses. There is a need for a comprehensive understanding of the viability, challenges, and best practices in this field [10]. There is a need to systematically survey the existing literature to identify current trends, gaps, and opportunities for enhancing programming education through mobile learning technologies.

The primary objective of this precise writing survey is to comprehensively analyze and synthesize existing studies, consideration articles, and reports on the utilization of smart mobile learning in programming courses. Identify the main subjects, patterns, and strategies employed in current literature. Assess the feasibility of mobile learning interventions for enhancing software education outcomes. Recognize challenges and obstacles to the successful integration of flexible learning in programming courses [3, 11]. Investigate best practices and techniques for planning and implanting mobile learning activities in programming education. Identify gaps in the current literature and suggest directions for future research to focus on this area.

This study, divided into several sections, started with a background on the meaning, definition, and features of learning systems and programming courses. Second, a literature examination involved a systematic review of existing studies relevant to the objectives of this study. Third, a data collection method and a model proposal were utilized in the development of this study. Further, significant factors could be defined for this type of learning. Then, model features are used to propose appropriate factors and types of relationships to connect its parts. Finally, results and a discussion section were added to explain the hypotheses proposed in the study, followed by a conclusion.

2 BACKGROUNDS

One of the critical issues in education is enhancing the fundamental skills of students. Examining programming languages in secondary schools plays a significant role in developing critical thinking skills. As programming proficiency improves, students develop high-level skills in critical thinking, analytical thinking, logical thinking, and creative thinking. In this sense, students who receive programming instruction at the basic level and grasp the program logic can succeed in various courses. Among these languages, scratch is one of the most widely recognized. Scratch programming supports higher-order thinking skills, such as critical reasoning abilities [1] [12].

Teaching programming and introducing fundamental programming concepts in preschools have sparked a legitimate concern within educational and academic communities. International research has shown that encouraging programming for young children influences the development of their cognitive abilities. As of now, there are many programming environments available that are suitable for preschoolers. Researchers are adjusting their perspectives regarding the age limit at which young children can effectively engage with programming [2]. The widespread adoption of various types of ICT has enabled students to achieve success in practical learning, fostering higher levels of practical skills that are valuable in STEM education, particularly in environmental contexts. As Wing states, this information is referred to as computational thinking, which builds on computing processes, providing students with the essential principles and models to understand problems and structural systems [2] [8]. This study aims to develop a mobile application to improve programming skills using the Scratch programming language.

The emergence of job opportunities and the prevalence of unemployment may diminish the value of university education for students, leading them to prioritize work and income, especially in nations that need more effective strategies to enroll or employ college graduates. Furthermore, we require additional plans and systems to support young individuals in managing their careers. The scope of our research is to serve the students of Al-Buraimi University College in the field of IT, with the main objective being to assist students in programming [9]. This research helps students learn shortcuts and specialized symbols in IT terminology. The analysts started to understand the subjective load hypothesis in order to establish the framework of principles that constitute the e-learning theory. The psychological burden hypothesis refers to the mental effort involved in working memory [20]. There are some negative perspectives about e-learning, as it lacks the human component necessary for effective learning. Moreover, it might be quite expensive, as some materials can be costly.

This examination assesses the effectiveness of e-learning in tertiary education institutions. Current advancements in data and communication technologies for teaching and learning are crucial for higher education institutions. This investigation surveys writing and provides a comprehensive foundation by checking on specific contributions made by various experts and institutions on the concept of e-adapting, particularly its use in teaching and learning in higher education instructions. It uncovers various perspectives that individuals and institutions worldwide have shared on the adoption and integration of e-learning technologies in education through surveys and other observations [21]. It examines the significance of e-learning as defined by various experts [10].

3 LITERATURE REVIEW

3.1 Recent studies for mobile learning

Later, I highlighted the growing interest and significance of incorporating smart mobile learning into programming courses. For this case, [11] conducted a comprehensive investigation of portable learning applications used in programming instruction, identifying emerging trends and evaluating their impact on student learning outcomes. Essentially, the study by [12] examined the effectiveness of versatile gamification strategies in enhancing student engagement and motivation in programming courses, highlighting innovative approaches to mobile learning designs.

Drawing upon a primary source of information is essential for understanding the theoretical foundations and academic recommendations of smart mobile learning in programming courses. One critical area of focus at the center is learning theories, which offer essential insights into how learners engage with mobile technology and acquire programming skills.

Constructivism, as articulated by [13], emphasizes the dynamic development of knowledge through social interaction and hands-on experiences. Applying constructivist principles to flexible learning in programming courses emphasizes the importance of interactive and collaborative activities that promote exploration, experimentation, and problem-solving. Connectivism, as proposed by [14], emphasizes the importance of structured learning environments and innovation in promoting the creation and dissemination of information. Within the context of smart mobile learning, interface standards emphasize the potential of mobile devices to connect learners with various resources, communities, and expertise, fostering a dynamic and participatory learning environment. As emphasized by [15], arranged learning emphasizes the significance of proper settings and social cooperation within the learning environment. The situated learning hypothesis emphasizes the significance of real-world problem-solving tasks and collaborative projects, bridging the gap between classroom teaching and practical application when it comes to mobile learning in programming.

[27] The analysts conducted an efficient writing audit centered on instructional points related to the instructional triangle of teaching: the student, teaching, curriculum, and assessment. The initial stage involved selecting papers and categorizing them into these high-level groups. The entire collection of 2189 papers was classified, with each reviewer handling approximately 200 papers based on abstracts and full texts.

The subsequent steps involved small groups focusing on specific subjects. They assessed the congruity of the papers, extracted relevant information, synthesized conclusions, and delivered the final report. Information extraction involved providing concise summaries of the main topics covered in each paper related to the subjects under consideration. Several papers were renamed or omitted during this training [30]. The study acknowledges a departure from Kitchenham's guidelines, particularly in the limited filtering based on quality, as the primary focus was on the subject's relevance rather than intrinsic quality. The study's approach veers away from Kitchenham's guidelines, emphasizing a thorough understanding of the discussed subjects while acknowledging the limitations of addressing each paper point by point.

Another way to organize a precise audit is to select the documents that will form the basis for the audit. The workload was divided among the reviewers, who examined each title and abstract and compared the entire paper when necessary to determine its relevance to the review process. This preparation reduced the number of papers by more than half, as shown below. ACM full content collection: 1126 (51%). IEEE Investigate: 448 (63%), ScienceDirect (Elsevier): 62 (13%) SpringerLink (most significant 1000): 204 (20%). Scopus: 349 (51%). Add up to 2189 (43%).

In computer science, proficiency in computational thinking is demonstrated through programming courses. Among the aptitudes that make up computational thinking is proficiency in organizing problems, making decisions, and addressing creative issues [32]. It may be an apparent reality that many public and private universities worldwide demand numerous aspects of advancement and respect for higher education. This creates a need to implement computer applications to provide more comprehensive services and easier management using modern programming languages.

3.2 E-learning

E-learning refers to a learning system that can be accessed via the Internet using an electronic device. Furthermore, whether referred to as online education or distance learning. The term implies a system that can provide information and skills to at least one person. When the web began, individuals were skeptical of this type of education. As innovation and learning frameworks improved, online learning became more widespread [19] [8].

Likewise, e-learning, despite its advantages when integrated into education, has some drawbacks. Studies show that e-learning has some drawbacks. To answer the question, which academic approaches and guidelines, as well as planning standards, are most effective in leveraging mobile technology? For this argument, despite claims that e-learning can enhance training quality, [23] argues that the innovative learning materials available online lead to improved learning outcomes only for specific types of comprehensive assessment. Additionally, [16] questioned whether e-learning is a supportive tool for existing learning methods. The most noticeable drawback of e-learning is the complete lack of essential personal interactions between students and instructors, as well as among peer students [20].

3.3 Smart programming courses

Within the dynamic field of education, the integration of technology has brought about significant transformations in redefining traditional learning norms, especially in programming courses. As the demand for computer proficiency and coding abilities continues to rise, teachers are increasingly turning to creative approaches to enhance the effectiveness and accessibility of programming instruction. Among these approaches, the concept of "shrewd programming courses" has emerged as a pivotal point of transformation, harnessing the power of mobile learning to redefine the educational experience. This comprehensive writing review aims to explore the intersection of interactive mobile learning and programming courses, highlighting the various strategies, technologies, and educational methods used to enhance learning outcomes in this field. By delving into existing research, this study elucidates the multifaceted dimensions of intelligent, adaptable learning in programming education and marketing experiences that can inform future developments and implementation within smart programming courses.

In [31], the author categorizes software visualization into the following categories: Programs view, which focuses on the graphical representation of a running program and its data; algorithm animation, which tests instructional use and demonstrates the fundamental operations of an algorithm; visual programming, which uses visual components to build a program; and viewing statistics, such as access points in the code, in terms of counting errors, is an example of computational visualization. This study demonstrates the significant impact of mobile learning interventions on enhancing and retaining programming concepts.

3.4 Smartphones collaborate smart learning

In the computerized age, smartphones have transcended their traditional role as communication devices to become powerful tools for learning. The combination

of shrewd innovation with instructive practices has given rise to the concept of "smart learning," where versatile devices act as catalysts for enhanced engagement, flexibility, and accessibility in education. Within this system, the integration of smartphones and intelligent learning processes represents a paradigm shift in how information is acquired and disseminated. This area explores the beneficial relationship between smartphones and smart learning strategies, highlighting their collaborative potential to revolutionize educational experiences across various settings, with a specific focus on programming courses. By examining existing literature and case studies, this field highlights the transformative impact of using smartphones for smart learning activities and promotes experiences related to the challenges, opportunities, and best practices associated with this innovative approach.

According to [26], active learning can be facilitated by the use of mobile robots in a collaborative environment. The main benefits of using robots include promoting active learning, engaging students, fostering enthusiasm, and enhancing the learning process. Additionally, it offers hands-on experience with real machines, encourages creativity, allows students to generate and test hypotheses with immediate feedback, supports good design and planning, and cultivates leadership through practical experience, thereby encouraging autonomous learning [24]. As programming training enhances students' high-level skills in problem-solving, critical thinking, logical reasoning, and creative thinking, the main objective of his study is to enhance the effectiveness of Scratch learning by transitioning the learning process to a mobile environment with adaptable opportunities to address the research question and identify the main challenges and obstacles faced by teachers in implementing mobile learning. To conduct the examination, the problem is divided into the following subproblems: This paper highlights the impotence of e-learning in modern education and discusses its technical aspects, market, advantages and disadvantages, instructor-led training, and the likelihood of e-learning replacing traditional classroom techniques.

3.5 Students' engagement with smart learning courses

Student engagement in elementary programming has received significant attention in this review, including papers focusing on task time, the promotion of self-regulated learning, and distance issues. It is not surprising that a significant factor in students' success is their self-motivation and ability to engage with the learning opportunities available to them [2]. In any case, students drop out for various reasons, which are often complex [32] [5]. Given the particular intrigue of the inquiry into community engagement, it is worth highlighting key commitments to student engagement in this specific area. Numerous papers published during the period discuss observational thinking, focusing on the internal characteristics of students [11] and their role in self-regulated learning [3]. Some of these studies consider highlighting specific advancements deserving of support and attention, such as achievement goals [31] and instrumental perceptions [5] and [4], as well as how these may vary among different sub-populations in several key categories [10]. Analysts also examine a range of motivational sub-factors; for instance, identifying a weak correlation between performance in early programming and social motivation would be beneficial if you were an individual [5] [6]. Software visualization involves mapping abstract ideas represented in code into visual representations to facilitate the observer's understanding and operation of the system [23].

3.6 Perpetual and excellent family conditions

Some students suffer from challenging family circumstances that put pressure on them and hinder their ability to focus on their studies. These issues might be as significant as passing or family crises and could be as enduring and traditional as conflicts between parents, physical pressure, or encountering a spouse's resistance to completing education. And so forth. However, the college student perceives it differently upon entering college life and becomes more confident and self-assured, considering it as one of the main reasons [14]. Devices with limited memory capacity can affect storage and speed, impacting the user experience when using these devices. Next, all new devices, such as the iPad and iPhone, will have higher capacity and incorporate advanced technology to assist us. Apps on the rise: Significant software enhancements of the iPhone when first released in 2007 included a much-improved web browser, a high-resolution screen, and a more powerful processor. The apps also automatically assist users in downloading lessons and definitions.

According to [24], despite all the obstacles to e-learning, numerous benefits drive its adoption and encourage the exploration of ways to mitigate its drawbacks. The burdens of rediscovery through contemplation include the following: E-learning as an educational method leads students to experience isolation, detachment, and a lack of interaction or connection. Along these lines, strong motivation and skills in time management are required to reduce such effects [10]. E-learning may need to focus on addressing theft and copyright infringement, influenced by inadequate decision-making skills such as ease of copying and pasting [10]. The reception of e-learning in training, especially in higher educational institutions, offers several advantages. Given its numerous advantages and benefits, e-learning is considered one of the best techniques for training. Several researchers and authors have highlighted the benefits and specifics, often stemming from the integration of e-learning technologies into schools [3] [13]. Several studies indicate that e-learning holds a favorable position because of its ability to focus on students' needs. For instance, [20] noticed that one of the benefits of e-learning in instruction is its emphasis on individual students' requirements as a significant factor during schooling rather than solely focusing on the needs of the teacher or educational institutions [22]. Each student can choose the location and time that suit them. As stated by [30], a substantial amount of data can create opportunities for connections among students through exchange forums. Through this, e-learning barriers that can impede investment, such as the fear of interaction with a diverse group of students, are eliminated.

4 METHODOLOGY

The method used involved creating a survey and collecting data to assess the validity of the model. A survey distributed in a pilot study involved 45 participants from two programming courses at Al-Buraimi University College (BUC) in Oman. The survey consists of five general questions regarding smartphone usage for learning purposes. This research utilized SQLite, a C-language library that implements a small, fast, self-contained, high-reliability, full-featured SQL database engine. SQLite is integrated into all mobile phones and most computers, and it comes pre-installed with numerous other applications that people use daily [6] [12]. The program was distributed to the student as an initial copy along with instructions on how to use the application, experiment with it, and assist them in using it. They started using it and then evaluated it. The alpha Khronbakh's reliability is 0.893, which is considered

acceptable for the model as the standard value should be above 0.7 [17]. Educators must choose their teaching strategy based on a robust framework design, accurate task analysis, and obtaining essential knowledge about significant factors in mobile design applications, such as e-learning device screen size and phone size. Implement the prototype and evaluate the assessment of the product. In all these phases, consulting with an instructional designer may positively influence the process and enhance efficiency [25].

4.1 Data collection

When planning an information collection arrangement to study the effectiveness of an intelligent learning application to support students in programming language courses, it is important to consider various factors. Here is a layout for gathering data from a sample of 320 participants:

Sampling Strategy: Utilize stratified random sampling to ensure representation from diverse demographics, including different programming proficiency levels, age groups, and educational backgrounds [28]. Participants' Socioeconomics: Collect data on participants' age, gender, educational background, and previous programming experiences.

Baseline Evaluation: Perform a pre-assessment of degree participants' initial programming knowledge and skills who have been using the intelligent learning application for some time. Implementation of the Smart Learning Application: The smart learning application will be integrated into the participants' programming language course. Monitor participants' intelligence using the application by tracking the time elapsed, modules completed, and any challenges encountered [33].

Administer questionaries and surveys to gather subjective information on participants' perceptions of the smart learning application. Incorporate questions on ease of use, engagement, and observed learning results [22]. Performance Feedback Sessions: Conduct feedback sessions or interviews with a subset of members to gather in-depth insights about their experiences, challenges faced, and suggestions for improvement.

4.2 Model features

Building a demonstration to assess the effectiveness of a smart learning application in supporting students in programming language courses involves defining measurable outcomes and identifying key factors. Usage Measurements: degree of frequency and duration of students' use of the smart learning application. This includes measurements such as the number of logins, time spent per session, and completed modules [29]. Interaction Designs: Analyze how students engage with various application features, such as quizzes, tutorials, and coding. demographic data: consider age, sexual orientation, and previous programming experiences.

Learning objective: Evaluate the impact of the keen learning application on students' programming knowledge and skills using post-assessment scores. Baseline Execution: incorporating pre-assessment scores as a control variable for comparing participants' introductory programming capability [30].

Data collection and investigation arrangement: Gather information on usage metrics, interaction patterns, and statistical data throughout the programming language course. Administer pre-assessment and post-assessment tests to determine

learning outcomes. Utilize a suitable statistical software program to analyze the information, taking into account the significance levels and effect sizes [29].

5 CHALLENGES

Addressing these challenges systematically and transparently during the literature review process will improve the reliability and validity of research findings. Table 1 presents these challenges.

Table 1. Expected challenges for smart programming learning

Challenges	Description
Diverse Definitions of Smart Learning	Variations in how "smart learning" is defined across studies make it difficult to establish consistent criteria [6].
Heterogeneous Methodologies	The use of diverse research methods in the studies was identified, complicating the synthesis and comparison of results [3, 8].
Limited Standardization in Assessments	There are no standardized metrics to evaluate the effectiveness of smart learning applications in programming courses [1].
Publication Bias	The ability to only successfully deploy smart learning applications is publicized, leading to misleading perceptions about their overall effectiveness [12].
Rapid Technological Changes	The dynamic nature of technology can lead to outdated information and difficulty applying results to current educational contexts [19].
Accessibility and Open Access Issues	Some articles are challenging to access due to paywalls or restricted access, preventing a comprehensive material review.
Lack of Consistent Terminology	The inconsistencies in the use of terms regarding smart learning and programming education require careful interpretation [25].
Limited Generalizability of Findings	Difficulty in generalizing results due to differences in demographics, educational contexts, and smart learning applications.
Quality of Identified Studies	Changes in the quality and rigor of studies affect the reliability and validity of conclusions drawn from the literature.
Overemphasis on Positive Outcomes	There is a potential bias towards reporting positive results, ignoring negative or neutral results from the literature.
Incomplete or Inaccessible Data	Some studies identified may need more complete data or more time to collect adequately, affecting the depth of analysis [30].
Time Constraints	The rich nature of the literature can pose challenges when reviewing a large volume of studies within a limited time frame [32].

6 DISCUSSION

This paper evaluates research on unit testing for functional requirements and UI. An evaluation was conducted to assess the utility of the research and propose new areas for development. After testing the research with a group of students and analyzing the results of the second questionnaire, it is evident that the study significantly enhances the learning outcomes of BUC students in a prompt and direct manner. Giving feedback helps the administrator and developer avoid any system problems. It is ready to deliver and use the smart mobile system [31] and [32]. This result shows that they can adopt new development, modification, and change programs. We have successfully achieved

the goal of the implementation process, as indicated by the survey results showing satisfaction and acceptance by the students through the published questionnaire.

1. Usage speculation: The investigation reveals a statistically significant positive relationship between the frequency of student engagement with the smart learning application (measured by logins and time spent) and improvements in software knowledge and skills. This suggests that students who frequently use the application tend to achieve better learning outcomes in their programming courses [23].
2. Interaction speculation: The results demonstrate a strong positive relationship between dynamic support in intuitively highlighted areas (coding, testing) of the intelligent learning application and improved learning outcomes [14]. Understudies who engage more actively with the interactive elements demonstrate better programming capability than those who participate less actively [30].
3. Content: The study suggests a positive correlation between students' perceived relevance of the smart learning application's content to real-world programming scenarios and their academic performance [33]. This implies that the effectiveness of the application is enhanced when students perceive the content as directly relevant and crucial to their future programming endeavors.

7 CONCLUSION

The studies and surveys confirmed that the questionnaire results and the application are user-friendly for students, making it easy to operate. In conclusion, the rapid advancement of technology in recent years has significantly transformed the education landscape, particularly with the emergence of e-learning. This report delves into the increasing use of technology in student learning and summarizes its significant impact on the field of education. E-learning, a channel for delivering information to students, has become essential in modern communication methods involving computers, networks, and multimedia platforms. Whether accessed remotely or within the confines of a classroom, the digital revolution has effectively shrunk the world into a miniature electronic screen, amalgamating media technology, information, culture, and innovation.

This paper has focused on developing an e-learning system customized for mobile devices to meet the needs of college students. With mobile phones now ubiquitous among students, e-learning has become a potent tool for fostering education and enhancing comprehension. Furthermore, the implementation of such technology has been shown to elevate student performance levels. This research has demonstrated promising results after rigorous testing and evaluation through the implementation of an application specifically designed for this purpose. Anticipated to be embraced by universities to augment learning experiences, the integration of e-learning is poised to significantly enhance students' educational journeys and academic outcomes, as corroborated by the favorable survey responses following its implementation.

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10 AUTHORS

Ghaliya Al Farsi, Information Technology Department, Al Buraimi University College, 512, Buraimi, Oman (E-mail: galfarsi@buc.edu.om).

Ragad M. Tawafak, Information Technology Department, Al Buraimi University College, 512, Buraimi, Oman.

Ibrahim Yaussef Alyoussef, Education Technology Department, King Faisal University, Alahsa, Saudi Arabia.

Waleed Mugahed Al-Rahmi is affiliated with the Computer Science Department at the Community College, King Saud University, Riyadh, Saudi Arabia, and the Faculty of Social Sciences and Humanities, School of Education, Universiti Teknologi Malaysia, Skudai 80990, Malaysia.