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A Review of Mobile Learning in School Experience Programs on Student -Teachers' Competence and Perceptions in School (With Reference to Nirmal District, Telangana India)

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Abstract

This paper explores the relationships between m-learning, learning outcomes, and developing critical thinking in university students. A systematic review of empirical articles in English published in journals indexed in the Web of Science from 2015–May 2024 was carried out. A sample of 50 articles was obtained. The results show that, in most of the analyzed articles, integrating m-learning tools can potentially to improve students' learning outcomes and critical thinking skills. Considering the above, we recommended that educators and university managers integrate and promote the adoption of new technologies in teaching methods. Several recommendations are provided for the effective integration of m-learning into learning activities, stressing the importance of teachers becoming familiar with technology-enhanced learning environments early in their training.

Keywords: Mobile Learning, M-Learning, Mobile learning application, mobile device, technology, Higher education, systematic review

Introduction

Over the last decade, the advancement of digital technologies has radically transformed the concept and methodology of learning. Particularly, during this period, mobile devices have been progressively incorporated into educational environments, redefining how knowledge is accessed and the way educational content is interacted with.

A leading innovation in this area is mobile learning (m-learning), which refers to using mobile devices, such as smartphones and tablets, to facilitate anytime, anywhere learning. This educational approach leverages the portability, connectivity, and accessibility of these devices to offer new opportunities for personalized, interactive, flexible and motivating learning.

Thanks to the powerful processing power and portability of mobile devices, coupled with wireless communication and context-sensing tools, mobile devices have been transformed into powerful educational tools with immense potential in both traditional classrooms and informal outdoor learning. M-learning platforms take full advantage of these capabilities, allowing students to access vast amounts of information through search engines or specialized applications, share ideas and experiences with other students through social networks, and facilitate their learning activities in a more dynamic and interactive way. These platforms include applications ranging from educational games to e-books and learning management systems such as Moodle, which provide interactivity and flexibility in education, empowering mobile learning through wireless or networked devices.

The use of technology in education brings significant benefits, empowering students to develop 21st century skills, such as critical thinking and problem solving. It also opens up new opportunities for formal

education and innovative learning practices. This empowerment allows students to plan their own learning autonomously and actively, transforming content production, fostering collaborative inquiry, and supporting contextualized and authentic learning.

Similarly, m-learning is a catalyst for enhanced student engagement and motivation By integrating multimedia, immersive elements, and gamified learning experiences, among others, m-learning makes the educational process more engaging and effective. This compelling potential positions m-learning as an instrumental tool in the transformation of the higher education sector.

Recognizing the importance of m-learning, this study explores how m-learning, learning outcomes, and the development of critical thinking in university students are related. In particular, it seeks to answer two main questions:

RQ1: Does the adoption of m-learning tools influence the learning outcomes of undergraduate university students?

RQ2: Does the adoption of m-learning tools influence the development of critical thinking skills in undergraduate university students?

Although numerous systematic reviews have been conducted on m-learning in the context of higher education, e.g., Refs., this systematic review is distinguished by its particular focus on the relationships between mobile learning, learning outcomes, and the development of critical thinking. This article seeks to provide a deeper understanding of the potential of this type of learning, thus enriching existing knowledge on the subject.

2. Background

2.1. Learning Outcomes

When talking about learning outcomes, we generally refer to aspects such as academic performance, attitude, motivation, and higher-order thinking skills [20]. One dimension considered in measuring learning outcomes is students' acquisition of knowledge, which involves recalling the content seen and understanding it to evaluate and address new problems The importance of assessing the achievement of learning outcomes lies in the fact that it results directly from the educational process and is often linked to the quality of teaching.

M-learning has the potential to improve motivation and efficiency in information acquisition by facilitating more frequent interactions, providing constant feedback, and enabling more dynamic assessments, thus overcoming the limitations of conventional teaching. Understanding the link between m-learning and learning outcomes could therefore critically influence education policy reform.

2.2. Critical Thinking

Critical thinking is a complex cognitive process recognized as essential for the 21st century. It is considered a model of intelligence for addressing real-world problems [1], as it involves skills such as interpreting, analyzing, evaluating, inferring, explaining and self-regulating. This cognitive process fosters the ability to reflect and reason logically and coherently, evaluating a problematic situation from different perspectives to find an adequate solution.

The success in developing critical thinking can be affected by several factors, including students' characteristics (such as their motivation, learning style, and self-confidence), as well as methodological (such as the method and duration of instruction, tools used, and feedback) and contextual aspects.

Technology integration in education has revolutionized information access and retention, providing a more significant storage and a more engaging presentation of content. Consequently, it has made education more interactive and accessible, increasing enthusiasm for learning. Additionally, this technology could

facilitate and enhance the process of educational intervention, particularly in developing students' critical thinking, through a series of functions that promote learning and constant self-assessment.

The characteristics of m-learning, such as high searchability and rich interactions, along with performance-based analytics, promote effective learning. Suitably designed instructional technology tools can organize interactive courses and stimulate students to become active learners, which can help them achieve higher-order thinking skills, ranging from the basic cognitive knowledge level, such as remembering and understanding, to the advanced levels of applying, analyzing, evaluating, creating, and improving their reasoning processes.

3. Materials and Methods

A systematic review approach was used to answer the research questions. This method aims to identify, critically evaluate, and synthesize existing scientific research on a topic in order to answer a predetermined question. This work complies with the guidelines established in the PRISMA statement, used as a methodological guide.

3.1. Document Selection and Search Approach

A search was conducted on 1 May 2024 in the Web of Science (WoS). This database's selection was explained by its wide international recognition for including prestigious journals in different areas of knowledge and for its extensive coverage. Moreover, as a selective, structured and balanced database, its use facilitates a variety of informative purposes and ensures a consistent comparison of studies within a sound methodological framework.

A search protocol was delineated for the database that included the definition of key descriptors, inclusion and exclusion criteria for all relevant papers, and methods for retrieval and evaluation of articles. The descriptors used were: "mobile learning" or "m-learning" (All fields). The search was also guided by the definition that the concepts of "higher education" or "university*" should be found in the abstract. The inclusion criteria are defined as follows:

- Type of Document: Articles as they are the primary means of scientific communication.
- WoS Index: Social Sciences Citation Index (SSCI), Science Citation Index-Expanded (SCI-E), and Arts & Humanities Citation Index (A&HCI). Emerging Sources Citation Index (ESCI) is excluded as it mainly incorporates journals of regional importance.
- Language: English is recognized as the language of international science, and continues to dominate scientific activities to this day.
- Time period: 2015–2024. The reason for this is because m-learning is a field that is continuously and rapidly evolving, and findings from older work may no longer be applicable today. This ensures the relevance and currency of our research.
- Study type and participants: Empirical (primary/participatory) research focusing on undergraduate students.
- Context: Research should not have been conducted during the COVID-19 pandemic since, in general, the use of technologies in teaching was mandatory and sudden for remote course delivery, which may have consequences for design, acceptance by students, and evaluation of the real effects (this condition does not apply to distance education universities).
- Concerning RQ1, studies that objectively measure the achievement of learning outcomes are included (self-perceived achievements are excluded). As an inclusion criterion, it is also defined that those studies with experimental or quasi-experimental designs must have a control group (same cohort) to measure the real effects of m-learning initiatives.

- Concerning RQ2, studies that objectively (e.g., test) and subjectively (opinion, self-reflection, and others) measure changes in the levels of critical thinking are included.

3.2. Concepts Associated with the Analysis

In addition to what is involved in m-learning, learning outcomes and critical thinking there are other concepts that need to be explained as they are referred to in the paper. Each of these concepts is described in detail below.

Experiment, Randomized Experiment, and Quasi-experiment: An experiment refers to a study in which a variable is manipulated under controlled conditions to observe its effects. A randomized experiment, for instance, is one in which students are randomly assigned to the group that will receive the treatment. At the same time, a quasi-experiment implies that students will be assigned to the same group by convenience or by the researcher's judgment (with no randomization component).

Experimental group (EG) and control group (CG): The EG receives the designed treatment, which may consist of a single or multiple sessions. The CG, meanwhile, does not receive any intervention and serves to determine whether any change can be attributed to the treatment or not.

Pre-test, post-test, and delayed post-test: Pre-test is intended to measure, in this case, students' knowledge or skills prior to any intervention and to ensure comparability of the two groups (EG and CG). The post-test allows researchers to determine whether or not the treatment had an immediate effect on the outcomes (using the CG as a comparison). At the same time, the delayed post-test also seeks to assess the effect, but in the long term.

3.3. Data Analysis

Using Microsoft Excel 2021 (Microsoft Corporation, Redmond, WA, USA), the data were extracted on the same day as the search, and the results were organized. The analysis process included reading and re-reading the selected papers by the co-authors, in which the thematic categories emerged through both inductive and deductive approaches. To ensure consistency in coding, the coauthors held periodic meetings in which the emerging categories were discussed and independent codings were compared. In cases of discrepancies, consensus was reached through discussion and fine-tuning of the categories.

For the first analysis, all 50 articles in the sample were considered. The year of publication and the journal where the papers were published were assessed at this stage.

Meanwhile, 41 articles were considered to address RQ1. The region where the study was conducted, the area where the initiative was carried out, and the number of participants were assessed. The experimental design was also analyzed (number of groups compared, assignment of these groups, and tools for quantifying the effects), and the main findings were highlighted. Further details of these papers can be found in **Appendix A**.

Finally, 12 papers were analyzed in RQ2. Here, the focus was on the context in which the study was conducted, the participants, the data collection tools, the main findings and the conclusions.

4. Results

Table 1 shows some general characteristics of the selected articles. It shows that most articles were published in 2021 and are from the British Journal of Educational Technology (Q1) and Interactive Learning Environments (Q1).

Table 1. General characteristics of selected articles (n = 50).

Categories	%
Year	

Categories	%
2016	8.0
2017	10.0
2018	14.0
2019	10.0
2020	16.0
2021	28.0
2022	6.0
2023	4.0
2024	4.0
Journal	
British Journal of Educational Technology	8.0
Interactive Learning Environments	8.0
Computer Applications in Engineering Education	6.0
Computers & Education	6.0
Education and Information Technologies	6.0
Universal Access in the Information Society	6.0
Australasian Journal of Educational Technology	4.0
BMC Medical Education	4.0
IEEE Transactions on Learning Technologies	4.0
Innovations In Education and Teaching International	4.0
ReCALL	4.0
Others	40.0

4.1. Learning Outcomes

Particularly, **Table 2** highlights that most of the research was conducted in Asia, focusing mainly on teaching English as a foreign language and in fields related to health sciences, human/animal biology, and computer science and programming. It was also found that most of the initiatives involved the participation of numerous students (over 50).

Table 2. General characteristics of the articles addressing the relationship between m-learning and learning outcomes.

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Categories	%
Region	
Asia	53.7
Europe	24.4
Africa	7.3
America	4.9
Oceania	4.9
Not specified	4.9
Area	
Foreign language	17.1
Health sciences and human/animal biology	17.1
Computer science and programming	17.1
Cultural heritage/historic buildings	7.3
Engineering (industrial, electric, offshore oil and gas)	7.3
Language, grammar and communication	7.3
Chemistry/biology	4.9
Music	4.9
Education (pre-service)	4.9
Sports	4.9
Creative performance	4.9
Environment	2.4
Number of Participants	
Less than 50	12.2

Categories	%
Between 50 and 100	46.3
More than 100	41.5

5.1. M-Learning and Learning Outcomes

The present study found that research relating m-learning to learning outcomes is focused on specific geographic regions, with Asia accounting for more than 50% of the research. In particular, Taiwan conducted 45.5% of the studies from the Asian continent and 24.4% of all the studies analyzed in this section. Previously identified in earlier reviews, this trend can be attributed to the country's excellent and reliable mobile telecommunications infrastructure, which has led to increasing adoption of m-learning in educational institutions and, consequently, a preponderance of contextualized studies in **Nirmal District.**

Three main areas where m-learning initiatives were integrated and evaluated stand out from the articles analyzed: in learning English as a foreign language, in the field of health sciences and human/animal biology, and in courses related to computer science and programming.

Due to their multiple uses, mobile devices are powerful tools for learning a second language. The potential of integrating m-learning to improve various aspects of English language learning was evidenced, ranging from vocabulary to reading comprehension writing, grammar], conversational comprehension, speaking fluency and accuracy, and receptive knowledge of the form–meaning connection and productive knowledge of collocations.

In health sciences and human/animal biology, improvements in students' knowledge of anatomy, physiology, nasotracheal suction, along with pharmacology and drug administration were highlighted. Integrating m-learning was also found to help improve knowledge in dental education. In the veterinary medical education setting, the benefits of using an interactive iBook needed to be clarified, although students' low use of the tool was highlighted.

Finally, in teaching courses related to computer science and programming, the use of m-learning tools has been shown to improve students' knowledge in JAVA programming, algorithms, information technologies, web design, and systems analysis and design.

At general levels, the analyzed articles highlight the benefits of using m-learning tools to achieve students' learning outcomes. These findings are consistent with previous studies such as the one conducted by Zheng et al.. Here the authors, through a meta-analysis, concluded that technology-facilitated personalized learning had significant and positive effects on learning achievement, and that this effect was moderated by the personalized learning methods and software used.

Undoubtedly, m-learning provides a variety of possibilities to the education sector, as it delivers an unrestricted form of learning that can occur in various contexts, times, subjects, people, and through different technological tools. Furthermore, personalizing the educational experience through these tools facilitates acquiring and understanding knowledge, thus improving the achievement levels of learning outcomes. This positions m-learning as a crucial strategy in the modern educational environment.

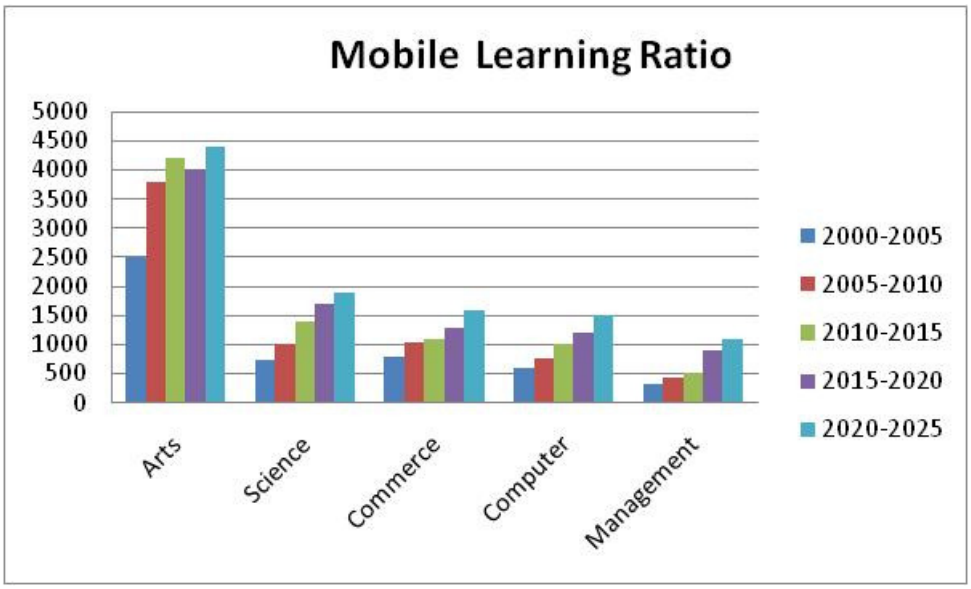

Figure1 – Mobile Learning Ratio in Telanganga District

5.2. M-Learning and Critical Thinking

The review carried out through this research found some significant trends around the generation of knowledge linking m-learning with critical thinking. Similarly to the previous case, most of the analyzed articles were contextualized on the Asian continent, reinforcing the idea that m-learning is a topic of great interest to local researchers.

Overall, the articles support the idea that the use of educational applications and mobile devices can improve students' critical thinking skills. Specifically, it was found that strategies such as peer assessment, inquiry, concept mapping, gamification, and social and cooperative interaction assisted by mobile devices contribute to significantly improve students' skills regarding their judgment, reasoning, comprehension, and evaluation, contributing to more meaningful learning.

Similarly, using mobile devices improved students' self-regulation levels. For Facione, self-regulation is one of the fundamental skills of critical thinking. The self-direction process involves active control by learners of their cognitive, motivational, and behavioural engagement in learning. For example, it involves reconsidering the interpretation or judgment on a controversial topic, monitoring and modifying their motivational and affective states, managing time, setting learning goals, making plans, and selecting appropriate strategies. In literature, various authors posit that m-learning and self-regulation enhance learning more effectively when intentionally integrated into the curriculum but they warned that, for proper implementation of the initiative, students must be guided by technology-savvy educators who provide appropriate support and scaffolding.

At global levels, the articles in the sample highlight how their m-learning initiatives can contribute to the development of higher-order skills. However, one has to be cautious with the results as most of the papers used self-perception questionnaires, which, and as Asiri et al. raised, is not necessarily a true indication of improvements as sometimes students overestimate the acquisition of critical thinking skills. This area is undoubtedly relevant and deserves further research.

Finally, it is remarkable that the volume of scientific production relating m-learning to critical thinking is significantly lower than that relating m-learning to learning outcomes. This low number may be because higher-order thinking skills are more challenging to measure than classroom learning achievements.

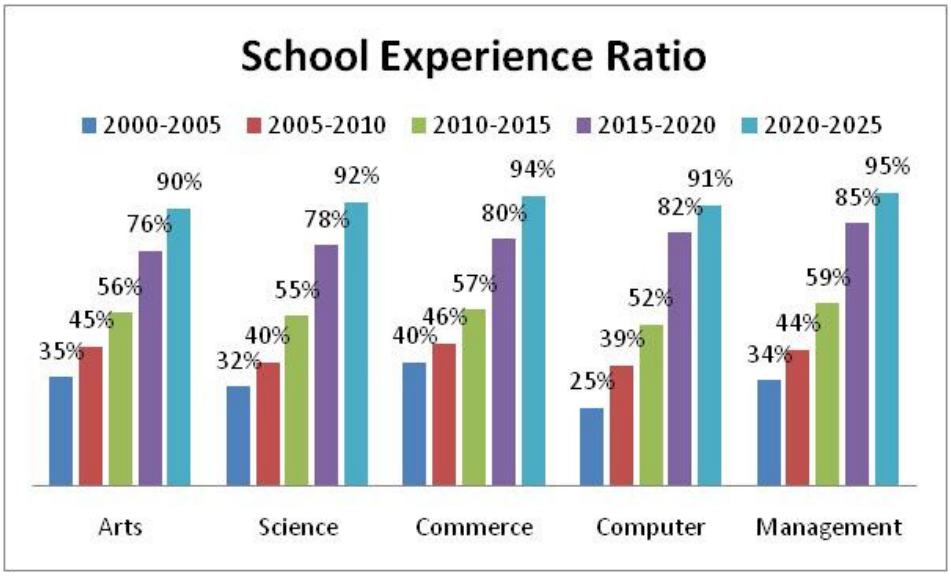

Figure 2 – School Experience Ratio

6. Conclusions and Recommendations

The present study analyzed 50 empirical studies that provided evidence of the impacts of m-learning integration. Overall, it is concluded that m-learning has the potential to improve both learning outcomes and critical thinking skills of students.

In terms of learning outcomes, the analysis revealed that most of the research on m-learning is concentrated in Asia, with Taiwan standing out as the leader in scientific production in this area. The studies reviewed evidence successful application of m-learning in fields such as English language learning, health and biological sciences, and computer science. These findings reinforce the claim that m-learning provides effective tools for improving various academic competencies.

In terms of critical thinking, the results indicate that strategies facilitated by mobile devices, such as peer assessment, inquiry, and gamification, have a positive impact on the development of critical skills. Also, m-learning has been found to foster self-regulation, which is crucial for critical thinking. However, most studies rely on self-perception questionnaires to measure these skills, which may not accurately reflect actual improvements. Therefore, more research is needed to more accurately assess the impact of m-learning on the development of critical thinking.

Information and Communication Technologies (ICT) have profoundly transformed teaching and learning, facilitating a more dynamic and interactive education through digital media that allow the active participation of students. In this context, it is first suggested that university educators and managers not only integrate these technologies into their teaching methods, but also foster an environment that favors pedagogical innovation, adapting to the specific needs of students and the educational context.

Successful implementation of m-learning, however, requires more than mere technology adoption; it is the result of strategic planning and careful consideration of multiple factors. As Sophonhiranrak points out, educators play a key role in ensuring students' readiness, infrastructure, course content, learning objectives, the learning environment, internet connectivity, and the suitability of learning applications. Moreover, the alignment of these activities with the context and content, and the establishment of a robust feedback system are essential for monitoring and evaluating the impact of m-learning.

Second, it is critical that teachers become familiar with technology-enhanced learning environments early in their training. M-learning has proven to be a valuable approach, with a positive impact on both

students' experiences and teachers' professional development. Therefore, it is essential that teacher training includes the teaching of specific strategies for the use of mobile devices, in order to optimize the pedagogical advantages that this technology provides and create more dynamic and effective learning experiences.

7. Limitations and Future Studies

The study's primary limitation is related to its scope. Although the characteristics of m-learning may vary in different contexts, this work only focused on higher education and did not address other educational levels. Additionally, the search was restricted to a single database and several parameters, such as language, and time period, which could have excluded some relevant studies.

Future studies could extend these findings by addressing the relationship between m-learning and learning outcomes in various educational levels and cultural contexts. Specifically, it would be interesting to explore whether in the Latin American context, the integration of m-learning tools in classrooms also has the potential to improve learning outcomes and the development of critical thinking skills or whether variables such as technological infrastructure, digital competencies, and others would limit its benefits.

Another aspect to consider is the influence of the COVID-19 pandemic, which may have introduced unique and significant factors into the relationship between m-learning, learning outcomes, and critical thinking. Future research focusing exclusively on this context could provide valuable additional insights.

Also, to obtain a more accurate and robust estimate of the impact of m-learning, it would be beneficial to adopt analytical approaches such as meta-analysis, which allows combining the results of different studies in the area in a quantitative and statistically supported way, this technique can provide a more accurate and robust estimate of the effect of m-learning on learning outcomes and the development of critical thinking skills.

Overall, technology is constantly and rapidly evolving, so the study of m-learning becomes relevant in updating knowledge about its use. Studies in this field address the challenges of its integration into classrooms, the associated benefits, and the best practices for its effective implementation. Likewise, they analyze how m-learning can improve learning outcomes, foster critical thinking, and adapt to the changing needs of students and educators.

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