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PAPER

Mobile Application with Augmented Reality, Gamification and Microlearning for First Aid Learning

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ABSTRACT

Insufficient first aid training is a major problem in society, as it limits people's ability to adequately respond to medical emergencies. The objective was to develop a mobile application with augmented reality (AR), gamification, and microlearning to improve the first aid learning of citizens. This study was applied in nature, with a quantitative approach, a pre-experimental experimental design. The levels of increase in knowledge, motivation towards learning, satisfaction with learning were measured and a positive effect on the learning of first aid was found. The sample consisted of 30 citizens, who were evaluated by means of a questionnaire before and after using the application. The results revealed an increase in first aid knowledge, a higher motivation towards learning, and an increase in user satisfaction.

KEYWORDS

augmented reality (AR), mobile application, first aid learning, educational technologies

1 INTRODUCTION

The lack of first aid knowledge is a major problem in society, as it limits people's ability to respond adequately to medical emergencies. This gap in first aid information highlights the urgent need to implement the use of effective educational strategies aimed at increasing the population's competence in this crucial aspect of public health [1]. In addition, the knowledge taught in educational programs regarding first aid is very scarce, which leads to a concern about whether schoolchildren are prepared to act in case of an emergency [2]. Meanwhile, educational programs within their curricula and teachers who are not trained and updated to provide quality education are an obstacle in the learning of first aid, in this context it is clear that it is necessary to design and develop new strategies to integrate first aid into the educational curriculum so that students acquire the ability to know how to act in case of any emergency [3].

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Mapping studies reveal that the discourse surrounding the teaching of first aid to students includes the responsibilities of school personnel in first aid education. In addition, these studies provide instructional information used in educational settings and emphasize the integration of first aid into the school curriculum [4]. It is important for a learning environment to consider aspects that ensure that users are learning [5]. On the other hand, the lack of advanced technology equipment may prevent aid organizations from providing better care. Hence, there is a clear need for the development of an intelligent support system using technologies such as the Internet of Things, image recognition and augmented reality (AR), which aims to improve the efficiency and quality of services provided in emergency situations by improving both the response capacity and the capacity to provide care in critical periods of time [6]. For example, it was demonstrated that the application of AR helped to improve the teaching and learning of mathematics [7], for example, it was shown that applying AR helped improve mathematics teaching and learning [8], achieving greater student motivation [9].

However, with technological advancement, mobile applications have revolutionized teaching methods. A prime example is Duolingo, a platform that uses microlearning to facilitate English language study, as validated by data collection from 150 students [10]. In addition, gamification [11] has proven to be effective in motivating people to face challenges and modify unwanted habits, as well as positively influencing subjective well-being and improving aspects of health, such as daily sleep and wakefulness patterns [12]. The virtualization of AR, gamification, and microlearning has been consolidated, making these tools essential in the field of education, and the use of the advantages of mobile technologies are complemented to perform quality teaching [13].

2 RELATED WORKS

2.1 Identifying the problem and the suggested findings

The study by [14] reported that the development of soft skills is vital in today's world, both in the everyday context and in the successful work environment. In response to this need, microlearning has been explored as one of the effective tools to educate these skills to university students. The two groups of students were compared: the first one that took courses in study skills and emotional intelligence through microlearning and the second one that was trained through the traditional method. In this case it was possible to highlight that both learning methods achieved the same index of knowledge to apply the techniques studied, thus reinforcing that microlearning also contributes to the teaching of these skills, and that its implementation is feasible in other branches of study of university student.

According to [15], focused on examining the motivations of philology students for the use of gamification with AR in education. Research was conducted that involved collecting information through a survey and an interview with students of the Mykhailo Stelmakh Faculty of Philology and Journalism. The students showed high acceptance and motivation towards the use of gamification and AR in their learning, which in turn positively influenced their participation, involvement, and understanding of the content. Finally, the use of gamification with AR was constructed as an innovative strategy to enhance teaching and make the learning process more interactive and motivating in the field of philology.

In addition, [16] proposed to analyze how AR affects the resolution of academic tasks, to achieve this they experimented with 36 aeronautical engineering students, between the groups AR and printed material were used, highlighting those students who used AR stood out in the times of completion of tasks, although it took them longer to interact with the technology. Therefore, it is recommended to use AR for academic activities.

In the analysis of [17], he carried out the topic of AR, gamification and serious games in their effects on computer education. Through a mobile educational application and an experiment in which 117 university students participated, it was shown that education can be enhanced by these technologies through student participation in the planning and execution of interactive activities. The results showed an increase in students' desire and engagement along with the development of their social and critical thinking skills. These results are in line with the theory of the need for the adoption of these technologies as a means of cognitive and emotional development of students in the educational setting.

On the other hand, the study by [18] investigated the knowledge and attitudes of Chinese university students about first aid for epilepsy. Conducted between January and April 2022 at eight universities in Henan province, it involved 2,376 participants. Although the majority demonstrated a good understanding of epilepsy, only 9.3% adequately answered all questions on first aid. A connection was found between attitude toward people with epilepsy, understanding of the disease, and knowledge of first aid. In addition, medical students showed a more positive attitude toward people with epilepsy compared to other students. These results emphasize the need to optimize the educational system and awareness of epilepsy and first aid, especially among university students.

For [19] AR and gamification in the educational environment has shown much effectiveness when used in learning methods, as it is known AR and gamification have been topics of study individually, what this study seeks is how the integration of these impacts, improves the development in the learning of university students. In a study of 95 students, it was found that the usability of AR motivates students, which is why its use in higher education should be disseminated in the curricula.

According to [20] this study assessed the first aid (PA) knowledge and skills of primary school teachers in Ibadan, Nigeria, before and after a training program. Seventy teachers were randomly assigned to intervention and control groups, and their knowledge and skills were assessed through a survey and simulated scenarios. The results showed a significant increase in AP knowledge and skills in the intervention group, both immediately after and three months after the training, while there was no change in the control group. In conclusion, the training program resulted in substantial and sustained improvements in teachers' ability to provide appropriate care in first aid situations.

Also [21] this study evaluated the effectiveness of simulation in teaching Psychological First Aid in Operations (PFA-O) and the factors that motivate trainers to adopt this technique. Through a questionnaire sent to 59 trainers in France, three dimensions were analyzed: usability, usefulness and acceptability. The results showed significant correlations between these dimensions, teacher motivation and course implementation, with a final model explaining 71% of the variability in motivation. In conclusion, the didactic model is useful for assessing the motivational factors that drive the adoption of simulation in training, with applicability in educational contexts beyond the military.

In this context, the present research aims to develop a mobile application with AR, gamification, and microlearning for citizens' first aid learning.

3 THE APPLIED METHODOLOGY

3.1 Method

The research methodology was applied since it focused on the use of technologies to determine how a mobile application with AR, gamification, and microlearning improves the learning of first aid; in addition, with a quantitative approach and pre-experimental design, thus following a unitary or competence-based approach. The meaning of competence as the integration of several components was important for the achievement of meaningful outcomes. That is, the combination of knowledge, skills and abilities was decisive for accrediting the acquisition of a competence [22]. In addition, as for the sample, 30 people were considered, who were of legal age with a mobile phone (smartphone). [23] felt that it is important to establish inclusion and exclusion criteria to identify who will be included in the population, thus ensuring that the results are representative and applicable to the objective. This specific selection allowed to focus on a manageable group within the general population, thus facilitating data collection. In this study, a non-probability convenience sampling strategy was employed. [23] applied this type of sampling, which selects a specific sample based on the researcher's criteria, which is useful when working with hard-to-reach populations or when a sample is required to reflect certain characteristics important to the study. In addition, the use of mixed techniques, such as surveys and register analysis, to obtain varied and detailed data was highlighted.

Data were collected through questionnaires and surveys designed to measure the effectiveness of implementation, following ethical criteria that support the validity of the research. The questionnaire was pilot-tested and validated by expert judgement to ensure its reliability and relevance.

3.2 Case study

On the other hand, Mobile-D is a development methodology designed specifically for mobile applications, ideal for small teams working in short development cycles. According to [24], Mobile-D consists of five phases: exploration to plan the project, initialization to verify critical issues, production to iteratively implement requirements, stabilization to ensure quality, and testing to obtain feedback and correct defects, emphasizing that Mobile-D focuses on software functionality over documentation, actively involves the customer, is highly flexible to changes, and is committed to timely delivery of products through fast production cycles of demos and deliverables.

Phase 1: Exploration

a) **Scope:** Develop a mobile application with AR, gamification and microlearning for learning first aid.
b) **Functional Requirements:** Table 1 shows the requirements necessary for the development of the system.

Table 1. Functional requirements

Code	Functional Requirement
RF01	The application will have a login for users to access.
RF02	The application will have learning modules in microlearning format, divided into short lessons.
RF03	The application will have interactive simulations using augmented reality.
RF04	The application will have a gamification system that will include points.
RF05	The application will have questionnaires to evaluate the user's learning after completing the modules.
RF06	The application will have a learning module with interactive videos for each first aid technique.
RF07	The application will have a record of the user's progress in the learning modules.

Phase 2: Initialization

a) **Environment configuration**
   - **Hardware:** HP AMD RYZEN 7 laptop and mobile device (cell phone).
   - **Software:** Android Studio, Firebase, Unity 3D.

b) **Technological architecture for the development:** The mobile application was developed using Android Studio, with integration of Unity 3D for AR and Firebase as a real-time database. See Figure 1.

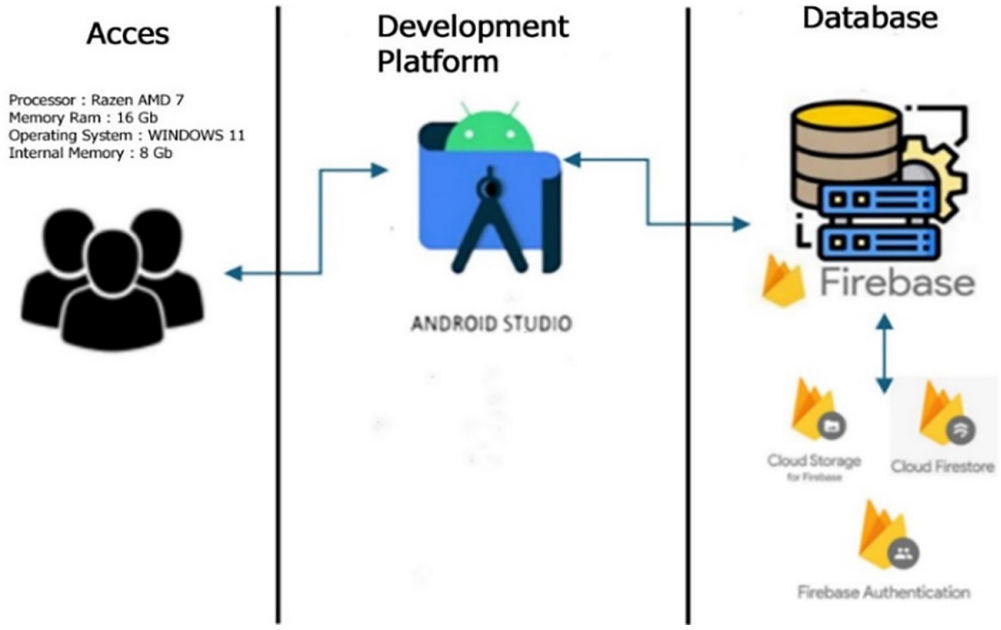

Fig. 1. Technological architecture of the project

Phase 3: Production

Incremental versions of the application are produced, adding features such as learning content, AR visualization, and integration of interactive interfaces (Refer to Table 2).

Table 2. Modular plan

Module	Code	Process	Requirement
User Authentication Module	M01	Manages secure access through credential verification, enabling user login and registration.	RF01
First aid training module	M02	Provides educational content on first aid, structured in short, practical lessons.	RF02
Video playback module	M03	Allows viewing of instructional videos as part of the interactive learning process.	RF03
Augmented reality module	M04	Integrates virtual elements over the real environment to simulate first aid situations, improving practical understanding.	RF04
Gamified quiz module	M05	Features interactive quizzes with game mechanics to assess knowledge and motivate learning.	RF05
Multimedia content module	M06	Offers access to resources such as images, graphics and complementary texts that enrich the learning process.	RF06
Progress tracking module	M07	Monitors and records user progress, providing feedback and statistics on course performance.	RF07

Phase 4: Stabilization

In this phase, the application's functionalities are incorporated, ensuring that each component works properly. Errors identified during development are corrected immediately. In addition, exhaustive tests are performed to ensure that all modules operate optimally and meet the defined requirements.

a) **Recommendations for mobile equipment:** It is recommended to use a mobile device with sufficient storage space, and it is suggested that the device has access to a stable internet connection to perform the analysis in the cloud and synchronize the results with the database (Refer to Table 3).

Table 3. Cell phone recommendations

Hardware	Software
RAM 4GB or more	Android 8.0 or higher
	4G network

Phase 5: Testing

The testing phase focuses on evaluating the functionality and performance of the application in a real environment, ensuring that it meets the expectations and objectives set during development. During this stage, exhaustive tests are performed to identify possible errors or areas for improvement, ensuring the stability and usability of the product. In addition, feedback from end users is collected to make necessary adjustments before final implementation, ensuring an optimal experience aligned with their needs.

a) Unit test 01: Augmented reality interaction module: Table 4 shows the unit test on login.

Table 4. Augmented reality interaction test

Code	Name
M01	Augmented reality interaction module.
Target	The mobile application must be able to show the simulation of the courses taught, as well as the materials used in the interventions.
Steps	– Enter username and password – Enter course 1 and/or materials – Enter simulation
Results obtained	The user will be able to see the simulation of the material or course to be studied.

4 RESULTS

The objective was to develop a mobile application with AR, gamification and microlearning to improve users' learning of first aid. To measure the indicators: first aid knowledge (KPI-1), first aid learning motivation (KPI-2), and user satisfaction (KPI-3), two questionnaires were applied: pretest and posttest.

4.1 KPI-1

Figure 2 shows the results obtained in the pre-test with 19% and post-test with 31%, where it is evident that knowledge in first aid increased after using a mobile application with AR, gamification, and microlearning.

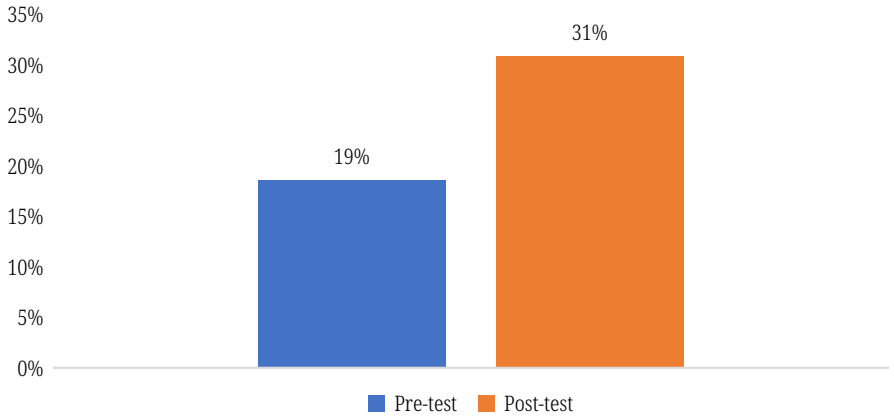

Fig. 2. Pre- and post-test results on first aid knowledge

In Table 5, 24 positive ranks are presented with an average rank of 17.42 and a total sum of ranks of 418.00 showing that 24 users increased first aid knowledge after using a mobile application with AR, gamification and microlearning.

Table 5. Wilcoxon signed ranks – increase in knowledge

Range				
		N	Average Rank	Sum of Ranks
Post-test Pre-test	Negative ranges	5[a]	3.40	17.00
	Positive ranks	24[b]	17.42	418.00
	Ties	1[c]		
	Total	30		

Notes: [a]Post-test < Pre-test, [b]Post-test > Pre-test, [c]Post-test = Pre-test.

In Table 6, the Wilcoxon signed-rank test yielded a value of Z = –4.710 with a two-tailed asymptotic significance of p = 0.000 (<0.05), showing statistically significant differences between pre- and post-test results in terms of first aid knowledge. The calculated effect size was $r = 0.86$, which represents a large effect according to Cohen's criteria, showing that the magnitude of the improvement was substantial. This finding confirms that the mobile application based on AR, gamification, and microlearning generated a significant increase in the participants' knowledge levels, validating its effectiveness as a learning support tool.

Table 6. KPI-1 Test statistics[a]

	Post-test Pre-test
Z	–4.710[b]
Asymptotic (bilateral)	0.000

Notes: [a]Wilcoxon signed-rank test, [b]Based on negative ranks.

4.2 KPI-2

Figure 3 shows the results obtained in the pre-test with 25% and post-test with 32%, where it is evident that the motivation for learning first aid increased after using a mobile application with AR, gamification, and microlearning.

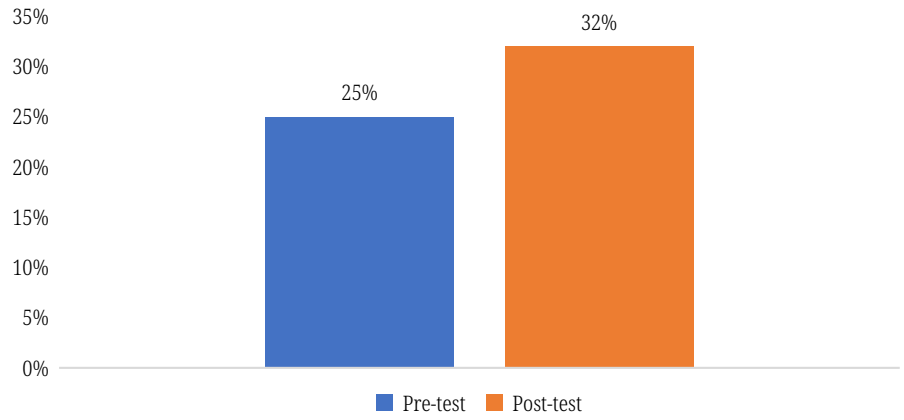

Fig. 3. Pre- and post-test results on motivation to learn first aid.

Table 7 shows 22 positive ranks with an average rank of 17.45 showing that 22 users increase motivation for learning first aid after using a mobile application with AR, gamification, and microlearning.

Table 7. Wilcoxon signed ranks – motivation impact

Range				
		N	Average Rank	Sum of Ranks
Post-test Pre-test	Negative ranges	8[a]	10.13	81.00
	Positive ranks	22[b]	17.45	384.00
	Ties	0[c]		
	Total	30		

Notes: [a]Post-test < Pre-test, [b]Post-test > Pre-test, [c]Post-test = Pre-test.

In Table 8, the Wilcoxon signed-rank test showed a value of Z = –4.786 with a two-tailed asymptotic significance of p = 0.000 (<0.05), which shows statistically significant differences between the pre-test and post-test in motivation for learning. The calculated effect size was r = 0.87, which represents a large effect according to Cohen's criteria, indicating that the magnitude of the change in motivation was considerable. These results confirm that the mobile application based on AR, gamification, and microlearning had a positive and significant impact on participants' motivation to learn first aid.

Table 8. KPI-2 Test statistics[a]

	Post-test Pre-test
Z	–4.786[b]
Asymptotic (bilateral)	0.000

Notes: [a]Wilcoxon signed-rank test, [b]Based on negative ranks.

4.3 KPI-3

Figure 4 shows the results obtained in the pre-test with 24% and post-test with 34% where it is evident that satisfaction increased after using a mobile application with AR, gamification, and microlearning.

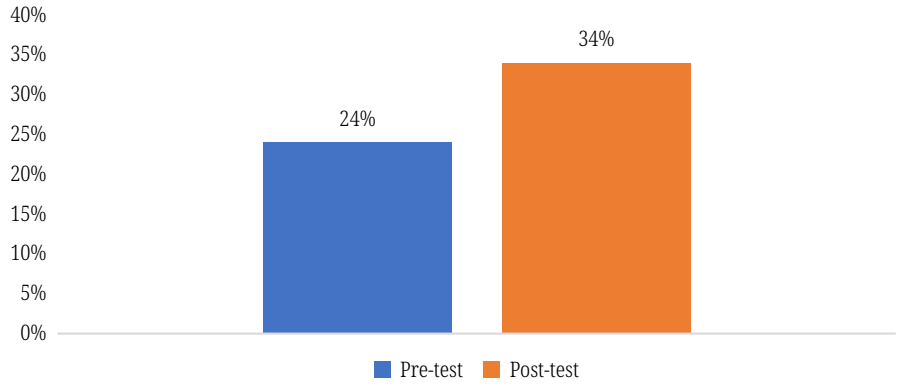

Fig. 4. Pre- and post-test results on user satisfaction

In Table 9, 25 positive ranks are presented, with an average rank of 16.14 and a total sum of ranks of 403.50 showing that 25 users increased satisfaction after using a mobile application with AR, gamification, and microlearning.

Table 9. Wilcoxon signed ranges, user satisfaction

Range				
		N	Average Rank	Sum of Ranks
Post-test Pre-test	Negative ranges	4[a]	7.88	31.50
	Positive ranks	25[b]	16.14	403.50
	Ties	1[c]		
	Total	30		

Notes: [a]Post-test < Pre-test, [b]Post-test > Pre-test, [c]Post-test = Pre-test.

In Table 10, the Wilcoxon signed-rank test yielded a value of Z = –4.706 with a two-tailed asymptotic significance of p = 0.000 (<0.05), showing statistically significant differences between pre- and post-test scores in terms of satisfaction with first aid learning. The calculated effect size was $r = 0.86$, which represents a large effect according to Cohen's criteria, indicating that the magnitude of the change in satisfaction was substantial. This result confirms that the mobile application based on AR, gamification, and microlearning generated a significant increase in participants' satisfaction levels, demonstrating its effectiveness in promoting more engaging, dynamic, and satisfying learning experiences.

Table 10. KPI-3 Test statistics[a]

	Post-test Pre-test
Z	–4.706[b]
Asymptotic (bilateral)	0.000

Notes: [a]Wilcoxon signed-rank test, [b]Based on negative ranks.

5 DISCUSSION

The results presented the high level of verification of learners' knowledge, as well as the high motivation of users. Compared to [18], the result was lower due to the fact that the present study according to the self-directed way of studying, and the academic settings of the study are the structured way, while [25] is regarding the effectiveness of microlearning on practical skills and on the contrary [26] observed low levels of knowledge due to the lack of new information. This implies that, although the use of technology in education is certainly a successful way, the context, the use and the dedication of the learner are the factors that determine this impact on education, therefore, it is a good idea to mix technology with structured training offerings and when trainers should practice playing the role of a trainer to allow for more interactive.

The results of the study showed that the application managed to significantly increase the motivation of users, who highlighted the interaction with realistic

environments and gamification as key factors in maintaining their interest and focus on the study topics. This positive impact coincided with previous research such as that of [19] which observed an increase in motivation when using emerging technologies, although in this project a greater impact was achieved. Similarly, [27] documented a high acceptance and motivation towards these technologies among students. The analysis showed that users not only felt more motivated but also perceived a more engaging and effective learning experience, validating the potential of these technologies to transform first aid education and foster sustained interest in their practice. User satisfaction is crucial in educational environments, as it reflects whether the tools used meet their expectations. According to [19] motivation and participation in interactive technologies such as AR improve performance and satisfaction, while [27] highlight that gamification and AR make learning more dynamic and engaging. The study showed that users experienced greater satisfaction when using the application, valuing elements such as personalization, immersive environments and rewards in interactive games, which favored their interest and engagement. These results surpassed those of [19] by including achievements and rewards and supported the contributions of [27] and [17] on the effectiveness of these technologies to enrich the educational experience. As observed, the integration of AR, gamification and microlearning proved to be effective in optimizing user satisfaction and fostering user engagement, recommending their implementation in innovative educational environments.

For [19] gamification demonstrates much effectiveness in people's learning since nowadays we all own smartphones which makes it faster to use and easier to access information content in the same way with AR that with its realistic simulator environment contributes to more effective learning. The use of the mobile application significantly improved first aid learning by providing quick access to content, interaction with realistic environments through AR and gamification elements that increased interest, which facilitated dynamic and hands-on learning, keeping users motivated and engaged.

The results show that mobile applications improve the learning of students and workers by integrating microlearning, gamification, and AR, which increases their interest in learning. In this regard, [28] highlighted the improvement in worker performance with similar technologies, and [29] highlighted that these technologies optimize efficiency and response times in organizations, which was also reflected in this study. The study showed that the integration of AR, gamification, and microlearning improved first aid learning and maintained user interest, better preparing us to react to emergencies. This underscores the effectiveness of these technologies in practical teaching and their usefulness in critical situations, coinciding with the findings of other studies, albeit with different approaches and technologies. The study conducted in Ibadan, Nigeria also showed a significant improvement in primary school teachers' knowledge and skills in first aid after a training program, although it did not use emerging technologies but traditional methods [20]. On the other hand, the PFA-O study evaluated simulation as a teaching technique and highlighted the importance of trainer motivation, similar to your results, which highlight how interactive technologies, such as AR and gamification, can increase user motivation and engagement [21]. Taken together, these studies highlight the effectiveness of interactive teaching strategies. This study demonstrates that mobile technologies and personalization significantly improve user engagement and satisfaction, which could overcome the limitations of traditional methods.

6 CONCLUSIONS

In conclusion, the impact of a mobile application combining AR, gamification, and microlearning on improving learning, motivation and user satisfaction was determined. The findings indicate that these technological tools had a positive effect. This is achieved through improved training in basic first aid concepts and procedures and greater engagement in the learning process, proving effective in improving first aid knowledge, enabling faster and more comprehensive acquisition of practical skills, suggesting that these technologies may be key to overcoming the limitations of traditional methods. Making use of the mobile application with AR, gamification and microlearning significantly increased user motivation, making them more interested and engaged in learning. This interactive approach improves information retention and participation in the educational process. Users showed high satisfaction with the application due to the personalization and immersive interaction provided by AR. This highlights the importance of not only focusing on the content but also on the overall user experience to keep users engaged.

Limitations of the study include technical requirements such as the need for mobile devices compatible with AR technologies, which may restrict usability on low-end devices or devices with outdated operating systems. In terms of user accessibility, not all participants had the same level of familiarity with using mobile educational applications, which could impact the learning experience. In addition, there was no formal usability evaluation through user experience testing, which limits the understanding about ease of navigation and interaction. Regarding scalability, the study was applied to a small sample and for convenience, and no tests were conducted to analyze system performance against a larger number of users or in more diverse contexts. Finally, the long-term sustainability of the interaction could be affected by the lack of updated content and the absence of dynamic feedback, which could decrease user motivation and interest over time.

Future research could explore the effectiveness of the app in a variety of settings, such as rural areas or environments with limited technological infrastructure, and examine how the content could be adapted to other health-related topics. It would also be beneficial to incorporate emerging technologies, such as artificial intelligence, to facilitate personalized learning experiences and real-time performance monitoring. In addition, expanding the study to include a larger and more diverse group of participants, assessing knowledge retention over extended periods of time, and comparing the effectiveness of the app with that of traditional first aid training methods would provide a more complete understanding of its educational impact.

7 REFERENCES

[1] M. T. P. Galiano, L. M. V. Ramírez, and M. Á. Ñ. García, "Educational intervention in first aid in physical education classes [Intervención Educativa en Materia de Primeros Auxilios en las Clases de Educación Física]," *Retos*, vol. 48, pp. 554–563, 2023. https://doi.org/10.47197/retos.v48.96158

[2] G. Mylonas, D. Amaxilatis, L. Pocero, I. Markelis, J. Hofstaetter, and P. Koulouris, "An educational IoT lab kit and tools for energy awareness in European schools," *Int. J Child. Comput. Interact.*, vol. 20, pp. 43–53, 2019. https://doi.org/10.1016/j.ijcci.2019.03.003

[3] R. Barcala-Furelos, L. Peixoto-Pino, J. Zanfaño-Ongil, and S. Martínez-Isasi, "Desafíos en la enseñanza escolar de los primeros auxilios: análisis de la legislación educativa (LOMLOE) y orientación curricular," *Rev. Esp. Salud. Publica.*, vol. 98, p. e202402013, 2024.

[4] L. C. de Melo Alves Silva *et al.*, "First aid teaching for schoolchildren: Scoping review," *International Journal of Educational Research Open*, vol. 5, p. 100305, 2023. https://doi.org/10.1016/j.ijedro.2023.100305

[5] R. O. Flores-Castañeda, S. Olaya-Cotera, and O. Iparraguirre-Villanueva, "Benefits of metaverse application in education: A systematic review," *International Journal of Engineering Pedagogy (iJEP)*, vol. 14, no. 1, pp. 61–81, 2024. https://doi.org/10.3991/ijep.v14i1.42421

[6] C. Z. Ying, "Development of a first-aid smart assistant device using IoT technology and augmented reality," in *IRC-SET 2020*, H. Guo, H. Ren, and N. Kim, Eds., Springer, 2021, pp. 741–757. https://doi.org/10.1007/978-981-15-9472-4_63

[7] E. Pineda-Torres, W. Rodriguez-Lopez, and O. Iparraguirre-Villanueva, "Role of augmented reality, virtual reality and streaming services in the field of education (2020–2023) – A systematic review," *International Journal of Engineering Pedagogy (iJEP)*, vol. 15, no. 3, pp. 134–151, 2025. https://doi.org/10.3991/ijep.v15i3.51595

[8] O. Iparraguirre-Villanueva, C. Paulino-Moreno, H. Chero-Valdivieso, K. Espinola-Linares, and M. Cabanillas-Carbonell, "Integration of GeoGebra calculator 3D with augmented reality in mathematics education for an immersive learning experience," *International Journal of Engineering Pedagogy (iJEP)*, vol. 14, no. 3, pp. 92–107, 2024. https://doi.org/10.3991/ijep.v14i3.47323

[9] H. Gharbaoui, K. Mansouri, and F. Poirier, "Social learning and gamification strategies for optimizing online learning in a computer science course," *International Journal of Engineering Pedagogy (iJEP)*, vol. 15, no. 3, pp. 60–74, 2025. https://doi.org/10.3991/ijep.v15i3.54101

[10] A. T. Van Pham and L. T. T. Le, "Students' perceptions towards Duolingo app as a micro-learning tool," in *ACM International Conference Proceeding Series*, 2023, pp. 213–217. https://doi.org/10.1145/3631991.3632026

[11] G. Lampropoulos, E. Keramopoulos, K. Diamantaras, and G. Evangelidis, "Integrating augmented reality, gamification, and serious games in computer science education," *Educ. Sci. (Basel)*, vol. 13, no. 6, p. 618, 2023. https://doi.org/10.3390/educsci13060618

[12] A. E. Ilhan, B. Sener, and H. Hacihabiboglu, "Improving sleep-wake behaviors using mobile app gamification," *Entertain. Comput.*, vol. 40, p. 100454, 2022. https://doi.org/10.1016/j.entcom.2021.100454

[13] D. C. Claros-Perdomo, E. E. Millán-Rojas, and A. P. Gallego-Torres, "Uso de la realidad aumentada, gamificación y m-learning," *Revista Facultad de Ingeniería*, vol. 29, no. 54, p. e12264, 2019. https://doi.org/10.19053/01211129.v29.n54.2020.12264

[14] Y. N. Romanenko, E. Solodovnikova, and N. Maksimenko, "Microlearning as a new method of teaching soft skills to university students," *Front. Educ. (Lausanne)*, vol. 8, 2023. https://doi.org/10.3389/feduc.2023.1177516

[15] O. Petrovych, I. Zavalniuk, V. Bohatko, N. Poliarush, and S. Petrovych, "Motivational readiness of future teachers-philologists to use the gamification with elements of augmented reality in education," *International Journal of Emerging Technologies in Learning*, vol. 18, no. 3, pp. 4–21, 2023. https://doi.org/10.3991/ijet.v18i03.36017

[16] K. B. Borgen, T. D. Ropp, and W. T. Weldon, "Assessment of augmented reality technology's impact on speed of learning and task performance in aeronautical engineering technology education," *International Journal of Aerospace Psychology*, vol. 31, no. 3, pp. 219–229, 2021. https://doi.org/10.1080/24721840.2021.1881403

[17] A. P. Moreno *et al.*, "Effectiveness of a digital application to improve stroke knowledge for kids [Efectividad de una aplicación móvil para mejorar el conocimiento sobre los síntomas de ictus en una población pediátrica de Colombia]," *Neurologia*, vol. 38, no. 4, pp. 278–283, 2023. https://doi.org/10.1016/j.nrl.2021.10.011

[18] T. Zhao *et al.*, "Awareness, attitudes and first aid knowledge of epilepsy among university students – A cross-sectional study in Henan Province, China," *Epilepsy Res*, vol. 201, 2024. https://doi.org/10.1016/j.eplepsyres.2024.107315

[19] E. Ivarson, V. Erlandsson, M. Faraon, and S. Khatib, "Augmented reality and gamification in higher education: Designing mobile interaction to enhance students' motivation and learning," *E-Learning and Digital Media*, vol. 22, no. 6, 2024. https://doi.org/10.1177/20427530241239981

[20] A. Ibrahim *et al.*, "A training program improves poor first aid knowledge and skills among primary school teachers in Ibadan, Nigeria," *Pan African Medical Journal*, vol. 50, 2025. https://doi.org/10.11604/pamj.2025.50.58.38707

[21] E. Saguin, J. Salomé, B. Favodon, B. Lahutte, and F. Gignoux-Froment, "Validation of a didactic model evaluating the usability, usefulness and acceptability of psychological first aid teaching through simulation," *BMC Med. Educ.*, vol. 24, no. 1, p. 1431, 2024. https://doi.org/10.1186/s12909-024-06491-y

[22] J. J. Castro Maldonado, L. K. Gómez Macho, and E. Camargo Casallas, "La investigación aplicada y el desarrollo experimental en el fortalecimiento de las competencias de la sociedad del siglo XXI," *Tecnura*, vol. 27, no. 75, pp. 140–174, 2023. https://doi.org/10.14483/22487638.19171

[23] Investigalia, "Los sujetos de studio," 2020. Accessed: 2024. Available: https://investigaliacr.com/investigacion/los-sujetos-de-estudio/

[24] H. A. Al-Rabaiah and N. Medina-Medina, "Agile Beeswax: Mobile app development process and empirical study in real environment," *Sustainability*, vol. 13, no. 4, p. 1909, 2021. https://doi.org/10.3390/su13041909

[25] Y. N. Romanenko, E. Solodovnikova, and N. Maksimenko, "Microlearning as a new method of teaching soft skills to university students," *Front. Educ. (Lausanne)*, vol. 8, 2023. https://doi.org/10.3389/feduc.2023.1177516

[26] P. Hegde, S. Gibikote, A. Kumar, M. Thenmozhi, and S. Jehangir, "Knowledge of prevention and first aid in burn injuries among health care workers and non-health care persons in India," *Burns*, vol. 50, no. 4, pp. 1024–1029, 2024. https://doi.org/10.1016/j.burns.2024.01.011

[27] O. Petrovych, I. Zavalniuk, V. Bohatko, N. Poliarush, and S. Petrovych, "Motivational readiness of future teachers-philologists to use the gamification with elements of augmented reality in education," *International Journal of Emerging Technologies in Learning*, vol. 18, no. 3, pp. 4–21, 2023. https://doi.org/10.3991/ijet.v18i03.36017

[28] A. Dolowitz, J. Collier, A. Hayes, and C. Kumsal, "Iterative design and integration of a microlearning mobile app for performance improvement and support for NATO employees," *TechTrends*, vol. 67, no. 1, pp. 143–149, 2023. https://doi.org/10.1007/s11528-022-00781-2

[29] C. Z. Ying, "Development of a first-aid smart assistant device using IoT technology and augmented reality," in *IRC-SET 2020*, 2021, pp. 741–757. https://doi.org/10.1007/978-981-15-9472-4_63

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