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Original Research Article

Introduction of Mobile Application-Based Skills Teaching in Postgraduate Orthopaedics Course

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Abstract

Introduction: The COVID-19 pandemic has fundamentally transformed educational methodologies, accelerating the adoption of digital learning platforms and smartphone applications across various fields. In the realm of medical education, these apps have emerged as crucial tools, offering students access to high-quality resources and expert knowledge at their convenience. This instant access to information not only broadens the learning experience but also enhances clinical decision-making and subject comprehension. However, despite the potential benefits, there remains a slow adoption of mobile application-based skills training in medical education, primarily due to a lack of awareness regarding available apps and their effective utilization. Furthermore, there is limited documentation on the actual uptake of these applications by students, as well as a need to evaluate their effectiveness and user satisfaction as teaching and learning tools. This study aims to address these gaps by assessing the awareness, usage, and perceived value of smartphone applications in medical education.

Material and Methods: This prospective observational study was conducted among post-graduate students at Government Medical College, Patiala, specifically targeting those in the Orthopaedics department (2024 cohort). Ethical approval was obtained from the Ethical Committee and Research Committee prior to the study's initiation, ensuring adherence to ethical guidelines. The study included consenting residents who participated in biweekly assessment sessions designed to enhance their learning experience through interaction and support. A feedback questionnaire, validated by the MEU, was utilized to assess the effectiveness of these sessions. Data collection involved a Google Forms-based questionnaire featuring a 5-point Likert scale to capture participant's attitudes and perceptions regarding the mentoring experience. Feedback was collected both before and after each session, with a comprehensive questionnaire distributed at the end of the study. Participants included PG residents from the Orthopaedics department, providing insights into the process from both perspectives. The collected data was systematically compiled and analysed using appropriate statistical methods to draw meaningful conclusions about the impact of mentoring on the residents' educational outcomes.

Results: A total of 20 PG residents participated in the study, with a mean age of 28.7±2.98 years in Group A and 29.5±3.03 years in Group B ($p = 0.5591$). All participants were male, and a significant majority resided in hostels (80% in Group A and 90% in Group B; $p = 0.04767$). Group A residents had greater access to resources and reported higher motivation and interactivity from using smartphone applications alongside books. Assessment scores at 2 weeks showed Group A with a mean of 18±0.94 compared to 15±1.56 in Group B ($p = 0.000061$), and continued to demonstrate significant differences at 4 weeks (Group A: 18.2±0.79; Group B: 14.4±1.35; $p < 0.00001$) and 6 weeks (Group A: 18.2±0.63; Group B: 14.5±1.27; $p < 0.00001$). No significant differences were observed in assessment scores over time within each group (Group A: $p = 0.8124$; Group B: $p = 0.5960$). All residents expressed support for the continuation of the program for future batches, with 80% in agreement and none in disagreement.

Conclusion: Incorporating digital technologies into the orthopaedic curriculum marks a significant advancement in medical education, effectively bridging traditional methods with the preferences of today's digital generation. The adoption of a blended learning model enhances student engagement and accessibility while fostering a more interactive and practical learning environment. As technological advancements continue

to influence healthcare, it is essential to evaluate the effectiveness of these educational strategies through systematic analysis of post-implementation data to optimize learning outcomes for future medical practitioners.
Keywords: Smartphone applications, Academic mentors, Postgraduate residents, teaching faculty, Orthopaedics.
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Introduction

The COVID-19 pandemic has radically reshaped educational landscapes worldwide, necessitating a rapid pivot to online learning methods and digital platforms. This unprecedented situation has served as a catalyst for change, accelerating the adoption of innovative teaching strategies and technologies.[1] Among these, smartphone-based educational applications have surged in popularity, particularly within the field of medical education. These applications provide students with immediate access to a wealth of knowledge, bridging gaps that traditional educational settings have often struggled to fill.[2]

As the demand for flexible and accessible learning solutions has grown, educational apps have emerged as essential tools, enabling students to engage with expert-led content anytime and anywhere. This new mode of learning offers significant advantages, including enhanced interactivity, personalization, and the capacity for self-paced study. [3,4] Medical students can tap into a diverse array of resources that not only include lectures from esteemed educators but also incorporate various learning modalities such as videos, quizzes, and real-time feedback mechanisms. This broad accessibility facilitates a deeper understanding of complex clinical concepts, supporting better clinical decision-making and ultimately leading to improved patient care outcomes.[5]

Despite the evident benefits that mobile applications present, the adoption of these resources within medical education has not been as widespread as one might expect. This slow uptake can be attributed to several factors. One significant challenge is the limited awareness among students and educators regarding the plethora of available applications and their potential utility in enhancing educational outcomes.[6] Many students may not be fully informed about the capabilities of these applications or how to utilize them effectively in their studies. Additionally, there exists a cultural resistance to integrating technology into traditional curricula, which further hampers the full realization of mobile learning's potential.[7]

Moreover, the decision-making processes surrounding the purchase and use of educational apps remain poorly documented. It is essential to understand why students choose specific applications and how these choices align with their learning needs and preferences. Insights into such decision-making can provide valuable information to app developers and educators, enabling them to create more effective and tailored resources for medical students. [8,9]

Another critical dimension that requires exploration is the effectiveness and impact of these mobile applications as teaching and learning tools. Although numerous apps claim to offer enriching educational experiences, the extent to which they fulfil this promise has yet to be substantiated through rigorous research. Evaluating the perceived usefulness of these applications and the satisfaction levels of students who use them is vital for gauging their true value in academic settings. [10,11] Such evaluations can lead to improvements in both the applications themselves and the teaching methodologies employed in medical training.

This study seeks to address these gaps by conducting comprehensive research into the awareness, adoption, and perceived utility of mobile applications in medical education.

By examining the factors influencing student engagement with these technologies and assessing the effectiveness of mobile learning methods, this research aims to provide insights that could inform the future integration of digital tools into medical curricula. Ultimately, it strives to contribute to a more robust understanding of how mobile applications can enhance educational experiences and outcomes for medical students, paving the way for a more adaptive and responsive approach to learning in the medical field.

Aims and Objectives:

Aim: Assessing the usage and efficacy of mobile applications among postgraduate students of orthopaedics, while also evaluating faculty perceptions regarding the integration of these apps in the teaching of the orthopaedics course at Government Medical College, Patiala.

Objectives:

1. To determine the number of post graduate students using the mobile apps and commonly used apps.
2. To evaluate the efficacy of mobile based apps amongst post graduate students of orthopaedics.
3. To determine the perception of faculty for the mobile application-based teaching of orthopaedics course.

Methodology

Prospective Observational Study

Study Population: This research project focused on post-graduate students at Government Medical College, Patiala. This specific cohort was chosen due to its relevance in the medical education system and the potential impact on the students' future medical practice. Participants currently undergoing post-graduate training in department of Orthopaedics (2024) were invited to take part in the study.

Ethical Considerations and Approval Process: Before commencing the study, ethical approval was sought from the Director Principal, and Medical Education Unit (MEU). This research followed the prescribed ethical guidelines and safeguards.

Study Group and Sample Size: -The study included consenting residents from the department of Orthopaedics, Government Medical College, Patiala. Out of these all-consenting students were allowed to participate.

Validation of Feedback Questionnaire by MEU: -The feedback questionnaire (Appendix1) was subjected to validation by the Medical Education Unit (MEU) of the institute.

Mentoring Sessions and Frequency: Participating PG residents of the Orthopaedics department attended mentoring sessions at least once a week in the teaching sessions. These sessions provided a platform for interaction, guidance, and support contributing to the overall learning experience.

Feedback Collection: To gauge the effectiveness of the mentoring sessions, feedback was collected both before and after each session and finally a google questionnaire was distributed at the end to seek responses immediately after the final session. This allowed for a comprehensive assessment of any changes or improvements in perceptions, understanding, or skills as a result of the mentorship.

Tools Used: The primary tool for data collection in this prospective observational study is a questionnaire. This questionnaire will be designed to capture relevant information related to the impact of mentoring sessions on the participating PG residents of the Orthopaedics department. The procedure of validation guaranteed the reliability and authenticity of the data obtained through this tool.

Data Collection: In this research project, data collection is a critical phase that involves obtaining feedback from multiple stakeholders, including PG residents of the Orthopaedics department, and Faculty of Orthopaedics. To ensure a systematic and standardized approach, a Google Forms-based questionnaire, FDG'S, Patient's records will be utilized, incorporating a 5-point Likert scale tailored specifically for this project.

Questionnaire Design: The questionnaire is meticulously crafted to cover key aspects relevant to the mentoring sessions and their impact on residents, and faculty of Medicine. Respondents could indicate how much they agree or disagree with statements using the 5-point Likert scale.

Participants:

PG residents of the Orthopaedics department: The individuals responsible for providing mentorship. Gathering feedback from mentors offered insights into their experience, challenges faced, and the perceived effectiveness of their mentoring role.

Faculty of Orthopaedics: Comprised of consenting faculty, who agreed to oversee and participate in the project. Feedback from the Faculty of Medicine provided a higher-level perspective on the overall implementation, challenges, and potential areas for improvement.

Google Forms Platform: Google Forms served as the platform for data collection. This online tool facilitated easy distribution of the questionnaire, ensuring accessibility for participants.

Pre-Formed Questionnaire: The questionnaire was for this research project

5-Point Likert Scale: The Likert scale was used method for capturing attitudes and opinions.

Data Collection Process:

- Distribution: The Google questionnaire was distributed electronically to PG residents, and Faculty of the Orthopaedics department involved in the project.
- Consent: An informed consent form explaining the study's objectives, confidentiality assurances, and the participants' voluntary involvement was taken from each participant.
- Completion: Participants were asked to complete the questionnaire immediately after the session.
- Reminder System: To enhance response rates, a reminder system was implemented in form of What's app group.

- FDG's were conducted and data was collected as per participant's activity and response.

Validation Process: Prior to implementation, the questionnaire underwent a validation process to ensure its relevance, clarity, and effectiveness in capturing the intended data.

Analysis Plan: Upon completion of data collection, the responses were compiled and subjected to statistical analysis. The 5-point Likert scale data will be analysed using appropriate statistical methods to draw meaningful conclusions and insights from the feedback provided by PG residents, and Faculty of the Orthopaedics department.

In this research project, the responses from PG residents, gathered through the modified questionnaire, underwent a comprehensive process of data collection, compilation, and analysis. The aim was to draw meaningful insights and conclusions based on predetermined parameters, utilizing numerical data, percentages, and relevant statistical tests. In conclusion, this prospective observational study aimed to the usage and efficacy of mobile applications among postgraduate students of orthopaedics at Government Medical College, Patiala, using a well-structured methodology and ethical considerations. The findings may have contributed valuable insights to medical education and mentorship practices.

Observations and results

20 PG residents consented to be a part of project. All filled the Pre session proforma. All these residents responded in post-session Questionnaire and participated in the study.

Table 1: Baseline characteristics

Variables	Group A (book + application)	Group B (books)	p-value (significance)
Age	28.7±2.98 years (25-34 years)	29.5±3.03 years (26-36 years)	0.5591 (NS)
Gender	100% male	100% male	1 (NS)
Residence	80% Hostellers	90% Hostellers	0.04767 (S)
	20% Day Scholar	10% Day Scholar	

In this study, the mean age of residents in group A was 28.7±2.98 years (range 25-34 years) and in group B, it was 29.5±3.03 years (range 26-36 years) [p 0.5591; non-significant]. All the residents were males [p 1; non-significant]. Majority of the residents were living in hostels (80% in group A and 90% in group B) [p 0.04767; significant].

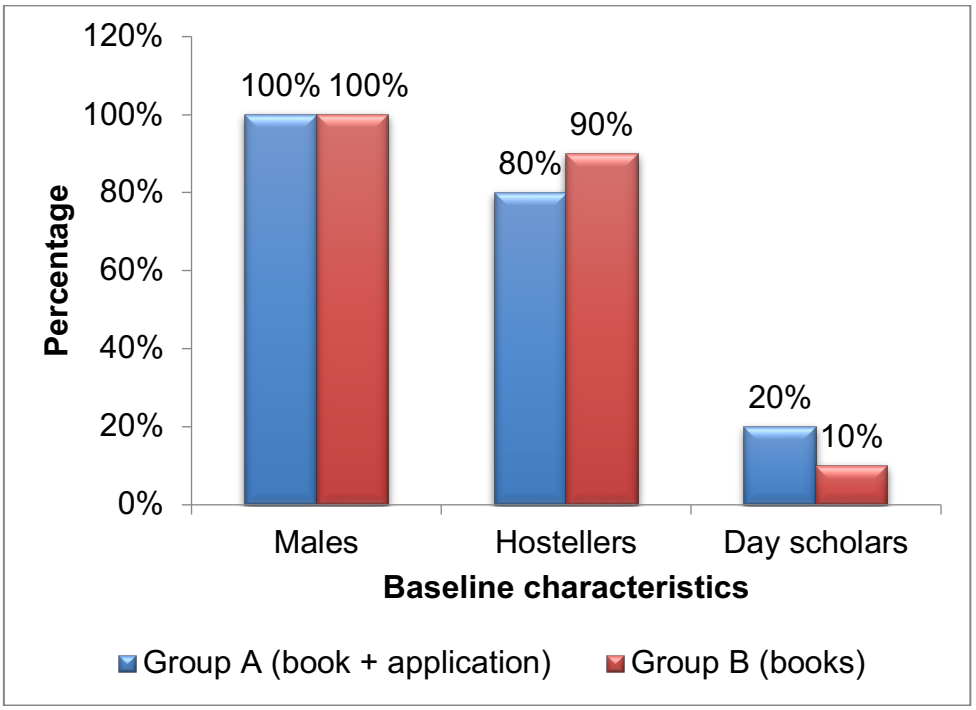

Figure 1:

Table 2: Perception of PG residents

Parameters	Variables	Group A (book + application)	Group B (books)
Accessibility		Anywhere 100%	Room 100%
Motivates me	Yes	90%	20%
	No	10%	80%
Knowledge increment	Yes	100%	100%
	No	0%	0%
Doubt solving live sessions	Yes	100%	0%
	No	0%	100%
Interaction	Yes	100%	0%
	No	0%	100%

Group A residents were able to access the resources (book/ application) from anywhere while group B residents could access books from their room/home. Majority of residents in Group A found the use of smartphone application along with books more motivating, better in doubt solving, and more interactive than group B residents. In terms of knowledge increment, all the residents were equally confident.

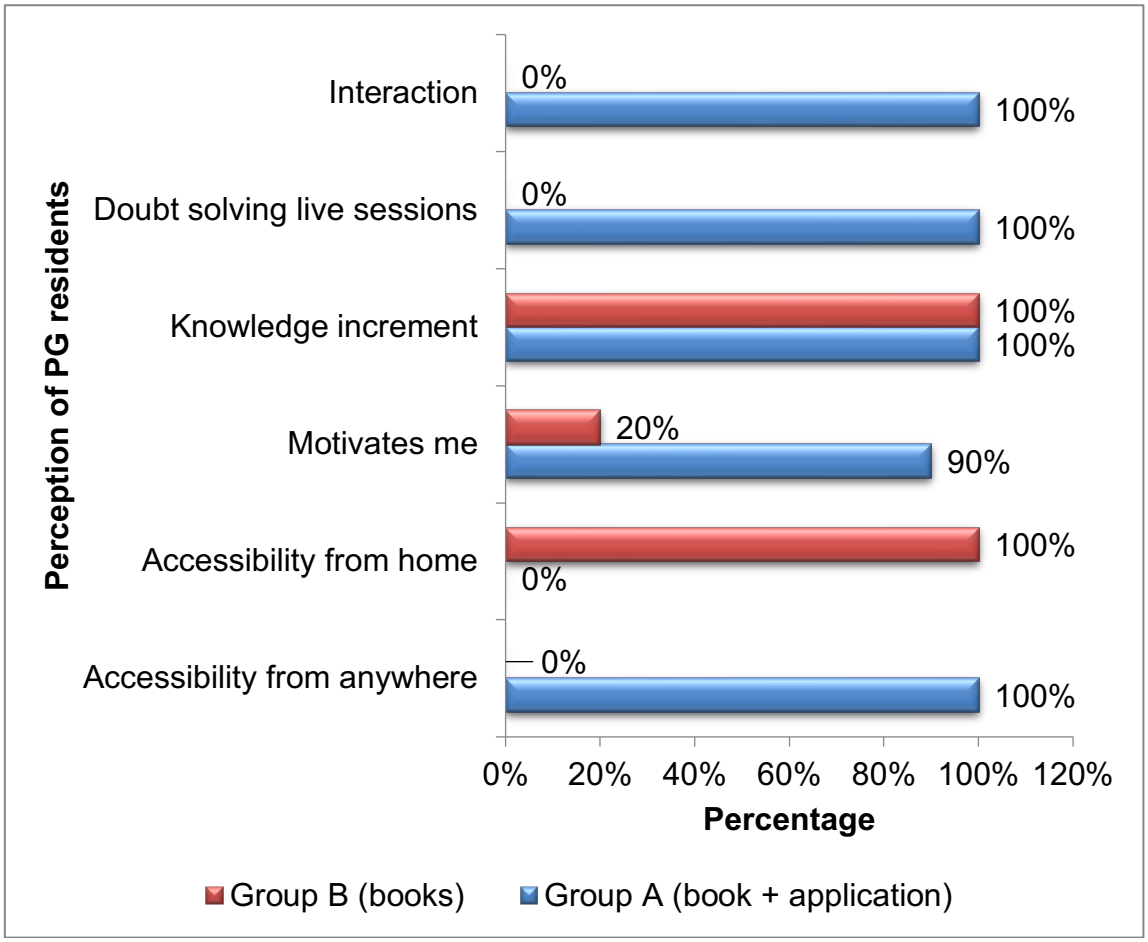

Figure 2:

Table 3: Assessment scores at 2 weeks

Scores	Group A (book + application)	Group B (books)
11-15	0%	60%
16-20	100%	40%
Mean± SD	18±0.94	15±1.56
Range	17-20	12-18
p-value	0.000061 (HS)	

The mean assessment scores at 2 weeks in group A was 18±0.94 (range 17-20) and in group B, it was 15±1.56 (range 12-18) [p 0.000061; highly significant].

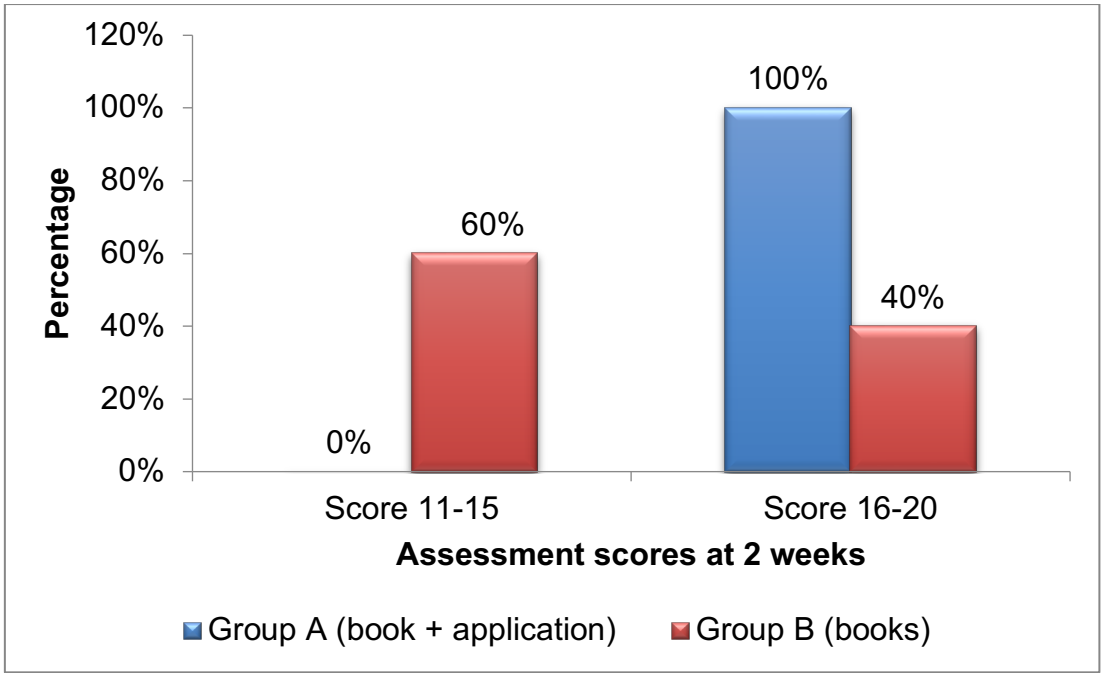

Figure 3:

Table 4: Assessment scores at 4 weeks

Scores	Group A (book + application)	Group B (books)
11-15	0%	80%
16-20	100%	20%
Mean± SD	18.2±0.79	14.4±1.35
Range	17-19	13-17
p-value	< 0.00001 (HS)	

The mean assessment scores at 4 weeks in group A was 18.2±0.79 (range 17-19) and in group B, it was 14.4±1.35 (range 13-17) [$p < 0.00001$; highly significant].

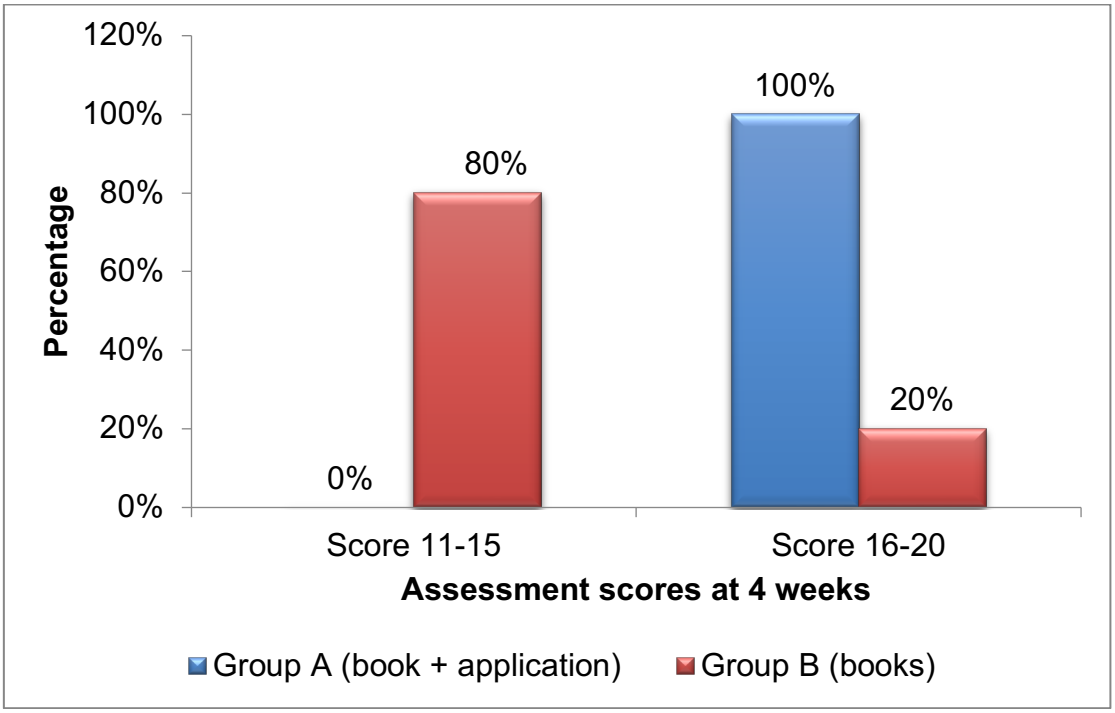

Figure 4:

Table 5: Assessment scores at 6 weeks

Scores	Group A (book + application)	Group B (books)
11-15	0%	80%
16-20	100%	20%
Mean± SD	18.2±0.63	14.5±1.27
Range	17-19	12-16
p-value	< 0.00001 (HS)	

The mean assessment scores at 6 weeks in group A was 18.2±0.63 (range 17-19) and in group B, it was 14.5±1.27 (range 12-16) [p < 0.00001; highly significant].

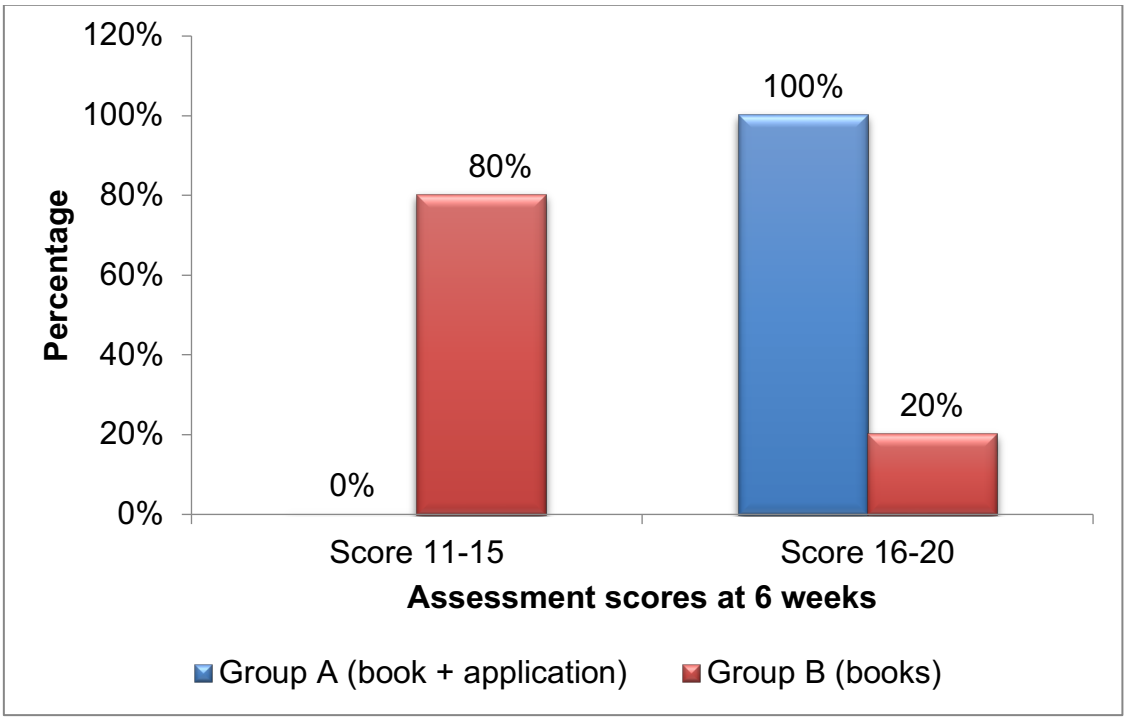

Figure 5:

Table 6: Intra-group comparison of Assessment scores at different timepoints

Time points	Group A (book + application)	Group B (books)
2 weeks	18±0.94	15±1.56
4 weeks	18.2±0.79	14.4±1.35
6 weeks	18.2±0.63	14.5±1.27
p-value	0.8124 (NS)	0.5960 (NS)

In group A, the mean assessment scores were 18±0.94, 18.2±0.79, and 18.2±0.63 at 2 weeks, 4 weeks, and 6 weeks respectively. The difference in assessment score at different timepoints was found to be statistically non-significant (p 0.8124). In group B, the mean assessment scores were 15±1.56, 14.4±1.35, and 14.5±1.27 at 2 weeks, 4 weeks, and 6 weeks respectively. The difference in assessment score at different timepoints was found to be statistically non-significant (p 0.5960).

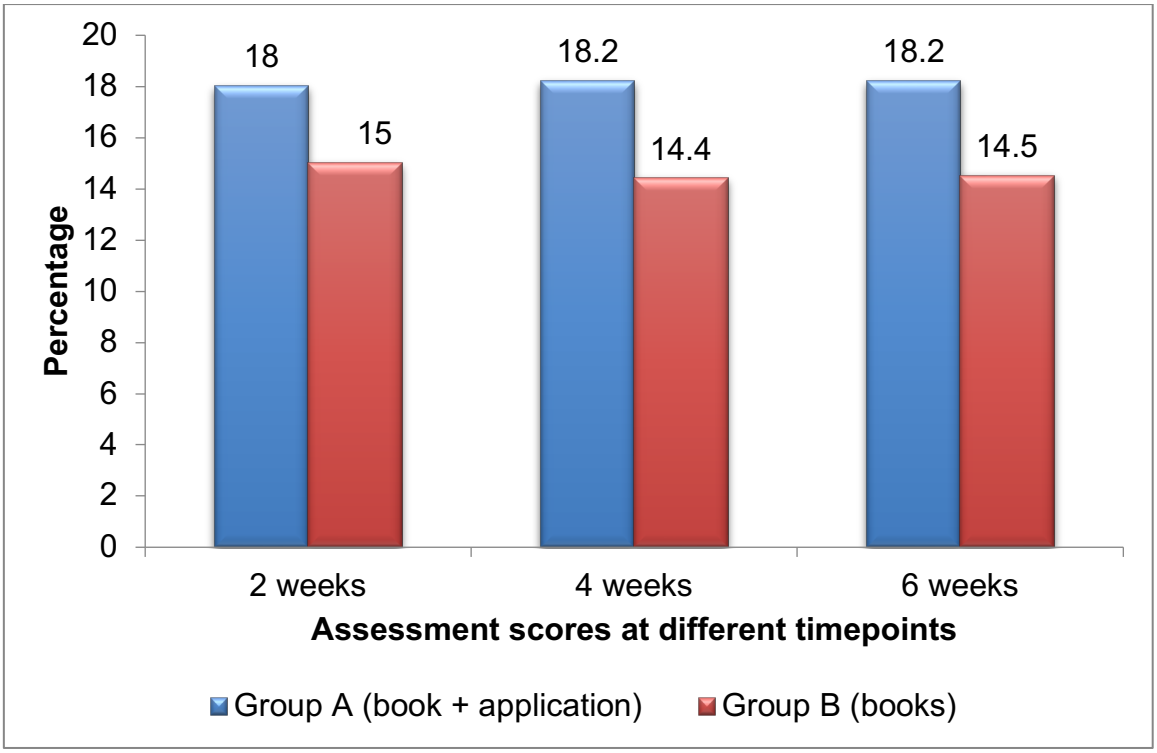

Figure 6:

Appendix -1

Outcomes	Evaluation Questions	Indicators	Data Sources	Data Collection Methods
Students were more relaxed and had flexibility to learn at their own pace	How comfortable and stress free were students by introduction of mobile based skills??	All the students felt stress free while learning.	Post graduate students in Dept of Orthopaedics.	Feedback Questionnaire in Google forms
The students became more knowledgeable with better skills.	What percentage of students improved their knowledge and skills by this augmentation of teaching method?	More than 80% students showed better skills theoretically and practically.	Post graduate students in Dept of Orthopaedics.	Feedback Questionnaire in Google forms, FDGs
This augmentation of teaching method enhanced the surgical and teaching skills of faculty.	Did the addition of mobile application-based skills, dissemination of knowledge to students help motivate and refine the surgical skills of faculty??	More than 80% faculty showed improvement in gaining & disseminating knowledge.	Co Faculty in Dept of Orthopaedics.	FDGs
Increased overall better patient care due to raised threshold of knowledge in the department.	Did the smartphone-based apps help to increase the patient care?	More than 75% students & faculty agreed on better patient care.	Post graduate students of Dept of Orthopaedics, faculty of Dept of Orthopaedics and Patient's Records.	FDGs & Patient's records
Improved version of apps.	Did the apps improvise over time?	All apps improved over time.	Post graduate students.	Records of apps.

Appendix-2 Gantt chart

Task	Aug	Sept	Oct	Nov	Dec	Jan	Feb
1. Finalization of project plan and submission							
2. IEC Permission							
3. Literature review							
4. Sensitization of students & co faculty							
5. Module preparation							
6. Module implementation							
7. Student & faculty feedback							
8. Data collection & analysis							
9. Poster preparation & submission							
10. Poster presentation							

All PG residents agreed that it should be continued for future batches with 80% agreed and 20% neutral responses and no one disagreed.

Open Ended Questions: Responses to the open-ended questions were analysed and following data emerged about strengths, weaknesses, Challenges faced and solutions to these issues.

Strengths of Program: Enhanced learning, allows simulation of complex surgical procedures minimizing errors in real time practice, allows freedom of time to attain knowledge, bridges the gap between traditional and modern practices.

Weaknesses of Program: Procurement and maintenance of software and devices can be costly. Dependence on internet connectivity can be an issue. Faculty may require sensitization and training to integrate applications.

Challenges faced: Initial resistance from faculty, Planning and procurement of mobile apps was a hassle initially.

Suggested Solutions: Few sensitization sessions with faculty and senior residents made all the difference. Once apps are designed they can become part of future teachings so it's a onetime exercise only.

Discussion

The results of this study provide valuable insights into the performance and learning outcomes of residents in two distinct groups, A and B, over a six-week period. The demographic analysis revealed that the mean age of residents in both groups was comparable, with no significant differences noted ($p = 0.5591$). This suggests that age-related factors are unlikely to influence the assessment scores or the effectiveness of the educational interventions employed in this study. Additionally, the uniformity in gender distribution across both groups ($p = 1$) further strengthens the validity of the findings, as it minimizes the potential for gender-based biases in performance.

Lavadia WT et al (2023) reported that the mean age of residents was 30.4 years. Similar to our study, this study also included millennial learners who were well-versed in all platforms of digital technology, including smart phones and chat apps. The participants are mostly Generation X and Millennial learners and as digital natives, all are very comfortable with the smart phones and chat apps.[12]

A notable finding was the living arrangements of the residents, with a significant majority residing in hostels (80% in group A and 90% in group B; $p = 0.04767$). This factor may have implications for the social dynamics and support systems available to the residents, potentially influencing their learning experiences and outcomes. The environment in which residents live can impact their stress levels, study habits, and overall well-being, which are critical components of effective learning.

Residents in Group A had the advantage of accessing learning resources (books and applications) from any location, whereas Group B residents could only access books from their rooms or homes. A majority of residents in Group A reported that utilizing the smartphone application, in conjunction with traditional books, was more motivating, effective for resolving doubts, and interactive compared to Group B residents. Despite these differences in resource access and learning tools, all residents expressed equal confidence regarding their knowledge increment.

Alencar JB et al (2020) reported that 100% said smartphone application was a useful technology in the resident's theoretical development. 124 (93.9%) agreed it was an auxiliary learning method for orthopedic doctors in general.[13]

The assessment scores at various time points revealed a stark contrast between the two groups. Group A consistently achieved higher mean scores compared to group B at all assessment intervals (2 weeks, 4 weeks, and 6 weeks), with the differences being statistically significant ($p < 0.0001$) as compared to group B. This suggests that the educational interventions utilized in group A were more effective in enhancing residents' knowledge and skills. It is essential to explore the specific

components of the educational strategies employed in group A that contributed to these superior outcomes, as understanding these elements could inform future curriculum development in orthopaedic education.

Moreover, in today's era, the mobile smartphone has become a necessary tool for access to resources that may not be within easy grasp, of which teleconferencing, and webinars have now provided, and with the ease of communications through this gadget, it has further enhanced the learning experience. The study provides evidence that the participants have shared a very positive outlook on the use of the app for their daily work and activities.

Interestingly, while group A demonstrated consistently high scores, the assessment scores for group B showed a decline over time, with mean scores decreasing from 15 at 2 weeks to 14.4 at 4 weeks and slightly increasing to 14.5 at 6 weeks. However, the differences in scores at different time points within group B were not statistically significant ($p = 0.5960$). This trend may indicate challenges faced by residents in group B, possibly related to the instructional methods or content delivery. Further qualitative research could help identify specific barriers to learning in this group and guide improvements in educational practices.

Valle J et al (2017) also found that smartphones have more positive than negative effects on the ability to enhance patient care and medical education.

In group A, the lack of statistically significant differences in assessment scores across the different time points ($p = 0.8124$) suggests a level of mastery and retention of knowledge that was maintained throughout the study duration. This stability in performance may reflect the effectiveness of the teaching methods employed, which could be beneficial for developing long-term learning strategies in medical education.

Overall, the findings of this study underscore the importance of tailored educational interventions in medical training, particularly in orthopaedics. The significant differences in assessment scores between the two groups highlight the need for ongoing evaluation and adaptation of teaching methodologies to optimize learning outcomes. Future research should focus on longitudinal studies to assess the long-term retention of knowledge and skills, as well as the impact of different learning environments on resident performance. By continuously refining educational strategies based on empirical evidence, medical education can better prepare residents for the complexities of modern healthcare.

Conclusion

In conclusion, the integration of digital technologies into the orthopaedic curriculum represents a significant evolution in medical education, aligning traditional methods with the needs and preferences of the digital generation. The adoption of a blended learning model not only enhances educational engagement and accessibility for students but also fosters a more interactive and practical learning environment. As advancements in technology continue to shape healthcare, it is crucial to rigorously evaluate the effectiveness of these educational strategies through careful analysis of post-implementation data. This will clarify the correlation between enhanced learning outcomes and improved clinical performance, ultimately contributing to the development of a more competent and adaptable workforce in orthopaedics. Moving forward, ongoing research and feedback from both students and educators will be essential to refine these innovative approaches, ensuring they meet the evolving demands of the healthcare sector. Moreover, the institute will not be burdened by this kind of medical education, and resources already in place were used.

Implications for Practice and future Research

The findings of this study have significant implications for both the practice of medical education and future research in orthopedic residency training.

Implications for Practice

1. **Integration of Technology in Learning**: The positive outcomes associated with the use of smartphone applications and digital resources in Group A suggest that integrating technology into the curriculum can enhance learning experiences. Medical education programs should consider adopting similar digital platforms that facilitate access to resources, promote interactivity, and improve knowledge retention.

2. **Tailored Educational Interventions**: The stark differences in assessment scores between the two groups highlight the necessity of personalized educational strategies. Institutions should evaluate their teaching methodologies to ensure they cater to the diverse learning preferences of residents. This may involve incorporating blended learning approaches that combine traditional methods with digital tools.

3. **Supportive Learning Environments**: Given the significant percentage of residents living in hostels, programs should consider the social dynamics and support systems available to residents. Creating collaborative learning environments, whether through peer study groups or mentoring programs, could enhance the educational experience and address challenges faced by residents.

4. **Continuous Feedback Mechanisms**: Implementing regular feedback loops for residents can help identify learning barriers and areas for improvement. This could involve surveys or focus groups to gather insights on the effectiveness of educational tools and strategies.

Future Research

1. **Longitudinal Studies**: Future research should focus on longitudinal studies to assess the long-term retention of knowledge and skills gained through the use of digital tools in medical education. Understanding how these tools impact learning over time will provide valuable insights for curriculum development.

2. **Qualitative Research on Learning Barriers**: Further qualitative research is needed to explore the specific challenges faced by residents in Group B. Identifying barriers to learning can guide improvements in instructional methods and content delivery, ensuring that all residents benefit from the educational interventions.

3. **Comparative Studies**: Conducting comparative studies across different medical specialties could provide broader insights into the effectiveness of digital learning tools in various contexts. This would help establish best practices that can be adopted across medical education.

4. **Impact of Learning Environments**: Research should also investigate the effects of different learning environments on resident performance. Understanding how factors such as living arrangements and access to resources influence educational outcomes can inform strategies to optimize learning conditions.

5. **Exploration of Mobile Learning Trends**: Given the increasing reliance on smartphones and digital resources, future studies should explore emerging trends in mobile learning and their implications for medical education. This includes evaluating new applications, teleconferencing tools, and online resources that could further enhance the learning experience. By addressing these implications for practice and avenues for future research, medical education can continue to evolve, ensuring that residents are well-prepared to meet the challenges of modern healthcare.

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