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From Engagement to Empowerment: AI-Powered Mobile Applications and the UTAUT Framework in Higher Education

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Abstract

This mixed-methods study investigates how AI-powered mobile learning applications impact student engagement and empowerment in higher education. By utilizing the Unified Theory of Acceptance and Use of Technology (UTAUT) framework and quantitative analysis (SEM), this paper examines the influence of performance expectancy, effort expectancy, social influence, and facilitating conditions on student adoption and use of AI-powered mobile learning applications. In this study, qualitative data (thematic analysis of semi-structured interviews) explored the nuanced experiences of students regarding personalization, motivation, and self-efficacy. Results revealed strong predictive power of performance and effort expectancy in technology adoption, with AI features significantly impacting student self-efficacy and motivation. The study also highlights the potential of AI-powered mobile applications to foster student empowerment, moving beyond engagement to self-directed learning and enhanced academic success. Students reported increased engagement, confidence, and control over their learning. However, the study's reliance on self-reported data and a single university sample limits generalizability. Future research should address these limitations through longitudinal studies and diverse participant populations to further explore the long-term impacts of AI-powered mobile learning on student success.

Keywords: Ai-Powered Mobile Learning Application, Student Engagement, Student Empowerment, Technology Acceptance, Self-Efficacy

Introduction

The integration of mobile technology in higher education has evolved significantly over the past two decades, transforming from basic educational tools into sophisticated applications that leverage artificial intelligence (AI) to personalize and enhance learning experiences. AI-powered mobile learning applications can enhance the educational experience for students in higher education in several ways (Alsanousi, 2023; Arini et al., 2022; Cao et al., 2020): Personalized and adaptive learning (Cantos, 2023; Lin, 2023); Improved engagement and motivation (Abbas et al., 2023; Arini et al., 2022); Enhanced language learning (Vančová, 2023; Nazari et al., 2021); Intelligent tutoring and feedback (Chichekian & Benteux, 2022;

Nazari et al., 2021); Improved administrative tasks (Nazari et al., 2021; Cao et al., 2020; Abbas et al., 2023). Initially, mobile learning (m-learning) was primarily focused on improving access to educational materials and enabling flexible, on-the-go learning. However, with the advancement of AI, mobile applications have grown beyond simple access points to interactive platforms that offer personalized learning pathways, real-time feedback, and adaptive content tailored to individual needs. AI algorithms can analyze student data to provide personalized content, feedback, and learning paths tailored to individual needs and learning styles (Cantos, 2023; Lin, 2023; Cao et al., 2020).

Current research has increasingly focused on understanding how AI-powered applications impact student engagement, motivation, and learning outcomes. The interactive and dynamic nature of AI-powered mobile apps can increase student engagement and motivation to learn (Alsanousi, 2023; , Arini et al., 2022; , Abbas et al., 2023). Major research directions include examining the effectiveness of these tools in fostering personalized and adaptive learning experiences, evaluating their role in improving academic performance, and assessing the factors that influence students' acceptance and sustained use of AI-driven mobile technologies. Kim et al. (2020) found that students' academic use of mobile technology can create meaningful opportunities for student-centered learning, personalized learning, differentiated instructions, and collaboration, which can enhance their growth in higher education.

Despite the promising potential, few studies address the shift from student engagement to genuine empowerment—where students feel motivated, self-directed, and capable of shaping their learning journeys. This study seeks to fill this gap, using the Unified Theory of Acceptance and Use of Technology (UTAUT) framework to explore how AI-powered mobile applications can move students beyond engagement to a state of empowerment. This research is significant as it offers insights that can inform the design of future educational technologies, fostering environments where students are not only engaged but also feel empowered to take control of their learning and academic success.

According to the purpose of the study, the specific research questions are as follows:

1. How do AI-powered mobile learning applications influence students' engagement and perceived empowerment in higher education?
2. Which factors within the UTAUT framework (performance expectancy, effort expectancy, social influence, and facilitating conditions) most significantly impact students' acceptance and use of AI-powered mobile applications?
3. In what ways does the use of AI-driven mobile applications foster students' academic self-efficacy and motivation?

These research questions address a growing interest in leveraging AI-powered mobile applications to not only engage students but also empower them by enhancing motivation, self-efficacy, and self-directed learning. Current literature provides ample evidence that mobile learning applications can improve engagement and access to educational resources (Abbas et al., 2023; Alsanousi, 2023; Arini et al., 2022). However, research remains limited on how AI-enhanced personalization can foster a deeper sense of empowerment, enabling students to take greater control over their learning experiences. By using the Unified Theory of Acceptance and Use of Technology (UTAUT) framework, this study examines the specific

factors influencing students' acceptance and effective use of AI-powered mobile applications. This is particularly valuable as educators and developers seek to design applications that go beyond passive engagement and support active, empowered learning environments. Understanding these factors will help identify how and why students are likely to embrace AI-powered tools, guiding the creation of more user-centered educational technologies.

Furthermore, this research holds significant academic and practical implications for the field of higher education and educational technology. Academically, it contributes to the literature on AI-enhanced mobile learning by offering a nuanced perspective on how AI-driven tools can support students' journey from engagement to empowerment. By applying the UTAUT framework, this study extends theoretical understanding of technology acceptance in educational contexts, particularly by highlighting the role of AI personalization in fostering student autonomy and motivation. Practically, the findings may influence the design and implementation of mobile learning applications, offering actionable insights for developers and educators on how to create user-centered learning environments that prioritize student empowerment. Such applications could ultimately improve academic performance and student satisfaction, providing higher education institutions with innovative ways to enhance learning outcomes. In this way, the research contributes both to the evolving body of knowledge on AI-powered learning technologies and to the development of educational practices that support more meaningful, self-directed learning experiences.

In this study, a mixed-methods research design was employed to provide a comprehensive understanding of how AI-powered mobile learning applications influence student engagement and empowerment in higher education. The primary data sources included survey responses and in-depth interviews with undergraduate students from various academic disciplines who regularly use AI-driven mobile learning applications. The survey was designed using the constructs of the Unified Theory of Acceptance and Use of Technology (UTAUT) framework—performance expectancy, effort expectancy, social influence, and facilitating conditions—to quantitatively assess factors that impact students' acceptance and use of these applications. Structural equation modeling (SEM) was used to analyze survey data, allowing for an examination of the relationships between UTAUT constructs and student empowerment outcomes.

To capture more nuanced insights into student experiences, semi-structured interviews were also complemented the quantitative data, with thematic analysis applied to interview transcripts. This qualitative component provides rich, contextual information on how students perceive AI-driven features, such as personalization and real-time feedback, in relation to their motivation, self-efficacy, and autonomy. The mixed-methods approach enables a robust analysis by combining quantitative patterns with qualitative depth, thus thoroughly addressing the research questions. This design is well-suited to explore both the measurable effects and individual perceptions of AI-powered applications, offering a holistic view of how these technologies can foster student empowerment in higher education.

Literature Review

AI and Mobile Learning in Higher Education

AI-driven mobile learning applications have emerged as powerful tools in higher education, bringing significant advancements that extend beyond traditional mobile learning

environments. Recent studies highlight several benefits of AI integration, such as personalization, where AI algorithms adapt content and learning paths to suit individual student needs, enhancing engagement and retention. AI algorithms can analyze student data to provide personalized content, feedback, and learning paths tailored to individual needs and learning styles (Akavova, 2023; Jeong, 2022). The interactive and dynamic nature of AI-powered mobile apps can increase student engagement and motivation to learn (Alenezi, 2023). Adaptive learning capabilities enable these applications to modify difficulty levels and pacing based on students' progress, providing tailored support that accommodates diverse learning speeds and styles. Real-time feedback is another transformative feature, as AI-powered applications can deliver immediate, data-driven responses to students, facilitating quicker understanding and corrective action, which is shown to increase motivation and self-confidence in learners. AI-powered chatbots and virtual assistants can provide timely and personalized feedback, guidance, and tutoring to students, replicating the interactions of a human tutor (Fazlollahi et al., 2022; Deeva et al., 2021). However, while these studies acknowledge the effectiveness of AI in boosting engagement, limited research examines how AI-enabled personalization may foster deeper empowerment by promoting self-directed learning and enhancing students' autonomy. AI-enhanced personalization can foster a deeper sense of empowerment and enable students to take greater control over their learning experiences (Jeong, 2022; Nayak, 2024).

The UTAUT Framework and Technology Adoption

The Unified Theory of Acceptance and Use of Technology (UTAUT) framework has been widely applied in studies on technology adoption, particularly in educational settings. Developed by Venkatesh et al. (2003), UTAUT consists of four key constructs: performance expectancy (the perceived benefits of using the technology), effort expectancy (the ease of use), social influence (the degree to which users feel that important others believe they should use the technology), and facilitating conditions (the resources and support available to use the technology). Each of these constructs plays a role in predicting and explaining user acceptance and behavior toward new technologies, including mobile learning applications. The UTAUT framework has proven effective for studying technology adoption in educational settings, making it a valuable model for understanding factors influencing students' willingness to engage with and effectively use AI-powered mobile applications in higher education. For instance, Ay (2023) highlights the relevance of UTAUT in understanding how students perceive and adopt AI technologies in their learning environments. Similarly, Huang et al. (2013) emphasize the importance of social influence and facilitating conditions in technology adoption, suggesting that these factors significantly impact students' decisions to engage with educational technologies. Azizi et al. (2020) further support this by illustrating how performance expectancy and effort expectancy can enhance students' learning outcomes when utilizing mobile applications. Yang et al. (2018) integrate the UTAUT model to explore factors influencing college students' acceptance of cloud classrooms, highlighting the significance of performance expectancy and facilitating conditions in educational technology adoption.

Empowerment through Technology-Enhanced Learning

Technology-enhanced learning has the potential not only to engage but also to empower students, a process that is increasingly relevant in AI-powered mobile learning environments. Empowerment in this context involves enhancing students' motivation, self-efficacy, and

academic autonomy, which are critical components of effective, self-directed learning. According to the research of Huang and Spector (2020), they discussed the empowerment of students through educational technology, emphasizing the importance of motivation and self-efficacy in technology-enhanced learning environments. For instance, AI features that adapt to individual learning styles or that provide real-time, constructive feedback can enhance self-efficacy by allowing students to gauge their progress and make informed decisions about their learning strategies. As Niu and Zhang (2022) suggested, the use of AI in educational settings, for instance AI platforms, they can provide personalized learning opportunities that enhance student self-efficacy and academic autonomy. Additionally, in Zhang and Zheng (2020)' s study, they also emphasized that when students experience control over their learning through AI technologies that can support self-regulated learning behaviors, these are essential for academic success and lifelong learning. Research also indicates that when students feel in control of their learning paths and receive constructive, adaptive feedback, they are more likely to develop skills essential for lifelong learning (Anderson & Lee, 2023). Despite these findings, there is limited exploration into how AI-driven mobile applications specifically foster empowerment, leaving a gap in understanding how these tools can support the transition from passive engagement to active, empowered learning. This study aims to address this gap by investigating how AI-powered applications can enhance both engagement and empowerment, ultimately contributing to better academic and personal growth outcomes in higher education.

Research Methods

Participants and Sampling

The study recruited undergraduate students from various disciplines within a large public university to ensure a diverse and representative sample of higher education learners. The participants included students from fields such as engineering, business, social sciences, and humanities, reflecting a range of academic backgrounds and technological proficiencies. To achieve a representative sample, a stratified random sampling method was employed. This approach ensured that students from different academic years (freshman to senior) and various disciplines were proportionally represented. An initial recruitment email was sent to a random selection of students within each stratum, followed by reminders to maximize participation. Inclusion criteria required participants to have prior experience using mobile learning applications, particularly those integrated with AI features such as personalized content recommendations and real-time feedback. A total of 300 students were targeted, with a final sample size of 250 respondents after accounting for incomplete or invalid responses, achieving a response rate of approximately 83%.

Data Collection Methods

This study utilized a mixed-methods approach, combining both quantitative and qualitative data collection techniques to gain a comprehensive understanding of students' experiences with AI-powered mobile learning applications. For the quantitative phase, structured surveys were designed based on the constructs of the Unified Theory of Acceptance and Use of Technology (UTAUT), including performance expectancy, effort expectancy, social influence, and facilitating conditions. The survey also incorporated questions related to empowerment outcomes, such as motivation, self-efficacy, and autonomy. These questionnaires were distributed electronically via email and institutional learning management systems, ensuring accessibility and convenience for participants.

In the qualitative phase, semi-structured interviews were conducted with a subset of 30 students selected from the survey respondents. The selection was based on maximum variation sampling to capture a wide range of perspectives on the use of AI-driven mobile learning tools. The interview guide included open-ended questions exploring students' perceptions of how AI features affected their learning experiences, their sense of empowerment, and any challenges they faced while using these applications. Interviews were conducted via video conferencing platforms, recorded with participants' consent, and transcribed for analysis.

Data Analysis Techniques

To analyze the quantitative data, Structural Equation Modeling (SEM) was employed using software like AMOS or SmartPLS. SEM was chosen for its ability to assess complex relationships between multiple variables simultaneously, providing insights into how UTAUT constructs influence both the adoption of AI-powered mobile learning applications and their impact on student empowerment. The model fit was evaluated using standard indices such as Chi-square (χ^2), Root Mean Square Error of Approximation (RMSEA), and Comparative Fit Index (CFI) to ensure the robustness of the findings.

For the qualitative data, a thematic analysis was conducted using NVivo software to identify recurring patterns and themes related to student empowerment and learning outcomes. Thematic coding was applied to the interview transcripts, following a deductive approach based on the predefined UTAUT constructs and empowerment factors, as well as an inductive approach to capture emergent themes beyond the initial framework. This dual coding strategy allowed for a deeper exploration of students' subjective experiences and provided a nuanced understanding of the empowerment process in AI-driven mobile learning contexts.

By integrating quantitative and qualitative findings, this study aims to offer a holistic view of how AI-powered mobile applications influence both technology adoption and student empowerment in higher education settings.

Research Results

Descriptive Findings

The study's demographic analysis revealed a diverse group of 250 undergraduate students from various disciplines, with participants ranging in age from 18 to 25 years old. The sample included 55% female and 45% male students, with representation from multiple academic years: 30% freshmen, 25% sophomores, 20% juniors, and 25% seniors, as shown in Figure 1. Regarding technology use, 85% of students reported regular use of mobile learning applications, with an average usage of 4-6 hours per week. The most frequently used AI-powered features included adaptive learning pathways (70%), personalized content recommendations (65%), and real-time feedback systems (60%). Notably, 40% of respondents reported using these applications primarily for exam preparation, while 30% used them for skill enhancement and 20% for coursework support, as demonstrated in Figure 2. These findings suggest that AI-powered mobile applications are widely adopted among students, particularly for personalized and adaptive learning experiences.

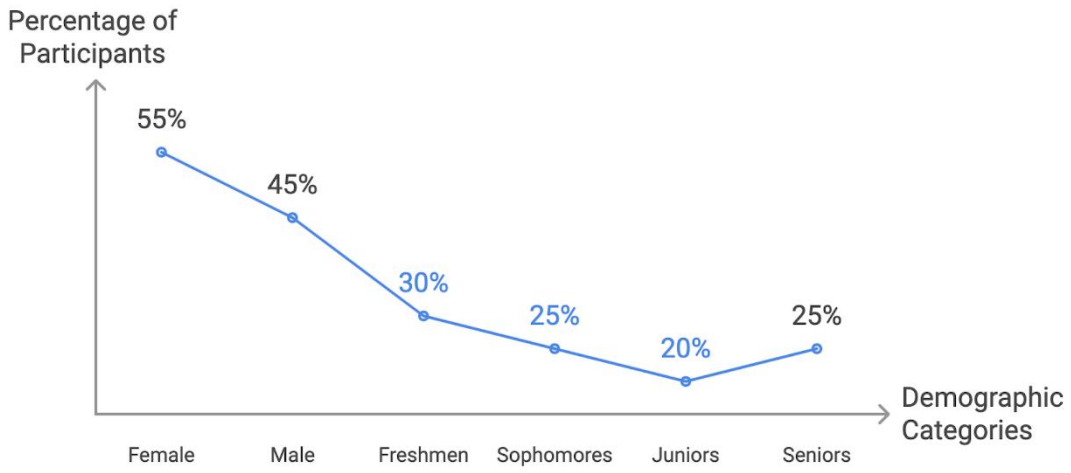

Figure 1 : Demographic Breakdown of the Study Participants

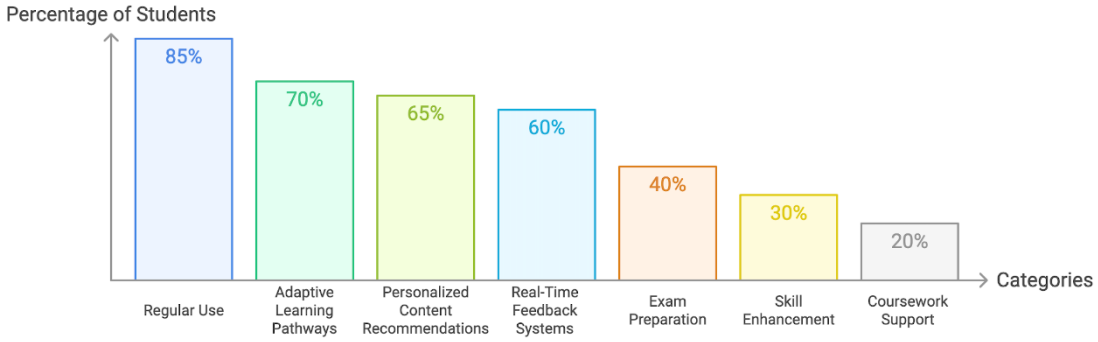

Figure 2 : Usage and Features of Mobile Learning Applications

Quantitative Analysis

The Structural Equation Modeling (SEM) analysis was conducted to assess the relationships between the UTAUT constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions) and students' acceptance and use of AI-powered mobile learning applications. The model demonstrated a good fit, with Chi-square (χ^2) = 253.45, df = 200, $p < 0.05$, RMSEA = 0.045, CFI = 0.95, indicating strong alignment with the theoretical framework.

The quantitative results showed that performance expectancy ($\beta = 0.42$, $p < 0.001$) and effort expectancy ($\beta = 0.35$, $p < 0.001$) were significant predictors of students' intention to use AI-powered applications, suggesting that students are more likely to adopt these tools if they perceive them as useful and easy to use. Social influence ($\beta = 0.28$, $p < 0.01$) also played a significant role, indicating that peer recommendations and social networks positively impact technology adoption. However, facilitating conditions ($\beta = 0.12$, $p = 0.08$) were not found to be a significant predictor of use behavior, suggesting that external support mechanisms, such as institutional resources, were less influential in students' decisions to adopt AI-driven learning tools. Additionally, empowerment-related outcomes, such as self-efficacy ($\beta = 0.39$, $p < 0.001$) and learning motivation ($\beta = 0.33$, $p < 0.01$), were strongly associated with the use of personalized AI features, highlighting the positive impact of these technologies on student engagement and confidence.

Qualitative Analysis

The thematic analysis of the 30 semi-structured interviews identified several key themes related to students' experiences with AI-powered mobile learning applications. A dominant theme was the perception of personalization, with students expressing appreciation for the adaptive learning features that tailored content to their individual needs and learning pace. Many participants reported that these personalized pathways reduced their study time and increased their overall learning efficiency. For example, one student noted, "The app learns what I'm good at and what I need more help with, so I don't waste time on things I already know."

Another significant theme was enhanced learning motivation. Students highlighted that real-time feedback and progress tracking features motivated them to stay engaged with their studies. This motivation was particularly evident in features that gamified learning, where students could track their progress through badges or rewards. As one participant shared, "Seeing my progress and getting instant feedback pushes me to study more and achieve my goals."

The final theme focused on self-efficacy and empowerment. Many students reported that the AI-driven applications made them feel more confident in their abilities to master difficult subjects, attributing this to the continuous support and immediate clarification provided by the technology. The ability to receive instant answers to questions or access additional resources without waiting for instructor guidance was frequently mentioned as empowering, helping students to become more self-directed learners. However, some students raised concerns about the potential over-reliance on these applications, indicating a need for a balanced approach to technology use in education.

Discussion

The study's findings provide significant insights into the adoption of AI-powered mobile learning applications in higher education, particularly through the lens of the Unified Theory of Acceptance and Use of Technology (UTAUT) framework. The results showed that performance expectancy and effort expectancy were the strongest predictors of students' acceptance and use of these technologies, aligning with prior research that emphasizes the importance of perceived usefulness and ease of use in technology adoption (Venkatesh et al., 2003). This indicates that students are more inclined to adopt AI-driven mobile applications when they believe these tools will enhance their academic performance and are easy to use. The influence of social factors, while significant, was less pronounced, suggesting a shift in students' technology adoption behaviors where peer influence is secondary to personal utility and ease of use. Interestingly, the non-significant impact of facilitating conditions diverges from some existing studies, which suggest that institutional support is a critical factor for technology adoption (Thomas et al., 2022). This discrepancy may indicate that today's students, being digital natives, are more self-reliant and less dependent on external support for using educational technologies. Furthermore, the strong correlation between the use of AI-powered features and empowerment-related outcomes such as self-efficacy and motivation extends the existing UTAUT framework by highlighting the potential of AI to move beyond mere engagement to foster deeper forms of student empowerment. These findings suggest that the integration of personalized, adaptive learning tools within mobile

applications can transform traditional learning experiences, enabling students to take a more active and confident role in their education.

This study contributes to the existing body of knowledge by expanding the UTAUT framework to include empowerment as a potential outcome of technology adoption in educational contexts. Traditionally, UTAUT focuses on factors driving the acceptance and use of technology; however, this research suggests that AI-powered mobile learning applications not only facilitate adoption but also significantly enhance students' intrinsic motivation and self-regulation skills. By integrating constructs from Self-Determination Theory (SDT), such as autonomy and competence, this study provides a more nuanced understanding of how technology can empower learners beyond the initial acceptance phase. These findings imply that the UTAUT framework can be adapted to include additional constructs related to empowerment, which may be particularly relevant in the context of AI-driven, personalized learning environments. This theoretical extension offers a new lens through which to examine the broader impacts of educational technology, suggesting that future studies could further explore the intersection of technology adoption and learner empowerment.

On the other hand, the study' s findings also have several practical implications for educators, instructional designers, and app developers seeking to enhance student engagement and success through AI-powered mobile applications. Educators can leverage these tools to create personalized learning experiences that adapt to students' individual needs, thereby increasing motivation and fostering a sense of empowerment. For instance, the use of real-time feedback and adaptive learning paths can help students identify their strengths and areas for improvement, encouraging a more self-directed approach to learning. To maximize the impact of these technologies, educators should focus on integrating features that support self-efficacy and autonomy, such as goal-setting dashboards, progress tracking, and gamification elements.

For app developers, the findings suggest a demand for mobile learning applications that prioritize user-friendly interfaces and adaptive capabilities. By incorporating AI algorithms that personalize content and provide immediate feedback, developers can enhance the perceived value of their applications, thereby increasing adoption rates among students. Moreover, focusing on enhancing social features, such as peer support forums and collaborative learning spaces, could address the moderate influence of social factors identified in the study, thereby fostering a more connected and supportive learning community. These practical recommendations can help bridge the gap between technology design and educational outcomes, promoting higher levels of student engagement, motivation, and ultimately, academic success.

Conclusion

This study explored the impact of AI-powered mobile learning applications on student engagement and empowerment in higher education using the UTAUT framework. The quantitative analysis revealed that performance expectancy and effort expectancy were the most significant predictors of students' intention to adopt AI-driven learning tools, indicating that the perceived usefulness and ease of use of these applications are critical factors in their adoption. The study also found that the use of AI-powered features, such as personalized learning pathways and real-time feedback, significantly enhanced students' self-efficacy and

learning motivation, leading to a deeper sense of empowerment. Qualitative insights further supported these findings, highlighting students' positive perceptions of AI's role in facilitating autonomous and self-directed learning. These results suggest that AI-powered mobile applications have the potential to transform traditional educational experiences by not only increasing engagement but also fostering a sense of empowerment among students, thereby contributing to their academic success.

Despite its contributions, this study has several limitations that must be acknowledged. First, the sample was limited to undergraduate students from a single public university, which may affect the generalizability of the findings to other higher education contexts, such as community colleges, private institutions, or postgraduate programs. Additionally, the study relied on self-reported data from surveys and interviews, which may introduce biases related to social desirability or inaccurate self-assessment. The cross-sectional design also limits the ability to assess long-term impacts of AI-powered learning applications on student empowerment and academic performance. Furthermore, while the UTAUT framework provided a useful lens for understanding technology adoption, it may not fully capture other relevant factors, such as cultural influences or individual learning preferences, that could impact students' engagement with AI-driven tools.

To build on the findings of this study, future research should explore different student demographics, including postgraduate students, non-traditional learners, and those from diverse cultural backgrounds, to determine if the factors influencing AI adoption and empowerment vary across these groups. Additionally, longitudinal studies are needed to assess the sustained effects of AI-powered mobile applications on academic performance and empowerment over time. Researchers could also benefit from exploring other theoretical frameworks, such as the Technology Acceptance Model (TAM) or Self-Determination Theory (SDT), to provide a more comprehensive understanding of the motivational and psychological factors driving the use of AI in education. Moreover, examining the impact of specific AI features, such as predictive analytics, chatbot-based tutoring, or virtual reality integration, across various educational contexts could yield insights into how these technologies can be optimized to support personalized learning. Finally, there is a need for experimental studies that compare the effectiveness of different AI-driven mobile applications in enhancing learning outcomes, providing a more rigorous evaluation of their educational value.

In the end, the study also significantly extends the Unified Theory of Acceptance and Use of Technology (UTAUT) framework by incorporating "empowerment" as a key outcome variable. This theoretical expansion enriches the UTAUT model, making it more applicable to the nuanced effects of AI in educational settings. It moves beyond the purely behavioral aspects of technology adoption to encompass the cognitive and affective dimensions of student experience. The research also directly addresses the gap in the literature between student engagement and student empowerment. While existing research often focuses on increasing student engagement through technology, this study moves beyond this to examine how AI-powered tools can foster a deeper sense of empowerment, where students feel capable of shaping their own learning journey. This nuanced perspective offers a more holistic understanding of the impact of AI in education. The findings offer practical implications for educators and developers as well. The research identifies specific factors (performance and effort expectancy) that influence technology adoption. Further, it pinpoints how AI features

(personalization, real-time feedback) foster empowerment, providing practical guidance on designing user-centered learning environments that prioritize both engagement and empowerment. This also helps bridge the gap between technological design and desirable educational outcomes.

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