



Design and Optimization of Mobile Learning Resources within the Framework of User Experience Oriented Educational Technology

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Abstract: This study aims to examine the effectiveness of designing and optimizing mobile learning resources within a user oriented educational technology framework in enhancing students' learning engagement in higher education. The study employed a mixed methods approach with an explanatory sequential design. Participants were undergraduate students from Tianjin University of Technology selected through purposive sampling to ensure comparable academic backgrounds. Two intact classes were assigned as the experimental and control groups to maintain ecological validity. The experimental group consisted of 199 students, while the control group consisted of 200 students, resulting in a total sample of 399 participants (N = 399). Quantitative data were collected using validated scales measuring learning support, competence support, emotional support, learning self efficacy, learning engagement, were analyzed using ANCOVA, MANOVA, regression and mediation analysis. Qualitative data were obtained from learning behavior logs, classroom observations, and semi structured interviews and analyzed thematically. The results indicate that all three support dimensions significantly and positively influenced learning engagement, both directly and indirectly through learning self efficacy as a partial mediator. Learning support emerged as the strongest predictor of engagement, followed by competence and emotional support. These findings suggest that effective mobile learning is not determined by technological access alone, but by the quality of user-oriented learning experiences. This study provides empirical evidence that the MOVES framework offers a robust foundation for designing mobile learning resources that foster sustained engagement, self efficacy, and meaningful learning in digitally mediated higher education environments.

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Introduction

Digital transformation has positioned educational technology as a strategic foundation for developing the quality of 21st-century learning, particularly through the utilization of mobile learning. The quality of mobile learning resources is a determining factor in shaping meaningful, adaptive, and user-centered learning experiences, especially with the increasing penetration of mobile devices and the demand for flexible and personalized learning. Although the use of mobile learning has become widespread across various educational levels, the practice of designing learning resources still often focuses on technical aspects and content distribution, without being supported by a systematic and user-oriented educational technology framework (Ahmad et al., 2020; Okai et al., 2022). The gap between the pedagogical potential of mobile learning and the quality of user experience is still real, especially in aspects of content structure, learning interaction, emotional support, and the



effectiveness of using digital technology to support student engagement and learning outcomes (Nawir et al., 2024; Zulfikhar et al., 2024).

The main problem in mobile learning lies in the contradiction between the intensity of digital technology use and the quality of learning resource design that supports meaningful learning experiences. Many mobile learning resources are still focused on content delivery and short-term cognitive outcomes, while user experience, learning engagement and learners' psychological support have not been a primary concern (Haryati et al., 2023; Hasibuan et al., 2025). Several studies indicate that while mobile learning can improve accessibility and flexibility, the quality of learners' learning experiences is often moderate due to fragmented content design, superficial interaction, and a lack of adaptive and emotional support (Ahyati, 2021; Salsabila et al., 2020). This condition results in the phenomenon of low learning engagement despite the relatively high frequency of mobile device use. Previous findings also indicate a gap between the pedagogical potential of mobile learning and the implementation of learning resource design in the field, particularly in terms of managing cognitive load, personalizing learning, and integrating meaningful interactions (Fahmi et al., 2022; Li, 2025). Thus, mere mastery of technology and the availability of mobile devices do not guarantee effective learning unless accompanied by a systematic educational technology framework that is user experience-oriented.

Furthermore, the use of digital technology in mobile learning is still superficial and has not been meaningfully integrated into the learning process. Interactive features, multimedia, and visual elements in mobile learning resources generally serve as information presenters, rather than as a means to support learners' exploration, decision making, or problem solving (Wang, 2025; Zhang, 2025). Students are rarely encouraged to use mobile technology to navigate alternative learning pathways, reflect on their learning progress, or independently adjust their learning strategies. Various studies show that using technology without a proper pedagogical foundation does not automatically improve the quality of learning or student engagement (Elpina, 2023; Hidayat et al., 2023). A critical gap in mobile learning lies in the lack of support for procedural and self-regulated learning, which are essential prerequisites for meaningful learning. Many mobile learning resources train learners to consume content linearly and passively, without providing room for reflection, adaptation, and context-based decision making. This pattern produces learners who are able to complete instruction-based tasks but struggle to manage their learning independently, adjust their learning strategies, or optimize the use of learning resources when faced with complex and unstructured learning situations (Maria et al., 2023; Sarnoto et al., 2023). This condition becomes even more problematic in the context of 21st-century competency demands, which emphasize adaptive thinking, self-management, and lifelong learning. Therefore, strengthening mobile learning requires a learning resource design approach that explicitly integrates educational technology principles, user experience, and cognitive support so that learners are not merely consumers of technology, but active participants in the learning process (Yansyah et al., 2023; Yuliana et al., 2023).

Although technology-based mobile learning has been widely promoted as an innovative solution in education, existing implementations still show fundamental pedagogical weaknesses. Various mobile learning practices emphasize content availability, access flexibility, and the use of digital features, but they are not yet supported by an educational technology framework that systematically integrates content structure, learning interaction, and user experience (Studies, 2022; Zakiah et al., 2024). In practice, mobile learning resources are often reduced to information presentation media or fragmented



activities, without guiding learners through a structured, reflective, and adaptive learning process. Additionally, previous research tends to treat learning outcomes in mobile learning as a general construct, with limited attention to psycho-pedagogical mechanisms such as learning support, competence support, and emotional support that influence learning engagement. This condition is exacerbated by the tendency of educational institutions to adopt mobile learning technically without adequate instructional design transformation (Ulinuha, 2023).

To address the gap between the technological availability of mobile learning and the quality of user-centered learning experiences, this study proposes the MOVES framework as a design model for optimizing mobile learning resources. The MOVES framework integrates three complementary dimensions of learning support: Micro-content and Organization (learning support), interactive learning activities and feedback (competence support), and motivational–affective design elements (emotional support) that together shape a holistic learner experience. Unlike traditional instructional design models such as ADDIE, which primarily focus on sequential development procedures (analysis, design, development, implementation, and evaluation), MOVES emphasizes the quality of the learner’s interaction experience within mobile learning environments. Existing mobile learning frameworks often prioritize accessibility, content delivery, and technological features, while emotional and motivational aspects of learning remain underemphasized. The distinctive contribution of the MOVES framework lies in explicitly integrating cognitive structuring, competence-building interaction, and affective support as interrelated components that influence learning engagement and self-efficacy. By positioning emotional support as an integral design element rather than a peripheral outcome, MOVES aims to transform mobile learning resources from simple digital content platforms into adaptive learning environments that promote sustained engagement and meaningful learning experiences in higher education.

Research Method

This study uses a mixed methods design with an explanatory sequential approach to examine the effectiveness of designing and optimizing user-oriented mobile learning resources (Marito et al., 2025). The research stages began with the design of a mobile learning resource based on the MOVES framework, followed by the implementation of learning interventions in the target group, quantitative measurement through pretest-posttest and learning experience scales and the collection of learning behavior data based on system logs. Next, qualitative data were obtained through semi-structured interviews and open-ended questions to deepen understanding of user experiences, usability and the mechanisms influencing learning engagement. The integration of quantitative and qualitative data was conducted during the analysis phase to provide a comprehensive overview of the impact of mobile learning resource design and optimization strategies on user experience and learning engagement.

The digital devices used in this study include micro learning based mobile learning resources, a Moodle based learning management system, WeChat mini programs and a learning analytics system to record students' learning behavior in real time. The research sample consisted of two intact classes of undergraduate students from Tianjin University of Technology who had relatively comparable academic backgrounds and were enrolled in an information literacy course. In total, 399 students participated in the study (N = 399), consisting of 199 students in the experimental group and 200 students in the control group. The experimental group used mobile learning resources designed and optimized based on the



MOVES framework, whereas the control group used conventional mobile learning resources without systematic design optimization. The experimental group consisted of students who used mobile learning resources designed and optimized based on a user oriented educational technology framework, while the control group used conventional mobile learning resources without specific design and optimization strategies. The learning intervention was implemented over one academic semester with equal learning duration for both groups, thereby maintaining ecological validity and ensuring comparable learning exposure. Data collection was conducted using a combination of quantitative and qualitative instruments. The quantitative instruments included learning outcome tests developed by the researchers based on the course learning objectives, as well as several validated questionnaires. Learning engagement was measured using an adapted version of the Student Course Engagement Questionnaire (SCEQ), while learning self-efficacy was measured using items adapted from the Motivated Strategies for Learning Questionnaire (MSLQ). In addition, scales measuring learning support, competence support, and emotional support were developed based on the conceptual dimensions of the MOVES framework and validated through expert review and pilot testing prior to the main study. Qualitative data were collected through learning behavior logs obtained from the learning analytics system, classroom observations, and semi-structured interviews to gain deeper insights into students' learning experiences and perceptions of the mobile learning resources.

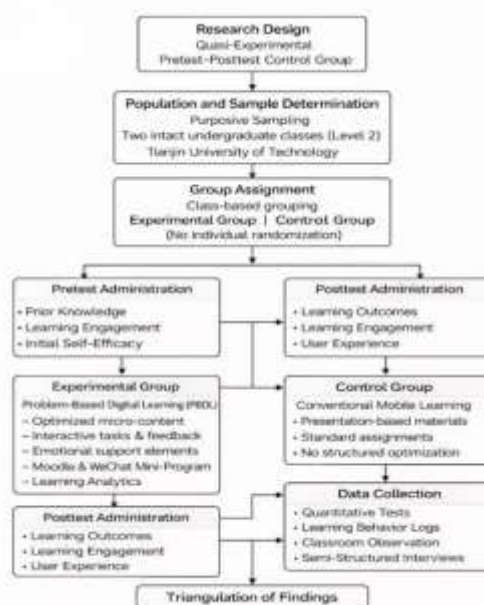


Figure 1. Flowchart of Research Procedures in User Oriented Mobile Learning Design

Data were analyzed using inferential statistical techniques ANCOVA and MANOVA to test for differences in posttest scores between the experimental and control groups, controlling for the influence of pretest scores as a covariate. Before inferential analysis was conducted, a series of statistical assumption tests were applied to ensure the suitability of the analysis procedure, including the normality test using Shapiro Wilk, the homogeneity of variance test using Levene's test and the linearity and homogeneity of regression slopes test to ensure consistency in the relationship between the covariate and the dependent variable in each group. The test results show that all data meets the required assumptions, allowing for valid ANCOVA and MANOVA analyzes to be performed. Quantitative analysis



simultaneously focused on measuring learning outcomes, learning engagement and user experience. Meanwhile, qualitative data obtained thru classroom observations, learning behavior logs and semi structured interviews were analyzed using a thematic analysis approach to identify behavioral patterns, user perceptions, and learning experience mechanisms that emerged during the intervention. All quantitative and qualitative findings were then integrated thru method triangulation to comprehensively explain how the Micro content and Organization (Learning Support), Interaction (Competence Support), and Emotion (Emotional Support) dimensions within the MOVES Framework contribute to increased student learning engagement and user experience in mobile based learning.

Results and Discussion

The results of this study indicate that the three support dimensions within the MOVES framework learning support, competence support, and emotional support significantly contribute to students' learning engagement in mobile learning environments. Statistical analysis shows that learning support, represented by structured micro-content and clear content organization, emerges as the strongest predictor of engagement, followed by competence support through interactive learning activities and feedback mechanisms, and emotional support through motivational and affective design elements. Furthermore, learning self-efficacy partially mediates the relationship between these support dimensions and learning engagement, suggesting that well-designed mobile learning resources influence engagement both directly and indirectly by strengthening students' confidence in managing their learning process. These findings can be interpreted through the perspectives of Self-Determination Theory (SDT) and Cognitive Load Theory. From the SDT perspective, competence support and emotional support correspond to the fulfillment of learners' psychological needs for competence and relatedness, which are essential for fostering intrinsic motivation and sustained engagement in learning activities. Interactive feedback, meaningful challenges, and supportive learning environments enhance students' perception of competence and encourage active participation in the learning process. Meanwhile, the micro content and structured organization component of the MOVES framework aligns with the principles of Cognitive Load Theory, which emphasize reducing extraneous cognitive load and optimizing the use of working memory during learning. By segmenting learning materials into manageable micro-learning units and presenting information in a structured sequence, the design facilitates more efficient cognitive processing and enables students to focus on meaningful learning tasks rather than struggling with information overload. These results are also consistent with previous studies indicating that effective mobile learning environments must integrate cognitive structure, interactive learning activities, and motivational support to sustain learner engagement. Prior research shows that although mobile learning systems often increase accessibility and flexibility, engagement does not automatically improve when instructional design lacks meaningful interaction and psychological support. The present findings therefore extend previous research by demonstrating that the MOVES framework integrates cognitive structuring, competence-oriented interaction, and affective support into a coherent design model, enabling mobile learning resources to function not only as content delivery platforms but also as adaptive learning environments that support learners' cognitive processing, motivational regulation, and emotional persistence. This suggests that improving the quality of user-oriented learning experiences, rather than merely increasing technological access, is a crucial factor in fostering meaningful engagement in higher education mobile learning contexts.



Table 1. Demographic Characteristics of the Sample

Variable	Option	Frequency	Persen(%)
Gender	Boy	188	47.1
	Girl	211	52,9
Value	freshman	98	24.6
	Second year student	130	32.6
	Young	105	26.3
	Senior	66	16.5
Student origin	Rural	167	41.9
	Urban	232	58.1
School category	Public school	190	47.6
	Private school	209	52.4
Will serve as a class cadre	Yes	118	29.6
	No	281	70.4
Score ranking	High	143	35.8
	Medium	132	33.1
	Lower	124	31.1
Total		399	100

Based on Table 1 of respondent characteristics, this study involved 399 students with a relatively balanced and representative demographic composition. In terms of gender, female students dominated the respondents at 52.9%, while male students accounted for 47.1%, indicating a proportional gender distribution. In terms of study level, second year students constituted the largest group (32.6%), followed by junior students (26.3%), new students (24.6%), and senior students (16.5%), reflecting cross-cohort representation. In terms of origin, the majority of respondents came from urban areas (58.1%), while 41.9% came from rural areas, allowing for analysis of learning experiences from diverse social backgrounds. In terms of school category, the proportion of private school graduates (52.4%) was slightly higher than that of public school graduates (47.6%). Most respondents did not serve as class leaders (70.4%), and the distribution of academic rankings was relatively even across the upper (35.8%), middle (33.1%), and lower (31.1%) categories. Overall, this composition provides a strong basis for further analysis of student learning experiences and engagement.

Table 2. Normality Test

Variabel	Skewness	Kurtosis
Learning support	-0,232	-1.143
Competency support	-0,482	-1.111
Emotional support	-1.059	-0,25
Self efficacy learning	-0,236	-1.103
Involvement in learning	-0,526	-0,864

Based on Table 2, the results of the skewness and kurtosis tests in the table above show that all research variables have data distributions that are within the acceptable limits of normality for parametric statistical analysis. The skewness values for all variables are in the moderate negative range, between -0.232 and -1.059 , indicating a slightly left-skewed data distribution, but without extreme deviations. This indicates that most respondents tend to give moderate to high ratings for each variable. Meanwhile, the kurtosis values of all variables are negative and far below the critical threshold, indicating a platykurtic data distribution or one that is relatively flatter than a normal distribution. This condition reflects a fairly even distribution of respondents' answers and does not center excessively on a particular value. Thus, the combination of skewness and kurtosis values indicates that the research data meets the assumption of statistical normality, making it suitable for use in further analysis such as



regression, ANOVA, and multivariate analysis without requiring additional data transformation.

Table 3. Variance Homogeneity Test

Variable	Levene's statistic	df1	Df2	P
Learning support	0,141	1	397	0,708
Competency support	0,003	1	397	0,954
Emotional support	0,364	1	397	0,547
Academic self-efficacy	0,276	1	397	0,599
Involvement in learning	1,996	1	397	0,159

Based on Table 3, the results of the variance homogeneity test using Levene's Test in the table above show that all research variables meet the assumption of variance homogeneity required for parametric statistical analysis. The significance value (p) for each variable is above the critical limit of 0.05, namely learning support (p = 0.708), competency support (p = 0.954), emotional support (p = 0.547), academic self-efficacy (p = 0.599), and involvement in learning (p = 0.159). These findings indicate that there are no significant variance differences between groups for each variable tested. In other words, the distribution of data between groups can be considered relatively uniform and comparable. This condition indicates that the variability of scores is not systematically influenced by group differences, so that the results of comparisons between groups can be interpreted validly. Therefore, the research data are suitable for analysis using parametric inferential statistical techniques such as ANOVA, ANCOVA, and regression, without requiring adjustments or corrections for violations of the assumption of variance homogeneity.

The results of the hypothesis testing show that all research hypotheses are empirically supported, both through correlational analysis, multiple regression, and mediation effect testing, thereby strengthening the validity of the conceptual model based on the MOVES Framework. Correlation analysis indicates that learning engagement has a positive and significant relationship with learning support (r = 0.530), competence support (r = 0.453), emotional support (r = 0.320) and learning self-efficacy (r = 0.511) at a significance level of p < 0.01, indicating a moderate to strong relationship between the main variables. Furthermore, simple regression analysis confirmed that learning support significantly predicted learning engagement ($\beta = 0.629$, p < 0.001) with a variance contribution of 34.5% ($R^2 = 0.345$), indicating that micro content structure and material organization are the main foundations of learning engagement in the context of mobile learning. Multiple regression analysis involving the three dimensions of support showed that learning support ($\beta = 0.307$), competence support ($\beta = 0.179$), and emotional support ($\beta = 0.124$) simultaneously had a significant effect on learning engagement ($R^2 = 0.354$; p < 0.001), with learning support remaining the most dominant predictor. These findings indicate that learning engagement is not shaped by a single design dimension, but rather by a combination of complementary cognitive, behavioral, and affective support. Furthermore, regression on learning self-efficacy shows that learning support ($\beta = 0.402$), competence support ($\beta = 0.330$), and emotional support ($\beta = 0.090$) significantly affect the increase in academic self-efficacy ($R^2 = 0.586$; p < 0.001), confirming the role of mobile learning resource design in building students' learning confidence. When learning self-efficacy was included along with the three dimensions of support in the learning engagement prediction model, all variables remained significant ($R^2 = 0.365$), with learning self-efficacy acting as an additional predictor ($\beta = 0.147$; p < 0.05). Mediation tests using PROCESS showed that learning self-efficacy partially mediated the relationship between learning support (19.22%), competence support (27.37%), and



emotional support (10.48%) on learning engagement. Overall, these results confirm that the optimization of mobile learning resources operates through two complementary pathways: the direct influence of learning support design on students' engagement and the indirect influence mediated through the enhancement of learning self-efficacy. From a theoretical perspective, this mechanism reflects the interaction between instructional design quality and learners' motivational regulation. Structured micro-content and well-organized learning materials reduce cognitive overload and facilitate more efficient information processing, which aligns with the principles of Cognitive Load Theory, suggesting that effective instructional structuring improves learners' capacity to process and integrate new knowledge (Sweller, Ayres, & Kalyuga, 2019). At the same time, the interactive and emotionally supportive components embedded within the MOVES framework strengthen students' confidence in managing learning tasks, thereby increasing learning self-efficacy. According to Bandura's social cognitive theory, higher self-efficacy enhances persistence, effort, and engagement in learning activities (Bandura, 1997). Empirical studies in mobile learning contexts also demonstrate that well-designed digital learning environments significantly influence engagement through motivational and self-regulatory mechanisms (Wang, 2025; Zhang, 2025). Therefore, the findings of this study provide empirical support that the MOVES framework functions as an integrated design approach that simultaneously optimizes cognitive learning structure and motivational support, ultimately fostering more sustained and meaningful engagement in mobile-based higher education learning environments.

Discussion

The findings of this study indicate that the effectiveness of mobile learning resource optimization within the MOVES framework is strongly associated with the integration of cognitive structuring, interactive learning processes, and affective support that collectively enhance students' learning engagement. The dominance of learning support through structured micro-content suggests that clearly organized instructional materials play a critical role in facilitating comprehension and reducing unnecessary cognitive burden during mobile-based learning. This pattern aligns with the principles of Cognitive Load Theory, which emphasize that segmenting complex information into manageable units improves learners' capacity to process and retain knowledge efficiently (Sweller, Ayres, & Kalyuga, 2019). In addition, the significant influence of competence support and emotional support indicates that engagement is not determined solely by content clarity but also by meaningful interaction, feedback, and motivational elements that sustain learners' participation in learning activities. From the perspective of Self-Determination Theory, learning environments that support competence and relatedness are more likely to strengthen intrinsic motivation and long-term engagement (Ryan & Deci, 2020). Previous studies also show that mobile learning designs integrating interaction, feedback, and psychological support foster higher levels of engagement and active learning behavior in higher education contexts (Wang, 2025; Zhang, 2025).

Conclusion

Based on the overall process and findings of the study, it can be concluded that the design and optimization of user experience oriented mobile learning resources is an effective approach to improving the quality of learning in higher education. This study proves that the integration of structured micro content design, learning interactions that support competencies and consistent emotional support can create a more adaptive and meaningful learning experience. Through the MOVES framework, mobile learning functions not only as



a means of delivering content, but also as a learning environment that encourages active engagement, strengthens academic self-efficacy, and regulates student learning. The mechanism for increasing learning engagement occurs through two main channels, namely the direct influence of the quality of learning resource design on engagement, and the indirect influence through an increase in students' self-confidence in managing their learning process. These findings indicate that the effectiveness of mobile learning is not determined solely by the intensity of technology use, but by the quality of the learning experience that is systematically built and user-oriented. Thus, this study provides empirical evidence that the MOVES framework can be a strategic foundation in the development of mobile learning resources that not only improve short-term learning outcomes but also support sustainable, independent learning that is in line with the demands of 21st-century competencies.

Recommendation

Based on the findings of this study, educational technology developers and learning designers are advised to adopt the MOVES Framework as the main reference in designing and optimizing mobile learning resources by balancing cognitive, competency, and emotional support in an integrated manner. The design of learning resources should not only focus on breaking down content into structured micro content but also integrate meaningful interactions with adaptive feedback and emotional elements that encourage users' confidence and comfort in learning. Educational institutions need to provide continuous professional development for lecturers and instructors so that they are able to utilize learning analytics data and user feedback to make evidence-based design improvements. Further research is recommended to expand the application of the MOVES framework to more specific disciplinary contexts, different levels of education, and longitudinal designs to test the sustainability of its impact on learning engagement, self-efficacy, and long-term academic performance, taking into account variations in technological readiness, learner characteristics, and diverse learning contexts.

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