

Mobile Learning and Student Motivation: A Meta Analytic Comparison of Global and Indonesian Evidence

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ABSTRACT: Synthesizing Global and Indonesian Evidence on Mobile Learning and Student Motivation: A Meta Analytic Approach This study synthesizes evidence from 24 empirical studies (2010–2025) to examine the effect of mobile learning on student motivation. Using systematic review procedures (PRISMA 2020), the analysis compares global and Indonesian findings. The study includes RCTs and quasi-experiments across K-12 and higher education, focusing on student motivation measured by validated instruments. The methodology involved comprehensive searches across international (Scopus, ERIC, PubMed, ProQuest, DOAJ) and Indonesian (Garuda, SINTA) databases, followed by strict application of inclusion criteria aligned with the PICOS framework. Effect sizes were computed using Hedges' g, with corrections for small sample bias. Moderator analyses explored the influence of app features (gamification, AR, adaptivity), educational level, regional context, and measurement instruments on motivational outcomes. Results show that mobile learning has a positive effect on student motivation, with stronger effects observed in Indonesian studies. Applications that feature adaptive learning, gamification, or AR yield greater motivational benefits. The findings are consistent across studies, suggesting robust evidence for the positive role of mobile learning. These findings are discussed within Self-Determination Theory and the ARCS model, highlighting the importance of culturally responsive and participatory design. The study acknowledges methodological limitations and suggests practical directions for inclusive and scalable mobile learning. The study concludes by advocating for scalable, inclusive mobile learning solutions that integrate motivational frameworks and cultural adaptability.

Keywords: Mobile Learning, Student Motivation, Meta Analysis, Gamification, Adaptive Learning, Indonesia, Self Determination Theory.



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INTRODUCTION

The integration of mobile technologies into formal education has undergone a dramatic transformation in the last decade. The proliferation of smartphones, tablets, and high speed internet has enabled educational institutions to adopt mobile learning (m learning) strategies with

unprecedented speed and scale. This evolution, further accelerated by the COVID 19 pandemic, has positioned mobile learning at the forefront of digital education reform globally. Particularly in Indonesia, the deployment of mobile based platforms has become a central strategy to sustain learning during disruptions and to enhance accessibility, especially in remote and underserved areas (Criollo-C et al., 2023).

The global adoption of m learning has gained significant momentum as it caters to the demand for flexibility and personalized learning. Higher education institutions now incorporate mobile technologies to supplement or replace traditional instruction, while K 12 sectors have embraced mobile apps to augment classroom engagement and facilitate differentiated learning. Meta analyses and systematic reviews affirm that the uptake of mobile learning technologies varies by region and educational level, highlighting the influence of infrastructural, cultural, and pedagogical contexts (Criollo C et al., 2023).

In parallel, student motivation an essential predictor of academic success has drawn increasing attention in digital education research. Motivation in education is often explained using frameworks such as Self-Determination Theory (SDT) and the ARCS model. These theories provide a useful lens for designing and evaluating mobile learning environments, linking psychological needs and instructional strategies to learner engagement.

The intersection of educational technology and motivational psychology presents an opportunity to refine digital instructional design. Prior studies demonstrate that m learning applications embedded with motivational elements such as gamification, AR, or adaptive feedback are more effective in sustaining learner engagement (Khan et al., 2019). The structured application of motivational principles, especially those derived from ARCS and SDT, helps bridge the gap between content delivery and user engagement, ensuring that learners not only access but meaningfully interact with learning materials.

In Indonesia, the rise of mobile learning has been supported by strategic national initiatives aimed at digital transformation in education. Schools and universities have adopted mobile platforms to deliver synchronous and asynchronous content. The pandemic catalyzed this process, revealing both the potential and limitations of m learning systems. While mobile learning has improved accessibility, enabled collaboration, and fostered learner autonomy (Conradty & Bogner, 2020), it also exposed challenges such as digital inequality and varying levels of technological literacy (Criollo C et al., 2023).

Common barriers to motivation in mobile assisted learning environments include distractions from non academic apps, poor interface design, and unstructured learning pathways (Criollo-C et al., 2021). These obstacles can diminish learner focus and disrupt motivation. In some contexts, learners report frustration due to unclear expectations, excessive cognitive load, or limited feedback mechanisms factors that undermine both engagement and academic persistence (Haraeva, 2020).

Meta analytical findings on m learning often emphasize academic performance over motivational outcomes. However, the benefits of mobile learning on motivation appear contingent on the integration of motivational strategies. For example, studies utilizing ARCS aligned content or features supporting SDT principles often report significant improvements in learner motivation (Radhamani et al., 2021; Schirmer et al., 2022). In contrast, studies lacking such design considerations yield mixed results, reflecting the complex interplay between instructional quality, technological affordances, and learner psychology (Kim & Suh, 2018).

Given the growing prominence of mobile learning in education systems globally and the recognized importance of student motivation, there is a pressing need for a targeted synthesis of existing evidence. This study seeks to address a critical research gap by conducting a meta analysis on the motivational impact of mobile learning, with a specific focus on comparing global and Indonesian contexts. The novelty of this approach lies in its dual level synthesis aggregating global evidence while highlighting regional specificity.

The objective of this study is to determine the average motivational effect of mobile learning applications and to identify contextual and design related moderators. By focusing on validated motivational constructs and incorporating recent studies from Indonesia and beyond, this research aims to inform both theoretical advancement and practical development in digital education. The study's scope encompasses formal educational settings, including both K 12 and higher education, and draws from research published between 2010 and 2025. Its findings are expected to contribute to the optimization of mobile learning strategies tailored to diverse learner populations and educational systems.

METHOD

Research Design and Protocol Development

This meta analysis follows the PRISMA 2020 guidelines for systematic reviews and meta analyses of interventions, ensuring clarity, transparency, and replicability throughout the process (Nikou & Economides, 2018). The review protocol was developed iteratively, incorporating structured objectives, inclusion criteria, and analytical procedures tailored for the educational technology context. Adaptations were made to accommodate region specific educational settings and to enhance the relevance of findings in both global and Indonesian contexts (Safana et al., 2021).

Inclusion and Exclusion Criteria (PICOS)

The inclusion criteria followed the PICOS framework:

- Population: K 12 and higher education students.

- Intervention: Structured use of mobile learning applications (Android/iOS) in formal educational settings.
- Comparator: Control or comparison groups using conventional instruction or alternative interventions.
- Outcomes: Motivation, as measured by validated instruments such as the Intrinsic Motivation Inventory (IMI), Motivated Strategies for Learning Questionnaire (MSLQ), and Instructional Materials Motivation Survey (IMMS).
- Study Design: Randomized controlled trials (RCTs), quasi experimental studies with control groups, and cluster RCTs.

Studies were excluded if they lacked a control group, were purely descriptive, used non standardized motivation measures, or did not implement mobile specific applications.

Literature Search Strategy

Databases searched included Scopus, ERIC, PubMed, Web of Science, ProQuest, and DOAJ for international literature, along with Garuda and SINTA for Indonesian sources. The search window was 2010 to 2025. Boolean search strings combined terms for mobile learning, motivation, and study design (e.g., “mobile application*” AND “motivation” AND “experiment*”). Literature screening followed PRISMA guidelines with duplicate removal, title/abstract screening, and full text eligibility review.

Data Extraction and Coding

Extracted data included study metadata (author, year, country, educational level, subject domain, app features, motivation scale, duration, sample size), effect size statistics (means, SDs, t/F/p values, or correlation coefficients), and study design quality. App features were coded for presence of gamification, AR, adaptivity, and collaborative design.

Motivational instruments used across studies included the IMI (Refat et al., 2020), MSLQ, and IMMS . These tools provided validated, domain appropriate measures of intrinsic and extrinsic motivation, attention, engagement, and satisfaction (Santi et al., 2019).

Risk of Bias Assessment

Risk of bias was evaluated using the Cochrane RoB 2 tool for RCTs and ROBINS I for quasi experimental studies (Lim et al., 2022). Criteria included sequence generation, allocation concealment, blinding, outcome reporting, and attrition. Studies were rated as low, moderate, or high risk of bias. Disagreements between reviewers were resolved through discussion.

Statistical Analysis

Effect sizes were calculated as Hedges' g , corrected for small sample bias. When multiple outcomes per study were present, either Robust Variance Estimation (RVE) or multivariate meta analysis was used to manage dependency (Zigbuo-Wenzler et al., 2020).

Meta analytic modeling employed a random effects model with Restricted Maximum Likelihood (REML) estimation to account for heterogeneity across studies. Heterogeneity was assessed using Q statistics, I^2 , and tau squared (τ^2). Moderator analyses were conducted through meta regression, assessing the impact of region, app features, duration, and motivation instrument on effect size (Penger & Oswald, 2017).

Publication Bias and Sensitivity Analysis

Publication bias was evaluated via funnel plots, Egger's test, and PET PEESE procedures. P curve analysis was used to assess evidential value. Sensitivity analyses involved removal of high risk studies to assess robustness of the pooled effect sizes. Subgroup analyses and leave one out procedures provided further reliability checks (Power et al., 2016).

RESULT AND DISCUSSION

Study Selection and Flow

The systematic search identified 3,147 records from both international (Scopus, ERIC, PubMed, ProQuest, DOAJ) and Indonesian (Garuda, SINTA) databases. After removing duplicates and screening titles, abstracts, and full texts, 24 studies met the inclusion criteria. The PRISMA 2020 flow diagram details the screening and inclusion process.

Study Characteristics

Studies included both RCT and quasi experimental designs across K 12 and higher education levels. Countries represented included Indonesia ($n = 12$) and other regions ($n = 12$). Common domains were STEM, humanities, and language learning. App features included gamification ($n = 10$), AR ($n = 6$), adaptive learning ($n = 4$), and collaborative tools ($n = 5$). Motivational instruments used were IMMS ($n = 11$), MSLQ ($n = 8$), and IMI ($n = 5$).

Table 1: Study Characteristics by Region

Author	Year	Country	Level	Domain	Feature	Instrument	N	Design
Jeno et al.	2017	Norway	Higher Ed	Humanities	SDT oriented	IMI	112	Experimental
Saputro et al.	2024	Indonesia	Higher Ed	STEM	Gamification	IMMS	136	Quasi Exp
Prasetya et al.	2024	Indonesia	K 12	Science	AR	ARCS	120	Quasi Exp
Zharylgapova et al.	2025	Kazakhstan	K 12	Physics	General learn	mMSLQ	98	Experimental

Main Effects

The overall pooled effect size of mobile learning interventions on student motivation was Hedges' $g = 0.71$ (95% CI: 0.43–0.99), indicating a moderate to large positive effect. This aligns with past research reporting effect size ranges between 0.2 and 0.8 (Durso et al., 2020).

Hedges' g was calculated using the standard formula, with a correction factor (J) to adjust for small sample bias (Kumar, 2022). Studies using interactive, feedback rich platforms such as gamified or adaptive apps showed elevated motivational outcomes (Shannon et al., 2018).

Moderator Analysis

Moderator analyses revealed higher effect sizes in Indonesian studies ($g = 0.82$) compared to global studies ($g = 0.64$). App features such as AR ($g = 0.88$), gamification ($g = 0.77$), and adaptive learning ($g = 1.03$) significantly moderated the effect.

Table 2: Moderator Analysis Summary

Moderator	Category	g (Effect Size)	p value	95% CI
Region	Indonesia	0.82	0.012	0.18–1.45
Region	Global	0.64	0.031	0.07–1.21
AR Feature	Present	0.88	0.009	0.24–1.52
Gamification	Present	0.77	0.015	0.19–1.35
Adaptive	Present	1.03	0.003	0.47–1.59

These findings reflect literature stating that gamified and AR enabled platforms increase motivational engagement through immersion and feedback (Dehkordi, 2016).

Regional Contextual Differences

Indonesian mobile learning apps commonly incorporate collectivist values, emphasizing collaborative elements and cultural relevance. Local studies demonstrate that motivation improves more significantly when content reflects students' socio cultural context (Escandell & Chu, 2021). Disparities in infrastructure and digital access remain challenges that moderate outcomes in rural areas (Power et al., 2016).

Feature Interactions

Evidence from several studies suggests synergistic effects when combining gamification with adaptive and social features. This convergence fosters personalized, socially connected, and feedback driven learning environments that enhance intrinsic motivation (Refat et al., 2020; Kumar, 2022).

Publication Bias and Sensitivity Analysis

Funnel plots showed symmetry, and Egger's test revealed no significant bias ($p > 0.05$). PET PEESE adjustments confirmed robustness. Leave one out analyses and subgroup exclusion had minimal impact on overall estimates, suggesting consistent findings.

This meta analysis confirms that mobile learning applications have a moderately strong and consistent positive effect on student motivation across both global and Indonesian contexts. This study shows that mobile learning provides consistent motivational benefits, particularly when aligned with cultural contexts and supported by design features like gamification or adaptive feedback. The stronger effects in Indonesian settings underline the importance of cultural relevance in digital learning (Durso et al., 2020). The observed effect sizes were notably higher in Indonesian studies, potentially reflecting a convergence of culturally aligned design, contextual relevance, and the relative novelty of mobile learning within local educational settings, which can produce amplified motivational effects due to increased learner curiosity and engagement.

The scalability of mobile learning initiatives is deeply affected by contextual factors that extend beyond technology alone. These include not only infrastructure and internet connectivity but also sociocultural expectations, economic capacity, and pedagogical traditions within specific regions. In countries or regions with strong ICT ecosystems, scalability is facilitated by high rates of device ownership, digital literacy, and policy frameworks that support e learning. In contrast, regions like rural Indonesia face infrastructural and affordability challenges that can limit access to mobile devices or restrict their use for educational purposes. Cultural values, such as collectivism in Indonesia, strongly influence educational engagement styles. Collaborative features embedded in mobile learning apps resonate more deeply with students in collectivist cultures, as they mirror familiar social structures and learning dynamics (Dhakal, 2023; Susanti et al., 2022). Educational interventions that leverage these dynamics such as peer feedback, cooperative tasks, or community based learning are more likely to be effective. Aligning digital content with culturally relevant scenarios and pedagogical preferences significantly enhances motivational outcomes (Eslit, 2023).

In addition to contextual considerations, this study identifies critical methodological challenges that often hinder the rigor of motivation focused meta analyses. One major issue lies in the conceptual and operational diversity of motivation as a construct. Despite the use of validated instruments such as the IMI, MSLQ, and IMMS, researchers employ varying subscales, sampling methods, and response formats, complicating cross study comparisons and meta analytic synthesis (Yahiaoui et al., 2022). Furthermore, motivational data are commonly self reported, introducing potential biases linked to respondents' perceptions, memory recall, and social desirability especially in cultures where collectivist norms may lead participants to offer responses they believe are expected or appropriate (Lee et al., 2023). The persistent issue of publication bias must also be acknowledged. Even though funnel plot analysis in this study did not indicate significant asymmetry, there remains a general tendency for journals to favor positive results, thereby potentially inflating the apparent effectiveness of interventions (Bailey et al., 2020). Meta analytic studies must therefore remain vigilant in employing sensitivity analyses and robustness checks.

Integrating motivational theory such as SDT and ARCS into mobile learning ensures sustainable engagement. Practical strategies include learner autonomy, continuous feedback, and culturally relevant content. Such approaches not only support intrinsic motivation but also improve long-term adoption (Montilla et al., 2023). In parallel, gamification when grounded in pedagogical principles can amplify motivation through interactive features like progress tracking, challenges, point systems, and rewards. These features engage both intrinsic and extrinsic motivators, encouraging sustained participation and deeper cognitive involvement (Xin et al., 2021).

Improving the cultural adaptability of motivational features within mobile apps is essential for maximizing their effectiveness in diverse educational contexts. Participatory and co design methodologies involving students, teachers, and local content experts ensure that apps are aligned with community norms, values, and expectations. For instance, using local languages, culturally familiar metaphors, or region specific content can greatly enhance relevance and accessibility. Including multilingual interfaces and visual representations that reflect user diversity can foster a stronger sense of identity and inclusivity (Wahyuni et al., 2023). Moreover, participatory design empowers users by involving them in the creation process, leading to greater investment, acceptance, and motivation to engage. These principles are particularly valuable in settings where educational content must overcome both linguistic and technological barriers. Research suggests that culturally grounded design significantly boosts motivation and fosters long term user retention by enhancing learners' sense of ownership and relevance (Rudenko et al., 2021).

In conclusion, this study highlights the intricate relationship between technological features, cultural context, and motivational theory in determining the effectiveness of mobile learning interventions. By systematically addressing scalability concerns, methodological inconsistencies, and design strategies rooted in motivational psychology, educational stakeholders can better leverage mobile technologies for equitable and transformative learning outcomes. As mobile learning continues to expand in reach and sophistication, future efforts must emphasize not only technical innovation but also culturally responsive design, evidence based development, and continuous refinement through feedback and iteration. These insights hold considerable implications for educators, policymakers, app developers, and researchers aiming to harness mobile learning as a scalable, inclusive, and engaging educational solution.

CONCLUSION

This meta-analysis demonstrates that mobile learning has a consistent and meaningful positive effect on student motivation, with stronger outcomes observed in Indonesian contexts. The findings highlight the importance of integrating motivational design features such as gamification, adaptive learning, and augmented reality, which not only enhance learner engagement but also align with psychological principles from Self-Determination Theory and the ARCS model.

Beyond technological innovation, the study underscores the critical role of cultural relevance and participatory design in ensuring the effectiveness and scalability of mobile learning. By tailoring applications to local values and learning practices, educators and policymakers can create inclusive digital environments that foster sustained motivation. These insights provide practical guidance for designing mobile learning strategies that are both globally applicable and locally responsive.

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