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RESEARCH ARTICLE

Adopting sustainable mobile learning: Investigating long-term integration at UEW with a focus on infrastructure, resources, and institutional support

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Abstract: This study investigates the long-term sustainability of mobile learning (M-learning) integration at the University of Education, Winneba, Ghana. It explores critical factors such as infrastructure, resource allocation, and institutional support. Employing a quantitative research approach, the study utilised a structured questionnaire to collect data from 69 respondents, including Level 400 students from the Information and Communication Technology and Communication and Media Studies departments. Key findings highlight the importance of robust infrastructure, adequate resource distribution, and comprehensive institutional backing for sustainable M-learning practices. The study offers valuable insights for policymakers, educators, and institutions aiming to enhance the longevity and effectiveness of M-learning initiatives in higher education.

Keywords: sustainable mobile learning, ICT in education, mobile learning challenges, digital learning resources, higher education technology

1 Introduction

The advancement of mobile learning (M-learning) in higher education reflects its potential to transform traditional educational systems by leveraging mobile technologies. This study examines the sustainability of M-learning at the University of Education, Winneba (UEW), focusing on the ICT Education and Communication and Media Studies departments. The research evaluates infrastructure, resource allocation, and institutional support to ensure long-term viability and effectiveness.

1.1 Background

M-learning is described as a new direction in education that leverages mobile technologies to enhance the educational experience. It focuses on the interaction between teachers and students within the educational process, adapting to the needs of modern learners (Uzunboylu & Azhar, 2023). This approach empowers students by enabling learners to interact creatively and conveniently with course materials and real-world contexts (Dahal et al., 2022; Papadakis et al., 2023). M-learning allows students to learn anytime and anywhere, using their mobile devices as learning tools (Sophonhiranrak, 2021). Devices like digital notebooks, tablets, laptops, and smartphones can be utilised for M-learning, supporting students as they move and access learning materials freely (Tülübaş et al., 2023). Informally, M-learning simplifies access to educational content through mobile applications (Alpochoritis, et al., 2022; Papadakis, 2023). Learner mobility, or letting students access the content at their speed, has been demonstrated to improve engagement and retention (Tsoukala, 2021). Recent trends highlight the importance of M-learning: More than 90% of college students in North America and Europe own smartphones, and 68% use them as their primary devices to access course materials, conversations, and assignments (EDUCAUSE, 2023). This trend is mirrored in Ghana, where smartphone penetration has grown, providing a robust foundation for M-learning adoption across higher education institutions like the University of Education, Winneba (UEW).

According to Zhihan et al. (2023), M-learning supports all forms of learning—formal, informal, and non-formal. Kids are gaining knowledge on almost any subject at an unheard-of pace from mobile devices in various forms. M-learning has made learning accessible to all, so intergenerational education for sustainable development (SD) may occur anywhere, anytime. Interest in the drive around the integration of M-learning into higher education institutions has

significantly increased in the past several years (Lavidas et al., 2022). A significant number of investigations have shown positive results in M-learning.

Mobile phones have their setbacks; many strongly argue against M-learning due to other features bundled into the devices, such as social media platforms, games, music, videos, movies, etc., which, to many, are a source of distraction (Karakose et la., 2023; 2022). Though the device is portable and very useful, this makes it prudent to research the sustainable development of M-learning at the University of Education, Winneba.

1.2 Statement of the Problem

The integration of M-learning in higher education, such as at UEW in Ghana, has surged in response to the opportunities for flexible, student-centred learning experiences (Vlachoudi et al., 2023). Given the increasing reliance on mobile devices in education globally (EDUCAUSE, 2023), ensuring the long-term sustainability of M-learning initiatives is essential. Although UEW's initial adoption of M-learning has been enthusiastic, maintaining sustainable infrastructure, resource allocation, and institutional support poses challenges.

This study addresses the long-term sustainability of M-learning at UEW by focusing on three critical areas:

(1) Infrastructure: Adequate technological infrastructure at UEW is fundamental to supporting M-learning initiatives. This includes network connectivity, device availability, and digital platforms that create seamless M-learning experiences.

(2) Resource Allocation: Appropriate resource allocation is imperative for M-learning to thrive. This encompasses funding for technology upgrades, faculty professional development, and M-learning content creation.

(3) Institutional Support: The commitment and support of the university administration, faculty, and students play a vital role in ensuring the long-term sustainability of M-learning. This support involves policy development, training, and a conducive environment for innovation.

1.3 Purpose of the study

This study aims to comprehensively evaluate and analyse the long-term viability of M-learning adoption at UEW in Ghana, focusing on the crucial elements of infrastructure, resource allocation, and institutional support. This study seeks to achieve the following objectives: Examine the Infrastructure for M-learning in Its Current State, Analyse the Distribution of Resources for M-learning, Assess Institutional Support and Policy Frameworks, Identify Barriers and Facilitators for Long-term Sustainability, and Create Suggestions for Improved Sustainability.

Through these goals, the study aims to provide insight into the challenges and possibilities surrounding the sustainability of mobile learning, eventually acting as a helpful resource for academic institutions, politicians., and educators looking to develop long-lasting and successful M-learning environments in the digital age.

The objective of the study include:

(1) To evaluate the current state of M-learning infrastructure at UEW and identify areas that require improvement.

(2) To evaluate Resource Allocation for M-learning.

(3) To evaluate the level of institutional support for M-learning.

(4) To develop suggestions for improved sustainability.

1.4 Research questions

(1) What is the present state of M-learning adoption at UEW in terms of the scope and makeup of its application?

(2) How are resources allocated for M-learning projects at the University of Education, Winneba, and how do these distributions affect the programs' long-term viability?

(3) To what extent do faculty and staff support and readiness influence the successful integration and sustainability of M-learning in the university?

(4) How do students perceive the integration of M-learning in their education, and what factors contribute to their acceptance and engagement in M-learning?

1.5 Significance of the study

This research's discoveries will hold significant implications for UEW and other higher education institutions embarking on a journey to integrate M-learning. It will provide actionable insights into the elements influencing sustainability over the long run of M-learning initiatives,

thus helping institutions make informed decisions to enhance the educational experience for their students.

1.6 Limitations of the study

This study has several areas for improvement, including its context-specificity, potential time constraints, reliance on self-reported data, limited resource allocation dynamics analysis, insufficient institutional support evaluation, and a narrow focus on infrastructure elements. The study also needs help with potential participation bias due to survey response rates. It employs a cross-sectional strategy, which offers a picture of a particular period and does not consider external factors impacting the uptake of M-learning.

The study is challenged to resistance to change in the following ways but limited to:

(1) Faculty and student resistance: Some educators and students may be reluctant to adopt M-learning due to various reasons, including a lack of experience, doubts about its efficacy, or worries about the technological shift.

(2) Pedagogical challenges: Major pedagogical adjustments may be necessary to incorporate M-learning into the curriculum. Teachers may require assistance and instruction to modify their methods of instruction.

1.7 Delimitations of the study

This study focuses solely on UEW, which restricts its applicability to other educational institutions. The research was limited to the Department of ICT Education and Media and Communication Studies students. Also, because of its limited temporal span, it may have missed recent advancements in M-learning.

Additionally, it only uses survey and interview techniques, which might not adequately convey the complexities of adopting M-learning. The study's chosen focus also constrains how deeply it may examine resource allocation dynamics, institutional support, and infrastructure factors.

2 Literature review

2.1 Introduction

This chapter's primary focus is the review of relevant literature on the topic. Paying attention to the works of other authors concerning Sustainable Mobile Learning Adoption: Examining the Long-term Sustainability of Integrating Mobile Learning in University of Education, Winneba, considering factors such as infrastructure, resource allocation and institutional support. The importance of this chapter is to provide a framework which forms the basis for analysing and finding the similarities and differences between this study and the other authors. Moreover, to find the areas that demand further research.

M-learning has become a game changer in education, providing students with flexibility and accessibility. According to Brinkerhoff & Goldsmith (1992), as educational institutions worldwide are working towards integrating M-learning into their teaching methods, the main focus is how to sustain these initiatives for the long term. This literature review examines the sustainability of M-learning adoption at the University of Education Winneba. This inquiry looks at the infrastructure, resource distribution, and institutional support that are important for maintaining the viability of mobile learning initiatives.

2.1.1 Evolution of M-learning in educational institutions

According to Kasemsap (2017), the evolution of M-learning in educational institutions has been a topic of interest in recent years, focusing on higher education. Chirino-García & Hernández-Corona (2020) emphasise the need for educators to teach students how to optimise and use mobile devices for academic purposes, while Aish et al. (2013) propose a sustainable model for the deployment of M-learning in universities. Giousmpasoglou and Marinakou (2013) discuss the popularity of M-learning among university students and the challenges it poses for educators, and Lakshminarayanan (2015) explores the challenges in implementing M-learning technologies in higher educational institutions, particularly in Oman. These studies collectively highlight the potential of M-learning in higher education while also underscoring the need for effective pedagogical strategies and the importance of addressing challenges in its implementation.

2.1.2 Significance of examining the long-term sustainability at UEW

The significance of examining long-term sustainability at UEW is emphasised by the institution's public responsibility to generate and transmit knowledge and its economic and social responsibility in resource management (Wigmore, 2020). This is particularly important in the context of the challenges faced by distance education students, which include institutional, instructional, social, psychological, and financial issues (Ohene & Essuman, 2014a). As the University of Minho demonstrated, implementing a sustainability strategy can provide valuable lessons for UEW, including the need for a mixed bottom-up and top-down approach, continuous monitoring, and the integration of collaborative networks (Ramísio et al., 2019). Furthermore, revenue sources, university-industry cooperation, government grants, and student publications in enhancing higher-education sustainability underscore the need for a comprehensive approach to sustainability at UEW (Usak et al., 2021).

2.1.3 Brief overview of factors influencing sustainability

Various factors influence sustainability, including institutional support, resource allocation, and infrastructure. Institutional factors such as climate change vulnerability, corporate social responsibility, and market coordination play a significant role in organisations' decisions to address sustainability issues (Rosati & Faria, 2019). Sustainable resource use, particularly in infrastructure, requires a focus on intergenerational equity and long-term decision-making (Rosa, 2011). The sustainability of development institutions depends on maintaining responsive output flows, cost-effective delivery mechanisms, and resources. Infrastructure, while crucial for economic productivity, can also have harmful social and environmental impacts, making it essential to establish long-term visions for sustainable national infrastructure systems (Thacker et al., 2019).

2.1.4 Theoretical Framework

The theoretical framework for sustainable M-learning adoption at UEW integrates critical factors from recent literature tailored to the university's unique context. Farley and Murphy (2013) highlight the need for an evaluation framework to guide the selection and justification of mobile learning initiatives. Alghazi et al.. (2021) highlight the importance of technical factors, such as device connectivity and compatibility, in influencing students' intention to use mobile learning. This underscores the need for a robust technical infrastructure at the university. Okai-Ugbaje et al. (2020a) further emphasise the roles and responsibilities of various stakeholders, including students, academics, IT personnel, and administrative leaders, in ensuring the sustainability of M-learning adoption. Applying this to UEW, each group's readiness and support are assessed to ensure collaborative engagement and long-term integration. These concepts collectively inform a comprehensive framework suited to UEW's needs in sustaining M-learning initiatives.

2.1.5 Application of theoretical concepts to the context of UEW

UEW faces various challenges in its distance education program, including institutional, instructional, social, psychological, and financial issues (Ohene & Essuman, 2014b). These challenges may also impact the long-term sustainability of integrating M-learning, which has been shown to enhance student collaboration, communication, and engagement (Rogers et al., 2017a). Factors influencing students' intention to adopt M-learning include performance expectancy, effort expectancy, and social influence (Bamidele, 2015). The combined effect of perceived ease of use and cognitive gratification has been found to have the highest impact on the intention to adopt M-learning (Aburub, 2019). These findings suggest that addressing the challenges in M-learning and enhancing the perceived ease of use and cognitive gratification of M-learning could contribute to the long-term sustainability of M-learning at UEW.

2.2 M- Learning adoption in educational institutions

2.2.1 Overview of the global trend in M-learning adoption

M-learning adoption is a global trend that is particularly significant in developing countries with high mobile phone penetration rates (Alkhalifah et al., 2017a). The demand for mobility in learning is increasing, with M-learning offering cost-effective and flexible learning opportunities (Ozdogan et al., 2012). Integrating mobile devices into educational contexts has numerous benefits, including improved interaction and communication, knowledge creation, and access to learning anytime and anywhere (Chee et al., 2017). However, challenges like the need for teacher and student acceptance and adoption of mobile technologies remain (Ferreira et al., 2013).

2.2.2 The impact of M-learning on student engagement and outcomes

Research consistently shows that M-learning has an encouraging impact on student engagement and outcomes. Bazhenova et al. (2022) found that mobile-based interventions significantly improved learning performance, with multimedia design, content diversity, and interaction opportunities being key facilitators. West (2020) further emphasised the potential of mobile devices to transform education and improve learning outcomes. Salhab and Daher (2023) identified various forms of engagement in M-learning, including social, cognitive, emotional, and behavioural, highlighting its multifaceted nature. However, Tabor (2016) noted that while M-learning has potential, its adoption is not guaranteed, and students may need support in understanding its value.

2.2.3 Integration of mobile devices in educational settings

The incorporation of portable devices in educational settings has been explored in several studies. Lundin et al. (2010) and Khaddage et al. (2011) both emphasise the potential of mobile technology in higher education, with Lundin specifically highlighting the use of students' own devices and Santos (2013) discussing the role of teachers in this integration. Moreover, Gikas & Grant (2013) provide further evidence of the benefits, with Santos reporting increased student engagement and learning and Gikas highlighting the advantages of mobile devices for interaction, collaboration, and content creation. However, Gikas (2013) also notes some frustrations, suggesting a need for further research and support in this area.

2.3 The current state of M-Learning in UEW

UEW faces various challenges in its M-learning education program, including institutional, instructional, social, psychological, and financial issues (Ohene & Essuman, 2014a). These challenges may also impact the long-term sustainability of integrating M-learning, which has been shown to enhance student collaboration, communication, and engagement (Kaliisa & Picard, 2017b). Factors influencing students' intention to adopt M-learning include performance expectancy, effort expectancy, and social influence (Bamidele, 2015). These findings suggest that addressing the challenges in distance education and enhancing the perceived ease of use and cognitive gratification of M-learning could contribute to the long-term sustainability of M-learning at UEW (Zhang, 2015).

2.3.1 Importance of studying M-learning adoption within the context of UEW

Adopting M-learning in the UEW context is a complex and multifaceted issue. Performance expectancy, perceived enjoyment, ubiquity, service quality, attainment value, and learning self-management are significant predictors of students' intention to use M-learning (Huang, 2014). However, socio-demographic variables, culture, and expectations around effort and performance must be considered, especially in a developing country like Ghana (Alkhalifah et al., 2017b). It is also essential to consider the potential negative influences, such as self-management of learning, on M-learning adoption (Yang, 2013). Therefore, a comprehensive understanding of the factors influencing M-learning adoption at UEW is crucial for successfully implementing M-learning strategies.

2.4 Factors Influencing M-learning Adoption

Several variables impact UEW's use of mobile education. Institutional elements, such as procedures to sustain legitimacy, play a significant role Lamptey, 2019. Instructors' intentions to use M-learning are influenced by their perceived usefulness, ease of use, and attitude towards the technology (Asunka, 2020). Students' readiness for M-learning is influenced by their attitudes, subjective norms, and perceived behavioural control (Tagoe & Abakah, 2014). Perceived enjoyment and usefulness are critical factors in students' intentions to adopt M-learning (Pramana, 2018). These findings highlight the importance of infrastructure, resource allocation, and institutional support in successfully adopting M-learning in UEW.

2.4.1 Infrastructure

M-learning infrastructure encompasses a range of components, including technological support, connectivity, and integration into everyday life (Sharples, 2013). In Africa, successful M-learning initiatives have been hindered by poor technological infrastructure, lack of access to modern mobile devices, and a lack of M-learning pedagogical skills among lecturers (Kaliisa & Picard, 2017b). However, M-learning can potentially overcome traditional infrastructure challenges in developing countries (Traxler & Kukulska-Hulme, 2020). The establishment of a M-learning community has been identified as a critical factor in promoting effective teaching

and learning (Wang & Ma, 2017).

2.4.2 Resource allocation

Research on M-learning has identified several critical factors affecting its success. Venkataraman and Ramasamy (2018) highlight the importance of effort expectancy and social influence, while Alrasheedi et al. (2016) emphasise the role of university commitment, learning practices, and change management. Alrasheedi and Capretz (2015) further underscore the significance of collaboration, ubiquitous learning, and user-friendly design. Liu et al. (2010) suggest that perceived long-term usefulness and personal innovativeness are critical to M-learning adoption. These studies underscore the need for a holistic approach to resource allocation, including technological, financial, and human resources, to support the effective implementation of M-learning programs.

2.4.3 Institutional support

Institutional support is a critical factor in the success of M-learning (Alrasheedi & Capretz, 2015). This support can be facilitated through faculty training and development, which has been shown to increase M-learning opportunities in higher education (Fraga & Flores, 2018). The role of institutional policies in supporting M-learning is also crucial, with a need for a best-practice framework to guide future action and thinking (Cobcroft, 2006). Successful cases of institutions with solid institutional support have demonstrated the benefits of M-learning in boosting interaction and collaboration among students and teachers.

2.5 Research gap

Recent studies highlight M-learning's benefits, yet significant gaps still need to be in understanding its sustainable adoption, especially at UEW. Okai-Ugbaje et al. (2020b) discuss the role of stakeholders but need more analysis of specific readiness and roles essential for sustaining M-learning at UEW. Wigmore (2020) and Salhab & Daher (2023) emphasise institutional support, yet they overlook structured, long-term policies tailored to UEW's needs. Similarly, Alghazi et al. (2021) point out technical barriers like connectivity without exploring necessary infrastructure upgrades for a sustainable model. This study addresses these gaps by examining stakeholder roles, institutional policies, and technical needs critical for UEW's sustainable M-learning adoption.

3 Research design and methodology

This chapter describes the research design and methodology used to investigate the long-term sustainability of incorporating M-learning at UEW. Key elements such as infrastructure, resource allocation, and institutional support were considered. This research seeks to thoroughly comprehend the techniques employed in gathering, analysing, and interpreting data for this study (Petousi & Sifaki, 2020).

3.1 Research design

This study adopts a positivist paradigm, which assumes that objective which assumes that objective reality can be measured and understood through empirical observations. This paradigm aligns with the structured approach used to investigate the sustainability of M-learning at UEW. According to Creswell & Creswell (2017), such an approach ensures that findings are systematic and replicable.

The research utilised a quantitative approach, emphasising numerical data to provide objective insights into the factors influencing M-learning sustainability (Bryman, 2016). Descriptive statistics, correlations, and regression analysis were applied to analyse patterns and relationships within the data systematically.

3.2 Population

The study's target population consisted of all students at UEW, with a representative sample of 69 students with perspectives on M-learning, a representative sample was selected. The sample included 53 Level 400 ICT students and 16 Level 400 students from the Communication and Media Studies department.

Following Cohen, Manion, and Morrison's (2017) guideline of a 10% sample for populations between 101 and 1,000, a combination of purposive and stratified sampling was used. Purposive sampling targeted students with relevant experience and engagement in M-learning. Stratified

sampling ensured proportional representation from Creswell in the ICT and Communication and Media Studies departments. (Table 1)

Table 1 Population sample table

Size of Population	%
0-100	100%
101-1,000	10%
1,001-5,000	5%
5,001-5,000	3%
10,000+	1%

3.3 Sampling methods and procedures

A combination of purposive and stratified sampling was used. Purposive sampling targeted students with significant engagement in M-learning, ensuring the sample reflected the research objectives. Stratified sampling ensured proportional representation across academic disciplines and genders. This approach follows Cohen, Manion and Morrison's (2017) guidelines, ensuring the sample's representativeness within a 10% selection rate for populations between 101 and 1,000.

Purposive Sampling: Selected Level 400 students were chosen for their engagement in M-learning, ensuring participants had relevant exposure. Specifically, Level 400 students were chosen as they have substantial exposure to the university's ICT infrastructure and academic environment.

Stratified Sampling: Ensured balanced representation across ICT and Communication and Media Studies departments, considering variables such as academic discipline and gender for diverse perspectives.

3.4 Sampling Procedure

The sampling procedure involved obtaining a list of eligible students from the university's administrative records. Students were randomly selected within each stratum to achieve the desired sample size, ensuring that the sample was representative of the overall student population.

According to Cohen et al. (2017), a sample size of 10% was deemed appropriate for this study. Thus, out of the 690 students (530 ICT students and 160 Communication and Media Studies students) in the target population, 53 ICT students and 16 Communication and Media Studies students were selected, for a total of 69 students. This approach ensured that the sample size was manageable and provided reliable data for analysis while considering time and financial constraints.

3.5 Data collection procedures

Data were collected over two weeks using an online method (Google Forms). A pilot study was conducted to refine the data collection instrument to ensure the reliability and validity of the findings. This addressed ambiguities in the questionnaire and ensured clarity of questions. Questionnaires were distributed electronically via WhatsApp and email. Participants were informed about the study's purpose and procedures, and informed consent was obtained. The confidentiality and anonymity of the respondents were assured throughout the research process.

3.6 Validity and reliability

A pilot study with a small participant group was conducted to assess and refine the survey and interview instruments, with expert feedback guiding adjustments for clarity and relevance. It was piloted with a small group of participants. Feedback from the pilot study was used to refine the instruments. Reliability was further tested using Cronbach's alpha, ensuring internal consistency and alignment with study objectives (Hair et al., 2017).

3.7 Data analysis

The collected data was analysed using SPSS software. Descriptive statistics, such as frequencies, means, and percentages, were calculated to summarise the data. Inferential techniques, including Pearson's correlation and regression analysis, were applied to assess relationships between variables, ensuring robust insights into M-learning adoption.

4 Data presentation, analysis and interpretation

4.1 Introduction

This chapter presents data analysis techniques and interprets the findings of examining the long-term sustainability of M-learning adoption. Data collected through questionnaires were analysed using descriptive and inferential statistics, and results are presented in tables and figures for clarity. Inferential statistics assessed relationships and differences between critical variables, offering a deeper insight into factors affecting M-learning adoption.

4.2 Questionnaire return rate

The study response rate was 100%, as shown in Table 2. All of the sampled students filled out the questionnaire.

Table 2 Return rate

	Freq.	%
Valid	69	100.0%
Total	69	100.0%

4.3 Socio-demographic characteristics

This section presents the socio-demographic information of the respondents in charts, graphs, and tables. The analysis solely relied on the information from the respondents. The study found it essential to gain the information since it contributes to the factors affecting the sustainability of M-learning adoption.

4.4 Distribution by gender

44 (63.8%) of the respondents were males, while 25 (36.2%) were females, as depicted in Figure 1. This indicated that more males were admitted to the Information Communication and Technology Department and the Media and Communication Studies Department.

4.4.1 Age

The data in Table 3 show the age distribution of the respondents. The largest group is between 28 and 33 years old, comprising 40.6% of the respondents. This is followed by those aged 23 to 27, who make up 30.4%. The 18-22 age range accounts for 17.4%, while the smallest group is those aged 34 and above, representing 11.6%. This range of ages illustrates a good mix of younger and older students participating in the study.

Table 3 Age of respondent

	Freq.	%
18-22	12	17.4%
23-27	21	30.4%
28-33	28	40.6%
>34	8	11.6%
Total		100.0

4.4.2 Level and department of respondents

The study targeted Level 400 and 300 students from the ICT Education Department and the Communication and Media Studies Department at UEW, with a total sample size of 69 participants. Of these, 71.0% were Level 400 students, and 29.0% were Level 300 students. Table 4 also shows that 76.8% (53 students) were from the ICT Education Department, and 23.2% (16 students) were from the Communication and Media Studies Department. The selection of these departments and levels was intentional in gaining insights into M-learning from students with relevant experience in using M-learning in U.EW.

4.4.3 M-learning infrastructure at UEW

This section presents the findings of the frequently used M-learning platform, the most preferred M-learning Platform, and the Challenges and Experiences gained through M-learning platforms (Al-Qora'n et al., 2023).

Table 4 Departments of respondents

	Freq.	%
ICT Department	53	76.8%
Comm. and Media Studies Department	16	23.2%
Total	69	100%

4.4.4 Frequency of M-learning platform usage

A t-test was conducted to explore the relationship between platform usage frequency and students' satisfaction, showing that daily users reported significantly higher satisfaction ($t = Z$, $p < 0.01$), according to the respondent. Notably, 62.3% of respondents said they regularly utilise M-learning platforms for school-related tasks, demonstrating a high dependence on these resources. The weekly usage is also notable, with 18.8% of students stating that they use M-learning platforms once a week. However, 7.2% of students use these sites infrequently, and 11.6% use them monthly. These results imply that UEW students have embraced M-learning in large numbers, with most of them incorporating these platforms into their daily and weekly study schedules. The high daily usage rate indicates that M-learning tools are well-received and emphasises their significance in meeting students' educational demands and calls for making it sustainable. (see in Figure 1)

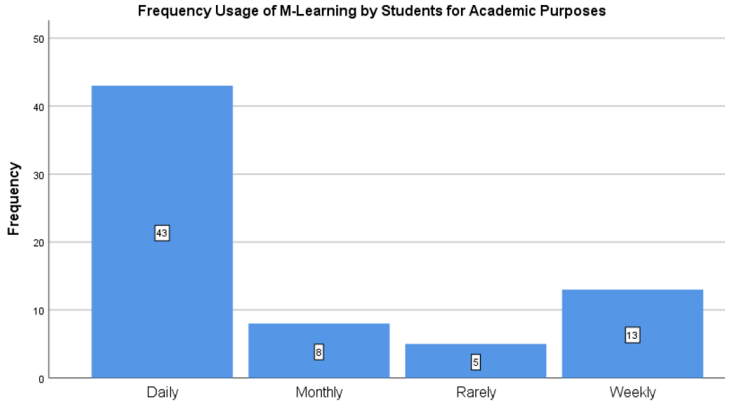

Figure 1 How often students use M-Learning in their studies

4.4.5 Overall Experience with M-Learning

Table 5 reveals that, of those surveyed, 52.2% had a good experience with M-learning at UEW, with 31.9% rating it as "satisfied" and 20.3% as "very satisfied." Nonetheless, 24.6% expressed neutrality and 23.2% expressed discontent. This shows that there has been a generally positive response, but it also emphasises the need for changes to address complaints and improve the table.

Table 5 Overall experience with M-learning usage

	Freq.	%
Dissatisfied	10	14.5
Neutral	17	24.6
Satisfied	22	31.9
Very Dissatisfied	6	8.7
Very Satisfied	14	20.3
Total	69	100.0

4.5 Challenges of M-learning

Respondents were asked to select from a list of challenges facing them in using M-Learning and were allowed to select more than one challenge; Figu's figure states the various difficulties that respondents faced. 76.8% of respondents say internet connection is the most frequent problem. Significantly, 62.3% of participants had technical issues, and 43.5% mentioned a lack of resources. A small percentage (2.9%) mentioned other unclear difficulties. These results

highlight the necessity of removing a variety of obstacles in order to enhance the M-learning process, with connectivity and technical assistance receiving special attention. (see in Figure 2)

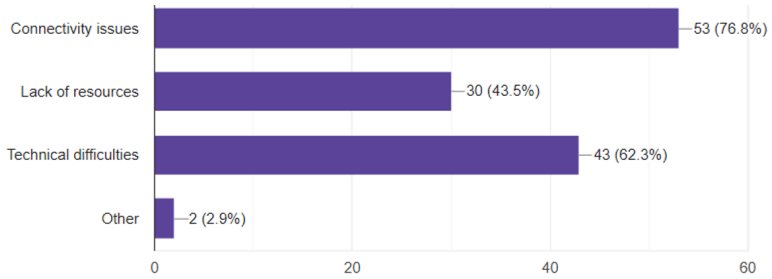

Figure 2 Overall experience with M-learning usage

4.6 Current infrastructure for M-learning in UEW

(1) Access to Technological Gadgets: Most respondents (97.1%) have access to necessary technological gadgets for M-learning, indicating the widespread availability of smartphones and tablets among students.

(2) UEW Technological Support: Internet connectivity and device compatibility were highlighted as primary challenges, correlating with dissatisfaction rates ($r = -0.45$, $p < 0.05$). This suggests that limited infrastructure negatively impacts user satisfaction.

(3) Improvement Suggestions: Most respondents (88.4%) prioritise improved internet access. Additionally, 65.2% emphasise better technical support and 53.6% call for more device access.

4.7 Resource allocation

4.7.1 Availability of learning resources

Responses are split, with 40.6% agreeing that sufficient M-learning resources are available and another 40.6% disagreeing, underscoring concerns about resource adequacy.

4.7.2 Funding and support

Inferential analysis (Pearson's correlation) revealed a strong positive correlation ($r = 0.65$, $p < 0.01$) between funding satisfaction and overall satisfaction with M-learning, indicating that increased financial resources are likely to enhance student satisfaction.

4.7.3 Suggestions for improvement

Respondents prioritise increasing funding for technology (76.5%), better access to educational resources (66.2%), and more training programs (64.7%). (see in Figure 3)

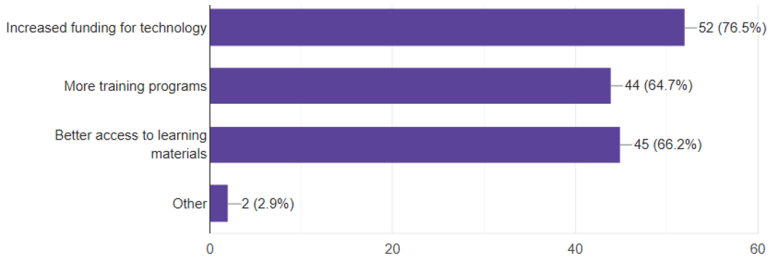

Figure 3 Ways resource allocation can be improved to enhance M-learning

4.8 Institutional support

4.8.1 Training and development

Inferential analysis revealed a positive correlation between training effectiveness and user satisfaction with M-learning ($r = 0.52$, $p < 0.05$). This finding underscores the importance of enhancing training programs to boost adoption and satisfaction.

4.8.2 Administrative support

Only 42% of students feel supported by the administration in M-learning initiatives, with 30.4% disagreeing and 21.7% remaining neutral, indicating inconsistent support experiences.

4.8.3 Long-term sustainability

Only 34.7% believe that the current M-learning practices are sustainable, while 57.9% express doubt, suggesting improvements to ensure long-term viability.

4.8.4 Critical factors for sustainability

Respondents emphasise the need for better IT infrastructure (89.6%), increased funding and resources (70.1%), and improved training (62.7%).

4.9 Suggestions for future improvements

The relationship between improved infrastructure and satisfaction was statistically significant ($r = 0.73$, $p < 0.01$), highlighting infrastructure as a critical factor.

4.10 Faculty and staff support

4.10.1 Faculty support

Regression analysis indicates that faculty support significantly predicts student satisfaction with M-learning ($\beta = 0.42$, $p < 0.05$), suggesting that greater faculty involvement could foster better M-learning engagement.

4.10.2 Staff readiness for integration

Opinions are mixed regarding staff readiness for integrating M-learning into the curriculum, with 33% neutral and 27.5% believing staff need to be prepared.

4.10.3 Factors influencing acceptance

Ease of use (77.6%) and accessibility of resources (52.2%) influence students' acceptance and engagement with M-learning. (see in Figure 4)

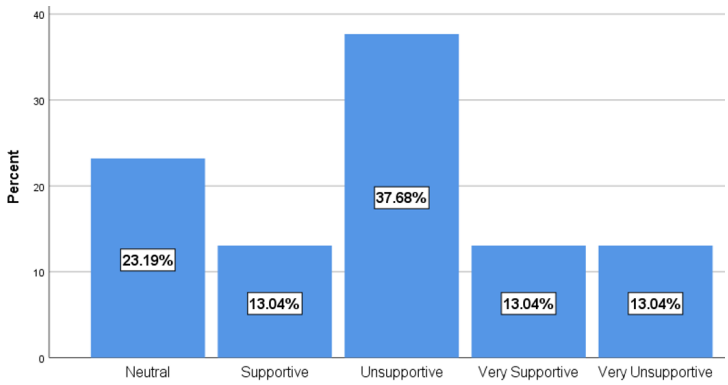

Figure 4 Faculty and staff support

4.11 Controlling external factors

Several measures were implemented to control external factors and enhance the validity of the findings. The selection of Level 400 students minimised discrepancies in academic exposure. A pilot study refined the questionnaire, reducing respondent misinterpretations. Additionally, stratified sampling ensured that differences in departmental characteristics did not bias the results. These controls ensured that the findings accurately reflected the factors influencing M-learning adoption at UEW.

5 Discussions

This study emphasises funding, infrastructure, and institutional support and identifies critical elements influencing the sustainability of M-learning at UEW.

5.1 Key implications

Technical Assistance and Infrastructure: UEW's limited access to dependable internet and gadgets significantly impacts M-learning efficiency, highlighting the need for better technological infrastructure. This result supports the findings of Alghazi et al. (2021) about the

significance of compatibility and connectivity for M-learning performance.

5.2 Allocation of resources

A lack of money limits training programs and M-learning resources, supporting Wigmore's (2020) contention that sustained M-learning requires steady financial backing. Increasing funding for M-learning materials may improve its long-term effects.

5.3 Institutional support

According to Okai-Ugbaje et al. (2020), inadequate training and policy support underscore the necessity of a more robust institutional structure.

6 Summary of findings, conclusion and recommendations

6.1 Introduction

This chapter summarises the key findings from the whole research process. It also provides a summary of the study, including the main findings, conclusions, recommendations, suggestions for further research, and a summary.

6.2 Summary of findings

This study is significant as it addresses critical challenges in sustaining mobile learning adoption, offering actionable insights to enhance student engagement, faculty involvement, and institutional readiness. Identifying key barriers and proposing evidence-based recommendations contributes to the discourse on sustainable educational technologies in higher education, particularly in Ghana.

Methodologically, the study employed a quantitative approach within a positivist paradigm, utilising structured questionnaires to collect data from 69 respondents. Descriptive and inferential statistics were employed, providing robust and generalisable insights into the sustainability of M-learning at UEW.

The data collected and analysed exhibited that students have a positive perception of M-learning in the context of UEW; findings are summarised below:

6.2.1 Current state of M-learning adoption

According to the study, 62.3% of students routinely utilise M-learning platforms; the most popular is the University's Virtual Learning Platform (VClass). Nonetheless, there were notable obstacles in the form of connectivity problems (76.8%) and technical difficulties (62.3%) (Alghazi et al., 2021).

6.2.2 Infrastructure

Although 97.1% of students have access to electronic devices, many have voiced discontent with the university's ICT infrastructure, citing the need for development, especially regarding internet connectivity and technical help (Sophonhiranrak, 2021).

6.2.3 Resource allocation

According to the survey, only 21.7% of respondents agreed that funding for M-learning at UEW was sufficient, which revealed that resource allocation needs to be improved. This shortage of resources emphasises how much more funding is required (Alkhalifah et al., 2017).

6.2.4 Institutional support

Only 42% of students felt the university provided enough support, indicating a deficiency in this area. Questions about the effectiveness of training programs (Okai-Ugbaje et al., 2020) suggest a need for improved support mechanisms.

6.2.5 Long-term sustainability

Concerns about the long-term sustainability of current M-learning practices were evident, with 57.9% of students expressing doubts. According to Alrasheedi et al. (2015), substantial advancements are required in infrastructure, resource allocation, and institutional support to guarantee sustainability.

6.3 Conclusion

The findings suggest that, while beneficial, M-learning at UEW faces sustainability challenges related to infrastructure, resource allocation, and institutional support. Addressing these barriers is essential for its long-term success.

6.4 Recommendations

Based on the findings, the following recommendations are proposed:

6.4.1 Improve technological infrastructure and internet access

(1) Upgrade campus-wide Wi-Fi infrastructure to provide high-speed, reliable internet access in all academic buildings, dormitories, and common areas. Focus initial efforts on high-traffic areas, such as libraries and lecture halls.

(2) Develop a phased implementation plan for internet upgrades to minimise disruptions, with clear timelines and performance benchmarks.

(3) Collaborate with telecommunication providers to create affordable data plans for students and faculty.

(4) Introduce regular maintenance schedules to ensure the sustainability of technological improvements.

(5) Procure mobile-compatible devices for shared use by students without personal access to technology.

Potential Impact: Improved infrastructure will enhance the accessibility and reliability of M-learning platforms, fostering greater engagement among students and faculty. This will also address disparities in digital access, ensuring equitable learning opportunities.

6.4.2 Increase resource allocation for M-learning initiatives

(1) Dedicate a fixed percentage of the university's annual budget for M-learning-related investments, ensuring consistent funding for software updates, hardware procurement, and content creation.

(2) Establish partnerships with international organisations, NGOs, and private sector companies for grants or technology donations.

(3) Form a dedicated M-learning task force responsible for monitoring resource usage and recommending areas for future investment.

(4) Allocate funding to develop locally relevant content that aligns with Ghana's educational curriculum and students' needs.

Potential Impact: Sustainable funding will ensure that M-learning initiatives remain up-to-date and effective. Localised content will increase students' engagement and comprehension while reducing reliance on costly external materials.

6.4.3 Develop and enforce comprehensive M-learning policies

(1) Draft institutional policies detailing the acceptable use of M-learning tools, data security guidelines, and student and faculty responsibilities.

(2) Include provisions for equitable device distribution and internet access to prevent digital exclusion.

(3) Regularly update these policies to align with emerging technologies and stakeholder feedback.

(4) Establish an enforcement body to monitor policy compliance and address misuse or inefficiencies.

Potential Impact: Clearly defined and enforced policies will provide a structured framework for integrating M-learning into the university's operations, ensuring equitable access and adherence to best practices.

6.4.4 Implement targeted training programs for faculty and students

(1) Develop a competency-based training curriculum tailored to different user groups (e.g., essential for students and advanced for faculty).

(2) Conduct regular workshops and webinars on M-learning best practices, including effective teaching strategies for faculty and student learning strategies.

(3) Create online resources, such as tutorials and FAQs, for users to access independently.

(4) Evaluate the effectiveness of training programs through post-training surveys and adjust content based on feedback.

Potential Impact: Structured and targeted training will increase the proficiency of faculty and students, leading to more effective use of M-learning tools. Enhanced skills will contribute to higher satisfaction and better academic outcomes.

6.4.5 Establish stakeholder feedback mechanisms

(1) Set up an annual feedback survey to gather insights from students and faculty on the performance of M-learning platforms and infrastructure.

(2) Organise biannual focus group discussions to identify and address emerging issues.

(3) Appoint a dedicated committee to analyse feedback and propose actionable changes to institutional leadership.

(4) Publicly share critical findings and planned actions to ensure transparency and foster trust.

Potential Impact: Engaging stakeholders in continuous feedback will keep M-learning initiatives aligned with user needs, promoting long-term sustainability and user satisfaction.

Conflicts of interest

The authors declare that they have no conflict of interest.

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