https://doi.org/10.70882/93ps3925

SCIENCE FORUM (JOURNAL OF PURE AND APPLIED SCIENCES) 26, (5 Special) (2026), 234 -247

Science Forum (Journal of Pure and Applied Sciences)

Journal Homepage: https://atbuscienceforum.com.ng/index.php/jpas

# User-Centred Design and Usability Evaluation of a Mobile Learning Application Prototype for Higher Education

**Sa'eed J. Ismail and Samaila Musa**

Department of Computer Science, Zamfara State University, Talata-Mafara

Abstract

This study investigated how undergraduate students' needs informed a mobile learning application prototype and how students experienced its interface during usability testing. The study was conducted in three stages at Zamfara State University, Talata-Mafara, Nigeria. First, a questionnaire completed by 100 undergraduates and semi-structured interviews with selected students examined smartphone use, preferred learning features, and contextual constraints. These findings informed a high-fidelity prototype developed according to the human-centred design principles of ISO 9241-210. In the third stage, ten undergraduates completed tasks using the prototype. Usability was assessed through task completion, completion time, observed errors, the System Usability Scale (SUS), and post-test interviews. The needs assessment found that students used smartphones to search for information and read course materials. However, learning was constrained by materials distributed across platforms, unstable internet connectivity, data costs, and device limitations. During testing, participants completed 86 of 90 task attempts successfully (95.6%). Mean task completion time was 60.5 seconds, and the mean SUS score was 84.0/100, indicating strong perceived usability. Interviews identified opportunities to improve material findability, access to discussions, download controls, and interface visibility. Overall, the results demonstrate the value of linking user research to task-based evaluation when designing mobile learning interfaces. The prototype showed promising usability under test conditions, while feedback highlighted targeted refinements for subsequent iterative development. Because testing involved a small sample at one institution and assessed a prototype rather than a deployed application, these findings provide formative evidence only. They do not establish long-term learning impact or representativeness of undergraduates nationally.

Keywords

Mobile Learning;
User-Centred Design;
Human-Centred Design;
Usability Ev Mobile Learning;
Interactive Prototype;
Higher Education;
Nigeria
Aluation;
Interactive Prototype;
Higher Education; Nigeria

EISSN: 3156-5190 (Online)
ISSN: 1119-4618 (Print)
JPAS
Faculty of Science, ATBU Bauchi

Corresponding Author: Sa'eed J. Ismail, Department of Computer Science, Zamfara State University, Talata-Mafara.
Email: jamila.saeed@zamsut.edu.ng © 2026 Faculty of Science, ATBU Bauchi. All rights reserved

## 1. Introduction

Mobile devices have become part of how university students search for information, read lecture materials, communicate with classmates, and keep up with academic activities. Their portability offers students opportunities to engage with learning resources beyond the classroom and at times that fit their circumstances. Yet the availability of a smartphone does not, by itself, ensure that learning through it will be straightforward. Students may still have to move between messaging applications, web searches, institutional platforms, and files shared by lecturers or classmates to locate what they need. The usefulness of mobile learning therefore depends not only on access to devices, but also on the design of the tools through which learning activities are organized.

These design questions matter in Nigerian higher education, where students' experiences of mobile learning can be shaped by internet reliability, the cost of mobile data, electricity supply, storage capacity, and the performance of their phones (Agbi & Sengsri, 2021; Musa & Amshi, 2024; Ekwu et al., 2025). In the needs assessment for this study, students reported using smartphones for academic searching, reading course materials, communication, and other learning activities. They also identified difficulty locating resources shared across different platforms, poor connectivity, data costs, and device limitations as concerns. An application that ignores these conditions may offer a long list of features while remaining inconvenient to use in the circumstances for which it is intended.

User-Centred Design (UCD), also described as human-centred design, offers a way to connect software design decisions with the experiences and requirements of intended users. ISO 9241-210 emphasizes understanding the context in which a system will be used, specifying user requirements, developing design solutions, and evaluating those solutions with users (International Organization for Standardization [ISO], 2019). In a mobile learning setting, this means that decisions about navigation, content organisation, downloads, and academic functions should follow from evidence about students' activities and constraints rather than from assumptions about what a learning application ought to contain.

Previous research has considered mobile learning adoption, educational technology usability, and prototype development from different perspectives (Kaisara & Bwalya, 2022; Valencia-Arias et al., 2024). Studies of mobile educational prototypes also illustrate the value of examining user requirements alongside interface design and usability (Kondoro et al., 2023; Pernando et al., 2025). There is still practical value in documenting how students' reported needs inform a particular interface and what happens when students attempt realistic academic tasks. Adoption studies can explain why students choose to use a platform, while usability evaluation can identify difficulties in the interaction itself. The present study brings these concerns together within one design process.

This paper reports the design and formative usability evaluation of a mobile learning application prototype developed for undergraduate students at Zamfara State University, Talata-Mafara. It addresses three questions: (1) How were students' mobile learning needs and contextual challenges translated into the prototype design? (2) How usable was the prototype in terms of task performance, completion time, and perceived usability? and (3) What difficulties and potential improvements emerged during evaluation? The paper's contribution is the documented connection between students' reported needs, the resulting interface and feature choices, and the usability evidence gathered from intended users. It does not claim that the prototype improves learning

outcomes or represents the experiences of all Nigerian university students.

## 2. Related Literature

### 2.1 Mobile learning in higher education

Mobile learning allows students to access academic resources and take part in learning activities through portable devices. In higher education, common uses include searching for academic information, reading digital notes, watching educational videos, communicating with peers and lecturers, receiving announcements, and completing assignments or quizzes. The needs assessment that informed this study reflected these practices: 93% of respondents reported using smartphones to search for academic information and 81% reported reading lecture materials on their devices. Web search, WhatsApp, and YouTube were among the sources students reported using for academic purposes.

These patterns show that mobile devices already support learning-related activity, but they do not necessarily indicate that students have access to a coherent mobile learning environment. When materials and announcements are distributed across multiple channels, students may have to remember where each item was shared and repeat searches to find it. The design challenge is therefore not simply to place existing content on a phone screen. It is also to organize academic information in ways that make common tasks understandable and reasonably direct.

### 2.2 Contextual constraints and interface design

Mobile learning takes place within practical conditions that influence whether students can access and keep using learning resources. Previous work on mobile learning in resource-constrained settings has noted the importance of connectivity, access, and local learning conditions (Musa & Amshi, 2024; Okai-Ugbaje et al., 2022; Saikat et al., 2021). In the present needs assessment, the highest mean concern was finding materials shared across different platforms (M = 3.84, SD = 0.950), followed by internet connectivity (M = 3.81, SD = 1.098), phone storage (M = 3.76, SD = 0.965), smartphone performance (M = 3.75, SD = 0.968), and mobile-data cost (M = 3.74, SD = 1.011). These figures suggest that students' concerns involve both the surrounding infrastructure and the design of the learning experience itself.

Some constraints, such as network coverage and electricity supply, cannot be solved through interface design alone. Nevertheless, design choices can avoid adding unnecessary burdens. Clear course organization can reduce repeated searching; visible download controls can make resource saving easier to understand; and concise screens can help users navigate on small displays. A prototype can also help researchers examine whether the intended navigation and task flow are understandable before a full application is developed. Any claim that a design reduces data use or supports offline learning, however, must be limited to what the prototype actually demonstrates unless those functions are implemented and tested.

### 2.3 User-Centred Design and prototyping

User-Centred Design places intended users and their context of use at the centre of design decisions. ISO 9241-210 describes a human-centred process that includes understanding the context of use, specifying user requirements, producing design solutions, and evaluating those solutions (International Organization for Standardization [ISO], 2019). The process is iterative: evaluation findings can reveal that a feature or interaction needs to be reconsidered rather than treated as finished simply because it has been designed. This emphasis on user involvement is also reflected in research on educational interfaces and interactive dashboards (Drzyzga & Harder, 2023; Pernando et al., 2025).

Prototyping makes proposed interface structures and interactions available for inspection before a complete software system exists. A high-fidelity

interactive prototype can represent screens, navigation paths, and simulated interactions closely enough for participants to attempt selected tasks. Prototype-based educational design studies have used this approach to examine interface structure before or alongside further system development (Drzyzga & Harder, 2023; Pernando et al., 2025). It is important, however, to describe the prototype honestly. A simulated assignment submission, for example, is not equivalent to a real submission processed by a university system.

A closely related example is Pernando et al. (2025), who described the development and usability evaluation of a mobile educational-system prototype using Figma. The present study follows a comparable broad sequence of user-needs consideration, prototype design, and usability evaluation, but uses Adobe XD and adds task-level completion, time, error, and SUS results alongside interview feedback. The comparison is methodological rather than a claim that the two prototypes or study contexts are identical.

### 2.4 Usability evaluation

Usability is commonly examined through effectiveness, efficiency, and satisfaction. Task completion and errors provide evidence of whether users can achieve intended goals and where they encounter difficulty. Time-on-task provides an indication of the effort required to complete an activity, while a standardised questionnaire such as the System Usability Scale (SUS) captures users' overall perceptions of usability. SUS has been applied in studies evaluating mobile applications, while usability reviews recommend making the methods and measures used in evaluations explicit (Afif, 2023; Johnson et al., 2022). Brief interviews can help explain why a task was difficult or which parts of an interface users found clear or confusing (Kondoro et al., 2023; Mwandosya et al., 2022).

Using more than one measure is valuable because perceived usability and observed task performance do not always tell the same story. A participant may give a favourable overall rating while still struggling to find a particular control. Conversely, a user may complete a task successfully but describe the process as unnecessarily complicated. Combining task records, SUS scores, and interview comments provides a fuller account of an interface than relying on one score alone, consistent with approaches used in mobile learning usability research (Afif, 2023; Kondoro et al., 2023; Mwandosya et al., 2022). The present study adopted this combined approach to identify both general perceptions and specific opportunities for refinement.

### 2.5 Research gap and position of the present study

The literature considered in this research covers mobile learning adoption, user-centred educational technology design, usability assessment, and mobile learning in resource-constrained settings (Kaisara & Bwalya, 2022; Naveed et al., 2023; Okai-Ugbaje et al., 2022; Valencia-Arias et al., 2024). The present research brings these strands together by documenting how undergraduate students' reported needs informed an interactive prototype and by examining task performance and user feedback during formative usability testing.

## 3. Methodology

### 3.1 Research design and setting

The study used a sequential mixed-methods design and was conducted at Zamfara State University, Talata-Mafara, Nigeria. It comprised three connected stages: a needs assessment, prototype design, and usability evaluation. The pragmatic orientation of the study allowed the use of quantitative measures to describe students' practices and task performance alongside qualitative accounts of their experiences. The design process was guided by the human-centred

design principles in ISO 9241-210 (International Organization for Standardization [ISO], 2019).

### 3.2 Stage One: needs assessment

The needs assessment involved 100 undergraduate students selected purposively from the university. A structured questionnaire collected information about demographic characteristics, smartphone and internet use, academic activities performed on mobile devices, preferred learning features, interface and navigation preferences, and challenges affecting mobile learning. The questionnaire included multiple-choice questions, Likert-scale items, and open-ended questions. Semi-structured interviews with selected students were used to explore their experiences and expectations in greater detail.

Questionnaire responses were summarized using descriptive statistics, including frequencies, percentages, means, and standard deviations where appropriate. Interview responses were reviewed for recurring issues relating to academic practices, access to learning materials, preferred features, navigation, connectivity, data costs, electricity, storage, and device performance. Interview accounts were considered alongside questionnaire findings to clarify the needs that appeared across the data sources.

### 3.3 Stage Two: prototype design

Findings from the needs assessment were translated into user requirements and used to guide content organization, navigation, and feature selection. The design process followed four connected activities: understanding the context of use, specifying user requirements, producing design solutions, and evaluating the design. User flows and wireframes were prepared before a high-fidelity interactive prototype was created in Adobe XD. The prototype made the planned screens and interaction paths available for user testing before full application development.

The prototype included a student dashboard, course and lecture-material access, downloadable learning resources, assignment-related screens, quizzes with feedback, academic announcements, discussion facilities, and progress or grade information. The design also considered clear navigation, readable interface elements, smartphone screen constraints, and students' concerns about data access and device limitations. These were prototype representations of the proposed application rather than a fully deployed service.

The prototype did not include a live backend database, actual assignment processing, or real-time server communication. The purpose of this stage was to make the proposed screens and interaction paths available for usability testing before full software development. Accordingly, results are interpreted as evidence about interaction with the prototype, not evidence that a production system's technical functions were operational.

### 3.4 Stage Three: usability evaluation

Ten undergraduate students from the intended user group participated in usability testing. Each participant attempted the same nine task scenarios: (1) find a course; (2) locate and open a learning material; (3) download a material and locate it in Downloads; (4) search for specified academic information; (5) reach the assignment-submission confirmation screen; (6) complete a quiz and reach the result screen; (7) open an academic announcement and examination timetable; (8) post a question in the course discussion area; and (9) view learning progress. Participants interacted with the prototype individually using the same task instructions. Because the prototype had no live backend, task completion for submission and other simulated interactions meant reaching the intended screen or interaction state, not completing a real server-side transaction.

The researcher recorded whether each task was completed, the time taken, observed errors, and navigation difficulties. The task log also

distinguished minor from major errors and noted whether assistance was needed. After the task session, participants completed the ten-item System Usability Scale (SUS), scored on a scale from 0 to 100 using the standard procedure. A short post-test interview asked about the interface, navigation, content organization, difficult areas, useful features, and possible improvements. Task results, SUS scores, and interview comments were considered together.

### 3.5 Ethical considerations

Participation was voluntary. Participants were informed about the purpose of the study and the nature of their involvement, and they were told that the prototype, rather than their personal ability, was being evaluated. Information collected during the study was treated confidentially and used for research purposes. Participants could decline or withdraw from participation.

## 4. Prototype Design and Development

The prototype was shaped by a practical issue that appeared in the needs assessment: students were already using smartphones for academic purposes, but the materials and services they needed were not always easy to locate in one place. The design therefore aimed to bring common learning activities into a coherent mobile interface rather than simply reproduce a collection of unrelated links.

### 4.1 From student needs to design decisions

The mapping in Table 1 links reported needs to the design choices they informed and to the usability questions those choices raised. It records design intent; it does not imply that every proposed function was technically implemented beyond the interactive prototype.

***Table 1. Mapping of student needs to prototype design decisions***

| Evidence from the needs assessment | Design response represented in the prototype | Usability concern to examine |
|---|---|---|
| Students reported difficulty finding materials shared through different platforms. | Organized course and lecture-material areas, with a course-focused route to weekly resources. | Can students locate the correct course and resource without unnecessary searching? |
| Students wanted easy access to lecture notes and other learning materials. | Course pages and downloadable-resource screens. | Are resource labels and download controls easy to identify? |
| Students identified the value of quizzes and feedback. | Quiz interface and score/feedback screens. | Can students find the quiz, complete the interaction, and recognize the result? |
| Students wanted academic announcements and notifications. | An announcement area for academic information. | Can students identify the latest relevant announcement? |
| Students wanted discussion or communication features. | A discussion area with a question-posting interaction. | Is the discussion entry point visible, and is the posting path understandable? |
| Connectivity, data costs, storage, and device performance were reported as constraints. | A mobile-first interface and resource-download representation intended to support access planning. | Are the interface and download interactions clear? Actual offline behavior and data savings require a functioning system to verify. |

### 4.2 Main interface areas

The prototype represented the main academic activities identified in the needs assessment. The dashboard served as an entry point to the application. Course and material screens organized resources around courses and weeks, while download interactions represented the intended route for saving learning materials. Quiz, announcement, discussion, and progress screens reflected students' requests for access to assessment-related activities, academic information, communication, and progress information.

The interface was designed for smartphone use, with attention to the placement and visibility of controls, readable labels, and navigation between the main areas. These considerations were particularly important because the evaluation asked students to perform concrete tasks rather than simply inspect static screens. A design element that appears attractive in isolation may still create difficulty if a user cannot find it while trying to complete an academic activity.




*Figure 1. Entry screens and student dashboard*

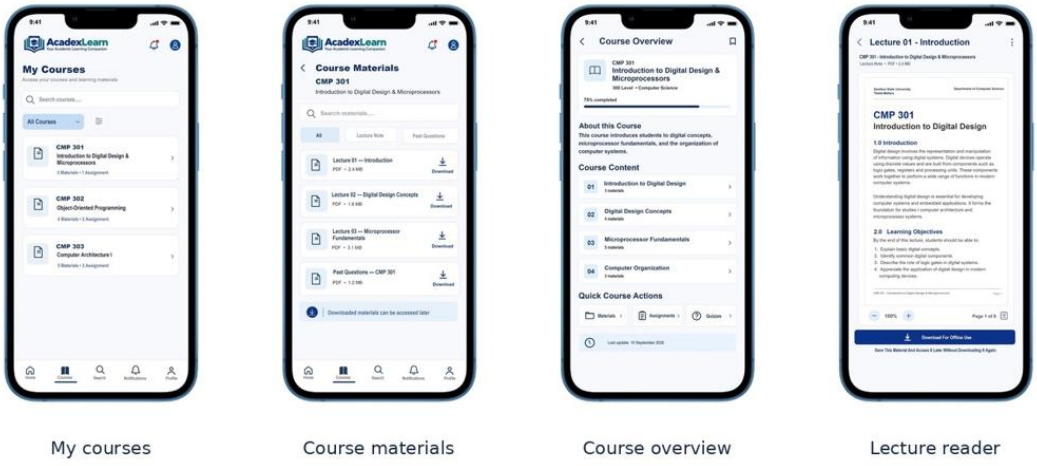



*Figure 2. Course and learning-material screens*

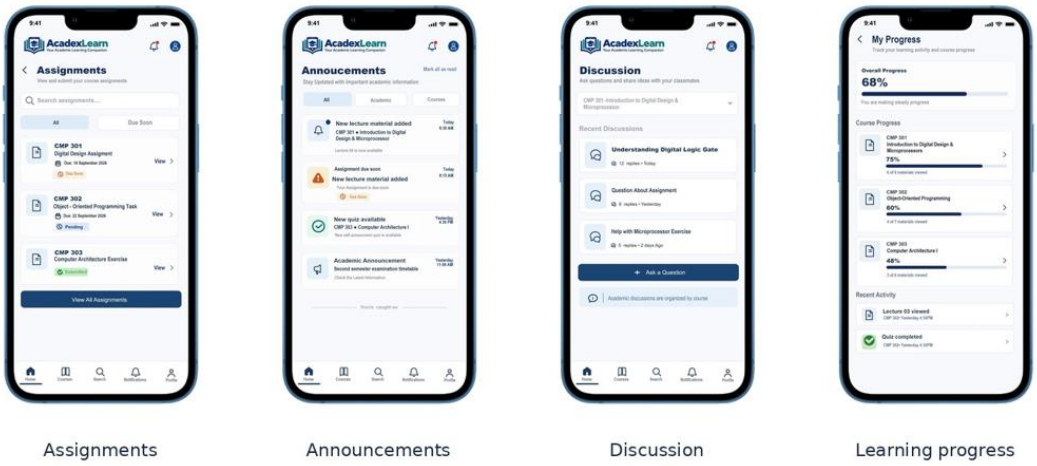



***Figure 3. Academic activity screens***

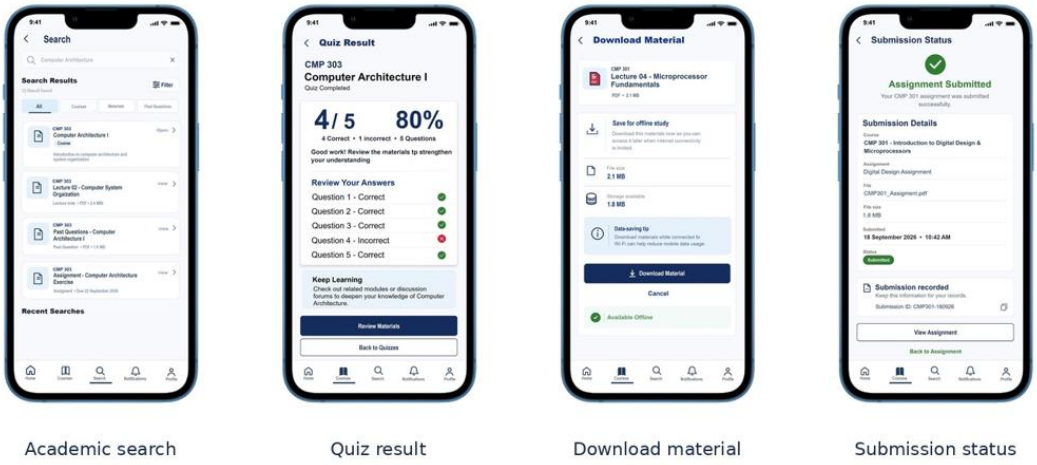



***Figure 4. Screens supporting key usability tasks***

### 4.3 Prototype scope

The prototype demonstrated screens and selected interactions but did not provide a live learning-management service. Consequently, the evaluation examined whether participants could follow the intended paths and understand the interface. It did not test real authentication, database operations, actual assignment delivery to lecturers, server response, or long-term offline access. These functions would require implementation and testing beyond the scope of the present study.

## 5. Results

### 5.1 Mobile learning practices and design needs

The needs assessment showed that smartphones were already used for a range of academic activities. Searching for academic information was reported by 93 of the 100 respondents (93%), while 81 respondents (81%) reported reading lecture materials. Communication with classmates was reported by 71 respondents (71%), academic announcements by 66 (66%), and watching educational videos and submitting

assignments by 59 respondents each (59%). Online quizzes were reported by 47 respondents (47%).

Students also relied on several sources to support academic work. Web search was reported by 84 respondents (84%), WhatsApp by 77 (77%), and YouTube by 65 (65%). Thirty-nine respondents (39%) reported using the university platform. This pattern points to a mix of general-purpose and institution-related tools rather than dependence on a single academic application.

The highest mean among the reported mobile learning challenges concerned difficulty finding materials shared across different platforms (M = 3.84, SD = 0.950). Poor internet connectivity followed (M = 3.81, SD = 1.098), then limited phone storage (M = 3.76, SD = 0.965), smartphone performance (M = 3.75, SD = 0.968), and the cost of mobile data (M = 3.74, SD = 1.011). Navigation difficulties and frequent internet requirements were also reported. These findings informed the emphasis on course organization, visible navigation, access to learning materials, and download-related interactions.

The ten usability participants represented three academic levels and ten programmes: Computer Science, Public Health, Physiotherapy, Human Nutrition and Dietetics, Mathematics, Accounting, Statistics, Mass Communication, Economics, and English. Seven participants were aged 18-24 and three were aged 25–29. Six were female and four were male. Five described their smartphone experience as intermediate, four as advanced, and one as beginner. Five reported often using smartphones for academic purposes, four very often, and one occasionally.

***Table 2. Characteristics of usability-test participants (n = 10)***

| **Characteristic** | **Category** | **n** | **%** |
|---|---|---|---|
| Age | 18–24 | 7 | 70 |
| Age | 25–29 | 3 | 30 |
| Gender | Female | 6 | 60 |
| Gender | Male | 4 | 40 |
| Academic level | 100 level | 3 | 30 |
| Academic level | 200 level | 4 | 40 |
| Academic level | 300 level | 3 | 30 |
| Smartphone experience | Beginner | 1 | 10 |
| Smartphone experience | Intermediate | 5 | 50 |
| Smartphone experience | Advanced | 4 | 40 |
| Academic smartphone use | Occasionally | 1 | 10 |
| Academic smartphone use | Often | 5 | 50 |
| Academic smartphone use | Very often | 4 | 40 |

**5.2 Usability task performance**

The ten participants attempted nine tasks each, producing 90 participant-task attempts. Overall, 86 attempts were completed successfully, giving a task-completion rate of 95.6%. Task completion was 100% for finding a course, opening a learning material, downloading a material, reaching the assignment confirmation screen, finding announcements and the examination timetable, and viewing learning progress. Academic information search and quiz completion each had nine successful attempts out of ten (90%). Posting a question in the discussion area had eight successful attempts (80%), making it the task with the lowest completion rate. Across the tasks, 32 errors were recorded: 26 minor and six major. Most errors were self-corrected, although a small number of participants needed assistance.

***Table 3. Task completion, mean completion time, and recorded errors***

| Task | Task description | Completed | Completion (%) | Mean time (s) | Errors |
|---|---|---|---|---|---|
| T1 | Find a course | 10/10 | 100 | 42.9 | 1 |
| T2 | Locate and open learning material | 10/10 | 100 | 58.0 | 6 |
| T3 | Download material and locate it in Downloads | 10/10 | 100 | 64.2 | 5 |
| T4 | Search for academic information | 9/10 | 90 | 55.3 | 3 |
| T5 | Reach assignment-submission confirmation screen | 10/10 | 100 | 74.4 | 6 |
| T6 | Complete quiz and reach result screen | 9/10 | 90 | 73.3 | 3 |
| T7 | Open announcement and examination timetable | 10/10 | 100 | 60.1 | 2 |
| T8 | Post a question in course discussion | 8/10 | 80 | 70.0 | 5 |
| T9 | View learning progress | 10/10 | 100 | 46.3 | 1 |
| Total / overall | 90 task attempts | 86/90 | 95.6 | 60.5 overall mean | 32 |

Mean completion times varied by task. Finding a course took 42.9 seconds on average, opening a learning material 58.0 seconds, downloading a material 64.2 seconds, searching for academic information 55.3 seconds, reaching the assignment confirmation screen 74.4 seconds, completing a quiz 73.3 seconds, finding announcements and the timetable 60.1 seconds, posting a discussion question 70.0 seconds, and viewing learning progress 46.3 seconds. The reported overall mean across the nine task means was 60.5 seconds. The assignment and quiz tasks took the longest on average, while finding a course and checking learning progress were the quickest.

### 5.3 Perceived usability

The ten participants' SUS scores were 100.0, 80.0, 97.5, 77.5, 72.5, 100.0, 55.0, 80.0, 100.0, and 77.5. The mean score was 84.0 out of 100, with scores ranging from 55.0 to 100.0. This indicates generally favorable perceived usability within this small sample, although the score does not remove the need to address specific navigation and visibility issues identified through task observations and interviews.

*Table 4. System Usability Scale (SUS) scores*

| Participant | SUS score |
|---|---|
| P01 | 100.0 |
| P02 | 80.0 |
| P03 | 97.5 |
| P04 | 77.5 |
| P05 | 72.5 |
| P06 | 100.0 |
| P07 | 55.0 |
| P08 | 80.0 |
| P09 | 100.0 |
| P10 | 77.5 |
| Mean | 84.0 |
| Range | 55.0–100.0 |

**5.4 Interview observations and issues for refinement**

Post-test interviews identified five connected themes. First, course and material organization was generally considered understandable, although P02 took longer to locate a material, while P05 and P07 explored menus before finding what they needed. P01 described course materials as "grouped clearly within the course," and P03 found opening a course and its material easy. Second, the discussion area was difficult to locate for several participants (P01, P03, P04, P05, P06, and P08). P02 suggested clearer icon labels, while P07 wanted navigation to be clearer. Third, participants valued the prospect of downloading materials for use when internet access was unreliable or when studying away from campus. However, P04 was unsure where downloaded files were stored, P07 struggled with downloading, and P10 wanted the download control to be more visible. Fourth, assignment and quiz interactions were generally manageable once participants found them, but P05 wanted the quiz-result location to be clearer and P10 found the result screen difficult to understand. Fifth, participants expressed willingness to use an application of this kind for academic activities, although some made that willingness conditional on improving navigation and resolving the identified interface issues. All ten participants indicated willingness in principle; this should not be interpreted as evidence of actual adoption or improved academic outcomes.

**5.5 Summary of findings**

Taken together, the needs assessment indicates that students already use smartphones for academic searching, reading, communication, and other study activities, but experience difficulties with fragmented access to materials and practical constraints such as connectivity, data costs, storage, and device performance. These findings informed the design of a mobile interface representing common academic functions. Usability testing produced 86 successful task attempts out of 90 (95.6%), an overall reported mean task time of 60.5 seconds, and a mean SUS score of 84.0. The task records and interviews also identified specific areas for refinement, particularly discussion access, download controls, icon labels, navigation, and quiz-result presentation.

## 6. Discussion

The needs assessment suggests that the central design problem was not a lack of smartphone use for academic purposes. Rather, students were already using phones to search for information, read course materials, communicate, and receive announcements, often through several different platforms. The high proportion reporting academic searching (93%) and reading lecture materials (81%) indicates that mobile devices formed part of students' study practices. At the same time, difficulty locating materials shared across platforms received the highest mean among the listed challenges. This combination makes content organization a substantive design issue, not merely a matter of visual preference.

The design response was to represent course materials and related academic activities within a connected interface. This approach follows the human-centred design principle that systems should be shaped around users' tasks and context of use (ISO, 2019). It also provides a clear route from the needs data to interface decisions: if students struggle to locate materials, course organization and resource labels need to be considered; if they want to download notes for later reading, the download control must be easy to find and understand. Similar links between user requirements and interface refinement are reported in prototype and mobile learning usability studies (Kondoro et al., 2023; Pernando et al., 2025). The prototype allowed these paths to be explored before a complete application was built.

The reported contextual constraints also matter for design. Connectivity and data costs may interrupt access, while storage limitations and phone performance can affect the handling of learning materials. A mobile interface cannot remedy unreliable infrastructure by itself. It can, however, avoid unnecessary steps, make resource actions clearer, and present content in an organized manner. Claims about actual offline availability, reduced data consumption, or reliable downloads must remain cautious because the prototype did not include the backend services required to establish those capabilities in real use.

The study's use of task records, SUS, and interviews reflects the value of examining usability from more than one angle. Task performance can show whether users reached a goal, SUS captures an overall perception, and interview comments can identify the interface elements behind a particular difficulty. The reported concerns about material findability, discussion access, download controls, and visibility illustrate why an overall usability score should not be used as the only basis for design decisions. Specific interaction problems can remain important even when users rate the prototype positively overall.

These findings should be interpreted in light of the study's scope. The usability evaluation involved ten students at one university and a high-fidelity prototype rather than a deployed application. The study can therefore provide formative design evidence and identify issues worth addressing in a subsequent version, but it cannot establish long-term adoption, effects on academic performance, technical reliability under real network conditions, or the views of undergraduates across Nigeria. A next development cycle should revise the identified interface areas and test the revised prototype with a broader and more varied group of students. A later implementation study could then examine actual downloads, data consumption, sustained use, and integration with university systems.

### 6.1 Practical implications

For designers and university teams, the study points to several practical considerations. First, course materials should be organized around students' likely tasks and labelled in familiar terms. Second, important controls such as downloads and discussion entry points should be visible and easy to distinguish. Third, mobile learning design should take account of device and

connectivity constraints rather than assuming continuous, high-quality internet access. Fourth, evaluation should combine task performance with users' perceptions and comments so that specific interface problems can be addressed. These are design implications from a single-site prototype study, not universal rules established for every institution.

## 7. Conclusion and Recommendations

This paper examined the design and formative usability evaluation of a mobile learning application prototype informed by undergraduate students' reported needs and constraints. The needs assessment showed that smartphones were commonly used for academic searching and reading, while students also experienced difficulty locating learning materials across platforms and reported connectivity, data-cost, storage, and device-performance concerns. These findings informed a prototype that represented course resources, downloads, quizzes, announcements, discussion, and progress-related functions in a mobile interface.

The research illustrates the value of connecting user research with prototype design and usability testing. Participants completed 86 of 90 task attempts successfully, and the mean SUS score was 84.0. Nevertheless, the discussion area, download controls, navigation labels, and quiz-result presentation require refinement. These results are formative evidence from ten students at one university using an interactive prototype; they do not establish long-term adoption, effects on academic performance, or the views of undergraduates across Nigeria.

Three next steps are recommended. First, revise the interface areas identified during testing, especially resource findability, discussion access, download controls, and the visibility of interface elements. Second, repeat usability testing with the corrected prototype and a more varied participant group. Third, if the project proceeds to full implementation, evaluate real technical functions and use over time, including offline access, data consumption, performance under unstable connectivity, and integration with institutional academic services. Further studies at other universities would be needed before drawing broader conclusions about mobile learning design across Nigerian higher education.

## Acknowledgement

This research was sponsored by Zamfara State University with reference number: TETF/DR&D/CE/UNI/ZAMFARA/IBR/2026/VOL.I

## References

Afif, M. H. (2023). Assessing students' perceptions of mobile applications usability using system usability scale. *Journal of Computer Science, 19*(1), 11-19.

Agbi, A., & Sengsri, S. (2021). Mobile learning for higher education in Nigeria: Prospects and challenges. *Journal of Education and Innovation, 23*(3), 425-441.

Drzyzga, G., & Harder, T. (2023). User-centered design and iterative refinement: Promoting student learning with an interactive dashboard. In *Proceedings of the International Conference on Web Information Systems and Technologies (WEBIST)* (pp. 340-346).

Ekwu, U. S., Njoku, C. N., Ikwuanusi, E. N., & Madu, O. (2025). Mobile-based learning and STEM education in Nigerian classrooms: Opportunities and challenges in the 21st century. *Faculty of Natural and Applied Sciences Journal of Mathematics and Science Education,* 6(4), 36-47.

International Organization for Standardization. (2019). *Ergonomics of human-system interaction - Part 210: Human-centred design for interactive systems (ISO Standard No. 9241-210:2019).* ISO.

Johnson, S. G., Potrebny, T., Larun, L., Ciliska, D., & Olsen, N. R. (2022). Usability methods and attributes reported in usability studies of mobile apps for health care education: Scoping review. *JMIR Medical Education, 8*(2), e38259.

Kaisara, G., & Bwalya, K. J. (2022). Trends in mobile learning research in sub-Saharan Africa: A systematic literature review. *International Journal of Education and Development Using Information and Communication Technology, 18*(2), 231-244.

Kondoro, A., Maro, S., Mtebe, J., Haßler, B., & Proctor, J. (2023). Usability testing of a mobile-based learning management system for teacher continuous professional development in Tanzania. *International Journal of Education and Development Using Information and Communication Technology, 19*(2), 75-92.

Musa, M. A., & Amshi, J. M. (2024). Mobile learning in higher education: An empirical investigation of technology and skills factors. *Nigerian Journal of Computing, Engineering and Technology, 3*(1), 204-216.

Mwandosya, G. I., Montero, C. S., & Mbise, E. R. (2022). Co-evaluating a mobile educational tool artifact in Tanzanian higher education: Teachers' and students' perspectives on usability and user experience. *International Journal of Education and Development Using Information and Communication Technology, 18*(2), 7-27.

Naveed, Q. N., Choudhary, H., Ahmad, N., Alqahtani, J., & Qahmash, A. I. (2023). Mobile learning in higher education: A systematic literature review. *Sustainability, 15*(18), Article 13566.

Okai-Ugbaje, S., Ardzejewska, K., & Imran, A. (2022). A mobile learning framework for higher education in resource-constrained environments. *Education and Information Technologies, 27*(8), 11947-11969. https://doi.org/10.1007/s10639-022-11094-5

Pernando, A., Danuarta, D. T., Nugraha, M. A., Fikri, D., & Sitepu, M. F. C. D. (2025). Development and usability evaluation of a mobile-based educational system prototype using Figma. *Digital Frontier: Journal of Computer and Science Innovation, 1*(2), 23–30. https://doi.org/10.67205/digitalfrontier.v1i2.4

Saikat, S., Dhillon, J. S., Wan Ahmad, W. F., & Jamaluddin, R. A. D. (2021). A systematic review of the benefits and challenges of mobile learning during the COVID-19 pandemic. *Education Sciences, 11*(9), Article 459.

Valencia-Arias, A., Cardona-Acevedo, S., Gómez-Molina, S., Vélez Holguín, R. M., & Valencia, J. (2024). Adoption of mobile learning in the university context: Systematic literature review. *PLOS ONE, 19*(6), e0304116. https://doi.org/10.1371/journal.pone.0304116