I. J. Education and Management Engineering, **2025, 3, 14-23**
Published Online on June 8, 2025 by MECS Press (http://www.mecs-press.org/)
DOI: 10.5815/ijeme.2025.03.02

Exploring Learner Experiences in Project-Based Learning for a Mobile Application Development Course

Anthony Wambua Wambua*
Department of Computer Science, Daystar University, Nairobi, Kenya
Email: awambua@daystar.ac.ke
ORCID iD: https://orcid.org/0000-0001-5110-9071
*Corresponding Author

Alex Maingi Wambua
Department of Computer Science, Daystar University, Nairobi, Kenya
Email: alexwambua@daystar.ac.ke
ORCID iD: https://orcid.org/0009-0002-0307-1026

Edwin Ragira Osoro
Department of Computer Science, Daystar University, Nairobi, Kenya
Email: eosoro@daystar.ac.ke
ORCID iD: https://orcid.org/0009-0003-1297-3168

Received: 07 January, 2025; Revised: 14 March, 2025; Accepted: 24 April, 2025; Published: 08 June, 2025

Abstract: As higher education increasingly shifts towards inquiry‐based learning to equipgraduates with industry‐relevant skills, project‐based learning (PBL) has emerged as a promising approach, particularly in technical disciplines such as computer science. This study investigates learner experiences with PBL in a semester‐long Mobile Application Development course for diploma students. Employing a case study design, we administered a mixed‐method questionnaire that captured both quantitative ratings and qualitative insights. Analysis of responses reveals that PBL significantly boosts motivation, engagement, and confidence while enhancing conceptual understanding, collaboration, and practical skills in mobile app development. Despite these benefits, students identified challenges related to inadequate computing resources and technical difficulties that can hinder project execution. Importantly, the findings indicate strong learner readiness for adopting PBL across other technical courses, offering practical direction for educators aiming to integrate PBL to foster both hard and soft skills in alignment with industry demands. These results underscore PBL's potential to transform technical education and inform curriculum design, while pinpointing needed improvements in resource allocation and support.

Index Terms: Project-Based Learning, Computer Science Education, Case Studies, Active Learning, 4Cs

1. Introduction

Higher Education Institutions (HEIs) are focusing on using inquiry-based approaches in training students in hard, soft, and professional skills. Especially in computer science, a conceptual understanding of the study materials does not suffice. Graduates are required to gain and hone the skills necessary for employment in the technological world. Some of the highly demanded hard skills in computer science include software engineering and, specifically, coding. Graduates are expected to have gained competencies in programming, problem-solving, debugging, and critical thinking necessary in designing algorithms that are applied in programming. Besides the hard skills, soft skills such as critical thinking, collaboration, creativity, and communication, collectively known as the 4C's or 21st-century skills, are required of learners [1].

Traditional teaching pedagogy, where the teacher is the source of knowledge and focuses on transferring knowledge and skills to students, has been ineffective in courses that require a hands-on approach. Teacher-centred approaches are deemed inadequate when dealing with complex engineering concepts and incapable of triggering student engagement [2]. Several strategies have been implemented to help solve the challenges associated with traditional

pedagogy. These strategies include puzzle-based learning [3], peer instruction [4], problem-based learning [5], and challenge-based learning [6] among others. All these strategies fall in the category of active learning, where the focus is to involve learners in the process of learning. Active learning strategies are thus learner-centered learning approaches that have the potential to prepare competitive learners with the ability to solve societal problems [7].

Project-based Learning (PjBL) is a mode of inquiry that allows learners to participate in real-world problem-solving and the construction of knowledge. PjBL is an experiential learning approach with theoretical roots in constructivism [8]; it focuses on student participation in projects [8-10]. Project-based learning allows learners to learn from their mistakes, acquire various skills, and actively engage in decision-making and time management [11]. PjBL may be applied to a single course or the entire curriculum [12], as with most capstone projects. The project duration may differ significantly depending on the scope of the project.

PjBL has been confused with Problem-Based Learning (PBL). Whereas PBL focuses on learning while solving problems, learning in PjBL must terminate with an artifact, a product [1, 13]. Another defining difference between PjBL and PBL is that the problems in PBL are structured and primarily fictional, while the projects in PjBL are mostly real-life or very close to real life [14].

PjBL must have five defining characteristics: centrality, driving question, constructive investigations, autonomy, and realism [9]. The centrality of the project implies that the project should be the curriculum and that learning content is achieved while working on the project. PjBL should involve learners in constructive investigation, a goal-oriented process involving knowledge creation and resolution. Constructive investigation implies that the project's complexity must warrant team effort and application of knowledge [15]. A driving question must exist to drive students towards carrying out specific activities to respond to the question. A clear connection must exist between the activities and the driving question. PjBL is student-driven; the projects should not be teacher-led or scripted. Lastly, there is realism; the projects should be closest to real-world scenarios. PjBL, therefore, advocates for learn-by-doing, which means that learners construct knowledge in the course of their experiences.

The experiential learning theory (ELT) by Kolb [16] has been widely accepted in PjBL studies as the theory has intersections with the characteristics of PjBL. ETL posits that learning happens through the transformation of experiences in a four-stage cylindrical process, as shown in Figure 1. First, learners create concrete experiences by engaging in activities that expose them to the content they are studying. In the case of PjBL, the project is central and helps the learners to cover the concepts of the curriculum. Second, reflections are critical to learning; in PjBL, reflections take the form of investigations into what activities were undertaken and insight gathering into what works and what does not. Third, from the reflections, abstract concepts are formed and connected back to theories and concepts. These abstractions are the generalizations that can be applied in similar contexts in future undertakings. Lastly, active engagement is where learners test the implications of the theories and concepts they have just formed in new situations. This exploration leads to new experiences, and the learning cycle starts again.

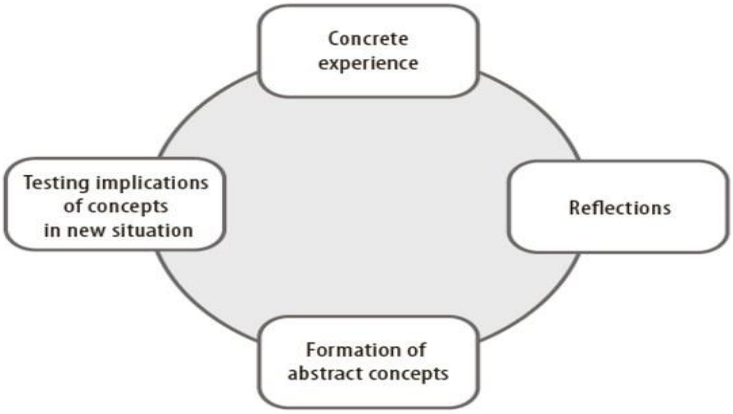

Fig. 1. Experiential learning (Kolb 1984, p. 21).

In Software engineering, specifically software development courses, solid links must be established between theory and practice; thus, PjBL becomes a natural choice of pedagogy [17] as it advocates for the bridging of the gaps between theory and practice. Most studies [18-22] have focused on the effectiveness of PjBL on students' performance. Further, such studies have only used quantitative or quasi-experimental approaches and, therefore, did not fully communicate learners' voices when expressing their views on PjBL.

The goal of this study is to characterize students' experiences with the use of PjBL. The specific objectives of the study are as follows.

1. To examine the perceived benefits of PjBL from students' perspective
2. To identify challenges faced by learners in project-based courses.
3. Assess students' readiness for future adoption of PjBL in all courses.

Similar studies have been conducted to understand the effectiveness, effect, and other aspects of PjBL, for example. Barron, et al. [23] carried out a study in which they designed and tested an approach for implementing PjBL. The authors argue that the greatest challenge in implementing a PjBL curriculum is the need to redesign the curriculum, instruction, and assessment. They observed that without proper attention, PjBL can turn into doing without really doing to understand. To this end, the study proposed four design principles i) Learning-appropriate goals: the driving question should relate to the activities envisaged, there should be reflections as opposed to just doing ii) scaffolds that support both student and teacher learning: there needs to be a balance between making the project 'real-world' and lesson plan iii) PjBL should offer frequent opportunities for formative assessment: there ought to be ways learners can assess what they have learned and correct areas they fall short iv) social organization that promotes participation: classroom ought to be reorganized in a manner they promote participation, this includes a careful grouping of learners. The authors implemented the design principle and found positive effects on students and student reflections.

A study by Rozal, et al. [22] sought to establish the effect of YouTube-based presentations as a final project on the cognitive domain learning outcomes for physics students. A quasi-experimental approach was adopted for the study. Results of the T-test used to determine if there was any significant difference in post-test scores between the experimental and control groups revealed that project-based learning has a significant effect on the cognitive domain. This study shows the potential of PjBL to improve learning outcomes. The study was quantitative and did not qualitatively survey the opinions or views of the learners.

Maros, et al. [21] examined the effectiveness of PjBL in teaching economics. In the study, 123 students were divided into experimental and control groups. The same teacher taught the two groups the same topic in the same time frame. For the experimental group, the project-based learning approach was applied. In contrast, for the control group, teaching was done traditionally using verbal and visualization with the help of a blackboard – 'chalk and talk'. At the end of the teaching period, a similar approach was used to ascertain knowledge levels for the two groups. The Parametric two-sample t-test was used to compare the means of the two groups. The study established the effectiveness of PjBL over the traditional teaching approach.

Mou [24] investigated the experiences of students with project-based learning in a 3D design modeling class. In this study involving 49 students, each student implemented a project-based assignment for the entire semester with in-class and out-of-class methods applied to see that students completed their projects. At the end of the semester, focus group interviews were held to understand students' experiences. The study established that students' experiences were mostly related to motivation, sharing and feedback, and the teaching approach employed in the class. Learners reported increased motivation towards achieving set goals, polishing 3D modelling skills, and modifying their learning attitude, owing to the sharing of feedback with their colleagues.

Marnewick [25] explored the experiences of learners in a project-based learning approach applied to an information system project. A case study was used to study groups formed by students with the goal of completing their capstone projects, which used the agile approach for project management. The project was divided into ten sprints, with the researchers reviewing all the sprints and the final artefact. During the year-long study, students were to complete a self-reflection journal by completing open-ended questions that sought to understand the students' experiences. When the 61 reflections from the students were analyzed, there was evidence that students had acquired skills such as communication, teamwork, analytical/critical thinking, time management, and hard skills such as database management and programming. Specifically, the study of PjBL in the context of agile project management is unique to this study as both approaches have different goals yet can be employed to enhance students learning.

Regarding challenges associated with PjBL, researchers have carried out studies and suggested some interventions. For example, Hussein [26] sought to address the collaboration problem among students in a project-based learning context. Upon analyzing 67 reflective reports, authors identified conflicting schedules, priority conflicts and project uncertainty as the primary sources of collaboration problems. Conflicting schedules arise as a result of students belonging to different groups or faculties in the case of multidisciplinary projects, while priority conflicts arise from extra responsibilities and undertakings such as extracurricular activities that students are involved in. Project uncertainty is especially experienced in the early stages when the team is not sure of the artifact to build, how to go about it, and what tools to use. The study recommended the adoption of a structured approach to planning, communication, and follow-up to address the collaboration challenge.

A defining difference between PBL and PjBL is that the latter requires knowledge and skills from different fields. For example, working on a computer Science project might require knowledge of database management, designing user interfaces, and programming using different languages for both front-end and back-end. As such, researchers have studied interdisciplinary and multi-level project-based learning strategies. Ricaurte and Viloria [27] presented a project-based learning methodology that included training at different levels in undergraduate engineering programs. A project on the industrial production of ethanol was used, and students picked from the 9^{th} and 5^{th} semesters of their engineering programme. The project promoted the interaction of students from different semesters as they worked on a common project. At the end of the semester, the results of the projects were presented to students in 3^{rd} semester to boost their interest in engineering programmes. A reflective session was held to understand students' experience. Students highlighted collaborative-integrated learning and greater interest in engineering courses as benefits of the project.

Mobile application development continues to gain traction among developers as many businesses explore the use of mobile applications to gain strategic advantage or solves existing challenges. Mobile applications or Apps require innovativeness and skill needed to create them cuts across other computer science areas such as networking, user

interfaces, programming and security [28, 29]. Further, the developed applications may need to use specific frameworks and address some crossplatform issues [30] most of which we have described in [31]. For this reason, many learners find learning how to create apps complex and requiring additional support from their teachers. As such use of PjBL that advocates for leaners' active involvement has been explored in studies such as [28, 29, 32]. The present study seeks to contribute to this discourse in two ways 1) We use mixed methods approach to bring out the voices of learners regarding their experiences in a Mobile Application class that employs the use of PjBL and 2) we provide a detailed model on how to implement PjBL in Mobile Application Course including the restructuring of the course outline to harmonize the concepts to be taugh and the project milestones.

2. Method

A case study was conducted among 25 diploma students taking the course Mobile Application Development. A case study approach was preferred as case studies allow an investigator to explore and describe real-life and time-bound phenomena [33]. Case studies allow us to answer the questions "*why*" and "*how*" and not just the "*what*" concerning a research problem [34], in the present research it is therefore preferred for its ability to provide detailed, indepth and a context sensitive framework that can offer insgights on the use of PBL in technical courses such as Mobile Application Development. Similar studies have been conducted with such small numbers as in our study; for example, Mak [2] conducted a project-based learning study involving 14 students. All the students in the study were pursuing a Diploma in Information Communication Technology (DICT), and the Mobile Application Development course was required for their major. At the beginning of the semester, which lasted for 13 weeks, an explanation was given regarding how the course will be offered. It was explained to the students that all assessments except the end-of-semester exam were based on the project's milestones.

Further, the course outline was harmonized with the project goals and milestones established for grading. It was necessary to adjust the course outline with the project milestones since students had no prior knowledge of mobile application development; hence, some training was needed before the actual project started. The harmonized course outline is shown in Table 1. To make sure students were guided, and especially thise who had no prior knowledge in Mobile Application Developmemt, once a certain module was covered in class, each student would implement the same in their proejects. Students were allowed to choose their own projectst as this creates more interest and stimulates enterprenuerial thinking amongst the students. The lecturer moderate the chosen projects so that the scope could be achived withing the semester. At the end all projects were pushed to Github and then presented for grading.

Table 1. Harmonized Course Outline.

Module	Concepts taught	Project milestones	Assessment
Introductory concepts	Overview and Architecture of Android	Identify a project based on the scope described previously.	
User Interface design	Overview of XML. Containers- Linear, Relative Defining widgets in XML and configuring properties	Complete the UI for the Login & Registration Screen	Quiz 1: Testing all Basics aspects of mobile programming and Android
Widgets	Buttons, CheckBoxes, ListViews, TextView	Design the UI for the main screen.	Continuous Assessment Test – Designing user interfaces for login and signup screens.
Linking UI and widget components with Java code		Navigation from one activity/screen to another.	
Persistence	Shared preferences, SQLite database	Implement data storage using both shared preferences and SQLite. Use SQL queries to implement CRUD (Create, Read, Update, and Delete)	
		Project presentation	Presentation: Fully working project that solves an identified computing problem

At the end of the semester, students were presented with survey questions through Windows Forms. The survey consisted of 1) open-ended questions that focused on students' experiences, challenges, views of future adoption of PjBL in all courses, and what they thought could be improved for future project-based courses 2) structured questions that sought to rate students' experience challenges and experiences on a 5-point Likert scale. The Likert rating had the options *Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree.* Having both the structured and open-ended questions allowed the authors to prope further on the experiences, challenges and views of learners regarding the use of PjBL in Mobile Application Development class. The approach also offered much need triangulation of the responses. Students were presented with the option of not taking part in the study if they so wished. A guarantee was given that their responses would only be used for research and would remain anonymous.

3. Results

This section presents the findings of the research based on the research objectives. The gender distribution of the survey participants is as shown in Figure 2.

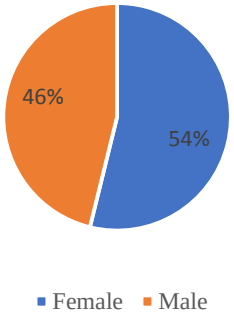

Fig. 2. Participant's Gender Distribution

3.1 Benefits of PjBL Based on Students' Perspectives.

On the benefits of PjBL, a 5-point Likert scale question was presented to survey participants to rate nine aspects. The 9 aspects included if learners 1) felt more motivated as a result of using PjBL, 2) felt involved in the learning process, 3) were now more confident in creating mobile apps, 4) could create mobile apps, 5) collaborated more in the course of their learning 6) had mastered app development concepts 7) had their interest for app development aroused 8) had to link with other computer science concepts in the course of their learning using PjBL and 9) felt better prepared for future projects. As shown in Figure 3, all learners either *Strongly Agreed*, *Agreed*, or were *Neutral.* There were no learners who disagreed or strongly disagreed with the nine aspects regarding the benefits of PjBL. Learners agreed most on feeling involved at 69% Strongly Agree, 23% Agree, and 8% Agree. Feeling better prepared for future projects and having their interest aroused towards mobile development had similar ratings, i.e., 63%, 31%, and 8%, for Strongly Agree, Agree, and Neutral, respectively. Only 38% strongly agreed, while 54% agreed, and 8% were neutral with being confident in terms of mobile app development. 54% Strongly Agreed that they had mastered mobile app development concepts, while 46% agreed on the same issue. On linking with other Computer Science concepts and increased collaboration in the course learning, 54% strongly agreed, while 46%.

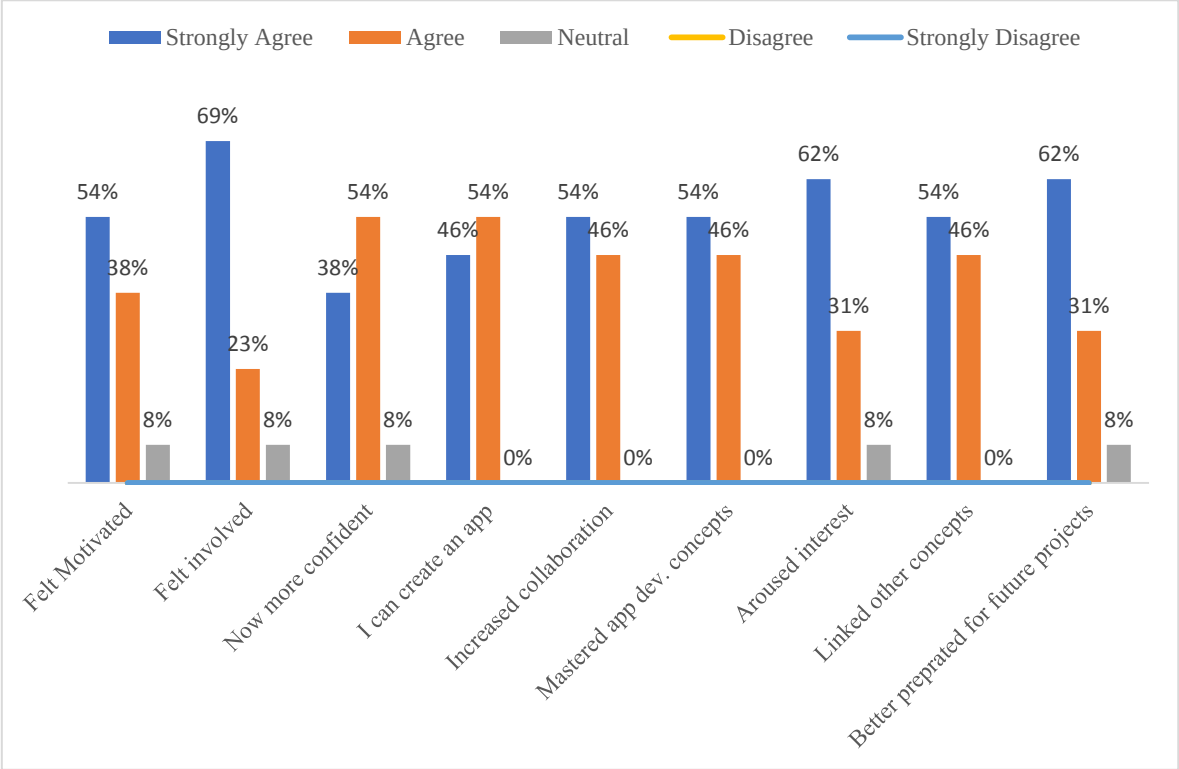

Fig. 3. Benefits of PjBL to learners

The analysis of the responses to the open-ended question regarding how students benefited from the PjBL approach identified five themes, namely, conceptual understanding, increased engagement and confidence, enhanced learning experience, practical skill development, and time management and project completion, as shown in Figure 4. Learners lauded the approach as it enabled them to create artifacts such as XML designs for mobile applications, complete their projects within the specified time, and build confidence.

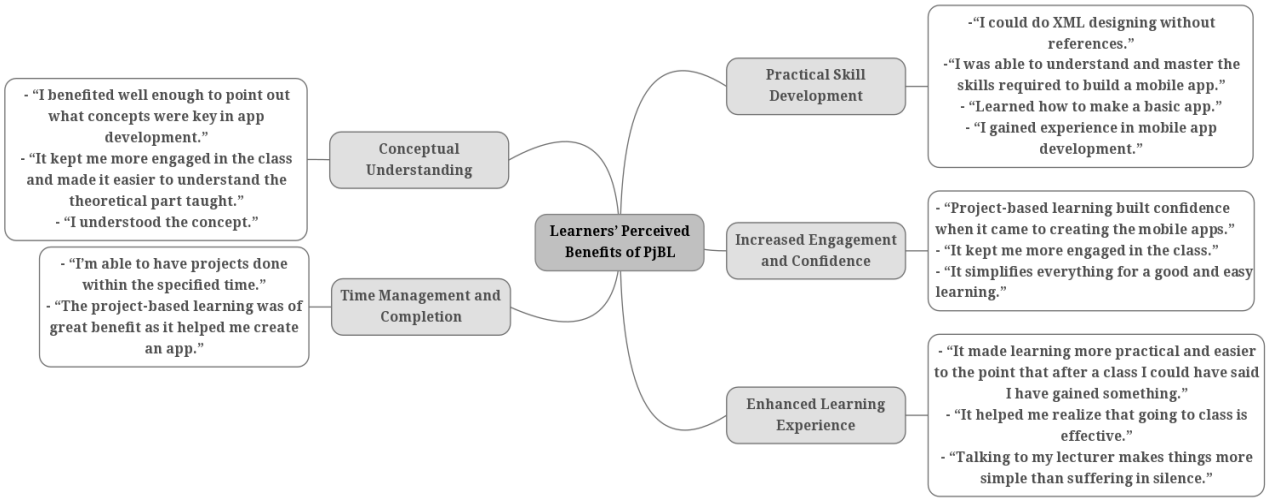

Fig. 4. Learners' Perceived Benefits of PjBL

Further, participants were asked about the most exciting aspects of using PjBL for the mobile application course. The analysis of the learners' responses to this question revealed that learners were excited about progression and achievement, practical application, project ownership, problem-solving, collaborative learning, ease and effectiveness, and creativity. Table 2 depicts these themes and examples from user responses regarding what they found exciting about using PjBL in the mobile application development course.

Table 2. Exciting Aspects of PjBL

Themes	Excerpts
Progression and Achievement	- "Learning through the projects you do and getting to progress even further." - "Seeing yourself achieve something you thought was hard."
Practical Application	- "I got actually to do what I was learning practically." - "Getting a chance to actually put it in practice individually, creating app."
Project Ownership and Interest	- "One is able to develop a project that he/she has interest in." - "Having to create your own app."
Problem-Solving	- "Make my project run because my codes normally don't run, but I enjoy the class."
Collaborative Learning	- "Discussions." - "Interactions."
Ease and Effectiveness	- "It was easy and effective."
Creativity	- "Making a discount code."

3.2 Challenges of PjBL Faced by Learners

Concerning the challenges faced in implementing PjBL, as shown in Figure 5, participants agreed more to having difficulties with computing devices than with any other aspect. 8% strongly agreed, 8% were neutral, 31% agreed, and 54% disagreed with having challenges with computers/laptops. On technical issues, 8% strongly agreed, 23% agreed, 15% were neutral, and 54% disagreed on facing technical issues. Concerning time, 8% Strongly agreed, agreed, were neutral, 69% disagreed, while 8% strongly disagreed with having challenges managing their time. On whether participants faced challenges conceptualizing projects, 8% strongly agreed, 15% agreed, 38% disagreed, and a similar number disagreed.

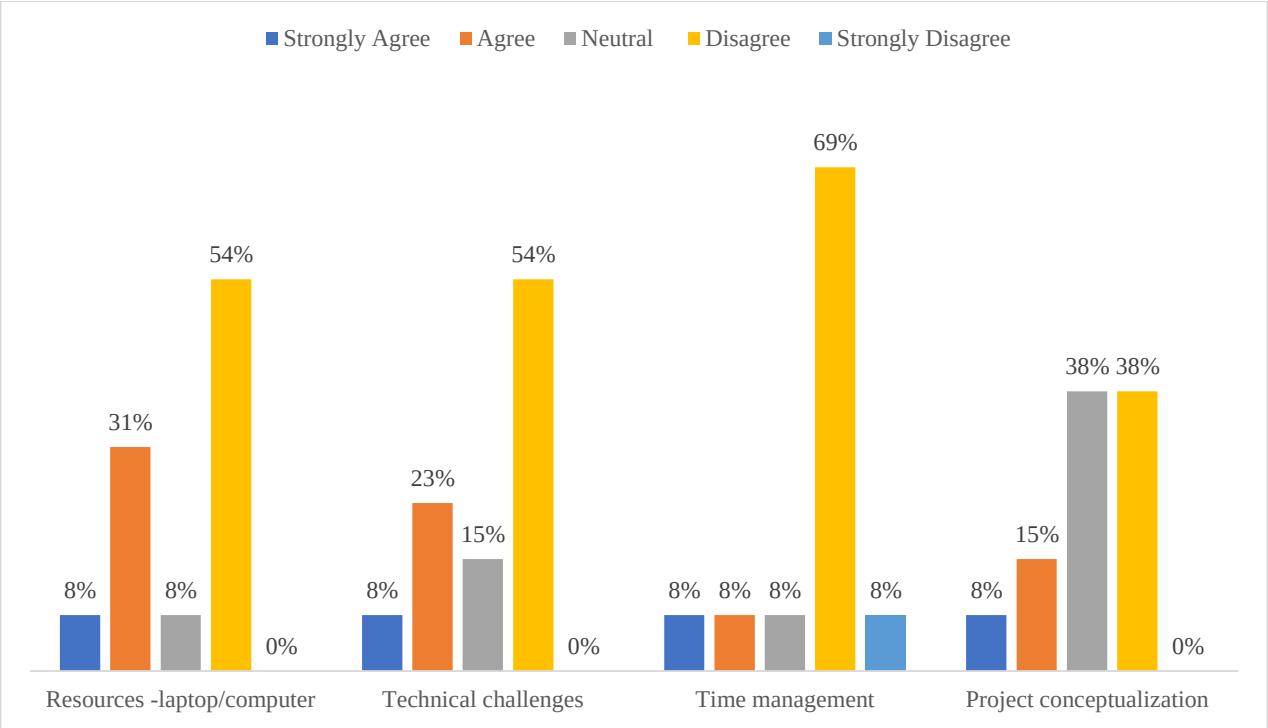

Fig. 5. PjBL Challenges Faced by Learners

Table 3 presents the aspects of implementing PjBL in the mobile application class that learners found discouraging. The aspects were grouped into technical challenges, resource-related challenges, time management, and difficulty in understanding concepts.

Table 3. Discouraging Aspects of PjBL

Themes	Excerpts
Technical Challenges	- "Mostly on creating your own database from scratch." - "Linking my login with regeneration page database." - "A lot of errors which I was able to solve later."
Lack of Resources	- "Lack of a laptop." - "Buying a laptop late."
Time Management	- "Time management." - "Timelessness."
Difficulty Understanding Concepts	- "At times I was left behind during the class...due to not understanding some concepts."
No Discouragement	- "No." - "None." - "None to the least." - "None, I prefer project-based learning."

3.3 Readiness for Future Adoption of PjBL in All Courses

As to what learners felt towards the future adoption of PjBL in all their courses in the diploma programme, learners expressed their readiness. Figure 6 is a word cloud created from learners' responses. Learners found this to be a great idea, a better approach to learning likely to increase understanding of course concepts. Lastly, learners pointed out areas of improvement in the implementation of PjBL. Table 4 presents a thematic analysis of the improvement areas as explained by participants. The need to provide better resources is amplified. Learners pointed to the need to keep the projects as individual instead of group while also pointing out the need for fair grading of the milestones made during the project development.

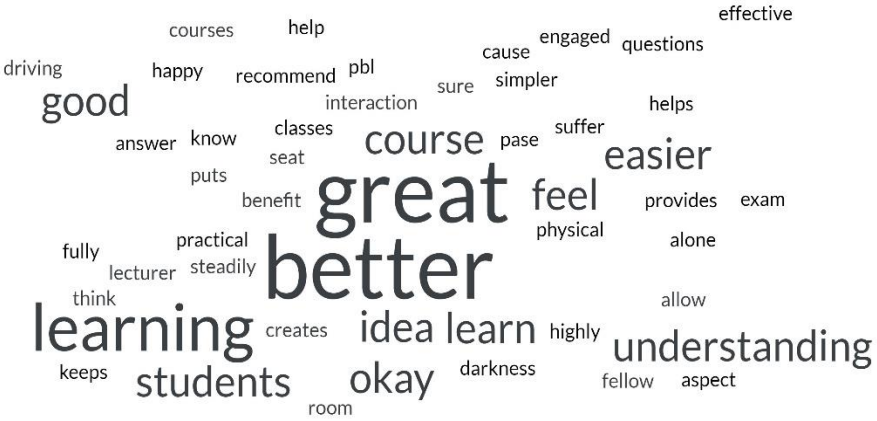

Fig. 6. Word Cloud of Learners' Readiness to Adopt PjBL

Table 4. Areas of Improvement in PjBL

Themes	Excerpts
Resource Challenges	- "Adding more RAM to the computers to allow efficient working." - "Provision of good resources for those that don't have, e.g., good computers for those without laptops."
No Improvement Needed	- "Everything was okay." - "None, I prefer the project-based learning."
Grading Fairness	- "Don't fail students who at least tried to do the project."
More Project Practice	- "More project practices."
Individual Project Preference	- "Keep it individual, not group work."

4. Discussion

It is evident from the findings of this study that students find PjBL beneficial. Students agree that PjBL makes the learners feel motivated and involved. Learners build hands-on skills, collaborate, master concepts, get interested, connect links with other courses, and become better prepared for future projects. Notably, the study findings are consistent with those of Iwamoto et al. [17], who found that PjBL increases self-efficacy, grows learners' mindsets, and makes learners feel in control of their learning. Similarly, Beier, et al. [8] found that involving learners in projects positively influenced learners' perceptions and skills toward STEM. PjBL affords learners the ability to "create" artifacts such as code and interfaces. Further, learners' ability to master concepts is significantly improved using PjBL, as they engage in learning activities and create their knowledge as advocated by [35] and [16]. This study established that learners found PjBL exciting because they could stay engaged in discussions and gain the ability to "create" and learn practically.

As for the challenges of implementing PjBL in software development courses, access to laptops and technical challenges feature prominently. Institutions implementing PjBL must ensure that learners have access to fairly usable computing resources, such as computers or laptops, since PjBL involves creating resources-intensive artifacts such as programs or user interfaces. Learners must be supported and guided on handling errors arising from their code using tools like ChatGPT and websites like Stack Overflow. Facilitators should be available to help learners through consultation, given that learners' ability to learn varies significantly. Time management during the project period should be emphasized, and learners should be encouraged to stick to the timelines as this practice is expected when they transion to industry. Intrestingy, students want to be assured of fairness in grading given that they feel their hands-on approach to the course ought to be reward. Some students express their preference for individual projects as opposed to group projects suggesting that use of PjBL makes them confident.

Learners are positive about adopting PjBL in all courses; they are confident that such a move would make them more engaged, put them in the driving seat, increase their understanding of concepts, and simplify learning. Some learners opine that PjBL should not be adopted in all courses; this requires in-depth study to ascertain the courses that are more appropriate for applying PjBL. As for future improvements on how PjBL is integrated with learning, most responses given by students focused on making sure that suitable hardware was available. Interestingly, learners are also keen to make sure that the facilitators give progress reports and that attempts count towards the final score and not just the ability to create the entire project. Evidently, as observed by Pan, et al. [36], a greater appreciation of the roles of both learners and facilitators is requisite for the proper implementation of PjBL. These are critical insights that should be factored in when planning to integrate PjBL into courses. Some learners want to attempt projects as individuals as opposed to groups, as shown in response 13 in Table 6. The importance of group work in software development and work environments cannot be underscored. Facilitators have to explain the critical role of learners being able to work in groups while working on the projects.

5. Conclusion

Our study sought to characterize learners' experiences with implementing project-based learning (PjBL) in a mobile application development course. The findings demonstrate that PjBL empowers students to take ownership of their learning process, fostering the creation of computer science artifacts while enhancing collaboration and communication skills. Learners expressed a strong desire for the broader adoption of PjBL in computer science courses, signaling its potential to transform technical education.

This study provides educators with a viable model for integrating PjBL into technical curricula. It highlights the importance of ensuring adequate computing resources and structured support to overcome challenges such as technical difficulties and time management issues. These insights are particularly useful for curriculum designers and policymakers aiming to align academic practices with evolving industry demands and the need for 21st-century skills.

The study's limitations include the small, context-specific class size and reliance on self-reported data may limit the generalizability of the findings to other settings, however, use of both qualitative and quantitative methods provides traigulations that help overcome personal biases among survey respondents. Future research should consider larger, more diverse samples and incorporate longitudinal designs to assess the long-term impact of PjBL on learner outcomes.

In sum, while acknowledging its limitations, this study underscores the transformative potential of PjBL in technical education and offers practical recommendations for its effective implementation.

References

[1] A. Asriani and R. Triwoelandari, "The Effectiveness Of Developing Science E-Modules Based Project-Based Learning To Improve The Communication Skills Of Grade 5th Students," *Jurnal Cakrawala Pendas*, vol. 9, no. 4, pp. 750-761, 2023.

[2] S. Y. Mak, "Better student engagement in class by implementation of self-initiated project in undergraduate mechanical engineering course," presented at the Proceedings of the 5th International Conference on Digital Technology in Education, Busan, Republic of Korea, 2022. [Online]. Available: https://doi.org/10.1145/3488466.3488494.

[3] R. Sooriamurthi, N. Falkner, E. Meyer, and Z. Michalewicz, "Puzzle-Based Learning: Introducing Creative Thinking and Problem Solving for Computer Science and Engineering (Abstract Only)," presented at the Proceedings of the 46th ACM Technical Symposium on Computer Science Education, Kansas City, Missouri, USA, 2015. [Online]. Available: https://doi.org/10.1145/2676723.2678301.

[4] J. G. Tullis and R. L. Goldstone, "Why does peer instruction benefit student learning?," *Cognitive research: principles and implications*, vol. 5, pp. 1-12, 2020.

[5] O.-S. Tan, *Problem-based learning innovation: Using problems to power learning in the 21st century*. Gale Cengage Learning, 2021.

[6] S. E. Gallagher and T. Savage, "Challenge-based learning in higher education: an exploratory literature review," *Teaching in Higher Education*, vol. 28, no. 6, pp. 1135-1157, 2023.

[7] K. D. Torralba and L. Doo, "Active learning strategies to improve progression from knowledge to action," *Rheumatic Disease Clinics*, vol. 46, no. 1, pp. 1-19, 2020.

[8] M. E. Beier, M. H. Kim, A. Saterbak, V. Leautaud, S. Bishnoi, and J. M. Gilberto, "The effect of authentic project‐based learning on attitudes and career aspirations in STEM," *Journal of Research in Science Teaching*, vol. 56, no. 1, pp. 3-23, 2019.

[9] J. W. Thomas, "A review of research on project-based learning," ed, 2000.

[10] A. Markula and M. Aksela, "The key characteristics of project-based learning: how teachers implement projects in K-12 science education," *Disciplinary and Interdisciplinary Science Education Research*, vol. 4, no. 1, pp. 1-17, 2022.

[11] A. Sharma, H. Dutt, C. N. V. Sai, and S. M. Naik, "Impact of project based learning methodology in engineering," *Procedia Computer Science*, vol. 172, pp. 922-926, 2020.

[12] J. W. McManus and P. J. Costello, "Project based learning in computer science: a student and research advisor's perspective," *Journal of Computing Sciences in Colleges*, vol. 34, no. 3, pp. 38-46, 2019.

[13] D. Kokotsaki, V. Menzies, and A. Wiggins, "Project-based learning: A review of the literature," *Improving schools*, vol. 19, no. 3, pp. 267-277, 2016.

[14] Y. Dilekli, "Project-Based Learning," in *Paradigm Shifts in 21st Century Teaching and Learning*, Ş. Orakcı Ed. Hershey, PA, USA: IGI Global, 2020, pp. 53-68.

[15] M. MacLeod and J. T. van der Veen, "Scaffolding interdisciplinary project-based learning: a case study," *European journal of engineering education*, vol. 45, no. 3, pp. 363-377, 2020.

[16] D. A. Kolb, "Experience as the source of learning and development," *Upper Sadle River: Prentice Hall*, 1984.

[17] B. P ́erez and Á. L. Rubio, "A project-based learning approach for enhancing learning skills and motivation in software engineering," in *Proceedings of the 51st ACM technical symposium on computer science education*, 2020, pp. 309-315.

[18] D. H. Iwamoto, J. Hargis, and K. Vuong, "The effect of project-based learning on student performance: An action research study," *International Journal for the Scholarship of Technology Enhanced Learning*, vol. 1, no. 1, pp. 24-42, 2016.

[19] O. Kızkapan and O. Bektaş, "The effect of project based learning on seventh grade students' academic achievement," 2017.

[20] T. T. Craig and J. Marshall, "Effect of project‐based learning on high school students' state‐mandated, standardized math and science exam performance," *Journal of Research in Science Teaching*, vol. 56, no. 10, pp. 1461-1488, 2019.

[21] M. Maros, M. Korenkova, M. Fila, M. Levicky, and M. Schoberova, "Project-based learning and its effectiveness: evidence from Slovakia," *Interactive Learning Environments*, pp. 1-9, 2021.

[22] E. Rozal, R. Ananda, A. Zb, M. Fauziddin, and F. Sulman, "The effect of project-based learning through YouTube presentations on English learning outcomes in physics," *AL-Ishlah: Jurnal Pendidikan*, vol. 13, no. 3, pp. 1924-1933, 2021.

[23] B. J. Barron *et al.*, "Doing with understanding: Lessons from research on problem-and project-based learning," in *Learning Through Problem Solving*: Psychology Press, 2014, pp. 271-311.
[24] T.-Y. Mou, "Students' evaluation of their experiences with project-based learning in a 3D design class," *The Asia-Pacific Education Researcher,* vol. 29, no. 2, pp. 159-170, 2020.
[25] C. Marnewick, "Student experiences of project-based learning in agile project management education," *Project Leadership and Society,* vol. 4, p. 100096, 2023.
[26] B. Hussein, "Addressing collaboration challenges in project-based learning: The student's perspective," *Education Sciences,* vol. 11, no. 8, p. 434, 2021.
[27] M. Ricaurte and A. Viloria, "Project-based learning as a strategy for multi-level training applied to undergraduate engineering students," *Education for Chemical Engineers,* vol. 33, pp. 102-111, 2020.
[28] F. Rahman, "Integrating Project-Based Learning in Mobile Development Course to Enhance Student Learning Experience," presented at the Proceedings of the 19th Annual SIG Conference on Information Technology Education, Fort Lauderdale, Florida, USA, 2018. [Online]. Available: https://doi.org/10.1145/3241815.3241851.
[29] R. Francese, C. Gravino, M. Risi, G. Scanniello, and G. Tortora, "Using Project-Based-Learning in a mobile application development course—An experience report," *Journal of Visual Languages & Computing,* vol. 31, pp. 196-205, 2015/12/01/ 2015, doi: https://doi.org/10.1016/j.jvlc.2015.10.019.
[30] S. El-Tawab, S. Iskandarova, M. Almalag, and P. Ghazizadeh, "A methodology of teaching mobile development for undergraduate students in project-based classes," in *Society for Information Technology & Teacher Education International Conference*, 2018: Association for the Advancement of Computing in Education (AACE), pp. 749-754.
[31] A. W. Wambua, "What Do Flutter Developers Ask About? An Empirical Study on Stack Overflow Posts," *Journal of Software Engineering Research and Development,* vol. 12, no. 1, pp. 7: 1-7: 13, 2024.
[32] Z. Nurbekova, V. Grinshkun, G. Aimicheva, B. Nurbekov, and K. Tuenbaeva, "Project-based learning approach for teaching mobile application development using visualization technology," *International Journal of Emerging Technologies in Learning (iJET),* vol. 15, no. 8, pp. 130-143, 2020.
[33] K. M. Alpi and J. J. Evans, "Distinguishing case study as a research method from case reports as a publication type," *Journal of the Medical Library Association: JMLA,* vol. 107, no. 1, p. 1, 2019. [Online]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6300237/pdf/jmla-107-1.pdf.
[34] R. K. Yin, *Case study research and applications: Design and methods*. Sage publications, 2017.
[35] D. A. Kolb, *Experiential learning: Experience as the source of learning and development*. FT press, 2014.
[36] G. Pan, P.-S. Seow, V. Shankararaman, and K. Koh, "An exploration into key roles in making project-based learning happen: Insights from a case study of a university," *Journal of International Education in Business,* vol. 14, no. 1, pp. 109-129, 2021.

Author Profiles

Anthony Wambua Wambua is a lecturer in the Department of Computer Science at Daystar University, Kenya. He holds an MSc in Computer Science and is currently pursuing a Ph.D. in the same field. He is a member of IEEE and ACM. His research interests include Software Engineering, Metaheuristic Algorithms and eLearning.

Alex Maingi Wambua teaches in the Department of Computer Science at Daystar University, Kenya. He holds an MSc in Computer Science and CCNA Certification. A member of International Association for Engineers (IAENG), his research interests include Networking for Big Data in Education, Quantum Networking and Secure IoT.

Edwin Ragira Osoro holds a master's degree in Computer Science and is currently pursuing a Ph.D. in the same field. As a member of ACM, his research interests include Cyber Security, Artificial Intelligence, Threat Intelligence, Data Security, and Software Engineering. He is a lecturer in the Department of Computer Science at Daystar University, Kenya.

How to cite this paper: Anthony Wambua Wambua, Alex Maingi Wambua, Edwin Ragira Osoro, "Exploring Learner Experiences in Project-Based Learning for a Mobile Application Development Course", International Journal of Education and Management Engineering (IJEME), Vol.15, No.3, pp. 14-23, 2025. DOI:10.5815/ijeme.2025.03.02