Mobile E-Portfolios on Google Sites: A Tool for Enhancing Project-Based Learning

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Abstract—Project-based learning is a student-centered approach to learning that emphasizes hands-on experiences, collaboration, and real-world problem-solving. The process of evaluating students' learning outcomes in a learning project, however, faces numerous challenges. This study investigates the potential of mobile e-portfolios on the Google Sites platform as a means of enhancing project-based learning in the field of physics education. The study utilized a quasi-experimental design with two groups: an experimental group consisting of 119 students and a control group consisting of 124 students. The data collected from the pre-test and post-test were analyzed using a t-test to determine the significance of the difference in the mean scores between the experimental group and the control group. The questionnaire data were analyzed using descriptive statistics to identify patterns and trends in student feedback. The results show that the use of mobile e-portfolios on the Google Sites platform significantly enhanced student interest and learning outcomes. After the pedagogical experiment, the experimental group's test scores (7.92) were higher than the control group's (5.22). According to the findings of the survey questionnaire given to the experimental group, the majority of students indicated that using mobile e-portfolios boosted their involvement and motivation to learning, as well as their ability to plan and present their project work. In conclusion, the findings of this study suggest that mobile e-portfolios on Google Sites can be an effective tool for enhancing project-based learning.

Keywords—assessment, e-portfolio, Google Sites, mobile e-portfolios, project-based learning

1 Introduction

The use of technology in education has been rapidly increasing over the last decade, and with it, the implementation of project-based learning has become a common teaching strategy. Project-based learning has been recognized as an effective teaching strategy that promotes student engagement, critical thinking, and problem-solving skills [1]–[3]. In project-based learning, students work collaboratively on real-world projects, which require them to apply their knowledge and skills to solve complex problems. However, assessing students' learning outcomes in project-based learning is challenging, as traditional assessment methods such as tests and exams may not accurately reflect the diverse range of skills and knowledge students acquire through project-based learning. Moreover, these methods may not provide students with opportunities to reflect on their learning or to showcase their learning in diverse ways. Portfolios have been proposed as an alternative assessment tool in project-based learning, as they can provide a more comprehensive and authentic representation of students' learning outcomes [4].

E-portfolios have emerged as a promising tool for assessing students' learning outcomes in project-based learning, as they offer several advantages over paper-based portfolios, such as greater flexibility, multimedia capabilities, and ease of sharing and collaboration [5]–[7]. While e-portfolios have been shown to be effective in promoting student learning and engagement, they can also be time-consuming and challenging to implement, especially in mobile learning environments. In recent years, the increasing availability of mobile devices such as smartphones and tablets has opened up new possibilities for using e-portfolios in education.

In today's fast-paced and highly connected world, mobile devices have become an indispensable part of our lives. With the widespread adoption of smartphones and tablets, people are increasingly using mobile technology to access information, communicate with others, and perform various tasks on-the-go. This shift towards mobile has had a profound impact on many areas of our lives, including education. Mobile technology has opened up new avenues for learning and has transformed the way we approach education. With mobile devices, learners can access educational resources anytime, anywhere, making learning more flexible and accessible. Mobile technology has also created new opportunities for collaboration, engagement, and personalized learning, enabling educators to create more dynamic and engaging learning experiences for students [8], [9]. As such, having e-portfolios available on mobile devices is a natural trend. By making e-portfolios mobile, individuals can showcase their achievements and skills in real-time, without being tied to a desktop computer. Thus, mobile e-portfolios is necessary to keep up with the changing needs and habits of people in today's digital world. Mobile e-portfolios allow students to capture and document their learning experiences on-the-go, using multimedia tools such as photos, videos, and audio recordings. This can help to enhance the authenticity and relevance of portfolio assessments, as well as increasing students' engagement and motivation [10], [11].

Physics is a critical area of study that aims to help students develop a deep understanding of fundamental physical principles and concepts. Physics education also aims to enable students to apply their knowledge to real-world problems and challenges. To achieve these goals, educators use various teaching methods, including project-based learning, to engage students and enhance their learning experiences [12], [13]. However, the process of evaluating students' learning outcomes in a learning project in physics education faces numerous challenges. In this study, we explore the use of mobile e-portfolios on the Google Sites platform [69] as a tool for enhancing project-based learning in the context of physics education. The use of Google Sites as a platform for e-portfolios has several advantages, including its ease of use, flexibility, and compatibility with other Google tools such as Google Drive [70] and Google Classroom [71]. The research problem addressed in this study is to determine the impact of mobile e-portfolios on student learning outcomes, and interest in the context of project-based learning in physics education. Specifically, the study seeks to answer the following research questions:

1. Does the use of mobile e-portfolios on the Google Sites platform impact student learning outcomes in project-based learning?
2. What are student perceptions of the usefulness and effectiveness of mobile e-portfolios on the Google Sites platform in project-based learning?

By addressing these research questions, this study aims to provide evidence for the potential of mobile e-portfolios as a tool for enhancing project-based learning in physics education, and to contribute to the broader conversation about the role of technology in promoting student learning and interest.

To achieve the research objectives, the study will use a quasi-experimental design with two groups: an experimental group and a control group. The effectiveness of the mobile e-portfolios will be assessed by comparing the mean scores of the experimental and control groups on a standardized physics test. In addition, students in the experimental group will be invited to participate in a survey to explore their perceptions of the usefulness and effectiveness of mobile e-portfolios in enhancing their learning, engagement, and motivation. The data will be analyzed to identify common themes and patterns in student feedback.

The results of the study showed that the use of mobile e-portfolios on the Google Sites platform significantly enhanced student interest and learning outcomes in project-based learning. Specifically, the experimental group's test scores were significantly higher than the control group's test scores, indicating that the use of mobile e-portfolios had a positive impact on student learning. Furthermore, the majority of students in the experimental group indicated that using mobile e-portfolios boosted their involvement and motivation to learn, as well as their ability to plan and present their project work.

The findings of this study are expected to contribute to the growing body of research on the effectiveness of e-portfolios and mobile learning in enhancing project-based learning in physics education. By providing evidence for the potential of mobile e-portfolios on the Google Sites platform as a tool for enhancing project-based learning in physics education, the findings may also inform the design and implementation of similar project-based learning activities in other subject areas and contexts, contributing to the growth of research on the use of mobile technologies in education.

2 Literature review

The purpose of this literature review is to explore the potential benefits of using mobile e-portfolios on Google Sites as a platform for enhancing project-based learning outcomes. While the use of mobile e-portfolios in project-based learning has shown promise, there is a lack of empirical research on their effectiveness in the context of Google Sites. This study aims to address this gap by investigating the impact of using mobile e-portfolios on Google Sites on students' learning outcomes in project-based learning, particularly in the context of physics education.

The definition of project-based learning in a nutshell is "a model of organizing learning around learning projects" [14]. To put it more precisely, this is a method of instruction that involves students in the creation of knowledge by having them complete worthwhile projects and create things that have practical uses [15], [16]. Project-based learning is based on the student-centered principle and has the following features: learning is based on real-world situations; students actively engage in the learning process; and students reach their objectives through collaboration and sharing [17]. According to this model, students conduct research and develop their problem-solving skills [18].

At all learning levels, project-based learning has a host of beneficial effects [17]. Numerous studies demonstrate how project-based learning encourages active participation from students [19], [20], which reduces procrastination [21], [22]. It also encourages students to take responsibility for their learning and to act independently [18]. Once again, it helps students develop their study skills [23], particularly their ability to think critically [24], [25], creatively [24], [26], [27], and collaboratively [28]. This approach is also employed to evaluate students in an efficient manner [29]. Many of the products produced through project-based learning are not only used for educational purposes but also have a wide range of practical applications [30]. According to Hira and Anderson's research, project-based learning has also helped to improve the quality of online instruction [31].

Project-based learning also has some drawbacks, such as a growing workload that takes a lot of time and requires ineffective teamwork that produces subpar project results [32], [33]. It can be challenging to assess the outcomes of project-based learning. In actuality, the primary method of assessing the outcomes of project-based learning is through evaluating the learning products of the project [34]. The evaluation of the finished product only looks at the outcome; it ignores the project members' roles, implementation progress, and other important information. It is necessary to assess the procedure and make modifications in order to effectively monitor and evaluate the progress [35].

Portfolios are a required and suitable form of assessment in project-based learning. The assessment will be more accurate because students will have documented their work and outcomes in portfolios while the project is being carried out. On the other hand, using traditional portfolios to evaluate project-based learning's outputs presents many challenges. The diversity and richness of the output forms for the learning project cannot be accommodated by using conventional portfolios, which can only represent written and graphic records. Additionally, ongoing progress reviews cannot be accommodated in traditional portfolios on a regular basis. Peer feedback is more useful than instructor feedback when carrying out a learning project [36]. At the same time, student participation in more active learning projects is encouraged by feedback from peers [37], [38]. However, traditional portfolios find it challenging to meet these demands.

E-portfolios were developed with remarkable advantages to overcome the drawbacks of traditional portfolios. E-portfolios are collections of student work that serve as a visual representation of the student's learning journey [39]. Products include completed research projects, images, motion pictures, observations, and assessments.

Students can quickly arrange, edit, and combine documents from outside sources with the help of e-portfolios [40]. Studies by Lin [41], Abrami & Barrett [42], and Yang et.al [43] have shown that using e-portfolios can increase students' engagement in a task and their motivation to learn, as well as give them the opportunity to become independent and interactive. Lukitasari et al. demonstrated that e-portfolios are suitable tools for project-based learning product evaluation because they have exceptional benefits like multimedia performance, regular process monitoring, and peer-review interaction [5]. Gülbahar and Tinmaz [7] presented a case study of the implementation of project-based learning and e-portfolio assessment in a small-scale (N=8) undergraduate course in the Department of Computer Education and Instructional Technology. The study aimed to investigate the suitability of project-based learning and e-portfolio assessment in this specific context, which was the compulsory Design, Development, and Evaluation of Educational Software course. The authors found that despite the small class size and students' challenges with animation software, project-based learning was an appropriate choice for conducting the course. The use of e-portfolio assessment was also found to be valuable in supporting project-based learning. Overall, this study provides empirical evidence of the potential of project-based learning and e-portfolio assessment in the context of undergraduate education. The study demonstrates the benefits of using e-portfolios to support project-based learning and highlights the importance of integrating technology in the teaching and learning process.

Physics education is a critical area of study that seeks to provide students with a deep understanding of fundamental physical principles and concepts. It also aims to equip students with the ability to apply their knowledge to real-world problems and challenges [44]. To achieve these goals, educators employ various teaching methods [45 – 49], including project-based learning, to engage students and enhance their learning experiences. In the context of physics education, project-based learning can provide students with opportunities to explore complex concepts more engagingly and interactively [50]. By engaging in project-based learning activities, students can develop a deeper understanding of physics principles and concepts, while also building important skills such as critical thinking, problem-solving, and collaboration [51].

The use of e-portfolios in project-based learning in physics education can enhance students' learning experiences in several ways. E-portfolios can provide students with a more dynamic and engaging platform for documenting and showcasing their work than traditional paper-based portfolios. On the other hand, it can enable students to incorporate multimedia elements such as videos, images, and audio recordings into their portfolios, which can help them to communicate their ideas more and demonstrate their understanding of physics concepts. E-portfolios can give students a more individualized and self-directed learning experience. By allowing students to take ownership of their learning and track their progress over time, e-portfolios can enhance students' motivation and interest in physics education [52].

Despite the growing body of literature on e-portfolios in project-based learning, there are still several outstanding issues that need to be addressed. One major challenge is the lack of a unified framework for e-portfolio assessment in project-based learning [53]. This has led to inconsistencies in the assessment of e-portfolios and a lack of clarity in terms of how to evaluate the quality of student work. Another issue is the need for greater attention to the development of students' digital literacy skills in the use of e-portfolios [54]. However, the traditional desktop-based e-portfolio platforms may limit the mobility and accessibility of e-portfolios, which can be problematic for project-based learning activities that require students to work collaboratively and document their work on-the-go [55].

Given the increasing reliance on technology in education, it is essential that students are equipped with the necessary digital skills to effectively utilize e-portfolios in their learning. Mobile learning has become an important area of research in recent years due to the proliferation of mobile devices and the increasing importance of technology in education. Mobile learning refers to learning that takes place through the use of mobile devices, such as smartphones and tablets. Mobile learning has become increasingly popular in recent years due to the widespread use of mobile devices and the growing availability of mobile learning technologies. Mobile learning can enhance project-based learning by providing students with access to resources and learning opportunities anytime and anywhere [56], [57], [58].

Mobile learning and e-portfolios are important topics in modern education research, and there is a growing body of literature on these subjects. Many researchers agree that mobile learning can enhance student learning outcomes by providing access to resources and learning opportunities anytime and anywhere [56], [59], [60]. Similarly, e-portfolios are seen as a useful tool for supporting student learning and reflection. Modern views on the issue suggest that the use of mobile e-portfolios in project-based learning can enhance student learning outcomes by providing students with a platform to showcase their work, reflect on their learning, and collaborate with their peers.

Mobile e-portfolios have been identified as a promising tool for enhancing project-based learning. Related research is also conducted on nursing students in clinical wards [10]. The study found that mobile e-portfolios are a user-friendly, accessible, and attractive method for the objective assessment of students. This tool allowed for careful assessment of the students by encouraging their information literacy and feedback, and it satisfied 70% of the students. The study provides valuable insights into the potential of mobile e-portfolios as a tool for assessing the performance of nursing students in clinical wards. However, this study has some limitations, including a relatively small sample size and a lack of a control group.

There are not many empirical studies have explored the use of mobile e-portfolios in project-based learning. Therefore, further research is needed to explore the effectiveness of mobile e-portfolios in larger and more diverse samples and to compare their efficacy with other assessment tools.

In particular, more studies are needed to investigate the impact of mobile e-portfolios on student learning outcomes and engagement in different educational contexts and subject areas. This is particularly true in the context of project-based learning in physics education. As such, there is a need for further research to explore the efficacy of using mobile e-portfolios in project-based learning and to identify the factors that contribute to their success, particularly in the context of using Google Sites as a platform for creating and sharing mobile e-portfolios.

This study aims to address this gap by investigating the impact of using mobile e-portfolios on Google Sites on students' learning outcomes in project-based learning.

The use of mobile e-portfolios on the Google Sites platform is a promising approach for enhancing project-based learning. Google Sites is a free, user-friendly platform that allows users to create and share websites. Mobile e-portfolios on Google Sites have several advantages over traditional paper-based portfolios, including greater flexibility, ease of access, and the ability to embed multimedia content such as videos and images.

In a related study, Gan et al. reported on several approaches, including mobile learning projects, social learning platforms, wiki and web page creation tools, and project-based learning [61]. The authors suggest that Google Sites provides an opportunity for students to collaborate and contribute to a shared platform that can be used to create and present content related to course topics. This approach to collaborative learning using Google Sites allows students to take ownership of their learning process by engaging in activities that promote critical thinking, problem-solving, and collaboration. However, it relies heavily on anecdotal evidence and does not include a rigorous empirical evaluation of the impact of digital media on student learning outcomes.

This study seeks to build on previous research by exploring the efficacy of mobile e-portfolios on Google Sites in project-based learning in the context of physics education, with a focus on assessing student interest and learning outcomes. The findings of this study will contribute to the growing body of research on the use of interactive mobile technologies in learning and teaching, and have potential implications for the design and implementation of project-based learning activities in a variety of contexts.

3 Methodology

3.1 Participants

To evaluate the effectiveness of mobile e-portfolios on the Google Sites platform in project-based learning, we conducted a pedagogical experiment with 243 high school students. The experiment involved the implementation of a project-based learning activity in a physics class. The participants were in the 11th grade, and their ages ranged from 16 to 18 years old. The sample was selected using a convenience sampling technique, with all students in the physics class being invited to participate in the study.

The study utilized a quasi-experimental design with two groups: an experimental group and a control group. The students were randomly assigned to one of two groups. The experimental group was given access to mobile e-portfolios on the Google Sites platform, while the control group was not.

The decision of which experimental samples to use has a big impact on the outcomes of pedagogical experiments. Students in the experimental and control groups must therefore be comparable in terms of student numbers, organizational conditions for the classroom, and the depth and quality of their learning (based on the learning results in previous semester). With these specifications, the sample is chosen to guarantee sample size and sample quality for pedagogical experimentation. Particularly, the distribution of students among the groups is as follows:

Table 1. Number of students in experimental and control groups

Experimental group		**Control group**	
No	***Qty***	***No***	***Qty***
EG1	42	CG1	39
EG2	20	CG2	22
EG3	27	CG3	29
EG4	30	CG4	34
Total	**119**	**Total**	**124**

3.2 Research design

Both groups were given a pre-test to establish a baseline level of understanding of the physics concepts covered in the course. Over the course of the semester, the experimental group was given access to the mobile e-portfolios on the Google Sites platform to create and showcase their learning projects. The control group did not have access to the e-portfolios but followed the same project-based learning curriculum.

The chapter "Eyes. Optical Instruments" of Physics 11 was chosen as the content for conducting pedagogical experiments. With the project "Making Simple Telescopes", problem-based learning is used in the teaching process.

- For the control group, conduct project-based learning and evaluate learning products using traditional portfolios;
- For the experimental group, conduct project-based learning and evaluate learning products using e-portfolios on the Google Sites platform.

Following the pedagogical experiment, we use appropriate statistical methods to verify and compare the results between the two groups of control and experimental groups. The goal is to see if the experimental group's learning results are better than the control group's, and if the experimental group's interest in learning is high or low. From there, conclusions about the feasibility of this study can be drawn.

The steps for conducting pedagogical experimentation are as follows:

* **Step 1:** Direct students toward understanding and creating mobile e-portfolios on the Google Sites platform.

Teachers create written instructions, create video tutorials, and upload them to YouTube to complete this step. The video can be found at this link: https://youtu.be/UjSeXbVwd34. Students participating in the implementation process will find it simpler to access and comprehend the construction process instruction provided via video.

* **Step 2**: Create a challenge and give the student the assignment to implement the educational project "Making Simple Telescopes" within the context of the chapter "Eyes. Optical Instruments", Physics 11

To carry out the project, the teacher quizzes the class and gives the students tasks to complete. The teacher also talks with the class to help them decide on the project evaluation criteria. Students move forward with developing the project plan by identifying the work that needs to be done, estimating the time, materials, funds, and methods of conducting; assigning work, and preparing the theoretical groundwork for project implementation. All plans and criteria must be updated by students on mobile e-portfolios for simple monitoring and implementation, based on receiving the direction of teachers.

* **Step 3**: Execute the project

The implementation procedure adheres to project-based learning's fundamental steps. Additionally, the teacher expects students to fulfill the following requirements as they carry out the project:

- Reading and comprehending theoretical background materials on thin lenses and telescopes and uploading to personal mobile e-portfolios;
- Regularly updating their progress by taking notes, snapping photos, or making videos to show how the project is being carried out;
- In order for students to make the best adjustments, teachers and classmates can access, monitor, and comment on the implementation process by using the link shared.

* **Step 4:** Report the learning project's

- In order for teachers and classmates to comment, students must prepare reports of results and proof of project products on mobile e-portfolios before class.
- Students use mobile e-portfolios to show the development of the learning project as well as to present the project's outcomes and products in class.
- Teachers and classmates discuss, comment on, and grade work based on the agreed-upon criteria after listening to reports and viewing students' mobile e-portfolios.

* **Step 5:** Assess students' understanding of lenses and optical devices

To ensure scientific rigor, carry out the same test as the control group, and then compare the results and analyze them to draw inferences.

* **Step 6:** Questionnaires to gauge students' interest

Following a pedagogical experiment, the instructor uses questionnaires to survey the students' levels of interest.

Methods for analyzing pedagogical experimental results. To analyze the outcomes of pedagogical experiments objectively and scientifically in order to respond to the initial research questions, we proceed as follows:

- Two tests are administered to students in the experimental and control groups jointly. The purpose of the first test is to assess the degree of similarity between the two experimental subjects and determine whether there are any differences between the experimental and control groups before the experimental is carried out. After the chapter "Eyes. Optical Instruments" ended, the second test was administered. To ensure fairness and objectivity in comparing the learning outcomes of the experimental group using mobile e-portfolios on the Google Sites platform and the control group using only traditional paper-based portfolios, the tests' content is identical.

- Questionnaires were used to conduct a survey of the experimental class's students at the conclusion of the pedagogical experiment to learn more about their experiences using mobile e-portfolios on the Google Sites platform.

The research was conducted with an experimental group of students who used mobile e-portfolios as a tool for enhancing project-based learning. To measure the students' interest and motivation in using the mobile e-portfolio tool, a survey questionnaire was developed based on the Technology Acceptance Model (TAM) [62]. The questionnaire included items that measured students' perceptions of the perceived usefulness and ease of using mobile e-portfolio on the Google Sites platform. The questionnaire was administered to the students at the end of the project-based learning activities, after they had completed their final presentations using the mobile e-portfolios on Google Sites. This allowed the students to reflect on their experiences and provide feedback on the effectiveness of the tool and the learning activities. The questionnaire was anonymous to encourage honest responses from the students and was designed to take approximately 5-10 minutes to complete. The participants rated their responses using a Likert-type scale, with scores ranging from 1 (strongly disagree) to 5 (strongly agree).

The choice of methods used in this study was based on the need to obtain reliable and valid data on the effectiveness of mobile e-portfolios on the Google Sites platform in enhancing project-based learning. The use of multiple-choice questions in the pre-test and post-test ensured that the assessment was objective and reliable, as the same questions were asked to both groups. The use of a questionnaire allowed for gathering qualitative data on student feedback and interest of the mobile e-portfolios, which provided additional insight into the effectiveness of the intervention.

4 Results

A total of 243 high school students participated in a pedagogical experiment to assess the effectiveness of using mobile e-portfolios on the Google Sites platform in project-based learning in the context of physics education. The results indicated that the use of mobile e-portfolios improved student interest and learning outcomes.

The box plot in Figure 1 shows the difference in the two tests between the experimental and control groups. For the first test before the pedagogical experiment (pre-test), the test scores of the experimental and control groups have Median = 6; Q1 = 5; Q3 = 8; IQR = 3. This means that there was no difference in test scores between both groups before the pedagogical experiment. However, for the second test after completing the pedagogical experiment (post-test), the difference in test scores of the experimental and control groups could be clearly seen. The experimental group has Median = 8; Q1 = 7; Q3 = 9; while the control group has Median = 5; Q1 = 4; Q3 = 6.

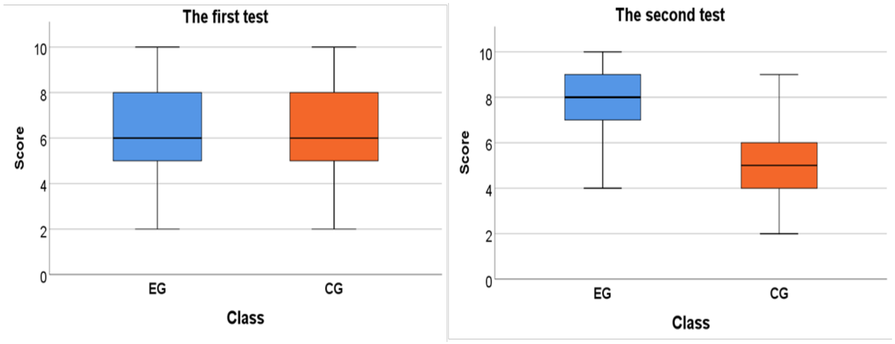

Fig. 1. Correlation between the two tests of the experimental and control groups

Besides, the Levene test's Sig index for the two tests is Sig1= 0.303 > 0.05 and Sig2= 0.305 > 0.05, respectively. This indicates that there is no variance difference between the experimental and control groups. As a result, Table 2's F-test results will be used. The results of the Anova test on the distinction between experimental and control groups in the two tests in Table 2 demonstrate that:

- For the first test, the F-test has Sig = 0.328 > 0.05. Therefore, it can be said that there is no difference in test scores between the experimental and control groups. This demonstrates that students' abilities were similar prior to the pedagogical experiment;
- However, in the second test, the F-test has Sig = 0.000 < 0.05. This demonstrates that there is a difference in the test results between the two groups of control and experimental groups.

Table 2. Anova results

		Sum of Squares	df	Mean Square	F	Sig.
Score1	Between Groups	3.859	1	3.859	.962	.328
	Within Groups	966.437	241	4.010		
	Total	970.296	242			
Score2	Between Groups	444.856	1	444.856	186.310	.000
	Within Groups	575.440	241	2.388		
	Total	1020.296	242			

According to Table 3, the groups' respective means for the first test are EG = 6.25 and CG = 6.00; for the second test, the respective means are EG = 7.92 and CG = 5.22. This demonstrates that after pedagogical experimentation, students can engage in problem-based learning through mobile e-portfolios on the Google Sites platform, which helps students achieve better learning outcomes than students using traditional paper-based portfolios.

Table 3. Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
						Lower Bound	*Upper Bound*
Score1	EG	119	6.25	2.072	.190	5.88	6.63
	CG	124	6.00	1.934	.174	5.66	6.34
	Total	243	6.12	2.002	.128	5.87	6.38
Score2	EG	119	7.92	1.480	.136	7.66	8.19
	CG	124	5.22	1.606	.144	4.93	5.50
	Total	243	6.54	2.053	.132	6.28	6.80

For the questionnaire, we ensure the reliability and validity of the survey instrument by conducting a pilot test of the questionnaire with a small group of students to identify any potential issues with the survey items. We then made revisions to the survey instrument based on the feedback received and conducted additional pilot tests until we were satisfied with the final version of the questionnaire. To assess the reliability of the survey instrument, we calculated Cronbach's alpha coefficient for each of the survey scales. The alpha coefficients ranged from 0.85 to 0.94, indicating good internal consistency and reliability of the survey scales.

After that, students in the experimental group who used mobile e-portfolios on the Google Sites platform to complete the project's product filled out a questionnaire as part of the study. Following data collection, SPSS version 25 was used to code and analyze the data. Descriptive measures for the variables at each level of measurement were included in the data analysis. Table 4 shows the results of the survey questionnaire administered to the experimental group. The majority of the students reported that using mobile e-portfolios increased their engagement and motivation to learn, as well as their ability to organize and present their project work.

Table 4. Results of the student survey

No	Content	Mean	SD
1	I've discovered that Google Sites makes it easier for me to comprehend and grasp the project's topic	3.89	0.77
2	Using Google Sites to present my project results and build websites made me feel at ease	4.27	0.72
3	When compared to other tools, using Google Sites helps me produce a better project outcome	2.45	0.62
4	Using Google Sites has made learning more enjoyable for me	4.41	0.69
5	I made the most of Google Sites' features to produce a project product of the highest caliber	3.67	0.75
6	For my upcoming learning projects, I want to keep using Google Sites	2.33	0.72
7	I believe Google Sites to be a helpful tool for me to present the project products in a professional manner	4.54	0.81
8	I find Google Sites to be very user-friendly and simple to use	3.80	0.69
9	I can update my learning project on Google Sites at any time, from anywhere.	3.87	0.79
10	I will suggest Google Sites to my friends for use in learning projects	4.32	0.74

The features of the platform that let students customize their portfolios were valued by the students, who found it simple to record their reflections on it. This made it possible for them to effectively reflect on their project-related progress and showcase their learning journey. The documentation and presentation of students' projects was made possible by the use of Google Sites. The platform gave students a structured, visually appealing way to present their work, which helped them become better communicators and presenters.

Overall, the findings suggest that the use of mobile e-portfolios on the Google Sites platform is an effective tool for enhancing project-based learning in physics education. The results contribute to the growing body of research on the use of interactive mobile technologies in learning and teaching, and suggest that e-portfolios are a promising tool for evaluating student learning projects. The use of mobile technologies in education has the potential for broader application in learning and teaching contexts, beyond the field of physics education.

5 Discussions

Based on the results of this study, it can be concluded that mobile e-portfolios on the Google Sites platform are an effective tool for enhancing project-based learning in the field of physics education. Specifically, the results suggest that the use of mobile e-portfolios can improve student interest and learning outcomes. These findings contribute to existing research on project-based learning and the use of mobile e-portfolios in education [63], [64]. This study highlights the potential of mobile e-portfolios to address some of these challenges by providing students with a tool to document and reflect on their learning process and outcomes.

Moreover, this study specifically focused on the use of Google Sites as a platform for mobile e-portfolios. Google Sites is a free and widely accessible platform, making it a practical option for educators looking to integrate e-portfolios into their teaching practice. This study's findings suggest that Google Sites can be an effective platform for mobile e-portfolios and may be suitable for other subject areas beyond physics education. This is consistent with previous research that has shown the benefits of mobile learning in enhancing student engagement and motivation [59], [65]. Mobile learning allows students to access educational resources and communicate with peers and instructors at any time and from any location.

However, some authors have raised concerns about the use of mobile e-portfolios in education. For example, Lorenzo & Ittelson [66] noted that technical challenges and privacy and data security concerns may restrict the adoption of e-portfolios. Additionally, some authors have raised concerns about the potential for e-portfolios to distract students from the actual learning objectives of the project [67], [68]. In light of these concerns, it is important to consider the implementation of mobile e-portfolios in project-based learning. Thus, effective implementation of mobile e-portfolios requires careful consideration of the instructional design, as well as technical support and training for students and teachers. Furthermore, safeguards must be put in place to protect the privacy and security of student data.

The significance of this research lies in its contribution to the field of educational science and specifically, to the area of project-based learning and the use of e-portfolios in education. This study provides empirical evidence of the effectiveness of mobile e-portfolios on the Google Sites platform in enhancing project-based learning outcomes in physics education. By demonstrating the effectiveness of mobile e-portfolios in project-based learning, this study provides teachers and educators with a new tool for evaluating student learning outcomes. Moreover, the study's use of Google Sites as a platform for e-portfolios provides a practical and accessible solution for educators looking to incorporate e-portfolios into their teaching. The findings of this study contribute to the growing body of research on the use of interactive mobile technologies in learning and teaching.

However, it is important to acknowledge the limitations of this study. Firstly, the study only focused on the use of mobile e-portfolios in the context of physics education, and future research is needed to explore their potential benefits in other subjects. Secondly, the study only examined the short-term effects of using mobile e-portfolios, and it is unclear whether these effects would be sustained over a longer period of time. Finally, the study did not compare the effectiveness of mobile e-portfolios with other assessment tools, and future research could explore the relative effectiveness of different assessment methods.

6 Conclusion

In conclusion, the current study provides evidence that mobile e-portfolios on the Google Sites platform can be an effective tool for enhancing project-based learning in physics education.

The findings demonstrate that the use of mobile e-portfolios was associated with higher test scores, increased student interest, motivation, and involvement in learning, as well as improved ability to plan and present project work effectively. These findings suggest that mobile e-portfolios can be an effective tool for educators to evaluate and support student learning outcomes in project-based learning contexts. In addition, the findings of this study contribute to the growing body of research on the use of interactive mobile technologies in learning and teaching, and suggest that e-portfolios are a promising tool for evaluating student learning projects.

The results of this study can be used to inform future research in several ways. First, future studies could build on these findings by exploring the impact of mobile e-portfolios in different educational contexts and with different populations of students. Additionally, future research could investigate the potential of mobile e-portfolios to support other aspects of project-based learning, such as collaboration and reflection. Furthermore, future studies could focus on developing and validating new instruments for assessing the impact of mobile e-portfolios on student learning outcomes. To build upon the findings of this study, future research could explore the potential benefits of mobile e-portfolios in other subjects and educational contexts. In addition, research could investigate the long-term effects of using mobile e-portfolios and compare their effectiveness with other assessment methods.

Future research can investigate the extent to which the findings of this study can be replicated in other disciplines and settings, as well as explore the potential of other mobile e-portfolio platforms beyond Google Sites. Furthermore, this study opens up opportunities for further research on the use of technology in project-based learning. Future research can investigate the role of other digital tools and platforms, such as virtual reality and social media, in supporting project-based learning outcomes. Additionally, future research can explore the impact of e-portfolios on other aspects of student learning, such as creativity, collaboration, and critical thinking.

7 References

[1] Kumar, J. A. (2021). Educational chatbots for project-based learning: investigating learning outcomes for a team-based design course. International Journal of Educational Technology in Higher Education, 18(1). https://doi.org/10.1186/s41239-021-00302-w

[2] Hawari, A. D. M., & Noor, A. I. M. (2020). Project Based Learning Pedagogical Design in STEAM Art Education. Asian Journal of University Education, 16(3). https://doi.org/10.24191/ajue.v16i3.11072

[3] MacLeod, M., & van der Veen, J. T. (2020). Scaffolding interdisciplinary project-based learning: a case study. European Journal of Engineering Education, 45(3). https://doi.org/10.1080/03043797.2019.1646210

[4] Jaeger, M., & Adair, D. (2015). Using an evidential reasoning approach for portfolio assessments in a project-based learning engineering design course. European Journal of Engineering Education, 40(6). https://doi.org/10.1080/03043797.2014.1001817

[5] Lukitasari, M., Hasan, R., Sukri, A., & Handhika, J. (2021). Developing student's metacognitive ability in science through project-based learning with e-portfolio. International Journal of Evaluation and Research in Education, 10(3). https://doi.org/10.11591/IJERE.V10I3.21370

[6] Maćias, J. A. (2012). Enhancing project-based learning in software engineering lab teaching through an e-portfolio approach. IEEE Transactions on Education, 55(4). https://doi.org/10.1109/TE.2012.2191787

[7] Gülbahar, Y., & Tinmaz, H. (2006). Implementing project-based learning and E-portfolio assessment in an undergraduate course. Journal of Research on Technology in Education, 38(3). https://doi.org/10.1080/15391523.2006.10782462

[8] Heflin, H., Shewmaker, J., & Nguyen, J. (2017). Impact of mobile technology on student attitudes, engagement, and learning. Computers & education, 107, 91-99. https://doi.org/10.1016/j.compedu.2017.01.006

[9] Papadakis, S., Alexandraki, F., & Zaranis, N. (2022). Mobile device use among preschool-aged children in Greece. Education and Information Technologies, 27(2). https://doi.org/10.1007/s10639-021-10718-6

[10] Mosalanejad, L., Saeedabdollahifard, & Rezaie, R. (2018). Mobile e-portfolio as a personal digital assistant in nursing education. Pakistan Journal of Medical and Health Sciences, 12(2).

[11] Urazbaev, K. (2020). INVESTIGATING THE ACCEPTANCE OF MOBILE E-PORTFOLIO AS AN E-LEARNING TOOL BY PRE-SERVICE TEACHER EDUCATION PROGRAM STUDENTS. EurasianUnionScientists, 1(11(80)). https://doi.org/10.31618/esu.2413-9335.2020.1.80.1089

[12] Baran, M., Maskan, A., & Yasar, S. (2018). Learning physics through project-based learning game techniques. International Journal of Instruction, 11(2). https://doi.org/10.12973/iji.2018.11215a

[13] Goldstein, O. (2016). A project-based learning approach to teaching physics for pre-service elementary school teacher education students. Cogent Education, 3(1). https://doi.org/10.1080/2331186X.2016.1200833

[14] Hugerat, M. (2016). How teaching science using project-based learning strategies affects the classroom learning environment. Learning Environments Research, 19(3). https://doi.org/10.1007/s10984-016-9212-y

[15] Brundiers, K., & Wiek, A. (2013). Do we teach what we preach? An international comparison of problem- and project-based learning courses in sustainability. Sustainability (Switzerland), 5(4). https://doi.org/10.3390/su5041725

[16] Krajcik, J. S., & Shin, N. (2014). Project-based learning. In The Cambridge Handbook of the Learning Sciences, Second Edition (275–297). Cambridge University Press. https://doi.org/10.1017/CBO9781139519526.018

[17] Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. Improving Schools, 19(3), 267–277. https://doi.org/10.1177/1365480216659733

[18] Chua, K. J., Yang, W. M., & Leo, H. L. (2014). Enhanced and conventional project-based learning in an engineering design module. International Journal of Technology and Design Education, 24(4). https://doi.org/10.1007/s10798-013-9255-7

[19] Fernandes, S., Mesquita, D., Flores, M. A., & Lima, R. M. (2014). Engaging students in learning: Findings from a study of project-led education. European Journal of Engineering Education, 39(1). https://doi.org/10.1080/03043797.2013.833170

[20] Dolezal, D., Posekany, A., Roschger, C., Koppensteiner, G., Motschnig, R., & Pucher, R. (2018). Person-Centered Learning using Peer Review Method – An Evaluation and a Concept for Student-Centered Classrooms. International Journal of Engineering Pedagogy, 8(1), 127–147. https://doi.org/10.3991/ijep.v8i1.8099

[21] Almulla, M. A. (2020). The Effectiveness of the Project-Based Learning (PBL) Approach as a Way to Engage Students in Learning. SAGE Open, 10(3). https://doi.org/10.1177/2158244020938702

[22] Santyasa, I. W., Rapi, N. K., & Sara, I. W. W. (2020). Project based learning and academic procrastination of students in learning physics. International Journal of Instruction, 13(1), 489–508. https://doi.org/10.29333/iji.2020.13132a

[23] Rais, M., Yahya, M., Jamaluddin, & Purnamawati. (2021). Comparing project-based learning and problem-based learning to foster 21st-century learning skills in agricultural seaweed product. Cypriot Journal of Educational Sciences, 16(3), 1217–1230. https://doi.org/10.18844/CJES.V16I3.5842

[24] Anazifa, R. D., & Djukri. (2017). Project- based learning and problem- based learning: Are they effective to improve student’s thinking skills? Jurnal Pendidikan IPA Indonesia, 6(2), 346–355. https://doi.org/10.15294/jpii.v6i2.11100

[25] Mutakinati, L., Anwari, I., & Yoshisuke, K. (2018). Analysis of students’ critical thinking skill of middle school through stem education project-based learning. Jurnal Pendidikan IPA Indonesia, 7(1). https://doi.org/10.15294/jpii.v7i1.10495

[26] Sumarni, W., & Kadarwati, S. (2020). Ethno-stem project-based learning: Its impact to critical and creative thinking skills. Jurnal Pendidikan IPA Indonesia, 9(1), 11–21. https://doi.org/10.15294/jpii.v9i1.21754

[27] Ummah, S. K., Inam, A., & Azmi, R. D. (2019). Creating manipulatives: Improving students’ creativity through project-based learning. Journal on Mathematics Education, 10(1), 93–102. https://doi.org/10.22342/jme.10.1.5093.93-102

[28] Sakulvirikitkul, P., Sintanakul, K., & Srisomphan, J. (2020). The design of a learning process for promoting teamwork using project-based learning and the concept of agile software development. International Journal of Emerging Technologies in Learning, 15(3), 207–222. https://doi.org/10.3991/ijet.v15i03.10480
[29] Guo, P., Saab, N., Post, L. S., & Admiraal, W. (2020). A review of project-based learning in higher education: Student outcomes and measures. International Journal of Educational Research, 102. https://doi.org/10.1016/j.ijer.2020.101586
[30] Das, L., Naiksatam, A., & Shama, M. (2020). Project based learning: Effective tool for a course on electronic product design. Journal of Engineering Education Transformations, 33(Special Issue), 257–259. https://doi.org/10.16920/jeet/2020/v33i0/150157
[31] Hira, A., & Anderson, E. (2021). Motivating online learning through project-based learning during the 2020 COVID-19 pandemic. IAFOR Journal of Education, 9(2), 93–110. https://doi.org/10.22492/ije.9.2.06
[32] Gardiner, W., & Robinson, K. S. (2009). Paired Field Placements: A Means for Collaboration. New Educator, 5(1). https://doi.org/10.1080/1547688X.2009.10399565
[33] Veermans, M., Lallimo, J., & Hakkarainen, K. (2005). Patterns of guidance in inquiry learning. Journal of Interactive Learning Research, 16(2).
[34] Barak, M. (2005). From order to disorder: The role of computer-based electronics projects on fostering of higher-order cognitive skills. Computers and Education, 45(2). https://doi.org/10.1016/j.compedu.2004.12.001
[35] Helle, L., Tynjälä, P., & Olkinuora, E. (2006). Project-based learning in post-secondary education - Theory, practice and rubber sling shots. Higher Education, 51(2). https://doi.org/10.1007/s10734-004-6386-5
[36] Hsu, S. (2005). Help-seeking behaviour of student teachers. Educational Research, 47(3). https://doi.org/10.1080/00131880500287716
[37] Ching, Y. H., & Hsu, Y. C. (2013). Peer feedback to facilitate project-based learning in an online environment. International Review of Research in Open and Distance Learning, 14(5). https://doi.org/10.19173/irrodl.v14i5.1524
[38] Gallegos, C., Gehrke, P., & Nakashima, H. (2019). Can mobile devices be used as an active learning strategy? Student perceptions of mobile device use in a nursing course. Nurse educator, 44(5), 270-274. https://doi.org/10.1097/NNE.0000000000000613
[39] Johnson, R., Mims-Cox, J., & Doyle-Nichols, A. (2014). Developing Portfolios in Education: A Guide to Reflection, Inquiry, and Assessment. In Developing Portfolios in Education: A Guide to Reflection, Inquiry, and Assessment. https://doi.org/10.4135/9781483349398
[40] Stefani, L., Mason, R., & Pegler, C. (2007). The educational potential of e-portfolios: Supporting personal development and reflective learning. In The Educational Potential of e-Portfolios: Supporting Personal Development and Reflective Learning. https://doi.org/10.4324/9780203961292
[41] Lin, Q. (2008). Preservice teachers' learning experiences of constructing e-portfolios online. Internet and Higher Education, 11(3–4). https://doi.org/10.1016/j.iheduc.2008.07.002
[42] Abrami, P., & Barrett, H. (2005). Directions for Research and Development on Electronic Portfolios. Canadian Journal of Learning and Technology / La Revue Canadienne de l'apprentissage et de La Technologie, 31(3). https://doi.org/10.21432/t2rk5k
[43] Yang, M., Tai, M., & Lim, C. P. (2016). The role of e-portfolios in supporting productive learning. British Journal of Educational Technology, 47(6), 1276-1286. https://doi.org/10.1111/bjet.12316

[44] Rebello, N. S., Cui, L., Bennett, A. G., Zollman, D. A., & Ozimek, D. J. (2017). Transfer of Learning in Problem Solving in the Context of Mathematics and Physics. In Learning to Solve Complex Scientific Problems. https://doi.org/10.4324/9781315091938-10
[45] Anh, T. T. N, Duy, Nhi, T. N (2021). Effectiveness of Kahoot on exam scores in physics of high-school sctudents: A case study in Vietnam. Journal of Legal, Ethical and Regulatory Issues, 24(1S), 1 - 12.
[46] Zourmpakis, A. I., Kalogiannakis, M., & Papadakis, S. (2023). A Review of the Literature for Designing and Developing a Framework for Adaptive Gamification in Physics Education, The International Handbook of Physics Education Research: Teaching Physics, edited by Mehmet Fatih Taşar and Paula R. L. Heron (AIP Publishing, Melville, New York, 2023), Chapter 5, 5-1–5-26. https://doi.org/10.1063/9780735425712_005
[47] Kalogiannakis, M., Papadakis, S., & Zourmpakis, A. I. (2021). Gamification in science education. A systematic review of the literature. Education Sciences, 11(1), 22. https://doi.org/10.3390/educsci11010022
[48] Zourmpakis, A.-I., Papadakis, St., & Kalogiannakis, M. (2022). Education of Preschool and Elementary Teachers on the Use of Adaptive Gamification in Science Education, International Journal of Technology Enhanced Learning (IJTEL), 14(1), 1-16. https://doi.org/10.1504/IJTEL.2022.120556
[49] Tran Thi Ngoc Anh - Nguyen Thanh Phong (2021). Designing of Optics Experiment for Visually Impared Students in Physics Learning. Review of International Geographical Education Online, 11 (10), 184-193.
[50] Susanti, E., Maulidah, R., & Makiyah, Y. S. (2021). Analysis of problem-solving ability of physics education students in STEM-based project based learning. Journal of Physics: Conference Series, 2104(1). https://doi.org/10.1088/1742-6596/2104/1/012005
[51] Mihardi, S., Harahap, M. B., & Sani, R. A. (2013). The Effect of Project Based Learning Model with KWL Worksheet on Student Creative Thinking Process in Physics Problems. Journal of Education and Practice, 4(25).
[52] Sarwandi, Wibawa, B., & Wibawa, R. (2022). Usage of e-portfolio as an assessment tool in physics learning. Journal of Physics: Conference Series, 2165(1), 012043. https://doi.org/10.1088/1742-6596/2165/1/012043
[53] Oakley, G., Pegrum, M., & Johnston, S. (2014). Introducing e-portfolios to pre-service teachers as tools for reflection and growth: lessons learnt. Asia-Pacific Journal of Teacher Education, 42(1). https://doi.org/10.1080/1359866X.2013.854860
[54] Abuzaid, M. M., Elshami, W., & Noorajan, Z. (2021). The impact of clinical practice E-portfolio in radiology education during COVID-19 outbreak. International Journal of Current Research and Review, 13(6). https://doi.org/10.31782/IJCRR.2021.SP172
[55] Wang, H. W. (2010). Finance e-learning and simulation toward the cloud service environment. International Journal of Internet Protocol Technology, 5(4). https://doi.org/10.1504/IJIPT.2010.039232
[56] Talan, T. (2020). The effect of mobile learning on learning performance: A meta-analysis study. In Educational Sciences: Theory and Practice (Vol. 20, Issue 1). https://doi.org/10.12738/jestp.2020.1.006
[57] Drolia, M., Papadakis, S., Sifaki, E., & Kalogiannakis, M. (2022). Mobile Learning Applications for Refugees: A Systematic Literature Review. In Education Sciences (Vol. 12, Issue 2). https://doi.org/10.3390/educsci12020096
[58] Papadakis, S., & Kalogiannakis, M. (2019). Mobile learning applications in early childhood education. In Mobile Learning Applications in Early Childhood Education. https://doi.org/10.4018/978-1-7998-1486-3

[59] Barreh, K. A., & Abas, Z. W. (2015). A Framework for Mobile Learning for Enhancing Learning in Higher Education. Malaysian Online Journal of Educational Technology, 3(3).
[60] Arizen, A., & Suhartini, S. (2020). Mobile learning student worksheet based on socio-scientific-issues: Enhancing students' scientific literacy skills in biology. JPBI (Jurnal Pendidikan Biologi Indonesia), 6(1). https://doi.org/10.22219/jpbi.v6i1.11196
[61] Gan, B., Menkhoff, T., & Smith, R. (2015). Enhancing students' learning process through interactive digital media: New opportunities for collaborative learning. Computers in Human Behavior, 51. https://doi.org/10.1016/j.chb.2014.12.048
[62] Davis, Jr., F. D. (1986). A technology acceptance model for empirically testing new end-user information systems: Theory and results [Dissertation]. Doctoral Dissertation, Massachusetts Institute of Technology.
[63] Devi Ariningsih, N. K., Artini, L. P., & Marsakawati, N. P. E. (2021). The Effect of E-Portfolio in Project-Based Learning toward Learner Autonomy and Writing Competency. Journal of Education Research and Evaluation, 5(1). https://doi.org/10.23887/jere.v5i1.29982
[64] Sutarno, H., Putro, B. L., Judhie, R. R., & Piantari, E. (2019). E-portfolio assessment model on collaborative problem solving (CPS) learning based on digital learning environment. Journal of Physics: Conference Series, 1280(3). https://doi.org/10.1088/1742-6596/1280/3/032030
[65] Anh, T. T. N., & Phong, N. T. (2023). The Effects of Socrative-Based Online Homework on Learning Outcomes in Vietnam: A Case Study. International Journal of Interactive Mobile Technologies, 17(05), 182–199. https://doi.org/10.3991/ijim.v17i05.37513
[66] Lorenzo, G., & Ittelson, J. (2005). An overview of e-portfolios. Educause, July.
[67] Habeeb, K. M., & Ebrahim, A. H. (2019). Impact of e-portfolios on teacher assessment and student performance on learning science concepts in kindergarten. Education and Information Technologies, 24(2). https://doi.org/10.1007/s10639-018-9846-8
[68] Kenny, A. J. (2015). Motivated for Learning? The introduction of e-portfolios to Level 1 students in a Further Education college. The Journal of Technology Enhanced Learning, Innovation & Change, 1(1).
[69] http://sites.google.com
[70] http://drive.google.com
[71] http://classroom.google.com

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