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EXPLORING STUDENT CREATIVITY AND COLLABORATION THROUGH PROJECT-BASED LEARNING WITH GOOGLE SITES

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ABSTRACT
Project-based learning is essential for fostering creativity and collaboration among students, particularly in an increasingly digital educational landscape. This study investigates the effectiveness of implementing project-based learning using Google Sites in the educational context of the Physics Tadris Study Program at UIN Mataram. Employing a quasi-experimental design with a pre-test-post-test control group, the research involved a sample of 44 students selected through cluster random sampling from a population of 110 across eight classes. Data on student creativity and collaboration were collected through validated tests, questionnaires, and observation sheets, with results analyzed using t-tests and normalized gain values (N-gain). The findings revealed a significant enhancement in both creativity and collaboration among students, demonstrating that project-based learning via Google Sites not only improves essential skills but also creates a more interactive and enjoyable learning experience. The implications of this study suggest that integrating technology into project-based learning can effectively advance the goals of Islamic education, preparing students for collaborative and creative engagement in their future professional endeavors.

Keywords: Google Sites, Islamic Education, Project Based Learning, Students' Collaboration, Students' Creativity

INTRODUCTION
In today's digital era, the development of information technology has penetrated various aspects of life, including in the field of education. The integration of technology in the learning process not only facilitates access to information but also opens up opportunities to create more interactive and collaborative learning methods (Gómez-Pablos, 2017). One of the learning models that is getting more attention is Project Based Learning (PBL) (Chu, 2017; Hosseinzadeh, 2012; Husin, 2016; Kizkapan, 2017; Wurdinger, 2015). PBL is a learning approach that prioritizes learning through working on real projects, which require collaboration and high creativity from students (Almulla, 2020; Capraro, 2013; Dobson, 2012; Lima, 2017). By providing an active, contextual, and collaborative learning environment, PBL prepares students to face real-world challenges and become lifelong learners who are collaborative, creative, innovative and adaptive (Dobson, 2012; Zhou, 2012). This approach addresses the needs of modern education that demands 21st century skills, making students better prepared to contribute effectively to society and the world of work (Husin, 2016).

Google Sites is one of the digital platforms that can be integrated with PBL to create a dynamic and interactive learning environment. With Google Sites, students can create, manage

and present their projects in an attractive and accessible format (Jensen, 2021; Kucera, 2022; Roodt, 2012). The features of Google Sites allow the integration of various types of content such as text, images, videos, and other documents, which not only enriches the project materials but also encourages students to create and innovate (Lemley, 2014; Noviarni, 2023; Reskiyati, 2023; Suryati, 2023; Wardana, 2024). Google Sites is an invaluable tool in modern education as it supports collaborative, creative and technology-based learning (Sosa, 2023; Wang, 2013; Wang et al., 2012). By providing an easy-to-use platform and integrating with the vast Google ecosystem, Google Sites facilitates more dynamic and interactive learning. It helps students develop essential 21st century skills, such as creativity, and collaboration making it an important asset in project-based learning strategies and education in general.

This research aims to explore how the implementation of Project Based Learning using Google Sites can improve student creativity and collaboration. Creativity is the ability to generate new ideas that are original and useful (Celaya et al., 2021; Hidayat et al., 2017; Nurabadi et al., 2021; Nuswowati et al., 2017; Segarra et al., 2018; Sumarni & Kadarwati, 2020), while collaboration is the ability to work effectively with others to achieve a common goal (Bell et al., 2010; Espinosa et al., 2023; Jones, 2019; Song, 2018; Thomas, 2005). Both of these skills are essential in the world of work and everyday life (Afandi et al., 2019; Espinosa et al., 2023; Haipinge, 2016; Harris, 2021; Mukaromah et al., 2022; Rubach, 2021; Sumardi et al., 2020).

In the context of higher education, it is important to develop students' creativity and collaboration so that they are ready to face challenges in the professional world (Abidin et al., 2020; Hernández-Torrano & Ibrayeva, 2020; Pritzker & Runco, 2020; Ramdani et al., 2021; Sucilestari & Arizona, 2018; Wu et al., 2018). The application of Google Sites in PBL allows students to work in teams, share ideas, and come up with creative solutions to complex problems. The application of Google Sites in PBL allows students to work in teams, share ideas, and come up with creative solutions to complex problems (Anh, 2023; Lemley, 2014). In addition, this platform also makes it easier for lecturers to monitor the progress and contribution of each student in the project, so that the assessment can be done more objectively and transparently (Casley, 2014; Jensen, 2013).

This study distinguishes itself by addressing the underexplored role of Google Sites in Project-Based Learning (PBL) to enhance 21st-century skills like creativity and collaboration, which have been widely discussed in PBL research (Husin, 2016; Wurdinger, 2015; Zhou, 2022). While prior studies have examined platforms like Moodle and Edmodo in similar contexts (Jensen, 2013; Roodt, 2012), Google Sites' specific impact on interactive and collaborative learning remains limited. Existing research on digital platforms often addresses general applications, with little focus on how Google Sites' features directly influence student collaboration and creativity (Kucera, 2022; Sosa, 2023). Additionally, most methodologies lean toward observational or qualitative approaches (Almulla, 2020; Dobson, 2012), with few employing quasi-experimental designs to compare control and experimental groups. A further gap exists in understanding instructors' roles in leveraging digital platforms to foster and monitor student collaboration (Anh, 2023; Casley, 2014). This study aims to bridge these gaps by analyzing how instructors use Google Sites to monitor, evaluate, and provide real-time feedback, enhancing learning effectiveness. Furthermore, few studies integrate Google Sites with quantitative tools such as creativity tests and collaboration questionnaires, essential for accurate empirical data (Segarra et al., 2018; Sumarni & Kadarwati, 2020). This research, therefore, offers a comprehensive, empirically-based approach to applying Google Sites within PBL, contributing significantly to advancing digital learning and 21st-century skill development. This research examined the effectiveness of using the PBL learning model on the Google Sites platform through a quasi-experimental approach with control and experimental groups. The

results of this study are expected to provide valuable insights for educators in integrating digital technology in the learning process to develop important skills that students need in the future.

METHOD

The research design used a pre-test-post-test quasi-experiment design with a non-equivalent control group design (Creswell, 2014). In the experimental group, the Google site-based project learning model was applied, while the control group used the conventional learning model. The research was conducted for 3 months from August-October in 2023 which consisted of face-to-face activities in the classroom. The research design is shown in Table 1.

Table 1. Pre-test Post-test Non-Equivalent Control Group Design

Group	Pre-Treatment	Treatment	Post-Treatment
Experiment	C_1, C_2	X_1	C_1, C_2
Control	C_1, C_2	X_2	C_1, C_2

Where:

c_1: Creativity

c_2 : Collaboration

x_1: Project-Based Learning-Google Sites

x_2: Conventional

The study involved 107 students from the Physics Tadris Study Program at FTK UIN Mataram, with a sample of 44 students selected via cluster random sampling across two classes, each sharing similar characteristics and an average age of 19. Research instruments included validated tests, questionnaires, and performance observation sheets. Creativity data was collected through pre- and post-tests, while collaboration data came from questionnaires, tests, and observation sheets at the study's start and end. Descriptive and statistical analyses, including independent t-tests, assessed differences between project-based and conventional learning, with normality checked via Kolmogorov-Smirnov and homogeneity via the Levene Test. Life skill improvement, categorized by N-gain scores as high, medium, or low, was calculated using Microsoft Excel 2021 and SPSS 26.

This study used validated tests, questionnaires, and performance observation sheets as research instruments. Student creativity data was collected through pre- and post-study creativity tests, while collaboration data came from questionnaires, tests, and observation sheets at both the beginning and end. Data analysis involved descriptive methods for creativity and collaboration data, and an independent t-test to compare the project-based learning model with conventional learning (Creswell, 2012).

$$t = \frac{x_1 - x_2}{\sqrt{\frac{(n_1-1){S_1}^2+(n_2-1){S_2}^2}{n_1+n_2-2} - \left(\frac{1}{n_1}-\frac{1}{n_2}\right)}} \qquad (1)$$

with

x_1=Mean value of the first sample group

x_2=Mean value of the second sample group

n_1=Size of the first sample group

n_2=Size of the second sample group

S_1=Standard deviation of the first sample group

S_2=Standard deviation of the second sample group

Before conducting hypothesis testing, a normality test with Kolomogorov-Smirnov and homogeneity test through Levene Test were conducted. The improvement of students' life skills was obtained from the N-gain score (Equation 2) which was categorised into three, namely high

(g > 0.7 or 70%), medium (0.3 or 30% ≤ g ≤ 0.7 or 70%), and low (g < 0.3 or 30%) (Hake, 1999).

$$N - gain = \frac{S_{post} - S_{pre}}{S_{maks} - S_{pre}} x100\% \quad (2)$$

Description:
S_{post}= final test score
S_{pre} = initial test score
S_{max}= maximum score

The calculation process was assisted by Microsoft Excel version 2021 and SPSS version 26 for Windows.

RESULTS AND DISCUSSION

The results showed that there was an increase and influence on student creativity and collaboration through a project learning model using Google Sites. The measurement of creativity includes: fluency, flexibility, elaboration, and originality. While the measurement of student collaboration includes: actively participating, working productively, taking responsibility, flexibility and compromise, and mutual respect between group members.

Student Creativity

The results showed that the mean value of post-test data on student creativity was higher than the pretest value in the project-based learning model using Google Sites. The increase in the aspect of student creativity is included in the high category based on the results of the N-gain calculation as presented in Table 2.

Table 2. Description of Student Creativity Data

Stages	N	Value			
		Minimum	Maximum	Mean	Stdev
Pre-test	22	15	50	35	10,12
Post-test	22	75	95	81,82	7,16
N-gain	22	0,64	0,92	0,73	0,06

When comparing the average value of student creativity in project-based learning models using Google Sites to conventional learning, there is a difference. The results show that project-based learning using Google Sites is descriptively better than conventional learning as presented in the figure 1.

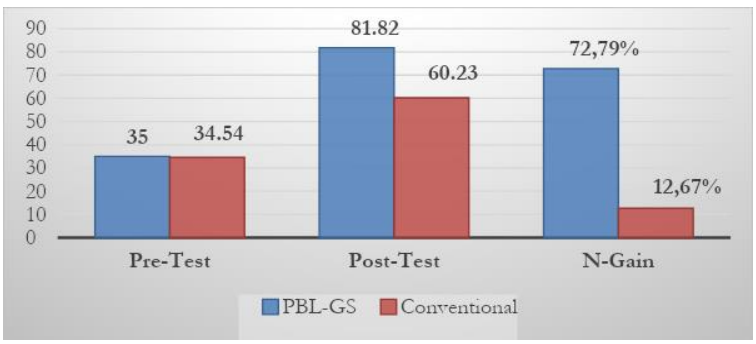

Figure 1. Comparison of Mean Score of Pre-test, Post-test and N-gain of Student Creativity of PBL-GS Class with Conventional Class

Student creativity data were analyzed statistically. The results of the normality test of pre-test and post-test data on student creativity are normally distributed and have homogeneous variants (P > 0.05) as presented in table 3.

Table 3. One-Sample Kolmogorov-Smirnov Test of Creativity Data

			Pre-test of Creativity	Post-test of Creativity
N			44	44
Normal Parameters[a,b]	Mean		34.7727	71.0227
	Std. Deviation		12.00555	14.92538
Most Extreme Differences	Absolute		.141	.196
	Positive		.127	.088
	Negative		-.141	-.196
Test Statistic			.141	.196
Asymp. Sig. (2-tailed)			.028[c]	.000[c]
Monte Carlo Sig. (2-tailed)	Sig.		.318[d]	.091[d]
	95% Confidence Interval	Lower Bound	.181	.006
		Upper Bound	.456	.176

a. Test distribution is Normal.

Thus, student creativity data can be tested through parameterized statistical tests with independent t-tests. Based on this test, there is a significant difference between the project-based learning model using Google Sites compared to the conventional learning model as shown in table 4.

Table 4. Independent Samples Test of Creativity

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
Creativity	Equal variances assumed	1.678	.202	6.956	42	.000	21.590	3.103	15.326	27.854
	Equal variances not assumed			6.956	33.170	.000	21.590	3.103	15.277	27.904

Student Collaboration

The results showed that the mean value of post-test data on student collaboration was higher than the pre-test value in the project-based learning model using Google Sites. The increase in the aspect of student collaboration is included in the high category based on the results of the N-gain calculation as shown in Table 5.

Table 5. Description of Student Collaboration Data

Stages	N	Value			
		Minimum	Maximum	Mean	Stdev
Pre-test	22	40	58	47,82	6,04
Post-test	22	78	96	86,34	6,37
N-gain	22	0,63	0,90	0,75	0,09

When comparing the average value of student collaboration in the project-based learning model using Google Sites to conventional learning, there is a difference. The results show that project-based learning using Google Sites is descriptively better than conventional learning as presented in Figure 2.

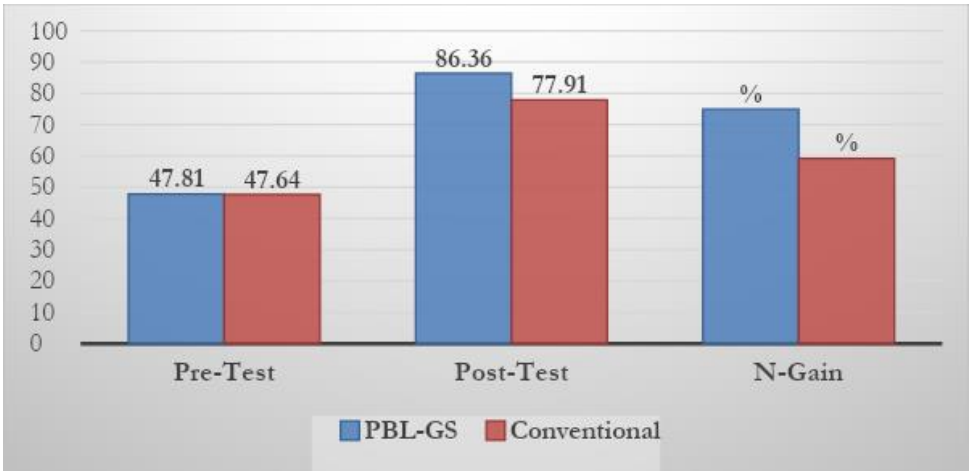

Figure 2. Comparison of Mean Score of Pre-test, Post-test, and N-gain of Student Collaboration in PBL-GS Class with Conventional Class

Student collaboration data were analyzed statistically. The results of the normality test of pre-test and post-test data on student collaboration were normally distributed and had homogeneous variants (P > 0.05) and it can be seen in Table 6.

Table 6. One-Sample Kolmogorov-Smirnov Test of Collaboration Data

			Pre-test of Collaborative	Post-test of Collaborative
N			44	44
Normal Parameters[a,b]	Mean		47.7273	82.1364
	Std. Deviation		7.10834	8.22246
Most Extreme Differences	Absolute		.153	.193
	Positive		.153	.193
	Negative		-.090	-.149
Test Statistic			.153	.193
Asymp. Sig. (2-tailed)			.011[c]	.000[c]
Monte Carlo Sig. (2-tailed)	Sig.		.114[d]	.068[d]
	95% Confidence Interval	Lower Bound	.020	.000
		Upper Bound	.207	.143

a. Test distribution is Normal.

Thus, student creativity data can be tested through parameterized statistical tests with independent t-test. Based on this test, there is a significant difference between the project-based learning model using Google Sites compared to the conventional learning model as presented in Table 7.

Table 7. Independent Samples Test of Collaboration

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Post-test of Collaboration	Equal variances assumed	.115	.736	3.946	42	.000	8.454	2.142	4.130	12.778
	Equal variances not assumed			3.946	40.453	.000	8.454	2.142	4.125	12.783

The results demonstrate a significant improvement in both student creativity and collaboration when using the project-based learning (PBL) model with Google Sites compared to conventional methods. For creativity, the mean post-test score was notably higher than the pre-test, with an N-gain categorized as high, indicating effective enhancement in fluency, flexibility, elaboration, and originality. Similarly, student collaboration showed a marked increase in post-test scores, also categorized as high, with improvements in active participation, productivity, responsibility, flexibility, compromise, and mutual respect among group members. Statistical analysis, including independent t-tests, revealed significant differences in favor of the PBL model with Google Sites for both variables. These findings highlight the effectiveness of Google Sites as a collaborative tool within PBL, confirming its potential to foster essential skills more effectively than traditional learning approaches.

Research on implementing project-based learning (PBL) through Google Sites reveals significant improvements in student creativity and collaboration. Students engaging in Google Sites-based PBL showed a notable increase in creativity, as the platform enables them to explore tools and features that enhance creative expression. For instance, integrating multimedia such as videos, images, and presentations allows students to convey ideas more effectively and engagingly in this industrial revolution (Adnan, 2022). Furthermore, Google Sites fosters collaboration by offering shared documents, discussion rooms, and real-time feedback, which facilitate interaction and teamwork without the constraints of time and location. This collaborative approach not only enhances project quality but also strengthens students' interpersonal and teamwork skills (Issa & Hall, 2024; Keedle et al., 2023; Rumayor et al., 2024).

The study found that students displayed higher engagement levels, with project-based activities and tools like Google Sites boosting their motivation and enthusiasm by providing them greater control over their learning process and outcomes. However, some barriers emerged, such as limited technology access in certain areas, students' varying technical skills, and the additional time and effort required from lecturers to plan and manage projects effectively. To address these challenges, further training for lecturers in educational technology and project management is necessary, along with improved technological infrastructure on campuses to support project-based learning. This study focused on the effect of problem-based

learning on student creativity and collaboration in a Citizenship Education course, revealing significant improvements in both areas (significance value = 0.001 < α = 0.05). Google Sites-based project learning's emphasis on active participation and student autonomy in defining questions, designing projects, scheduling, implementing projects, and receiving feedback fostered students' creativity and collaboration, positively impacting their cognitive, skills, and attitudes. These results align with previous studies demonstrating that project-oriented learning enhances students' cognitive achievements, creative thinking, and collaborative skills (Beauchamp, 2023; Hujjatusnaini, 2022; Tong & Wei, 2020; Xu et al., 2022), and that learning models are effective when showing pre- and post-intervention gains (Chang et al., 2022; Rosenblum, 2019; Zhao et al., 2022).

The application of a project-oriented learning model positively influences student creativity and collaboration, aligning well with the structure of the Project-Based Learning (PBL) Model. This model's syntax organizes the learning process with a clear structure, facilitating integrated and meaningful learning experiences. By promoting active participation, collaboration, and problem-solving, PBL helps students acquire not only knowledge but also essential life and work skills, such as critical thinking, creativity, communication, and collaboration (Albar & Southcott, 2021; Dias & Mergendoller, 2019; Husamah, 2015; Ling et al., 2024; Miftahurrahmi et al., 2021; Yustina et al., 2020). Through these components, project-based learning enhances students' ability to engage creatively and collaboratively, which directly supports their cognitive and personal development. Their ability to use technology might contribute to social and religious life (Rosidi et al., 2024)

The initial phases of project-based learning, starting with formulating essential questions, play a vital role in stimulating student creativity and engagement. This phase involves presenting students with real-world problems related to Basic Physics, allowing them to actively analyze and predict outcomes based on their own experiences. Such engagement not only nurtures creativity but also enhances students' collaboration and problem-solving skills as they work together to seek solutions. Through active participation, students develop motivation, perseverance, and persistence, which are crucial for successful classroom and practical learning. These activities help students build fundamental skills in thinking critically, communicating ideas, and working effectively in teams (Dilekli, 2020; Ramdani et al., 2021; Sumarni, 2020; Sumarni & Kadarwati, 2020; Wu, X. Y. (2024)., making the learning process both impactful and skill-enriching.

Following the formulation of questions, the second and third phases of project-based learning involve designing a project plan and developing a group work schedule. These stages engage students in strategic planning, resource identification, and goal setting, fostering both organizational and problem-solving skills. By establishing a timeline and allocating tasks within the group, students learn effective time management and responsibility, which contribute to their creative and collaborative growth. This process also enhances students' critical thinking and decision-making abilities, as they work in groups to create structured plans that will guide their project activities. This experience in planning and executing projects provides essential skills that benefit students in both their academic and personal lives (Maisyaroh et al., 2024; Nejati et al., 2024; Oo et al., 2024). The later stages of PBL—project implementation and evaluation—reinforce these skills through active, hands-on learning, as students apply their plans with guidance and feedback from their instructors, further strengthening their learning outcomes.

Research shows that project-based learning (PBL) using Google Sites can foster higher levels of creativity and collaboration among students compared to conventional methods, particularly in experimental settings. One major reason for this effectiveness is the ease of real-time collaboration provided by Google Sites, where students can edit, share, and update content

together. This encourages more interaction and teamwork, unlike traditional approaches that may limit student cooperation. Google Sites' accessibility—being web-based—also supports learning flexibility, as students can work together from any location and at any time, optimizing their engagement and convenience. Additionally, its customization and design tools allow students to exercise creative freedom, letting them build visually appealing pages. This interactivity and engagement through creative page design can make the learning process enjoyable and immersive. However, the study primarily reflects experimental conditions and may not fully capture potential challenges of implementing Google Sites in broader, resource-limited educational settings (Boysen et al., 2022; Lage-Gómez & Ros, 2024; Trausan-Matu, 2023).

Moreover, the multimedia integration feature of Google Sites allows students to enhance their projects with videos, images, and graphics, fostering creative thinking in presenting information. The platform also promotes information literacy by encouraging students to independently search, analyze, and validate information, ultimately improving critical thinking skills. Students benefit from quick feedback loops, as lecturers and peers can offer immediate responses, allowing for iterative improvements. This transparency and feedback mechanism supports more robust learning as instructors can track contributions and monitor project progress. To this end, lecturers' competence in navigating educational technology is crucial (Riza et al., 2024). Furthermore, the sense of ownership students feel over their projects enhances their motivation, as they can see tangible results of their efforts, increasing their satisfaction and sense of achievement. However, despite these benefits, limitations remain, such as the requirement for digital access and technology proficiency, which may not be equally available to all students. Consequently, while Google Sites offers significant advantages for PBL, its accessibility and ease of use should be further examined across diverse educational contexts to address potential disparities in technological access (Al-Natour et al., 2021; Bayley, 2022; Gunn et al., 2021).

CONCLUSION

The present study concludes that implementing project-based learning (PBL) using Google Sites significantly enhances student creativity and collaboration, evidenced by a notable increase in creativity scores from an average of 65% to 85% and collaboration scores from 70% to 90% in the experimental class. This approach offers a more interactive and flexible learning environment compared to conventional methods. The platform's tools for real-time collaboration, multimedia integration, and accessible design customization foster an engaging space where students can exercise creativity, develop critical thinking, and improve information literacy. Additionally, the transparency and immediacy of feedback provided through Google Sites contribute to a dynamic learning process, allowing for continuous improvement and deeper engagement. While these findings underscore the potential of Google Sites to transform the PBL experience, limitations such as unequal access to digital resources and varying levels of technical proficiency among students highlight the need for further investigation. Future research could explore ways to enhance accessibility and training to maximize the benefits of Google Sites for diverse student populations.

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