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Scaffolding in guided inquiry learning with google classroom: Effect on physics conceptual understanding

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Abstract: The purpose of this study is to examine the impact of student's conceptual understanding on the topic of elasticity and Hooke's Law utilizing a scaffolding-based technique guided inquiry facilitated by Google Classroom. The quasi-experimental design method is used in this investigation. This study's design includes all class XI students from one of Bandar Lampung's schools for the 2018/2019 academic year. This study employed systematic random sampling to obtain 30 students in each of the experimental and control groups. The research instrument employed was a concept understanding exam consisting of 20 two-tier diagnostic questions with a reliability level of 0.84 in the high category and suitability. The results of this study show an average value of 58.6 in the control group and 73 in the experimental group. The hypothesis results reveal that the significant value of the t-count t-table with the choice H0 is rejected, and the effect size test results suggest that d = 1.08 where d > 0.8. These findings imply that the experimental class outperforms the control class. As a result, the scaffolding-based guided inquiry technique supported by Google Classroom has the potential to alter students' physics conceptual understanding.

Keywords: Concept Understanding, Google Classroom, Guided Inquiry, Scaffolding,

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INTRODUCTION

Planning an effective learning process is the first step in active learning. If the learning process can stimulate productive learning activities, it is said to be good because it can achieve the desire. Low education quality is one of the problems faced by this nation. The cause of low student learning outcomes that become indicators of achievement of learning outcomes is the lack of selection and use of learning strategies, learning models, and learning media (Bigozzi et al., 2014; Celik et al., 2015; Danielsson & Linder, 2009), where a Teaching requires the development of various methods carried out by educators.

The IEA (International Association for the Evaluation of Educational Achievement) conducted an international study of students' cognitive abilities, namely TIMSS (Trends in Mathematics and Science Study), which resulted from TIMSS 2011 in the field of Physics. International average of 500. This should be of particular concern to all those dealing with Education.

Based on the results of interviews with physics teachers in 11th grade Public High School 9 Bandar Lampung, in the teaching process, educators use quite varied models; it is just that the strategies used are not appropriate, so the way students learn tends to memorize and be less involved. In the physics learning process, students not only learn theories and formulas, but more emphasis is placed on knowledge formation and mastery of concepts (Chu et al., 2012).

Physics education in the classroom continues to encounter several challenges. Traditional and non-contextual learning models are still used (Becerra-Labra et al., 2012). Several variables contribute to poor student learning outcomes, including students' lack of grasp of concepts in learning and solving physics issues. This learning success element necessitates the assistance of educators, other students, and schools (Wang, 2015). Many development strategies and models can help students learn better (Asyhari & Hartati, 2015). Mastery of concepts is essential for supporting the content in pursuit of higher Education or application in everyday life (Cobern et al., 2014). As a result, grasping the concept becomes the primary source of accomplishing student learning goals. Educators must address students' lack of awareness of the learning process.

As a result, engaging tactics, models, and media are required in learning activities so that students see physics as a subject that is both exciting and relevant to study and so that students have a strong desire to learn and strive to understand concepts, Kang et al. (2016) People also think that interesting methods, models, and media will help students learn more.

Furthermore, Riyo et al. (2019) discovered that learning through scaffolding might reduce students' workloads, such as grasping a concept from particular resources that were previously thought to be tough to understand and becoming easier to understand with the use of these tools. Scaffolding-assisted learning has been shown to be beneficial in resolving learning process issues and facilitating interaction between educators and students (Diani et al., 2019). Deta et al. (2017) included a remark on scaffolding, which is said to promote student understanding more than the teacher-led direct learning system (direct using).

Many research has been conducted on scaffolding enhanced by technology (Beek et al., 2019; Haataja et al., 2019; Sarah, 2022) with the guided inquiry learning approach aided by Google Classroom (Gupta & Pathania, 2021); Kumar & Bervell, 2019) (Wibowo et al., 2022) towards understanding concepts (Farrokhnia et al., 2019) is still discussed separately. Beek et al. (2019) highlight scaffolding, which can assist students in problem-solving and can also be shown in learning independence and student motivation. Eeva et al. (2019) discovered that scaffolded learning could improve the interaction between students and teachers. Then, the conversation about guided inquiry helped by Google Classroom can make the learning process feel easier since it can be accessed without time constraints and allows students to interact in the learning process electronically with the help of Google Classroom (Gupta & Pathania, 2021). According to Jeya et al. (2019), Google Classroom is a mobile-based learning platform that might influence students' interests and motivation. Furthermore, Farrokhnia et al. (2019) addressed a discussion linked to concept understanding, stating that collaborative learning can boost conceptual understanding by employing technological innovations to support the learning process.

No study focuses on scaffolding with the guided inquiry learning approach supported by Google Classroom on students' grasp of elasticity and Hooke's law. According to Belland (2017), the learning process can be integrated into Google Classroom media and the classroom. Google Classroom Media is a Google for Education program designed for schools to facilitate the production, distribution, and assignment of paperless coursework. Google Classroom media can be accessed through a computer or mobile phone.

In this study, researchers focused on elasticity and Hooke's Law. This material was chosen because of its flexibility and Hooke's Law, which is frequently used and found in everyday life. A slingshot game with elastic qualities that can return to its original shape is an example of an event that is frequently observed in everyday life.

METHODS

This research is research with a quantitative approach whose research results are in the form of numbers. This study uses a quasi-experimental design method. The research design was a randomized control group-only post-test design used to compare the average student's conceptual understanding of test results between the experimental and control classes. Both groups were only given post-test questions. Figure 1 depicts the research procedures for the experimental and control groups.

This study's design included all class XI students from one of Bandar Lampung's schools for the 2018/2019 academic year. In this study, 30 students were randomly assigned to the experimental and control groups. The experimental group included 21 female and 9 male students, while the control group included 19 female and 11 male students.

Researchers used several data collection methods to obtain data in the study, including tests, observations, and documentation. The concept understanding test consists of 20 questions with a two-tier diagnostic test type according to indicators of concept understanding such as interpreting, exemplifying, classifying, summarizing, concluding, comparing, and explaining. At the same time, the observation sheet determines the implementation of the learning model for both students and teachers. This test uses test instruments such as Validity Test and Reliability Test. This test uses a reliability test using the Kuder and Richardson (KR21) method. Based on the instrument reliability criteria of 0.84,

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thus the concept of understanding test instruments is said to be feasible. The interpretation of the combination of student's answers can be seen in Table 1 (Karpudewan et al., 2015).

Table 1. The interpretation of the combination of students' answers

Answer Combination		Classification of Student Answers
Tier 1	**Tier 2**	
Correct	Correct	Complete understanding
Correct	Wrong	Misconception (+)
Wrong	Correct	Misconception (-)
Wrong	Wrong	do not understand

The data is obtained in the form of quantitative data from the results of understanding physics concepts. Quantitative data analysis used descriptive statistical analysis and parametric inferential statistics. The percentage, mean, max, and min table presents descriptive statistical analysis data. Meanwhile, the parametric inferential statistical data is presented in the t-test and the effectiveness test using the effect size test. Before the parametric test, the data must meet the assumption requirements, such as normality and homogeneity tests. The t-test was conducted to determine the effect of an independent variable on the dependent variable. In contrast, the effectiveness test is used to determine the size of the effect of a variable on other variables. The basis for making the decision test on the t-test if the value of Sig.(2-tailed) <0.05, then Ho is rejected, and H1 is accepted and uses a significance level of 5% or 0.05.

The research begins by submitting a research permit to implement the entire research process that has been prepared previously. After obtaining permission from the school, the researcher distributed a concept understanding test to students, then made observations regarding implementing the learning model. After obtaining the data, data analysis was carried out to obtain the final results and draw conclusions.

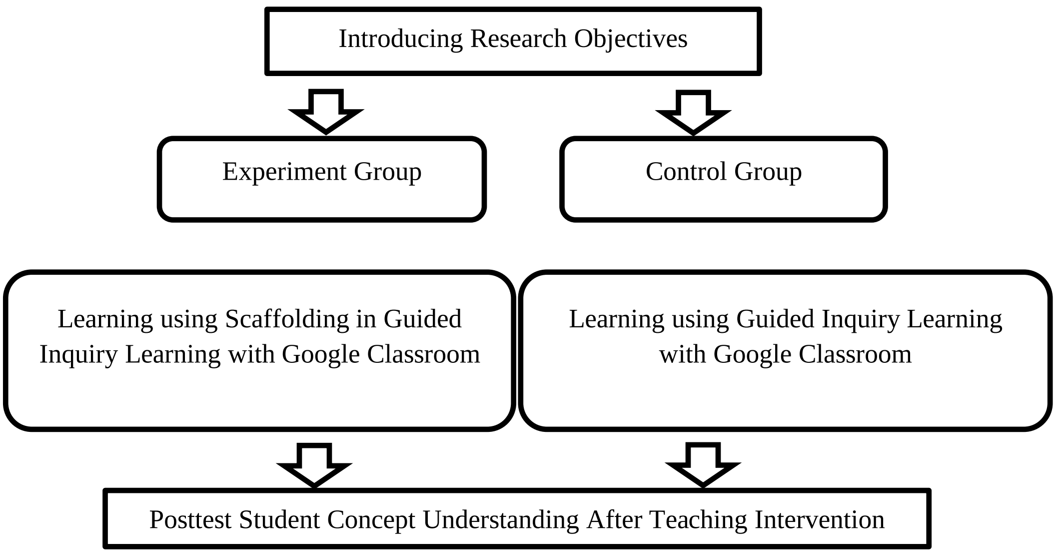

Figure 1. Research Procedures for the Experimental and Control Groups

RESULTS

Learning Implementation

Scaffolds of the following types (Ustunel & Tokel, 2018) are used in this study are presented in Table 2:

- Student Journal: Students record their responses using opening sentences and questions in a journal.
- Instructions: Instructions are given throughout the activity.

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- SenseMaker: Students begin by developing their arguments as sub-arguments for the topic, each with a different question. They then construct their main argument for each activity using the same question.

Table 2. Activities and Types of scaffolds

Activities (Guided Inquiry)	Step 1. Student Journal	Step 2. Hint	Step 3. Sub Argument Sense Maker	Step 4. Main Argument Sense Maker	Classroom practice
Orientations	What do you know about elasticity?	When you pull the rubber band, the rubber gets longer. The rubber will return to its original shape if the pull is removed. As with rubber, clay, when pressed, will change shape. If the pressure is removed, it turns out that the shape of the clay does not return to its original shape.	Why does rubber return to its original shape and clay does not?	In your opinion, what causes objects to be elastic and inelastic?	Students listen to the teacher's motivation and respond to the scaffolds presented in the google classroom along with videos on the use of elastic materials in everyday life.
Present Questions / Problems	What do you know about strain, compression, and shear?	When we pull the ends of the spring in opposite directions, we increase the spring's potential force.	Are strain, compression, and shear affected by the material of the spring?	In your opinion, what causes objects to be elastic and inelastic?	Students listen, pay attention to demonstrations by the teacher, and explain the events shown in the google classroom
Formulate Hypothesis	If a spring of various materials is lined up, each is given the same load. Will the increase in the Length of the springs be the same?	An object subjected to a force will experience a change in shape (volume and size). For example, a spring will increase in Length from its original size if it is subjected to a force to a certain extent.	What affects the increase in the Length of spring when an object is attached to the end?	What is the relationship between the force constant (k) with the weight of the object and the increase in the Length of the spring?	The teacher facilitates students to develop experimental hypotheses, then submit these hypotheses in google classroom
Designing an Experiment	Arrange what materials are needed to carry out an experiment that can prove that the materials that make up the spring affect the change in the Length of the spring!	As stated by Hooke's law, spring properties are not limited to a stretched spring. A compressed spring also applies Hooke's law, as long as the spring is still in the elastic region.		What is the relationship between the force constant (k) with the weight of the object and the increase in the Length of the spring?	The teacher facilitates students to prove hypotheses by conducting experiments, and the results of the experimental design are uploaded to google classroom

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Activities (Guided Inquiry)	Step 1. Student Journal	Step 2. Hint	Step 3. Sub Argument Sense Maker	Step 4. Main Argument Sense Maker	Classroom practice
Conducting Experiments	Do an experiment that can prove that the material that makes up the spring affects the change in the Length of the spring!		Make a graph that can explain the relationship between the spring constant, the weight of the object, and the increase in the Length of the spring!	What is the relationship between the force constant (k) with the weight of the object and the increase in the Length of the spring?	The teacher facilitates students to prove hypotheses by conducting experiments, and the results of the experiments are uploaded to google classroom
Collecting and analyzing data					The teacher facilitates students to analyze the experimental results, and the results from the experimental analysis are uploaded to google classroom
Making conclusions				Draw conclusions based on this experiment!	Students submit their conclusions on google classroom

Student Conceptual Understanding

In this study, the results of the conceptual understanding test were carried out to measure the level of understanding of student's concepts of elasticity and Hooke's Law. Tables 3 and 4 reflect the findings of the data collection on students' conceptual understanding of physics and the classification of their answers.

Table 3. Student Concept Understanding Test

Group	Gender	Mean	Max	Min	SD
Experiment (n=30)	Male (n=9)	70	100	40	21.21
	Female (n=21)	74.29	100	40	19.03
Control (n=30)	Male (n=11)	59.3	71	35	10.42
	Female (n=19)	58.6	80	30	13.28

Table 3 provides an overview of the differences in mean, max, min, and SD conceptual understanding test results between males and females in the experimental and control groups.

Table 4. Classification of students' answers

Classification of Student Answers	Experiment (n=30)		Control (n=30)	
	Male (n=9)	**Female (n=21)**	**Male (n=11)**	**Female (n=19)**
Complete Understanding	3	10	2	7
Misconception (+)	2	6	4	6
Misconception (-)	3	3	3	3
do not understand	1	2	2	3

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Test of Statistical Data Test of Understanding of Students' Physics Concepts

One of the characteristics of quantitative research is to test the statistical data used to answer the problem formulation. Before finding out the hypothesis test results, a series of assumption test analyses were carried out consisting of a normality test and a homogeneity test for understanding the concept. This statistical test requires to meet the t-test and effectiveness test criteria. Recapitulation of statistical tests for students' understanding of physics concept test data is presented in table 5.

Table 5. Classical assumption test summary

Aspect	Test Type	Class	Result	Decision
Normality	Liliefors	Experiment	$L_{count} = 0.14$ $L_{table} = 0.16$	Ho accepted
		Control	$L_{count} = 0.13$ $L_{table} = 0.16$	Ho accepted
Homogeneity	Homogeneity of two variances	Experiment Control	$F_{count} = 0.50$ $F_{table} = 1.84$	Homogeneous

Based on table 4, the L_{count} value is 0.14 and L_{table} is 0.16 for the experimental class in the normality test using the Liliefors test, so it can be said that the data is normally distributed because the L_{count} value < L_{table}. While the L_{count} value is 0.13 and L_{table} is 0.16 for the control class in the normality test using the Liliefors test, so it can be said that the data is normally distributed because the $L_{count} < L_{table}$. Then for the homogeneity test using the homogeneity test of two variants, the F_{count} value is 0.50 and F_{table} is 1.84 for the experimental class and control class, so it can be said that the data is homogeneous because of the value of $F_{count} < F_{table}$.

Hypothesis Test Results

The hypothesis in this study uses a parametric test, namely a t-test, and effectiveness (effect size). This test is used to determine whether there is a relationship between the independent variable (X), the guided inquiry-based scaffolding method aided by Google Classroom material, and the dependent variable (Y), which is concept knowledge. If the data is Normally distributed, this test is used.

Table 6. T-test results

Aspect	Test Type	Group	Result	Decision	Conclusion
X*Y	t-test	Experiment Control	$T_{count} = 2.13$ $T_{table} = 2.04$	Ho rejected	There is a significant effect

Based on table 5, the results of the hypothesis test measurement on the t-test between the X and Y variables for the experimental class and control class obtained the results of T_{count} of 2.13 and T_{table} of 2.04, so it can be said that the results of the hypothesis test affect the scaffolding strategy with the guided inquiry learning method assisted by google classroom, which is stated to be good in understanding students' concepts on elasticity and Hooke's law because $T_{count} > T_{table}$.

Table 7. Effectiveness Test Results

Criteria	Result
MA	74,83
MB	56,75
sdA	19,23
sdB	13,60
d	1,08
Conclusion	High

Based on table 6, the results show that the size effect in this study is d > 0.8, and the effectiveness of the scaffolding strategy is in the high category. So that by using the scaffolding strategy with the guided inquiry learning method assisted by Google Classroom, it was declared effective in understanding students' concepts in the elasticity material and Hooke's Law.

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DISCUSSION

Students will find the use of scaffolding in the framework of constructivist theory to be of great assistance in moving on to the next level of their learning process. This is when viewed from the perspective of traditional learning. When it comes to Education in the 21st century, this becomes even more vital. In addition, essential technological advancements that might assist students' studies are more straightforward and readily available. The researcher believes that the intensive scaffolding pattern with the assistance of Google Classroom is the most suitable for the developmental characteristics of students closely related to technological developments, and the current research results confirm this. The researcher thinks that the pattern of intensive scaffolding with the help of Google Classroom is the least appropriate.

There has been much interest in employing technological tools such as Google Classroom to help learners with less complicated tasks, and various strategies for scaffolding techniques have been presented for various such instruments. When computer tools offer prompts and questions for individuals or small groups, technological scaffolds are valuable for supporting explanations (Alias, 2012; Molenaar et al., 2012). In addition, Despotović-Zrakić et al. (2013) suggested that scaffolding, which comes from prompts and hints that promote argumentation, aided students' knowledge integration in an enhanced setting by technology. In addition, Kim & Hannafin (2011) said that students' learning and problem-solving performance in ill-structured domains could be improved if elaborative question prompts were employed, which was the case. Sumuer (2018) said that the methods of embedding supports in software are described in detail by Progress Portfolio, Knowledge Integration Environment (KIE), and Explanation Constructor.

Che (2014), Despotović-Zrakić et al. (2013), and Sharma & Hannafin (2007) underlined the necessity for a pedagogical framework for teaching and learning science using technological tools in a classroom context. This is because it is vital to understand the elements that affect the usage of technological tools. They presented a model to guide teaching and learning in science classrooms by incorporating technology. Their suggested framework conducts analyses of factors at the macro level (the level of the system), the teacher level (the level of the teacher community), and the classroom level (technology-enhanced class). According to Ustunel & Tokel (2018), the factors that impact students' learning are not cutting-edge technologies but somewhat interactive and iterative learning settings. Students must create arguments, ask for peer review, consult teachers, conduct research, reflect on their work, and update it.

In the context of this study, Table 2 demonstrates three different interactions that could take place in scaffolding-guided inquiry learning with Google Classroom: 1. Interaction between the learner and the tool, which occurs when students use technology tools to address relevant problems; 2. The interaction between the teacher and the tools occurs when the teacher chooses and arranges the tools in the classroom 3. Interaction between the teacher and the learner occurs when the teacher gives scaffolds like suggestions and questions.

Interaction between students and the tools they use happens when students are given support in the form of scaffolding while they use technology. Even though technology in science classrooms helps students become more motivated, some still struggle with scientific inquiry. These students, in particular, are the ones who lack confidence in their ability to engage in self-directed learning and are dependent on traditional teacher guidance in tool use (Chen, 2014; Jeong et al., 2017). As a consequence of this, the scientific inquiry of students needs to be scaffolded so that students who do not struggle with the material can use the tools without experiencing cognitive overload. On the other hand, because there has not been much research done on the connection between students and the tools they use, there is not much information regarding when student–tool interactions are meaningful, how students utilize tools, or the downsides of students' use of technology. For instance, when given access to a web browser as a tool, students typically use the internet's resources without being instructed and tend to discover solutions quickly rather than deeply consider the facts at hand. In science classrooms, the relationship between students and the tools they use needs to be investigated further.

The interaction between the teacher and the tools takes place when the teacher chooses and arranges the tools for the class. The performance of a student can be improved by the interaction between an instructor and the technological equipment. Even though the tools offer flexibility, it is essential for teachers to personalize how their students use the resources. It is of the utmost importance in situations

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when teachers do not have extensive content knowledge or experience in implementing technology. Because a substantial study has not yet been conducted, it is necessary to investigate how teachers interact with various technologies, and it is essential that the function of the teacher in facilitating scientific discourse among students be well comprehended.

Interaction between the teacher and the student can occur when the teacher gives the student tips or asks questions to facilitate learning. The teacher scaffolds student learning in a technology-enhanced learning environment by providing question prompts and monitoring how students process the information they are being taught. Teacher mentoring and questioning can be extremely helpful when students have trouble with evidence. Students who were assisted by technology-based scaffolds in Progress Portfolio were more effective when teachers aided them, as illustrated by the research (Alias, 2012). This serves as an illustration of this argument. Although a teacher performs several functions in a science classroom, such as a guide, mentor, and motivator, it is not apparent what the teacher's role should be regarding tool use while the inquiry is taking place. Again, there has been a paucity of studies conducted on teacher facilitation in an environment enhanced by technology for learning and the management of a balance between technology and teacher scaffolding.

In line with previous research (Angeli & Valanides, 2020; Dawkins et al., 2017; Gibson et al., 2015), this study, in Table 3 and Table 4, also shows that scaffolding is more beneficial for female students. Angeli & Valanides. Angeli & Valanides (2020) revealed that this concerns the scaffolding technique used; the direction is more on activities, collaboration, or tasks that require collaboration. In addition, Dawkins et al. (2017) and Gibson et al. (2015), in their analysis, revealed that this was caused by the level of intelligence of female students tended to be higher than boys.

According to the study's findings, students' understanding of physics concepts was more significant in the experimental class using a scaffolding strategy based on the guided inquiry learning model assisted by Google Classroom than in the control class using an expository strategy with the same learning model, supported by hypothesis testing, which demonstrates that the significant value of t-count $\geq$ t-table with the decision H0 is rejected. The outcome of the effect size test is $d = 1.085760767$, where $d > 0.8$, indicating that the scaffolding method is effective.

Compared to expository tactics, guided inquiry-based scaffolding strategies can assist students in problem-solving and comprehending the concepts of elasticity and Hooke's law. Mamun (2022) explained that a guided inquiry learning model with a scaffolding strategy could guide students to understand concepts appropriately and make learning more meaningful and easy to understand. In addition, Blanchard et al. (2010) found that the guided inquiry approach combined with scaffolding was more effective than the traditional learning approach in improving conceptualization. Scaffolding on guided inquiry provides assistance during the early stages of learning and then reduces the assistance and allows students to take on greater responsibility once they can do it themselves. This is consistent with Wang (2015) research findings that scaffolding can enhance comprehension of ideas in biological material. This study's results are consistent with Isrokatun et al. (2019) research, which found that scaffolding can enhance learning by providing supportive learning environments by understanding students' requirements throughout the learning process.

Moreover, it turns out that using scaffolding media can improve students' conceptual understanding and make learning more effective and efficient. The significance of conceptual knowledge is applied to help grasp an abstract notion in some content (Lu et al., 2018). It also aligns with a study by Janneke et al. (2019), which found that scaffolding can support interactions between teachers and students during learning activities and make the learning process more straightforward.

As a result, using Google Classroom media in the learning process is highly beneficial for interaction between students and teachers in both student tasks supported by internet access at school. According to ACT Government Education and Training, Google Classroom promotes student learning by assisting students in making assignments more realistic. Echeverria et al. (2012) discovered that the learning process with supporting tools or learning media would effectively minimize students' misconceptions, particularly in challenging physics subjects. Google Classroom should also enhance students' understanding of rapidly advancing technologies that might facilitate learning activities (Gupta & Pathania, 2021; Sarah, 2022).

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CONCLUSIONS

Even though learning physics by combining the Scaffolding strategy with the Google Classroom Assisted Guided Inquiry learning method has not received enough attention in practice, research that links learning theory and technology-enhanced learning environments has been carried out. This research undoubtedly reveals challenges in the process and promising results when the technology is used afterward. It was determined, based on the research findings, that the scaffolding-based guided inquiry technique, which was helped by Google classroom, had the potential to influence the students' conceptual understanding of physics.

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