Volume 11 Number 1, April 2026, pp. 42~55
P-ISSN:2477-7935
E-ISSN: 2548-6225
DOI: 10.59052/edufisika.v11i1.53948

PHYSICS CONCEPTUAL UNDERSTANDING AND STUDENT RESPONSES TO GOOGLE SITES-BASED E-LKPD INTEGRATED WITH GUIDED INQUIRY

Oktavianus Ama Ki'i[1], Maria Ursula Jawa Mukin[1], Claudia Mariska Mardikawati Maing[1], Yizrahya Juan Sae[1]
[1] Physics Education, Faculty of Teacher Training and Education, Universitas Katolik Widya Mandala, Kupang, Indonesia
Corresponding author email: oktavianus_a.kii@unwira.ac.id

Article Info
Received: 15 March 2026
Accepted: 01 April 2026
Publication: 04 April 2026

Abstract :
This study aims to examine students' understanding of physics concepts and their responses to the use of Google Sites-based e-worksheets (e-LKPD) integrated with guided inquiry in physics learning at SMAN 3 Kupang. It was designed to address the demands of implementing the Merdeka Curriculum through innovative learning models, despite limited instructional time and learning facilities at school. This quantitative descriptive study with a one-shot case study design was conducted in an 11th-grade class and involved 25 students. The instruments were a multiple-choice test and a student response questionnaire, which were validated by 3 experts and obtained an I-CVI score of 1.00 (valid). The conceptual understanding test showed acceptable internal consistency reliability (KR-20 = 0.66), while the student response questionnaire showed excellent internal consistency reliability (Cronbach's alpha = 0.93). The results showed that students' understanding of physics concepts was in the high category, with a mean score of 82.8, while their responses to the use of e-LKPD were in the good category, with a mean score of 3.29. The highest response scores were found in guided inquiry activities, material clarity, and learning motivation. The novelty of this study lies in integrating guided inquiry stages into Google Sites-based e-LKPD as an innovative learning alternative in the context of limited instructional time, allowing students to manage the learning process more independently and thereby supporting their understanding of physics concepts. The results indicate that Google Sites-based e-LKPD integrated with guided inquiry can serve as a feasible digital learning medium in physics learning.

Keywords: Google Sites-based e-LKPD; guided inquiry; physics conceptual understanding

INTRODUCTION

Improving the quality of education in East Nusa Tenggara (NTT) remains a challenge, particularly due to limited learning facilities, uneven teacher quality, and low student motivation. These conditions directly influence physics learning, which many students often perceive as difficult because it involves abstract concepts and mathematical calculations that require higher-level reasoning. Preliminary observations and interviews conducted at SMAN 3 Kupang showed that many eleventh-grade students had difficulty linking basic concepts to problem-solving tasks and tended to memorize formulas without fully understanding the relationships among concepts. In addition, limited classroom time reduced opportunities for students to explore scientific ideas independently, creating a gap between curriculum expectations and actual learning experiences in the classroom. This situation indicates the need for a learning approach that is structured, interactive, and able to help students develop their understanding of concepts step by step.

Recent studies have shown that guided inquiry learning model is effective in improving conceptual understanding, critical thinking skills, and student engagement in physics learning (Dewi Ranjani et al., 2025; Maknun, 2020; Ramadhan, 2024; Utami et al., 2025). This model is regarded as appropriate for secondary-level classrooms because it balances teacher guidance with opportunities for student exploration. Nevertheless, several studies have reported that its implementation is frequently constrained by limited instructional time (Fitzgerald et al., 2017; Mahbubah & Masnawati, 2024; Zulfa et al., 2025) and by the lack of instructional media capable of supporting all stages of inquiry within a coherent sequence of learning activities (Fadholi et al., 2025; Naswir et al., 2017). Learning activities may become fragmented because students are not fully involved in the stages of guided inquiry, as teachers often rush through the inquiry process and complete the stages collectively rather than allowing students to experience them independently. This indicates the need for instructional media that can expand inquiry activities despite the limited instructional time.

On the other hand, the use of electronic student worksheet (Indonesian: *lembar kerja peserta didik elektronik*, hereafter referred to as e-LKPD) has developed as a digital learning strategy that can enhance learner autonomy, interactivity, and access to learning materials (Arit et al., 2023; Basudewa & Hayuhantika, 2022; Fatmawati et al., 2023; Khotami et al., 2023). However, the effectiveness of digital media is strongly influenced by the quality of its design, ease of access, and students' readiness to use digital devices (Putri & Jumadi, 2017; Widiarini et al., 2025). Therefore, the selection of a platform for e-LKPD should consider the need for flexible and adaptive learning. Google Sites is one of the potential platforms for e-LKPD because it is lightweight, easily accessible across various devices, and can be integrated with Google Forms and Google Sheets for real-time data management. Google Sites also supports embedded HTML features within the e-LKPD interface, allowing a wider variety of content and interactive elements to be incorporated.

Although several initial studies have indicated that Google Sites can support structured navigation and independent learning, empirical evidence on its use in actual classroom implementation as part of guided inquiry particularly in the context of high school physics remains limited. Earlier studies on digital worksheets and Google Sites-based learning media have mainly focused on development and feasibility or practicality testing (Arit et al., 2023; Basudewa & Hayuhantika, 2022), leaving limited evidence on how such media function in actual classroom implementation to support students' conceptual understanding. Previous studies have not sufficiently explained how Google Sites-based e-worksheets can function as a structured guided inquiry pathway to help bridge the gap between the demand for innovative learning and limited instructional time in schools. The novelty of this study lies in examining Google Sites-based e-LKPD not merely as digital media, but as a structured pathway for guided inquiry that helps address limited instructional time, supports more independent engagement in inquiry stages, and strengthens students' conceptual understanding. In this way, the study contributes empirical evidence on the use of a structured digital learning pathway to support guided inquiry under contextual classroom constraints.

The novelty of this study lies in integrating guided inquiry stages into Google Sites-based e-LKPD as an innovative learning alternative in the context of limited instructional time, allowing students to manage the learning process more independently and thereby supporting their understanding of physics concepts. The results indicate that Google Sites-based e-LKPD integrated with guided inquiry can serve as a feasible digital learning medium in physics learning.

Based on this gap, the present study aims to examine the level of students' conceptual understanding of physics and describe their responses after the implementation of Google Sites-based e-LKPD integrated with guided inquiry in physics learning. The findings are expected to provide empirical support for the use of structured and accessible digital learning media to facilitate guided inquiry in physics, especially in school contexts with limited facilities and classroom time.

RESEARCH METHOD

Research Design

This study used a quantitative descriptive approach with a one shot case study design to examine students' conceptual understanding of physics and their responses after the implementation of Google Sites-based e-LKPD integrated with the stages of guided inquiry.

Research Target/Subject

The research was conducted at SMA Negeri 3 Kupang during the odd semester of the 2025/2026 academic year. The study was carried out in the context of physics learning on Newton's Laws using Google Sites-based e-LKPD integrated with the stages of guided inquiry learning. The population of this study consisted of all eleventh-grade students at SMA Negeri 3 Kupang. The research sample was class XI IPA 4, comprising 25 students. The sample was selected using purposive sampling based on the class's readiness to use digital devices and prior experience with guided inquiry-based learning.

Research Procedure

The research procedure began with the preparation of Google Sites-based e-LKPD integrated with guided inquiry for physics learning on Newton's Laws. The learning activities were then implemented in the selected class by following the stages of guided inquiry embedded in the e-LKPD. After the students completed the learning activities, data were collected through a conceptual understanding test and a student response questionnaire. The collected data were subsequently analyzed descriptively to describe students' conceptual understanding and their responses to the implementation of the digital learning medium. In addition, observations were conducted during the implementation to document the time allocation used by each of the student groups in completing the stages of the guided inquiry-integrated e-LKPD. These observations were used as supporting descriptive data to provide contextual information about the implementation of the learning activities within the available class time.

To facilitate understanding of the research procedure, the overall flow of the study is presented in Figure 1.

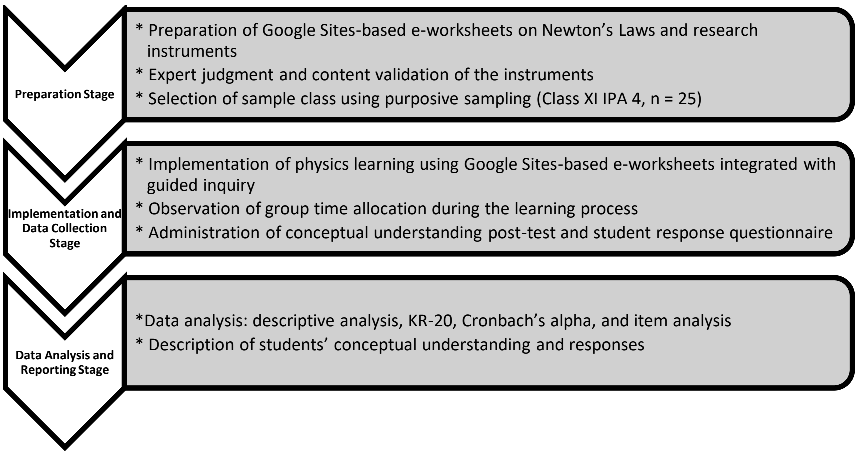

Figure 1. Research flow of the study

Instruments, and Data Collection Techniques

Two instruments were used in this study: a physics conceptual understanding test and a student response questionnaire. The conceptual understanding test consisted of 20 multiple-choice items on Newton's Laws and was constructed based on cognitive levels ranging from remembering (C1) to evaluating (C5). The distribution of the items included 2 items at C1, 4 items at C2, 6 items at C3, 4 items at C4, and 4 items at C5. The test was administered after the learning activities to measure students' conceptual understanding.

The student response questionnaire used a four-point Likert scale consisting of Strongly Agree, Agree, Disagree, and Strongly Disagree. It was designed to assess several aspects of students' responses, including the accessibility and interface of the e-LKPD, the clarity of the material and instructions, the guided inquiry learning process, perceived conceptual understanding, and motivation and overall impression of the learning experience. The questionnaire was administered at the end of the learning process to obtain students' responses to the implementation of the Google Sites-based e-LKPD.

Table 1. Aspects and items of the student response questionnaire

Aspect	Item statement
A. Accessibility and Interface of the E-LKPD	1. The E-LKPD is easy to access using my mobile phone/laptop. (A1)
	2. The display of the E-LKPD is attractive and increases my motivation to learn. (A2)
	3. The navigation (menus, buttons, pages) of the E-LKPD is easy for me to understand. (A3)
	4. The E-LKPD can be used without technical issues during the learning session. (A4)
B. Clarity of Material and Instructions	1. The physics material presented in the E-LKPD is clear and easy to understand. (B1)
	2. The instructions at each inquiry stage are clearly written. (B2)
	3. The videos and images in the E-LKPD help me understand physics concepts. (B3)
	4. The questions provided in the E-LKPD are easy to follow and understand. (B4)
C. Guided Inquiry Learning Process	1. The inquiry activities make me more active in learning. (C1)
	2. I find the step-by-step guidance in the E-LKPD helpful. (C2)
	3. Through the structured sequence of practice questions in the E-LKPD, I understand physics concepts better. (C3)
	4. The guided inquiry model makes learning more interesting for me. (C4)
D. Perceived Conceptual Understanding	1. The E-LKPD helps me understand physics concepts that were previously difficult. (D1)
	2. I find it easier to select the appropriate formula or concept when solving problems. (D2)
	3. I feel more confident in learning physics after using the E-LKPD. (D3)
	4. Learning via the E-LKPD helps me achieve better scores/grades. (D4)
E. Motivation and Impression of the Learning Experience	1. I feel more motivated to participate in physics lessons with the E-LKPD. (E1)
	2. Learning through the E-LKPD makes physics feel more enjoyable. (E2)
	3. I would like future physics lessons to also use media like the E-LKPD. (E3)
	4. Overall, I am satisfied with the learning experience using the E-LKPD. (E4)

Before being used in the study, both instruments were evaluated through expert judgment involving two physics education lecturers and one senior high school physics teacher. The experts assessed the instruments using a four-point scale. The aspects and item statements used in the validation process are presented in Table 2 for the conceptual understanding test and Table 3 for the student response questionnaire.

Table 2. Aspects and items of the test item validation sheet

Aspect		Item statement
A.	Content Appropriateness	1. Alignment of test items with the intended cognitive levels (C1–C5).
		2. Alignment of test items with the specified learning objectives
		3. Alignment of test items with the scope of the teaching material
B.	Construction	1. Clarity of item formulation.
		2. Appropriateness of the item format according to standard test-writing principles.
C.	Language	1. Items are formulated in communicative, clear, and age-appropriate language.
		2. Accurate use of terminology.

Table 3. Aspects and items of the student response questionnaire validation sheet

Aspect		Item statement
A.	Goal Appropriateness	1. Appropriateness of the questionnaire for the intended purpose.
		2. Sufficiency of items to represent all aspects/constructs of the intended "student response."
B.	Item Relevance	1. Relevance of the items to the research objectives.
		2. Relevance of the items to the specified indicators (aspects).
C.	Language Clarity	1. The wording of each item is clear and unambiguous.
		2. Suitability of terminology to students' linguistic ability and developmental level.

Data Analysis Technique

The expert assessment scores were analyzed to determine the content validity of the instruments using the Content Validity Index (CVI). CVI analysis was used to measure the level of agreement among experts regarding the relevance of each instrument item to the measurement objectives. For each item, expert ratings of 3 or 4 on the four-point scale were categorized as relevant (Wang & Sahid, 2024). The Item Content Validity Index (I-CVI) was calculated as the proportion of experts who rated the item as relevant to the total number of experts. Since the panel consisted of three experts, an item was considered valid when it achieved unanimous agreement (I-CVI = 1.00) (Polit et al., 2007; Wei, 2025)

Due to limitations in time and access to the class, a separate pilot test of the instruments was not conducted prior to the main study. Therefore, the internal reliability of the conceptual understanding test was analyzed using the Kuder–Richardson 20 (KR-20) coefficient, while the reliability of the student response questionnaire was analyzed using Cronbach's Alpha. The reliability analysis and item analysis were conducted based on the test and questionnaire data collected at the end of the learning implementation in the selected class. For the conceptual understanding test, item discrimination indices were also examined as part of the item analysis. For the student response questionnaire, corrected item-total correlations were analyzed to examine the consistency of each item with the overall scale. This approach provided an estimate of the instruments' internal consistency within the specific context of the learning implementation.

The data on students' conceptual understanding were analyzed descriptively based on the post-test scores. Each correct answer was scored 1 and each incorrect answer was scored 0. The total score obtained by each student was then converted into a score on a scale of 0–100. The results were summarized using descriptive statistics, including the number of students, mean score, standard deviation, minimum score, and maximum score, to describe the level of students' conceptual understanding after the learning process. To facilitate interpretation, the mean score was classified into five categories: 90–100 = Very High, 80–89 = High, 65–79 = Moderate, 55–64 = Low, and 0–54 = Very Low.

The student response questionnaire data were also analyzed descriptively using a four-point Likert scale. Since all questionnaire items were positively worded, the scoring was assigned as follows: Strongly Agree = 4, Agree = 3, Disagree = 2, and Strongly Disagree = 1. The mean score of students' responses was calculated for each item, each aspect, and the overall questionnaire. Based on these mean scores, students' responses to the implementation of Google Sites-based e-LKPD integrated with guided inquiry stages were classified into four categories: 3.26–4.00 = Very Good, 2.51–3.25 = Good, 1.76–2.50 = Fair, and 1.00–1.75 = Poor.

RESULTS AND DISCUSSION

Instrument Validity and Reliability

The research instruments, consisting of a physics conceptual understanding test and a student response questionnaire, were evaluated through content validity analysis using the Item Content Validity Index (I-CVI) before being used in the study. The test items were validated by three experts in terms of content appropriateness, construction, and language. The results of the validity analysis for each item, including the cognitive level, mean expert score, Item Content Validity Index (I-CVI), and validity decision, are presented in Table 4.

Table 4. Content validity analysis for the test instrument

Level	Item No.	Mean Total	I-CVI	Decision	Level	Item No.	Mean Total	I-CVI	Decision
C1	1	3.38	1.00	Valid	C5	11	3.48	1.00	Valid
C2	2	3.52	1.00	Valid	C3	12	3.29	1.00	Valid
C3	3	3.43	1.00	Valid	C5	13	3.38	1.00	Valid
C2	4	3.43	1.00	Valid	C3	14	3.38	1.00	Valid
C4	5	3.43	1.00	Valid	C4	15	3.38	1.00	Valid
C3	6	3.52	1.00	Valid	C2	16	3.38	1.00	Valid
C1	7	3.48	1.00	Valid	C3	17	3.43	1.00	Valid
C2	8	3.38	1.00	Valid	C5	18	3.57	1.00	Valid
C3	9	3.33	1.00	Valid	C4	19	3.57	1.00	Valid
C4	10	3.57	1.00	Valid	C5	20	3.57	1.00	Valid

The results in Table 4 showed that the 20 items of the physics conceptual understanding test obtained an Item Content Validity Index (I-CVI) value of 1.00. This result indicates complete agreement among the experts regarding the relevance and appropriateness of the test items for the intended measurement objectives. According to the I-CVI criterion for three experts (Du Wei, 2025; Polit et al., 2007), all test items were considered valid and suitable for use without substantial revision. The test items were developed by considering the alignment among the content, learning objectives, and the cognitive levels being measured.

In addition to the I-CVI values, the mean expert scores across items ranged from 3.29 to 3.57. These scores show that the items were consistently rated highly in terms of content appropriateness, construction, and language. Although there were small differences across items, the overall ratings still support the content validity of the instrument.

The content validity of the student response questionnaire was analyzed based on expert judgments of goal appropriateness, item relevance, and language clarity. The validity results for each questionnaire item, including the expert mean score, Item Content Validity Index (I-CVI), and validity decision, are presented in Table 5.

Table 5. Content validity analysis for the questionnaire instrument

Item Code	Mean Total	I-CVI	Decision	Item Code	Mean Total	I-CVI	Decision	Item Code	Mean Total
A1	3.39	1.00	Valid	C3	3.56	1.00	Valid	A1	3.39
A2	3.67	1.00	Valid	C4	3.50	1.00	Valid	A2	3.67
A3	3.61	1.00	Valid	D1	3.39	1.00	Valid	A3	3.61
A4	3.72	1.00	Valid	D2	3.61	1.00	Valid	A4	3.72
B1	3.50	1.00	Valid	D3	3.50	1.00	Valid	B1	3.50
B2	3.28	1.00	Valid	D4	3.44	1.00	Valid	B2	3.28
B3	3.39	1.00	Valid	E1	3.56	1.00	Valid	B3	3.39
B4	3.33	1.00	Valid	E2	3.44	1.00	Valid	B4	3.33
C1	3.56	1.00	Valid	E3	3.44	1.00	Valid	C1	3.56
C2	3.56	1.00	Valid	E4	3.39	1.00	Valid	C2	3.56

Table 5 shows that all items in the student response questionnaire obtained an I-CVI score of 1.00. These results indicate full agreement among the experts about the relevance of each statement to the measured response aspects. The mean expert scores ranged from 3.28 to 3.72. were assessed as clear, relevant to the research objectives, and written in language suitable for the students' developmental level. Based on the I-CVI criterion and the mean expert scores, the questionnaire items were considered relatively uniform across the measured response aspects and were deemed valid and suitable for use in this study.

The reliability analysis of the conceptual understanding test yielded a KR-20 coefficient of 0.66. This implies that the test possesses enough internal consistency to be used in this study. In terms of the discrimination index, a total of 8 items have a discrimination index of 0.40 or higher, and 7 items range from 0.20 to 0.29. Although 5 items have a discrimination index < 0.20, the test as a whole is still adequate for demonstrating variations in students' conceptual understanding.

The student response questionnaire yielded a Cronbach's Alpha coefficient of 0.93, indicating very high reliability. The corrected item-total correlation values ranged from 0.42 to 0.88, showing that all items were positively related to the overall scale. These results suggest that the questionnaire was reliable for assessing students' responses to the implementation of Google Sites-based e-LKPD integrated with guided inquiry.

Based on these analyses, both the physics conceptual understanding test and the student response questionnaire met the content validity criteria and were considered suitable for use in the study. The test was used to obtain data on students' conceptual understanding following the implementation of the learning activities, while the questionnaire was used to describe students' responses to the use of the guided inquiry-integrated Google Sites e-worksheet.

Physics Conceptual Understanding and Student Response

After confirming the validity and reliability of the instruments, the main data were analyzed descriptively to examine students' conceptual understanding and their responses following the implementation of the Google Sites-based e-LKPD integrated with guided inquiry in physics learning.

The results of the conceptual understanding test were analyzed descriptively based on the post-test scores. Table 6 presents the descriptive statistics of students' conceptual understanding following the implementation of the learning activities.

Table 6. Descriptive statistics for the physics conceptual understanding test

N	Mean	Standard Deviation	Min	Max
25	82.8	13.70	60	100

Table 6 shows that the 25 students obtained a mean score of 82.8, with a standard deviation of 13.70, a minimum score of 60, and a maximum score of 100. Based on the interpretation criteria used in this study, the mean score falls into the High category. This result indicates that, following the implementation of the Google Sites-based e-LKPD integrated with guided inquiry, students in the study class generally demonstrated a high level of conceptual understanding of Newton's Laws.

Although the average score reflects a high level of conceptual understanding for the class as a whole, the standard deviation and the range of scores indicate that conceptual understanding was not evenly distributed among all students. This variation suggests that while the learning design may have supported conceptual understanding at the class level, differences in students' learning pace, prior readiness, and learning participation may also influence the level of conceptual mastery achieved.

The e-worksheet, which was designed around the stages of guided inquiry, seemed to help students learn more independently without having to rely on the pace of other groups. Students first watched a case-based video embedded in the e-worksheet, and they could control the speed or replay the video as needed. After that, they were asked to identify the problem and propose an initial hypothesis based on what they had observed. At the data collection stage, students worked on step-by-step questions instead of doing a practicum, mainly because class time was limited. These questions acted as structured scaffolding, since each item was connected to the next and helped students build their understanding gradually.

Next, students were guided to analyze the different cases presented in the questions in order to develop their understanding of Newton's laws. After that, they checked their initial hypotheses and drew conclusions based on the concepts they had worked through. Comparing their initial hypotheses with the results of the analysis also seemed to help them reorganize their understanding and reduce misconceptions (Mamun, 2022; van Uum et al., 2017). In this process, students were encouraged to connect physical phenomena, predictions, evidence, and conclusions before moving to final answers. This may have helped them build a more meaningful understanding of Newton's laws, rather than relying only on the conclusions of other groups. Previous studies have also shown that guided inquiry and structured scaffolding can promote deeper conceptual understanding and reflective engagement in science learning (Mamun, 2022; Mazidah et al., 2023; van Uum et al., 2017).

Organizing the e-LKPD in a single digital platform seemed to help students follow the lesson more easily and use classroom time more efficiently. Through Google Sites, materials, videos, and tasks were available in one place, so students did not need to move between different media during learning (Culajara & Catalina, 2022; Data, 2022). This was especially useful in schools with limited facilities and instructional time, where guided inquiry can be difficult to manage in practice (Hermawati & Yulianto, 2025; Septiani & Krishantoro, 2025). In this study, Google Sites served a dual role: delivering content while also structuring the learning process. It helped students work through the inquiry stages in order and made the implementation of guided inquiry more manageable under existing classroom constraints.

To complement the conceptual understanding test and questionnaire data, we also observed the time allocation of the six groups during the implementation of Google Sites-based e-LKPD. The time used by each group varied across the different stages of the activity, as presented in Table 7.

Table 7. Time allocation by groups across guided inquiry stages

Guided Inquiry Step	Student Activity in the E-Worksheet	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Group Identity	Filling in student/group identity and reading the instructions for using the e-worksheet	1.00 min	1.00 min	1.00 min	1.00 min	1.00 min	1.00 min
Problem Orientation	Observing the phenomena presented in the e-worksheet	1.19 min	1.12 min	1.8 min	1.8 min	1.24 min	1.12 min
Problem Formulation	Formulating questions or problems in the e-worksheet based on the observed phenomena	1.30 min	1.30 min	3.00 min	3.00 min	3.00 min	5.00 min
Initial Hypothesis	Developing an initial hypothesis for the formulated problem	2.00 min	2.00 min	4.00 min	3.00 min	2.00 min	4.00 min

Data Collection	Completing the structured exercises provided in the e-worksheet	16.00 min	28.00 min	36.00 min	38.00 min	15.00 min	23.00 min
Data Analysis	Analyzing the structured tasks to develop understanding of Newton's Laws	15.00 min	20.00 min	33.00 min	30.00 min	20.00 min	29.00 min
Hypothesis Testing	Examining the validity of the initial hypothesis based on the results of the data analysis	8.00 min	6.00 min	7.00 min	14.00 min	4.00 min	13.00 min
Drawing Conclusions	Drawing conclusions based on the learning objectives related to Newton's Laws	5.00 min	10.00 min	11.00 min	19.00 min	7.00 min	15.00 min

The observation data showed that the early stages of the activity, including group identification, problem orientation, problem formulation, and initial hypothesis development, were usually completed in a short time. By contrast, the groups spent most of their time on data collection and data analysis. Across the six groups, the average time was about 26 minutes for data collection and 24.5 minutes for data analysis. This means that the largest part of the lesson was used for working through the structured questions and discussing the concepts related to Newton's Laws. These stages seemed to play an important role in conceptual understanding because students had to do more than just find information. They also had to connect the evidence from the tasks with the underlying concepts. The difference in time allocation suggests that students' attention was focused more on understanding the concepts than on finishing the procedural parts of the activity.

Table 7 also shows that the total time spent by each group to complete the e-LKPD varied, ranging from 49.49 minutes to 109.80 minutes. The largest differences were found in the time needed to complete the data collection, data analysis, and conclusion-drawing stages. This occurred because some groups needed more time than others to discuss and process the data. This variation may reflect differences in group dynamics, prior knowledge, or the speed with which students were able to interpret and negotiate conceptual meaning. This finding is relevant to the initial classroom condition identified during the preliminary observation, in which limited instructional time was one of the challenges in physics learning. Therefore, the observed time allocation provides supporting descriptive evidence that the implementation of the e-LKPD required careful time management, especially in the core inquiry stages. Although the one-shot case study design does not allow causal claims, these observations provide descriptive support for the interpretation that the guided inquiry-integrated e-LKPD may have created conditions conducive to conceptual engagement and understanding. Taken together, these time-allocation patterns suggest that the Google Sites-based e-LKPD did not eliminate the time demands of guided inquiry, but helped organize those demands more visibly and manageably within classroom implementation.

Students' responses to the implementation of the Google Sites-based e-LKPD integrated with guided inquiry were analyzed descriptively based on the questionnaire scores. The results are presented in Table 8.

Table 8. Student response analysis results

Aspect assessed	Student response level	Response category
A. Accessibility and interface of the media	3.24	Good
B. Clarity of material and instructions	3.33	Very good
C. Guided inquiry learning process	3.34	Very good
D. Perceived conceptual understanding	3.23	Good
E. Motivation and impression of the learning experience	3.33	Very good
Overall average	3.29	Very good

Table 8 shows that the overall mean score of student responses was 3.29 (Very Good). This indicates that students generally responded positively to the implementation of the Google Sites-based e-LKPD integrated with guided inquiry. The highest mean scores were obtained in the Guided Inquiry Learning Process aspect (3.34), Clarity of Material and Instructions (3.33) and Motivation and Impression of the Learning Experience (3.33), all in the Very Good category. These scores indicate that students had a positive view of the learning process, especially the way the inquiry stages were presented and carried out. Guided inquiry worksheets have been linked to active, student-centered learning and positive responses from both students and teachers (Fahyuni et al., 2019; Saputro et al., 2020). Guided inquiry-based learning has also been associated with stronger student engagement, confidence, and learning performance in different contexts (Drastisianti et al., 2024; Nguyen et al., 2024).

Students rated the clarity and motivational aspects of the e-LKPD positively. The structured design of the e-LKPD helped students engage more confidently in the guided inquiry learning process. In guided inquiry learning, clear instructions and structured guidance can make it easier for students to move through each stage and stay involved during the lesson (Cao et al., 2021; Drastisianti et al., 2024; Nguyen et al., 2024). This kind of support is also reflected in positive student responses to guided inquiry-based electronic materials and e-worksheets, particularly in terms of clarity, content organization, practicality, and support for learning motivation (Anisah & Nasrudin, 2023; Fahlevi & Maghfiroh, 2023; Fahyuni et al., 2019; Netriwati & Busmayaril, 2020; Selviandri et al., 2025).

Students' responses to the conceptual understanding aspect of the e-LKPD obtained an average score of 3.23 (Good). In general, students felt that the e-LKPD helped them understand physics concepts that had previously been difficult for them. It also helped them decide which formula or concept to use when solving problems and increased their confidence in learning physics. These responses were also consistent with the relatively high-test scores, which suggests that the e-LKPD helped support students' conceptual understanding. Positive attitudes and active participation in guided inquiry learning have often been linked to stronger conceptual understanding (Drastisianti et al., 2024; Nguyen et al., 2024; Sotiriou et al., 2020).

Students responded positively to the accessibility and interface aspect of the Google Sites-based e-LKPD during the learning process, with a mean score of 3.24 (Good). Classroom observation, however, a few practical difficulties were still noted, particularly when students navigated the pages or moved between learning components. This suggests that, while the platform was usable for guided inquiry activities, improvements in interface design and navigation would still be helpful. Google Sites-based and other web-based guided inquiry media have generally been reported as practical and appropriate for learning, although usability still needs improvement in some cases (Netriwati & Busmayaril, 2020; Nurlatifah & Jamil Suprihatiningrum, 2023; Padliah et al., 2025; Setiawan et al., 2024). Google Sites has also been used to support interactive and multimedia-rich learning when the interface is designed carefully so that students can use it comfortably across devices (Faiz et al., 2025; Nurlatifah & Jamil Suprihatiningrum, 2023).

Students responded positively to the Google Sites-based e-LKPD integrated with guided inquiry, as it helped create a digital learning environment that was structured, engaging, and manageable. Students generally experienced the learning activities in a favorable way through the inquiry process, clarity of instructions, and learning motivation of the e-LKPD. Guided inquiry-oriented e-worksheets and other electronic teaching materials have also been associated with positive learning experiences, student engagement, and conceptual understanding (Anisah & Nasrudin, 2023; Fahlevi & Maghfiroh, 2023; Mahyuna et al., 2024; Netriwati & Busmayaril, 2020; Selviandri et al., 2025). When the inquiry stages clear and manageable, students are more likely to participate actively, exchange ideas with peers, and stay involved in tasks that require deeper thinking. In this sense, the response data help explain why the e-LKPD was able to support students' conceptual understanding in the classroom.

The findings of this study imply that Google Sites-based e-LKPD can function as a digital learning tool that helps teachers organize innovative learning stages and supports students in following the learning process more systematically, especially in schools with limited time and resources. The e-LKPD also helps make classroom implementation more practical while keeping students engaged, because materials, videos, guiding questions, worksheets, and reporting tasks are provided on a single platform.

Several limitations were identified during the conduct of this study. The learning activities focused solely on conceptual understanding of Newton's First, Second, and Third Laws. These activities did not yet cover analytical and calculation-based situations involving various forces, such as friction, tension, normal force, as well as other problem-solving contexts related to dynamics. Another limitation is that not all digital inquiry activities could be fully integrated into a single Google Sites interface. Some interactive virtual laboratory resources cannot be embedded and run directly on the platform, so they must be accessed via external links. Therefore, the implementation of Google Sites-based e-LKPDs may vary depending on the physics topic and the extent to which the investigative stages can be supported by the platform.

Future research could extend the use of Google Sites-based guided inquiry e-LKPD to physics topics that go beyond conceptual understanding and involve more analytical and calculation-based tasks, such as friction, tension, and normal force. It would also be useful to examine its use in other physics topics to see whether all stages of guided inquiry can be supported equally well through Google Sites. Since some interactive virtual lab resources cannot be embedded and run directly on the platform, further studies could explore alternative ways of integrating these activities more smoothly into the learning design. Future studies could also employ more rigorous designs, such as pretest-posttest or comparison-group studies, to examine the contribution of Google Sites-based guided inquiry e-LKPD more comprehensively

CONCLUSION

This study showed that the implementation of Google Sites-based e-LKPD integrated with guided inquiry was associated with a high level of students' conceptual understanding of Newton's Laws in the selected class, as reflected in a mean test score of 82.8. Students also responded positively to the e-LKPD, with an overall mean response score of 3.29, particularly in the guided inquiry process and the clarity of materials and instructions. The observed time allocation across the six groups further showed that data collection and data analysis took the most time, indicating that guided inquiry still requires substantial classroom time even when it is supported by a more structured digital media.

ACKNOWLEDGMENTS

This research was funded by Widya Mandira Catholic University through the Regular Research Grant under Contract No. 046/WM.H9/SKP/IV/2025. The authors would like to thank the principal, physics teacher, and participating students of SMA Negeri 3 Kupang for their support and contribution to the implementation of this study. The authors also express their gratitude to the expert validators for their constructive feedback on the research instruments.

REFERENCES

Anisah, D. C., & Nasrudin, H. (2023). Development of guided inquiry-oriented e-worksheets to improve students' science process skills in acid-base material. *Jurnal Pijar Mipa*, *18*(4), 449–458. https://doi.org/10.29303/jpm.v18i4.5073

Arit, A., Masriani, M., Ulfah, M., Rasmawan, R., & Sartika, R. P. (2023). Development of google site-based e-lkpd to improve students' understanding of ion bond material. *Hydrogen: Jurnal Kependidikan Kimia*, *11*(5), 653–665. https://doi.org/10.33394/hjkk.v11i5.8875

Basudewa, W. D., & Hayuhantika, D. (2022). Pengembangan e-lkpd berbasis google sites bercirikan pendekatan saintifik untuk membangun pemahaman konsep matriks. *ARITHMETIC: Academic Journal of Math*, *4*(2), 93–112. https://doi.org/10.29240/ja.v4i2.5293

Cao, J., Chan, S. W. T., Garbett, D. L., Denny, P., Nassani, A., Scholl, P. M., & Nanayakkara, S. (2021). Sensor-based interactive worksheets to support guided scientific inquiry. *Proceedings of Interaction Design and Children, IDC 2021*, *21*, 1–7. https://doi.org/10.1145/3459990.3460716

Culajara, C. J., & Catalina, S. (2022). Maximizing the use of google sites in delivering instruction in physical education classes. *Physical Education and Sports: Studies and Research*, *1*(2), 79–90. https://doi.org/10.56003/pessr.v1i2.115

Data, N. H. (2022). Maximum utilization of google sites (mugs) in teaching english for academic and professional purposes. *AJARCDE (Asian Journal of Applied Research for Community Development and Empowerment)*, *6*(3), 68–72. https://doi.org/10.29165/ajarcde.v6i3.109

Drastisianti, A., Dewi, A. K., & Alighiri, D. (2024). Effectiveness of guided inquiry learning with phet simulation to improve students' critical thinking ability and understanding of reaction rate concepts. *International Journal of Pedagogy and Teacher Education*, *8*(2), 235–252. https://doi.org/10.20961/ijpte.v8i2.93924

Fadholi, A. H., Kosim, K., Zuhdi, M., & Ayub, S. (2025). Pengaruh model pembelajaran inkuiri terbimbing berbantuan media phet terhadap kemampuan pemecahan masalah. *Kappa Journal*, *9*(1), 121–128. https://doi.org/10.29408/kpj.v9i1.29651

Fahlevi, A., & Maghfiroh, S. (2023). Development of guided inquiry-based science electronic teaching materials to increase student learning motivation. *Jurnal Penelitian Pembelajaran Fisika*, *9*(1), 1–10. https://doi.org/10.24036/jppf.v9i1.120947

Fahyuni, E. F., Rusjiono, Masitoh, S., & Haryanto, B. (2019). How the teacher's teaching is? The guided-inquiry-worksheets to enhance science process skills. *Journal of Physics: Conference Series*, *1175*(1), 012136. https://doi.org/10.1088/1742-6596/1175/1/012136

Faiz, R. M. E., Julianto, & Widodo, W. (2025). Use of google site multiplatform in science learning to improve motivation and learning outcomes of elementary school students. *Journal of Innovation and Research in Primary Education*, *4*(3), 746–756. https://doi.org/10.56916/jirpe.v4i3.1451

Fatmawati, F., Rivaldi, M., & Suhaeni, S. (2023). Development of electronic student worksheets based local potential to enhance students' science learning outcomes. *Jurnal IPA & Pembelajaran IPA*, *7*(1), 56–71. https://doi.org/10.24815/jipi.v7i1.29443

Fitzgerald, M., Danaia, L., & McKinnon, D. H. (2017). Barriers inhibiting inquiry-based science teaching and potential solutions: perceptions of positively inclined early adopters. *Research in Science Education 2017 49:2*, *49*(2), 543–566. https://doi.org/10.1007/s11165-017-9623-5

Hermawati, V., & Yulianto, S. (2025). Development of google sites website based learning media to improve ipas learning outcomes on the material of sound and its properties: bahasa indonesia. *Jurnal Penelitian Pendidikan IPA*, *11*(2), 654–662. https://doi.org/10.29303/jppipa.v11i2.10277

Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and achievement in problem-based and inquiry learning: a response to kirschner, sweller, and clark (2006). *Educational Psychologist*, *42*(2), 99–107. https://doi.org/10.1080/00461520701263368

Khotami, M. H., Marlina, L., & Wiyono, K. (2023). The needs analysis of the electronic student worksheets (e-lkpd) based on discovery learning for the topic of traveling waves in high school. *Jurnal Pendidikan Fisika Dan Teknologi*, *9*(1), 163–170. https://doi.org/10.29303/jpft.v9i1.5223

Mahbubah, S. M., & Masnawati, E. (2024). Implementation of inquiry learning to enable student interaction on PAI Materials at SDI Musra. *Journal of Islamic Elementary Education*, *2*(1), 129–145. https://doi.org/10.32806/islamentary.v2i1.572

Mahyuna, Putri, D. R., Hasja, Y., Nuhari, I., & Azzarkasyi, M. (2024). Improving science process skills using guided inquiry-based student worksheet. *Proceedings of International Conference on Education*, *2*(1), 488–493. https://doi.org/10.32672/pice.v2i1.1399

Maknun, J. (2020). Implementation of guided inquiry learning model to improve understanding physics concepts and critical thinking skill of vocational high school students. *International Education Studies*, *13*(6), p117. https://doi.org/10.5539/ies.v13n6p117

Mamun, M. A. Al. (2022). Fostering self-regulation and engaged exploration during the learner-content interaction process: the role of scaffolding in the online inquiry-based learning environment. *Interactive Technology and Smart Education*, *19*(4), 482–509. https://doi.org/10.1108/ITSE-11-2021-0195

Mazidah, I. N., Widodo, W., & Tukiran. (2023). Profile of the implementation of guided inquiry-based interactive e-module in science learning. *Studies in Philosophy of Science and Education*, *4*(2), 43–55. https://doi.org/10.46627/sipose.v4i2.275

Naswir, M., Haryanto, H., & Wati, F. (2017). Analisis keterlaksanaan model pembelajaran inkuiri terbimbing untuk materi sifat koligatif larutan dan pengaruhnya terhadap kemampuan berpikir kreatif siswa kelas XII IPA SMA Islam Al-Falah Kota Jambi. *Journal of The Indonesian Society of Integrated Chemistry*, *9*(2), 43–51. https://doi.org/10.22437/jisic.v9i2.5113

Netriwati, N., & Busmayaril, B. (2020). The implementation of student worksheets (lkm) on relations and functions through website-based guided-inquiry approach student worksheet. *Desimal: Jurnal Matematika*, *3*(2), 169–174. https://doi.org/10.24042/djm.v3i2.5212

Nguyen, V. H., Halpin, R., & Joy-Thomas, A. R. (2024). Guided inquiry-based learning to enhance student engagement, confidence, and learning. *Journal of Dental Education*, *88*(8), 1040–1047. https://doi.org/10.1002/jdd.13531

Nurlatifah, & Jamil Suprihatiningrum. (2023). Pengembangan google sites berbasis inkuiri terbimbing pada materi asam basa sebagai media belajar mandiri siswa SMA/MA kelas XI. *Jurnal Pendidikan Sains Indonesia*, *11*(1), 67–83. https://doi.org/10.24815/jpsi.v11i1.27391

Padliah, S., Sjaifuddin, S., & Alamsyah, T. P. (2025). Development of guided inquiry-based student worksheets on the concept of classification of living organisms to train students science process skills. *Jurnal Pijar Mipa*, *20*(6), 1054–1062. https://doi.org/10.29303/jpm.v20i6.9759

Polit, D. F., Beck, C. T., & Owen, S. V. (2007). Focus on research methods: is the cvi an acceptable indicator of content validity? Appraisal and recommendations. *Research in Nursing and Health*, *30*(4), 459–467. https://doi.org/10.1002/nur.20199

Putri, R. F., & Jumadi, J. (2017). Kemampuan guru fisika dalam menerapkan model-model pembelajaran pada kurikulum 2013 serta kendala-kendala yang dihadapi. *Jurnal Inovasi Pendidikan IPA*, *3*(2), 201–211. https://doi.org/10.21831/jipi.v3i2.8636

Ramadhan, R. P. (2024). *Pengaruh model pembelajaran inkuiri terbimbing terhadap hasil belajar siswa pada materi laju reaksi*. [Skripsi, FITK UIN Syarif Hidayatullah Jakarta]. https://repository.uinjkt.ac.id/dspace/handle/123456789/76738

Ranjani, D., Parlindungan, S., Hera, N. (2025). *Implementasi model pembelajaran inkuiri terbimbing untuk meningkatkan keterampilan berpikir kritis dan kemampuan kognitif siswa*. [Thesis, Universitas Pendidikan Indonesia]. https://repository.upi.edu/138053

Saputro, T., Herlina, K., & Distrik, I. W. (2020). Guided inquiry based students' worksheet to grow students' critical thinking and communication skills. *Indonesian Journal of Science and Mathematics Education*, *3*(1), 18–26. https://doi.org/10.24042/ijsme.v3i1.5146

Selviandri, I., Nehru, N., & Riantoni, C. (2025). Development of guided inquiry-based student worksheet assisted by assemblr edu to enhance conceptual understanding in electronics course. *Lensa: Jurnal Kependidikan Fisika*, *13*(1), 126–135. https://doi.org/10.33394/j-lkf.v13i1.16069

Septiani, H. D., & Krishantoro, W. (2025). Implementation of online learning using google sites at PKBM Barokah LTF2SM Talang Tegal. *Journal of Artificial Intelligence and Engineering Applications (JAIEA)*, *4*(2), 1311–1316. https://doi.org/10.59934/jaiea.v4i2.910

Setiawan, M. A., Sriadhi, S., & Silaban, S. (2024). Development E-LKPD Based Guided Inquiry Using Google Sites for Elementary School Students. *Proceedings of the 9th Annual International Seminar on Transformative Education and Educational Leadership, AISTEEL 2024, 24 September 2024*, Medan, North Sumatera Province, Indonesia. https://doi.org/10.4108/eai.24-9-2024.2353276

Sotiriou, S. A., Lazoudis, A., & Bogner, F. X. (2020). Inquiry-based learning and e-learning: how to serve high and low achievers. *Smart Learning Environments 2020 7:1*, *7*(1), 29-. https://doi.org/10.1186/s40561-020-00130-x

Utami, T. E., Widodo, W., & Surabaya, U. N. (2025). Penerapan model inkuiri terbimbing berbasis media phet simulation untuk meningkatkan hasil belajar pada materi pemantulan dan pembiasan cahaya. *EDUCATIONAL : Jurnal Inovasi Pendidikan & Pengajaran* , *5*(1), 151–167. https://doi.org/10.51878/educational.v5i1.4608

van Uum, M. S. J., Verhoeff, R. P., & Peeters, M. (2017). Inquiry-based science education: scaffolding pupils' self-directed learning in open inquiry. *International Journal of Science Education*, *39*(18), 2461–2481. https://doi.org/10.1080/09500693.2017.1388940

Wang, F., & Sahid, S. (2024). Content validation and content validity index calculation for entrepreneurial behavior instruments among vocational college students in China. *Multidisciplinary Reviews*, *7*(9), 2024187–2024187. https://doi.org/10.31893/multirev.2024187

Wei, D. (2025). Content validation and content validity index calculation for teacher innovativeness instrument among henan private universities in China. *Communications on Applied Nonlinear Analysis*, *32*(10s), 175–187. https://doi.org/10.52783/cana.v32.4705

Widiarini, P., Ketut Rapi, N., Suastra,I.W., Suma, K. (2025). Studi pendahuluan: problematika pembelajaran fisika SMA. *SCIENCE : Jurnal Inovasi Pendidikan Matematika Dan IPA*, *5*(1), 131–143. https://doi.org/10.51878/science.v5i1.4430

Zulfa, L., Fauzi, H., & Kamal, R. (2025). Analisis sistematis strategi pembelajaran inkuiri terhadap pengembangan keterampilan abad 21. *JISPENDIORA Jurnal Ilmu Sosial Pendidikan Dan Humaniora*, *4*(1), 382–390. https://doi.org/10.56910/jispendiora.v4i1.2182