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# DESIGN OF AN E-STUDENT WORKSHEET ON MOTION ALONG A STRAIGHT LINE BASED ON GUIDED INQUIRY INTEGRATED WITH LOCAL WISDOM TO FACILITATE STUDENTS' CRITICAL THINKING SKILLS

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**ABSTRACT**

*The development of digital technology in the Society 5.0 era requires students to possess critical thinking skills so that they can understand, analyze, evaluate, and draw conclusions based on information and data. The initial analysis at SMAN 1 Batang Kapas shows that the average students' critical thinking skills are at 29%, which falls into the weak category. One of the reasons is the limited teaching materials that have not been systematically organized according to the learning model's syntax and do not include indicators of critical thinking skills. In addition, the teaching materials used have not integrated local wisdom and made use of interactive digital media to support understanding of physics concepts. This study aims to develop an Electronic Student Worksheet (E-Student Worksheet) on motion along a straight line based on guided inquiry integrated with local wisdom to facilitate students' critical thinking skills in a valid and practical manner. This study employed a Research and Development (R&D) methodology using the Four-D (4D) development model, which consists of the Define, Design, and Develop phases; the Disseminate phase was not implemented. The study involved one physics teacher, 34 10th-grade students in Phase E, and five expert validators. The validity of the E-Student Worksheet was analyzed using the V Aiken index, while its practicality was assessed based on feedback from teachers and students regarding ease of use and readability, presentation, efficiency, and the benefits of the E-Student Worksheet in learning. The results showed that the E-Student Worksheet achieved an average V Aiken score of 0.93, which falls into the "valid" category. The evaluation covered seven aspects: content substance, visual communication, E-Student Worksheet components, software utilization, guided inquiry, critical thinking skills, and local wisdom. Thus, the E-Student Worksheet developed in this study meets the criteria for high validity and can be used as teaching material in physics lessons on motion along a straight line. The results of the practicality test showed a percentage of 95.09% based on teacher responses and 93.52% based on student responses, both of which fall into the "very practical" category. Thus, the guided inquiry-based E-Student Worksheet on motion along a straight line, which integrates local wisdom to facilitate critical thinking skills, is considered valid and very practical for use in physics instruction. However, the effectiveness of E-Studens Worksheet in improving critical thinking skills has not been tested*

**Keywords :**E-Worksheet; guided inquiry; local wisdom; motion along a straight line; critical thinking skills.

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## I. INTRODUCTION

Technological and informational advances have increasingly influenced various aspects of human life and contributed to the emergence of the Society 5.0 era. This era emphasizes the utilization of technologies developed through the Industrial Revolution 4.0, including the Internet of Things (IoT), Artificial Intelligence (AI), Big Data, and robotics, to address challenges encountered in society [1]. These developments also affect educational needs, particularly the ability of students to process and respond to information critically. Critical thinking enables

students to examine information, assess problems, and formulate solutions through logical reasoning [2]. Previous research has indicated that students' critical thinking abilities require continuous development through learning activities that engage them in analyzing information and solving problems [3]. In physics learning, critical thinking skills are needed because students encounter various concepts and problems that require thinking processes to understand relationships among quantities and apply physics concepts [4]. The capacity for critical thought encompasses six key components: interpretation, analysis, evaluation, inference, explanation, and self-regulation [5]. Motion along a straight line is a subject within physics that can be connected to a variety of real-world movement occurrences. Consequently, educational endeavors may focus on observing phenomena, gathering data, examining findings, and formulating conclusions.

Based on an interview with a Grade X Pase E physics teacher at SMAN 1 Batang Kapas, physics learning has used inquiry learning and problem-based learning activities. However, the investigation stages have not been fully implemented, particularly in information gathering, invertigation, data analysis, and conclusion drawing Analysis of the teaching materials showed that they contain concepts, equations, graphs, examples, exercises, and learning objectives, but do not specify a particular learning model and do not guide students through investigation stages. Learning is still dominated by explanations of concepts and problem solving. The examples used have also not been specifically related to the students' environment. The findings highlight the importance of providing teaching materials that actively engage students in investigation activities while supporting the development of critical thinking skills. Previous research [6] on Guided Inquiry has demonstrated its potential to strengthen students' critical thinking abilities through structured inquiry-based learning activities. In physics education, study [7] lebih lanjut melaporkan bahwa penerapan model Penyelidikan Terpandu berkontribusi terhadap peningkatan keterampilan berpikir kritis siswa.

An E-Student Worksheet based on Guided Inquiry can serve as an alternative digital learning resource to facilitate these learning activities. It is designed as an electronic learning material that organizes instructional content, learning tasks, activity guidelines, and student activities into an integrated digital format. E-Student Worksheet development has been conducted as an alternative teaching material that can present materials and learning activities more systematically and can be accessed through electronic devices [8]. Other research has also shown that E-Student Worksheet can be developed to support the learning process by providing materials, activity instructions, and exercises that students can complete electronically [9]. Using E-Student Worksheets can boost students' critical thinking skills because it allows for presenting material, contextual phenomena, and analytical questions that encourage active student engagement in the learning process. Previous research [10] explain that E-Student Worksheet has the potential to be teaching material that facilitates critical thinking skills through carefully designed learning activities.

An based on guided inquiry can be developed by relating physics materials to phenomena in students' surroundings through local wisdom. Local-wisdom-based science learning can connect science concepts with knowledge and activities that have developed in community life [11]. Research by [12] showed that a local-wisdom-based worksheet on Batik Tulis Gedog could be used to improve the critical thinking skills of senior high school students. In physics learning, local wisdom can also be used as a context for identifying and explaining physics concepts found in community activities. Previous research has demonstrated that the Krapan Sapi tradition provides a relevant context for introducing physics concepts, particularly those associated with uniformly accelerated motion along a straight line [13]. Similarly, a study of the Toraja Pa'Gellu Dance identified physics concepts that could be incorporated into learning activities through a guided inquiry model [14]. These studies indicate that local cultural practices can serve as meaningful learning contexts for connecting physics concepts with phenomena familiar to students.

Research on E-Student Worksheet, guided inquiry, local wisdom, and critical thinking skills has been conducted across various topics and contexts. In [15], the authors introduced an E-Student Worksheet for motion along a straight linecResearch [9] developed a science-literacy-based E-Srudent Worksheet to train critical thinking skills. Meanwhile, research [12] demonstrated the use of local wisdom as a context in teaching materials to connect learning with the culture and phenomena of community life. Research [14] also showed the use of guided inquiry to explore physics concepts through local wisdom. However, research specifically developing an E-Student Worksheet on motion along a straight line based on guided inquiry, integrated with West Sumatran local wisdom, and directed toward the six critical thinking indicators [5] remains limited.

Based on the problems and review of previous studies, there is a need to develop teaching materials that integrate digital technology, guided inquiry, local wisdom, and critical thinking skills in motion along a straight line learning. The E-Student Worksheet organizes the learning activities into seven Guided Inquiry phases: observing and identifying the problem, formulating questions, designing the investigation, gathering information

and carrying out the investigation, interpreting the collected data, formulating conclusions, and presenting the investigation findings [16]. These activities are designed to support the development of critical thinking through the indicators of interpretation, analysis, inference, evaluation, explanation, and self-regulation [5]. The local wisdom contexts used in this study include the phenomena of the Mak Itam Train, bendi, and panjat pinang. These contexts were selected based on their relevance to the concepts of motion along a straight line and their potential to support student investigations. The Mak Itam Train, a historic steam locomotive in Sawahlunto, West Sumatra, represents motion with constant velocity. Students can investigate the train's motion along a straight section of track by examining the relationship between distance traveled and time to identify the characteristics of motion at constant velocity. Bendi, a traditional horse-drawn cart used in West Sumatra, serves as a context for learning motion with constant acceleration. The movement of a bendi, from starting at rest and increasing in speed to slowing down before stopping, can be used to examine changes in velocity over time. Panjat pinang, although practiced in various regions of Indonesia and not exclusive to West Sumatra, can still serve as a familiar cultural context for students to learn about vertical motion, particularly free fall, through the event in which a prize is released from the top of a pole and falls to the ground. Assuming that the prize is released from rest and air resistance is negligible, students can investigate the relationship between falling time, vertical displacement, and gravitational acceleration. Thus, this study aimed to develop and determine the validity dan practicality of an E-Student Worksheet on motion along a straight line based on guided inquiry integrated with local wisdom to facilitate students' critical thinking skills.

## II. METHOD

The research followed a Research and Development (R&D) design aimed at producing an Electronic Student Worksheet for motion along a straight line that incorporates Guided Inquiry and local wisdom to support the development of students' critical thinking skills. The product was developed using the Four-D (4D) model introduced by [17], which comprises four stages: Define, Design, Develop, and Disseminate. In this study, the development process was limited to the Define, Design, and Develop stages, whereas the Disseminate stage was not implemented. The research took place at SMAN 1 Batang Kapas during the first semester of the 2026/2027 academic yea. The Define stage involved one physics teacher and 34 Grade X students. In the Develop stage, five lecturers with expertise in physics education and E-Srudent Worksheet development served as validators to evaluate the product. The practicality test involved one physics teacher and 34 Grade X students, some of whom had also participated in the needs analysis. The involvement of only one physics teacher in the practicality test represents a limitation in obtaining assessments of the E-Studend Worksheet practicality from the teacher's perspective.

At the Define stage, five types of analysis were performed, namely front-end analysis, learner analysis, task analysis, concept analysis, and learning objective analysis. The front-end analysis focused on examining the problems encountered in physics learning as well as the teaching materials currently utilized. Learner analysis was carried out to examine the characteristics and needs of Grade X students who would use the E-Student Worksheet. Task analysis focused on determining the competencies to be achieved and the learning activities that students needed to undertake. Concept analysis was used to identify and organize the motion along a straight line concepts to be incorporated into the E-Student Worksheet. Meanwhile, learning objective analysis was conducted to formulate the learning objectives that guided the development of the content, learning activities, and exercises included in the E-Student Worksheet.

The Design stage focused on developing the initial framework of the E-Student Worksheet by referring to the findings obtained during the Define stage. In this stage, the E-Student Worksheet was structured around the Guided Inquiry learning model and incorporated six critical thinking indicators, namely interpretation, analysis, inference, evaluation, explanation, and self-regulation. The learning sequence was arranged to reflect the main processes of Guided Inquiry, beginning with observing phenomena and recognizing problems, followed by question formulation, investigation planning, data or information gathering and investigation implementation, data analysis, conclusion development, and presentation of the investigation results. These elements were subsequently organized into an integrated E-Student Worksheet as the developed learning product.

The Develop stage aimed to produce an E-Srudent Worksheet that had undergone validity and practicality assessments. The E-Srudent Worksheet was validated by five physics education experts from the Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang, who assessed its material substance, visual communication design, E-Srudent Worksheet components, software utilization, Guided Inquiry model, critical thinking skills, and integration of local wisdom. The product was subsequently revised based on the validators'

comments and suggestions. After revision, the E-Srudent Worksheet was tried out in classroom instruction involving one physics teacher and 34 Grade X Phase E students at SMAN 1 Batang Kapas. Following the learning activities, the teacher and students completed practicality questionnaires to evaluate the product in terms of ease of use and readability, presentation, efficiency, and usefulness.

Data collection in this study employed three categories of instruments: needs analysis instruments, a product validation instrument, and practicality questionnaires. The needs analysis instruments consisted of a teacher interview sheet, a student needs analysis questionnaire, a critical thinking skills test, and a learning implementation observation sheet. The teacher interview and student questionnaire were used to identify learning conditions, student characteristics, and the needs for teaching materials and learning activities. The critical thinking skills test consisted of essay questions developed based on four indicators: interpretation, analysis, evaluation, and inference. The learning implementation observation sheet was used to observe classroom learning activities and their alignment with the planned learning procedures.The product validation instrument was used by five expert lecturers to assess the E-Student Worksheet in terms of material substance, visual communication design, E-Srudent Worksheet components, software utilization, implementation of the *Guided Inquiry* model, critical thinking skills, and integration of local wisdom. Before being used to assess the product, the validation instrument was evaluated by four validators to determine its content validity using Aiken's V. The analysis yielded a mean Aiken's V coefficient of 0.93, categorized as valid.The practicality test was conducted using questionnaires completed by one physics teacher and 34 Grade X students. The questionnaires covered four aspects: ease of use and readability, presentation, efficiency, and usefulness. The involvement of only one physics teacher in the practicality test represents a limitation of this study in obtaining assessments of the E-Student Worksheet practicality from the teacher's perspective. The research was done with the school's permission. The participants were told about what the study was about and how the data would be collected.

The research data consisted of needs analysis, E-Student Worksheet validation, and E-Srudent Worksheet practicality data. The needs analysis findings informed the development of the E-Student Worksheet by considering the characteristics of the students and the intended learning objectives. Data for evaluating the validity were collected through assessments conducted by five validators, whereas practicality data were obtained from the responses of the physics teacher and students following the use of the E-Student Worksheet. The validity of both the research instrument and the developed E-Student Worksheet was determined using Aiken's V coefficient. The coefficient was calculated using the following equation:

$$V = \frac{\sum s}{[n(c-1)]} \qquad (1)$$

$$s = r - l_0 \qquad (2)$$

In this equation, denotes the rating assigned by the validator, while l₀ represents the minimum rating (1). The value of c refers to the maximum rating (4), and n indicates the total number of validators involved in the assessment [18]. The rating scale used consisted of four response options: Strongly Disagree (1), Disagree (2), Agree (3), and Strongly Agree (4) [19]. The resulting Aiken's V value was then interpreted based on the validity criteria in Table 1:

**Table 1.** Validity Criteria

| Interval | Category |
|---|---|
| $V \geq 0{,}80$ | Valid |
| $V < 0{,}80$ | Not Valid |

(Souce: Ref [18] )

Practicality analysis was conducted based on the questionnaire results provided by teachers and students. The practicality percentage was determined based on the results obtained from the following calculation:

$$Score = \frac{Score\ obtained}{maximum\ score}\ x\ 100\% \qquad (3)$$

The resulting practicality percentage was interpreted based on the categories proposed by [20]: 0–20% was categorized as impractical, 21–40% as less practical, 41–60% as moderately practical, 61–80% as practical, and 81–100% as highly practical.

## III. RESULTS AND DISCUSSION

### Result

### Needs Analysis

The Define stage focused on examining the learning needs and identifying problems encountered in physics instruction, which were subsequently used to inform the development of an E-Student Worksheet on motion along a straight line. The worksheet was designed using Guided Inquiry and incorporated local wisdom to support the development of students' critical thinking skills. Based on the document analysis, the instructional material available at SMAN 1 Batang Kapas covered motion with constant velocity and motion with constant acceleration. Analysis of the teaching material showed that the material had been presented systematically through concepts, equations, graphs, and examples, but did not specify a particular learning model and did not provide specific activities for observation, experiments, data collection, group discussion, collaboration, and learning reflection. The examples presented were also general and had not related the material to local wisdom. Teacher interviews showed that learning had used inquiry learning and problem-based learning models, but their implementation had not fully followed the syntax, particularly the investigation activities. Students often received information directly, so their opportunities to collect information, conduct investigations, analyze data, and construct concepts independently were still limited.

The learner analysis involved 34 Grade X Phase E students and focused on identifying their characteristics and assessing their critical thinking skills. Data on student characteristics were obtained through a questionnaire, while their critical thinking abilities were measured separately. The analysis of student characteristics based on a questionnaire administered to 34 Grade X Phase E students, showed that 89.71% of the students found physics easier to understand through hands-on practice, experiments, or physical activities. This result indicates that students tend to understand physics concepts more easily through learning activities involving direct experience and inquiry. Furthermore, 83.09% of the students reported that they found physics concepts easier to understand and analyze through real-life experiences. This indicates that relating physics concepts to contextual phenomena can help students understand and analyze the material. In addition, 86.03% of the students reported that they could remember the material more easily when it was presented through pictures, animations, or videos, suggesting that visual media can support students' understanding of learning materials. Furthermore, 79.41% of the students preferred group learning to individual learning, indicating that opportunities for discussion and collaboration should be provided during learning activities. Another 83.09% of the students reported that they found digital learning materials easier to understand than printed textbooks, indicating that digital learning resources align with their learning preferences. These results highlight the need for learning materials that accommodate students' characteristics and learning needs through inquiry activities, contextual phenomena, visual media, and group discussions supported by digital technology. However, the results of the critical thinking skills assessment showed an average score of 29%, categorized as weak, here are the results of the students' critical thinking skills test:

**Table 2.** Results of the students' critical thinking skills test

| Indikator | Presentase | Kategori |
|---|---|---|
| Interpretation | 48% | Enough |
| Analysis | 28% | Weak |
| Evaluation | 27% | Weak |
| Inference | 13% | Very Weak |

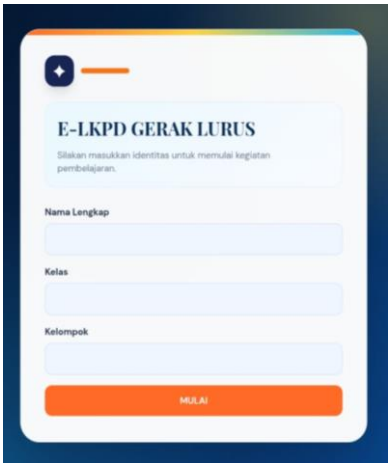
The low inference ability indicates that students still experience difficulties in drawing logical conclusions based on the information or data obtained. Students also tend to focus on using formulas without adequate conceptual understanding. These results indicate the need for an E-Student Worksheet that is appropriate to students' characteristics while providing investigative activities that can train students to interpret information, analyze data, evaluate results, and draw conclusions to facilitate their critical thinking skills. The initial assessment did not cover the evaluation and self-regulation indicators in the intended E-Student Worksheet framework; however, both indicators will still be integrated into the E-Student Worksheet design to provide opportunities for students to assess information and learning outcomes and reflect on their thinking processes.

Task analysis was conducted based on the Learning Outcomes, Learning Objectives, and Learning Objective Flow for motion along a straight line by integrating seven guided inquiry stages: identifying problems and conducting observations, asking questions, planning an investigation, collecting data and conducting an investigation, analyzing data, drawing conclusions, and communicating investigation results. The material analysis covered motion with constant velocity, motion with constant acceleration, and vertical motion. These materials

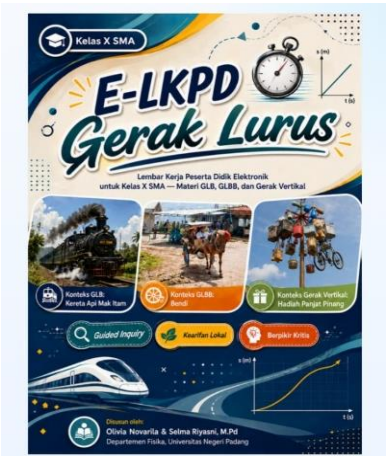
were related to local wisdom through the contexts of the Mak Itam Train for motion with constant velocity, bendi for motion with constant acceleration, and panjat pinang for vertical motion. Meanwhile, the learning objectives were directed toward enabling students to understand and analyze motion along a straight line concepts through investigation activities, process and analyze observation data, draw conclusions based on investigation results, and relate motion along a straight line concepts to phenomena in everyday life and local wisdom.

**E-Student Worksheet Design Results**

The design stage produced an initial design of an E-Student Worksheet integrated with local wisdom, developed using Canva AI. The E-Student Worksheet consists of several components designed to support the smooth presentation of materials and learning activites. The components include a login page, cover, main menu, preface, learning instroduction, product description, competencies, supporting informations, work steps, assessment, glossary, author information, and references.



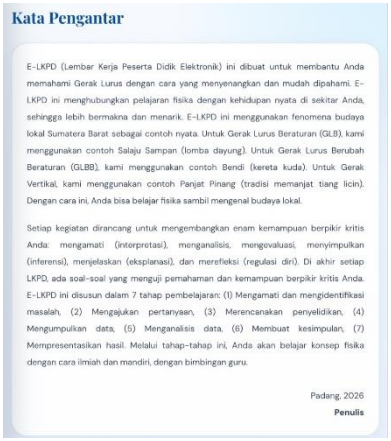

(a)



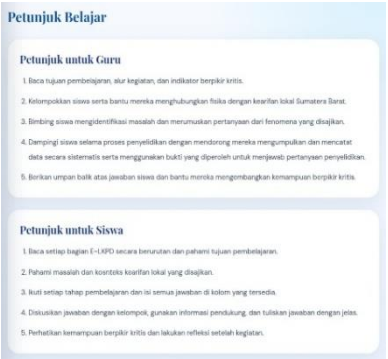

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(c)



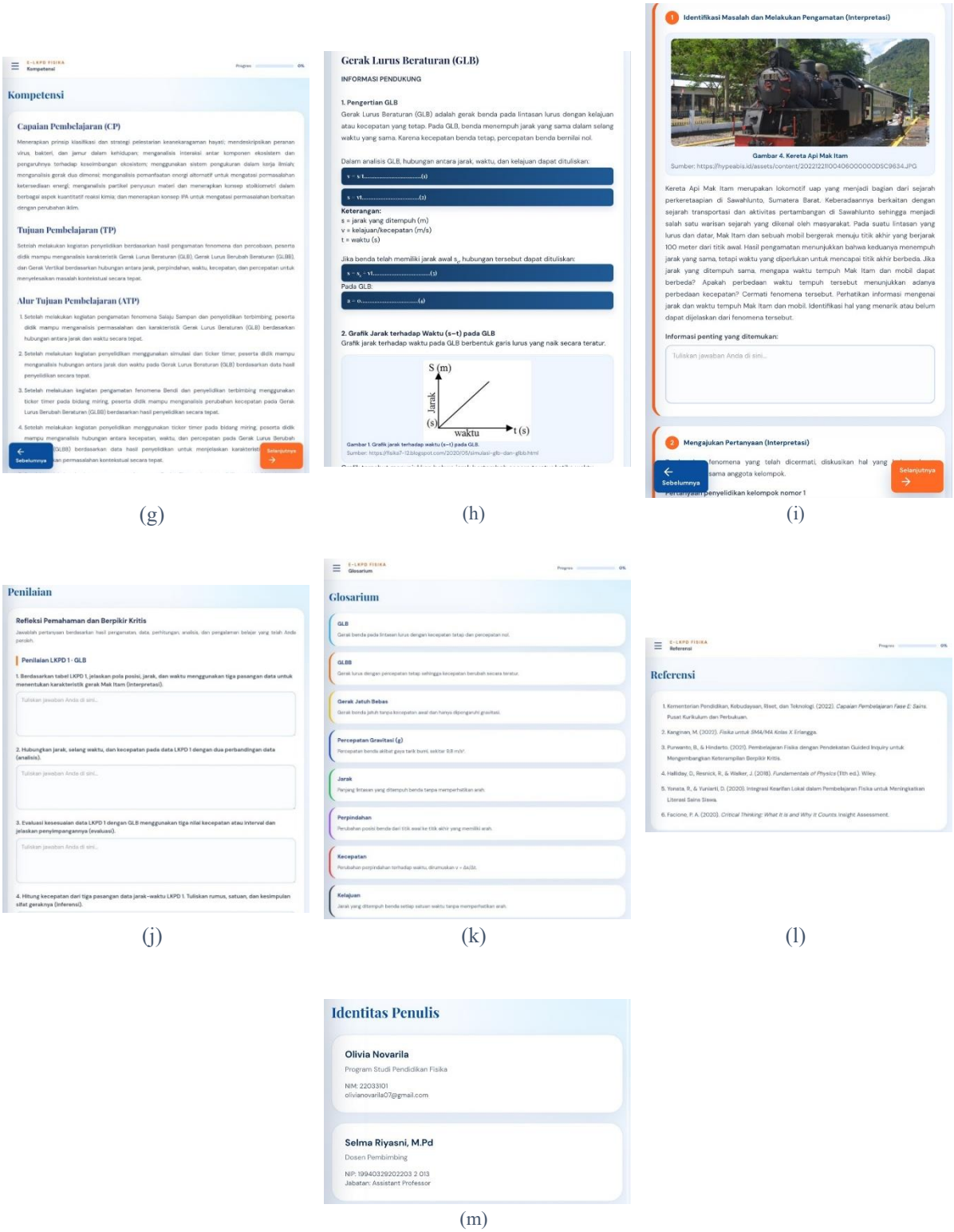

(d)




(e)




(f)




(g) (h) (i)

(j) (k) (l)

(m)

**Figure 1.** Display of E-Student Worksheet Components: (a) Login Page (b) Cover (c) Main Menu (d) Preface (e) Learning Instructions (f) Product Description (g) Competencies (h) Supporting Information (i) Work Steps (j) Assessment (k) Glossary (l) References (m) Author Information

Figure 1 presents the interface and components of the Electronic Student Worksheet (E-Student Worksheet) on straight-line motion based on *Guided Inquiry* and integrated with local wisdom to facilitate students' critical thinking skills. The E-Student Worksheet begins with a cover page displaying the product identity and learning topic. It is followed by a preface, learning instructions, and a product description that provide information about the objectives, characteristics, and procedures for using the E-Student Worksheet. The learning competencies

section presents the learning outcomes and objectives that guide the learning activities. The main components of the E-Student Worksheet consist of three learning activities: Worksheet 1 on motion with constant velocity ,Worksheet 2 on motion with constant acceleration, and Worksheet 3 on vertical motion. Each worksheet is organized according to the stages of *Guided Inquiry*, beginning with problem identification and observation, question formulation, investigation planning, data collection and investigation, data analysis, conclusion drawing, and communication of investigation results. Through these stages, students are guided to identify relevant information, formulate questions based on observed phenomena, determine investigation procedures, process data, evaluate their analytical results, and formulate and communicate conclusions.

The motion with constant velocity material incorporates the context of the Mak Itam Train in Sawahlunto, West Sumatra, to connect train movement with the physics concepts of distance, time, and speed. Students are guided to analyze the distance and time data provided in the worksheet to calculate speed and identify the characteristics of motion with constant velocity. The motion with constant acceleration material uses the *bendi*, a traditional horse-drawn carriage, as a context for exploring changes in motion, such as when the carriage starts moving, changes speed, and slows down until it stops. Through this context, students analyze information about changes in speed over time to understand the characteristics of motion with constant acceleration. Meanwhile, the vertical motion material incorporates *panjat pinang*, a traditional climbing activity commonly associated with Indonesian celebrations, as a context for examining vertical movement and analyzing changes in position or other motion quantities over time using the information provided in the worksheet.

The activities in each worksheet are designed to facilitate critical thinking indicators. Interpretation is encouraged through understanding phenomena and relevant information; analysis through data processing; evaluation through examining results and the accuracy of reasoning; inference through drawing conclusions; and explanation through communicating the reasoning and results of the analysis. Self-regulation is addressed through reflection on the learning process and outcomes, if such an activity is included in the product. The final section of the E-Srudent Worksheet includes an assessment to evaluate students' understanding, a glossary explaining important terms, references providing supporting sources, and author information. The overall organization integrates physics content, *Guided Inquiry* stages, local wisdom contexts, and learning activities intended to facilitate students' critical thinking skills.

**Table 3.** Mapping of Concepts, Local Wisdom, Guided Inquiry Stages, and Critical Thinking Indicators

| Concept | Local Wisdom | Guided Inquiry | Critical Thinking Indicator |
|---|---|---|---|
| Motion with constant velocity: relationship between distance, time, and constant velocity | Mak itam | Problem Identification and Observation | Interpretation |
| Motion with constant velocity: ormulating questions about the relationship between distance, time, and velocity | Mak itam | Formulating Questions | Interpretation |
| Motion with constant velocity: determining the quantities, equipment, and measurement procedures for distance and time | Mak itam | Planning the Investigation | Analysis |
| Motion with constant velocity: measuring distance and travel time and calculating velocity | Mak itam | Collecting Data and Conducting the Investigation | Analysis |
| Motion with constant velocity: comparing distance, time, and velocity based on the data | Mak itam | Analyzing Data | Analysis and evaluation |
| Motion with constant velocity: drawing conclusions about the characteristics of motion based on measurement results | Mak itam | Drawing Conclusions | Inference and explanation |
| Motion with constant velocity: presenting the analysis results and reviewing the conclusions | Mak itam | Communicating the Investigation Results | Explanation and self-regulation |
| Motion with constant acceleration: changes in velocity and acceleration | Bendi | Problem Identification and Observation | Interpretation |

| Concept | Local Wisdom | Guided Inquiry | Critical Thinking Indicator |
|---|---|---|---|
| Motion with constant acceleration: formulating questions about changes in velocity over time | Bendi | Formulating Questions | Interpretation |
| Motion with constant acceleration: determining the quantities, equipment, and investigation procedures using an inclined track | Bendi | Planning the Investigation | Analysis |
| Motion with constant acceleration: measuring the distance and time of a toy car's motion and calculating its velocity | Bendi | Collecting Data and Conducting the Investigation | Analysis |
| Motion with constant acceleration: analyzing changes in distance and velocity based on observational data | Bendi | Analyzing Data | Analysis and evaluation |
| Motion with constant acceleration: drawing conclusions about the characteristics of changing motion based on the investigation results | Bendi | Drawing Conclusions | Inference and explanation |
| Motion with constant acceleration: presenting the analysis results and reviewing the conclusions | Bendi | Communicating the Investigation Results | Explanation and self-regulation |
| Vertical motion: changes in the position of an object moving toward the ground | Panjat Pinang | Problem Identification and Observation | Interpretation |
| Vertical motion: formulating questions about the relationship between position, time, and velocity | Panjat Pinang | Formulating Questions | Interpretation |
| Vertical motion: determining the equipment and procedures to observe falling objects that are separate | Panjat Pinang | Planning the Investigation | Analysis |
| Vertical motion: recording the ball's motion and documenting its position over time | Panjat Pinang | Collecting Data and Conducting the Investigation | Analysis |
| Vertical motion: analyzing changes in distance and velocity, as well as the ball's acceleration | Panjat Pinang | Analyzing Data | Analysis and evaluation |
| Vertical motion: drawing conclusions about the characteristics of motion based on observational data | Panjat Pinang | Drawing Conclusions | Inference and explanation |
| Vertical motion: presenting the analysis results and reviewing the conclusions | Panjat Pinang | Communicating the Investigation Results | Explanation and self-regulation |

**E-Student Worksheet Validity**

The expert validation process resulted in several revisions to the developed E-Student Worksheet to improve its quality and suitability for learning activities. The revisions included improvements to the cover design, learning objectives, sequence of learning objectives, and indicators of learning objective achievement. In Worksheet 1, the local wisdom context was replaced, and the problem identification activity was revised to align with straight-line motion concepts and prevent potential misconceptions. In Worksheets 2 and 3, the problem identification activities were also revised to present contextual problems that could stimulate students' curiosity. In the assessment section, the critical thinking skill indicators were moved to the end of each question. Furthermore, the presentation was improved by adding table numbers and titles, figure numbers, captions and sources, and equation numbers, as well as correcting equation formatting. Graphs were also added to the supporting information section to complement the learning materials.

Following these revisions, the developed E-Student Worksheet was evaluated by expert validators across seven aspects: material substance, visual communication design, E-Student Worksheet components, software utilization, implementation of the Guided Inquiry model, facilitation of critical thinking skills, and integration of local wisdom. The analysis using Aiken's V yielded an overall validity index of 0.93, indicating that the E-Student

Worksheet was highly valid. Among the seven aspects, integration of local wisdom obtained the lowest validity index, at 0.89, but remained within the valid category. Overall, the validation results indicate that the developed E-Student Worksheet meets the validity criteria for supporting the intended learning activities.

**Table 4.** Product Validity Results

| Aspect | V | Category |
|---|---|---|
| Material Subtance | 0.91 | Valid |
| Visual Communication Design | 0.98 | Valid |
| E-Student Worksheet Components | 0.97 | Valid |
| Software Utilization | 0.93 | Valid |
| Guided Inquiry Model | 0.92 | Valid |
| Critical Thinking Skills | 0.91 | Valid |
| Local Wosdom Integration | 0.89 | Valid |
| Average | 0.93 | Valid |

**E-Student Worksheet Practicality**

After the validation and revision processes were completed, resulting in a valid E-Student Worksheet, a practicality test was conducted as the next stage of the study. The practicality of the E-Student Worksheet was evaluated by one physics teacher and 34 students at SMAN 1 Batang Kapas. The assessment covered four aspects: ease of use and readability, presentation, time efficiency, and usefulness. The overall practicality scores were 95.09% based on the teacher's assessment and 93.52% based on the students' assessment. The scores for each aspect are presented in Figure 3 and 4.

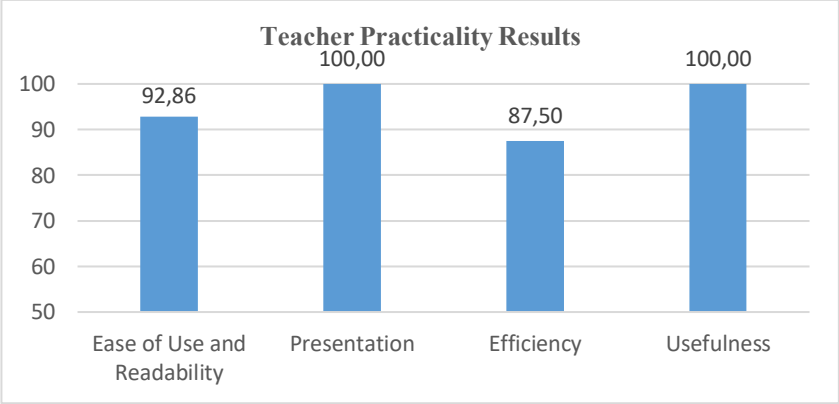



**Figure 2.** Teacher Practicality Result

The teacher's practicality assessment showed that the presentation and usefulness aspects obtained the highest scores, at 100.00% each. Ease of use and readability received a score of 92.86%, while time efficiency obtained the lowest score, at 87.50%. The overall practicality score based on the teacher's assessment was 95.09%. These results indicate that the E-Student Worksheet was considered practical by the physics teacher, although time efficiency may require further attention in subsequent product development.

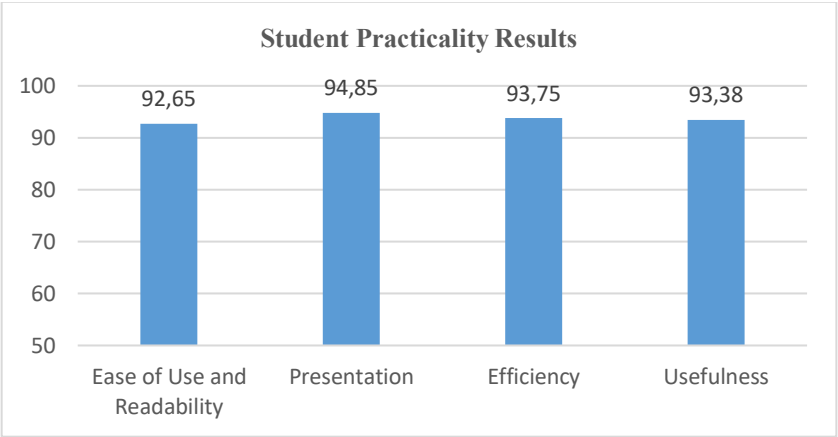



**Figure 3.** Student Practicality Result

The practicality assessment indicated that the E-Student Worksheet was practical for use in physics learning, with overall scores of 95.09% from the physics teacher and 93.52% from the students. The teacher's assessment covered four aspects: ease of use and readability, presentation, time efficiency, and usefulness. The scores were 92.86%, 100.00%, 87.50%, and 100.00%, respectively. Meanwhile, the student assessment yielded scores of 92.65% for ease of use and readability, 94.85% for presentation, 93.75% for time efficiency, and 93.38% for usefulness. These results show that the E-Student Worksheet received positive practicality assessments from both the teacher and students across the assessed aspects.

**Discussion**

The needs analysis results indicate that physics learning at SMAN 1 Batang Kapas still requires teaching materials that can guide students toward investigation activities and facilitate critical thinking skills. The teaching material used was material on motion with constant velocity and motion with constant acceleration, which already contained concepts, equations, graphs, and examples and discussions. However, it did not specifically provide observation, experiment, data collection, data analysis, group discussion, and reflection activities that support student involvement in the investigation process. In addition, the examples presented had not related motion along a straight line concepts to local wisdom. Interview results showed that inquiry learning and problem-based learning models had been used in learning, but the investigation stages had not been fully implemented. This indicates the need for teaching materials containing structured investigation stages and integrating local wisdom contexts to facilitate students' critical thinking skills. The results provided a reference for designing an E-Student Worksheet on motion along a straight line that combines the Guided Inquiry model with local wisdom.

Learner analysis was conducted through a student characteristics questionnaire and a critical thinking skills test for Grade X Phase E students. The questionnaire findings indicated that the students' characteristics were compatible with learning activities involving digital teaching materials, hands-on activities, collaborative group work, and learning situations connected to everyday experiences. In contrast, the results of the critical thinking assessment indicated that the students' overall abilities remained at a low level. Among the indicators examined, interpretation reached a sufficient level, whereas analysis and evaluation were categorized as low, and inference was classified as very low. The inference indicator had the lowest score, indicating that students have difficulty drawing conclusions from the information and data available to them. This difficulty is related to the requirement to formulate logical conclusions based on information and evidence rather than merely repeating concepts or calculation results. This finding highlights the need for learning activities that provide students with more opportunities to interpret information, examine and analyze data, evaluate the results obtained, and draw evidence-based conclusions.

At the design stage, the E-Student Worksheet based on guided inquiry integrated with local wisdom was designed using an appropriate writing process and structure. The E-Student Worksheet was organized into several essential components, consisting of the title, learning instructions, competencies, supporting information, learning activities or work procedures, and assessment [21]. The learning activities were designed around seven stages of Guided Inquiry integrated with local wisdom: (1) identifying problems through observation, (2) formulating questions, (3) designing an investigation, (4) gathering data and carrying out the investigation, (5) interpreting and analyzing the collected data, (6) formulating conclusions, and (7) presenting the investigation results. Each stage was also designed to engage the six critical thinking indicators identified by [5], including interpretation, analysis, inference, evaluation, explanation, and self-regulation. Once the E-Student Worksheet had been completed, its quality was examined prior to implementation through expert validation and a practicality assessment. The validation process focused on determining the alignment of the E-Student Worksheet with the learning objectives, motion along a straight line content, and targeted critical thinking indicators. Meanwhile, the practicality assessment examined how easily the developed E-Student Worksheet could be used in learning activities by teachers and students. This assessment was carried out during the Develop stage and involved a physics teacher and students as respondents.

The development phase focused on examining the quality and feasibility of the Guided Inquiry-based E-Student Worksheet for motion along a straight line. Its validity was evaluated by five physics education lecturers from the Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang (FMIPA UNP). The evaluation comprised seven components, namely material substance, visual communication design, E-Student Worksheet components, software utilization, implementation of the Guided Inquiry model, facilitation of critical thinking skills, and integration of local wisdom. The assessment indicated that the E-Student Worksheet fulfilled the validity requirements across all evaluated components. For the material substance, the evaluation considered the accuracy, scope, currency, and readability of the content. The motion along a straight line material was organized according

to scientifically correct concepts and aligned with the learning objectives and indicators of learning objective achievement. The content was arranged in a logical sequence and expressed using language that was accessible to students. In addition, the material incorporated current scientific developments and was aligned with the principles of the Merdeka Curriculum. Hence, the content was designed to serve more than the delivery of physics concepts; it was also structured to direct students toward the intended learning outcomes. This is consistent with [22], who evaluated material substance based on breadth, depth, accuracy, completeness, material presentation, learning assessment, student activities, and language. Their study highlights the importance of content accuracy, systematic presentation, and language clarity in assessing the validity of physics learning materials.

In the visual communication design aspect, the assessment covered navigation, fonts, media, colors, and layout. The E-Student Worksheet was equipped with clear navigation and instructions, used readable font types and sizes, included images that supported information, and employed proportional color combinations and layouts. These visual aspects support readability and facilitate students in following the activities contained in the E-Student Worksheet. These findings are consistent with [23], who reported that visual presentation and navigation are important components of instructional design validation. Their study supports the importance of clear visual presentation and accessible navigation in using physics worksheets to facilitate students' learning activities. In the E-Student Worksheet component aspect, the assessment covered the title, learning instructions, competencies to be achieved, supporting information, tasks or work steps, assessment, author, and references. These elements were organized in a coherent sequence so that each component contributed to the continuity of the learning process, beginning with the presentation of information and continuing through learning activities and assessment. Such completeness is essential because an E-Student Worksheet serves a broader function than simply presenting instructional content; it also provides students with directions for carrying out the learning activities. This is consistent with the study by [24], who developed a physics student worksheet comprising the title, learning instructions, competencies, supporting information, tasks and work steps, and assessment. Learning instructions guide students in using the worksheet, competencies clarify the intended learning outcomes, supporting information presents the learning materials, and tasks and work steps guide students in carrying out learning activities. These findings highlight the importance of organizing worksheet components systematically so that each component has a clear function and supports the coherence of physics learning activities.

In the software utilization aspect, the assessment covered interactivity, immediate responses to student activities, Canva AI accessibility through computers and smartphones, software operation, and product originality. Interactivity refers to the opportunities provided for students to engage with the digital features embedded in the E-Student Worksheet. Accessibility through computers and smartphones allows students to use the worksheet on different devices. Software operation concerns the functionality of the digital features and the ease of accessing and using them during learning activities. Product originality refers to the uniqueness of the developed E-Student Worksheet. These features support students in accessing learning materials, engaging with learning activities, and using the worksheet more flexibly.In the use of the guided inquiry model aspect, the assessment covered problem identification and observation, question formulation, investigation planning, data collection and investigation implementation, data analysis, conclusion drawing, and result communication. The seven stages were arranged sequentially so that students received guidance in conducting investigations, from recognizing phenomena to communicating the results obtained. These findings are supported by [25], who evaluated the validity of Guided Inquiry-based student worksheets based on the alignment of the content with the model's syntax, the systematic sequence of its stages, and the clarity of information and instructions at each stage. Their study highlights the importance of arranging the Guided Inquiry stages sequentially and explaining each stage explicitly to ensure that the worksheet activities are consistent with the learning model being used.

In the critical thinking skills aspect, the assessment covered interpretation, analysis, inference, explanation, evaluation, and self-regulation. Interpretation was facilitated through understanding phenomena and information, analysis through data processing and relationships among concepts, inference through drawing conclusions, explanation through providing explanations and reasons, evaluation through assessing information or results, and self-regulation through reflection on the learning process and outcomes. These findings are supported by [26], who examined the feasibility of a physics E-Student Worksheet designed to develop students' critical thinking skills. Their study supports the importance of assessing the alignment between instructional materials and the critical thinking skills they are intended to facilitate. Validity in this aspect is therefore necessary to ensure that the critical thinking indicators are appropriately represented in the E-Student Worksheet and supported by the learning activities provided. In the use of local wisdom aspect, the assessment covered the suitability of West Sumatran cultural and social contexts, integration of local wisdom with the material, clarity of presentation, support for critical thinking skills, and suitability for students' environment. The E-Srudent Worksheet integrates the Mak

Itam Train motion with constant velocity, bendi motion with constant acceleration, and panjat pinang in vertical motion as contexts in observation and investigation activities. These findings are supported by [27], which showed that integrating local wisdom into physics E-Srudent Worksheet can connect physics concepts with cultural contexts that are close to students and serve as contexts for learning activities.

A practicality assessment was carried out at SMAN 1 Batang Kapas with the participation of one physics teacher and 34 students. The assessment indicated that the teacher gave the highest ratings to the presentation and usefulness aspects, whereas the presentation aspect obtained the highest rating from the students. These results reflect the extent to which the E-Student Worksheet was considered clear and easy to follow, particularly through comprehensible instructions, readable font selection and sizing, appropriate visual elements, and sufficiently complete information. Such characteristics allow users to navigate the learning activities in an organized manner and understand the tasks provided in each stage. This is in line with the findings of This aligns with the research by [28], which shows that the suitability of instructions, text readability, and completeness of information are important aspects so that teachers and students can easily use E-Student Worksheet. The teacher's high rating of the usefulness aspect further suggests that the E-Student Worksheet can support the learning process beyond the delivery of content. Its use provides assistance in strengthening students' conceptual understanding, facilitating the achievement of learning objectives, and encouraging the development of critical thinking skills. This result is consistent with [29], which emphasized that useful teaching materials can contribute to the development of critical thinking while also providing practical benefits for both teachers and students during learning activities

Several limitations should be considered when interpreting these findings. The research was conducted at one school, SMAN 1 Batang Kapas, and the needs analysis and practicality assessment involved one physics teacher and 34 Grade X Phase E students.The development process also covered only the Define, Design, and Develop stages of the Four-D model; the Disseminate stage was not implemented. In addition, the study assessed validity and practicality but did not test effectiveness or compare students' critical thinking skills before and after using the E-Student Worksheet. The findings therefore do not establish whether the product improves critical thinking skills or learning outcomes. Future research should examine the product in schools with varied characteristics and include broader implementation and an effectiveness test.

Overall, this study produced an E-Student Worksheet on straight-line motion based on Guided Inquiry and integrated with West Sumatran local wisdom. The product combines structured investigation activities, digital learning materials, and contextualized physics phenomena to facilitate engagement with six critical thinking indicators. Expert validation established that the product met the validity criteria across all seven assessed aspects, while teacher and student responses indicated a very high level of practicality. These findings support the use of the E-Student Worksheet as an alternative digital teaching resource for straight-line motion learning. Its potential contribution to improving students' critical thinking skills, however, requires further investigation through broader implementation and effectiveness testing.

## IV. CONCLUSION

This study developed an E-Student Worksheet on straight-line motion based on Guided Inquiry and integrated with West Sumatran local wisdom. The product achieved an overall validity coefficient of 0.93, categorized as valid, with practicality scores of 95.09% from the physics teacher and 93.52% from students, both categorized as very practical. These results indicate that the developed E-Student Worksheet meets the validity and practicality criteria for use as a digital teaching resource for straight-line motion. However, the study was limited to one class and covered only the Define, Design, and Develop stages of the Four-D model. Furthermore, the product's effectiveness in improving students' critical thinking skills has not been evaluated.

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