

# Development of Differentiated Student Worksheets (LKPD) Oriented Towards Inquiry-Based Learning to Improve Critical Thinking Skills of High School Students on The Subject of The Human Digestive System

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**Abstract:** This study aims to produce differentiated student worksheets that are valid, practical, and effective in improving students' critical thinking skills. The research and development (R&D) design was conducted using the 4-D model, which consists of four steps: define, design, develop, and disseminate. The research subjects were 15 students in a small-scale trial and 66 students in a large-scale trial, all from class XI of SMA Negeri 1 Seputih Surabaya with cluster random sampling. The trial design used by the researcher was a non-equivalent control group design. The instruments used were needs analysis questionnaires, validity questionnaires, practicality questionnaires, learning implementation observation sheets, and pretest-posttest of critical thinking skills. Data analysis techniques for validity and practicality use descriptive percentage analysis, while data analysis for effectiveness uses statistical analysis (independent sample t-test, paired sample t-test and one-way anova). The results of the development research indicate that differentiated student worksheets are highly valid (94%); differentiated student worksheets are practical for improving students' critical thinking skills in terms of learning implementation; differentiated student worksheets were effective in improving students' critical thinking skills with a large effect size (0.99). The conclusion is that differentiated worksheets on the human digestive system have been developed that can improve students' critical thinking skills.

**Keywords:** Critical thinking skills; Differentiated instruction; Inquiry-based learning; Student worksheets

## Introduction

Critical thinking is one of the essential 21st-century skills needed to solve everyday problems (Agustina, 2019; Cynthia et al., 2023; Halim, 2022; Jannah et al., 2022; Kemendikbud, 2023; Mardhiyah et al., 2021). It is important for students to develop this skill so they can build strong arguments, evaluate the credibility of information sources, and make informed decisions (N. Anggraeni et al., 2022; Fatmawati et al., 2020; Januaripin, 2023; Putri et al., 2022). Students who think critically tend to contribute more actively to society by analyzing social issues and making decisions based on data or facts (Susanto et al., 2023; Syamsudin, 2020). With critical

thinking skills, students can become more adaptive, independent, competitive, and better able to reach their full potential—enabling them to face the challenges of the 21st century more effectively (Halpern, 2013).

Although critical thinking is one of the most important skills, the reality in Indonesia shows that students' critical thinking skills are still considered low (Diva et al., 2023; Nuryanti et al., 2016; Syafitri et al., 2021). According to the 2015 TIMSS survey, Indonesia scored 397 and ranked 44th out of 49 countries (Hadi et al., 2020; Nurmawanti et al., 2023; F. T. Wahyuni et al., 2022). This score is below the international average of 500 (Tanti, 2020; A. Wahyuni et al., 2020). Similarly, the 2022 PISA study showed that Indonesia ranked 66th out

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of 81 countries (Ansya et al., 2024; Hafizha et al., 2024). Indonesia's reading literacy score dropped by 12 points to 359, mathematics literacy by 13 points to 366, and science literacy by 13 points to 383 (Kemendikbud, 2017; OECD, 2023). The questions used in TIMSS and PISA assessments require higher-order thinking and problem-solving strategies that students may not have encountered before. To answer these questions, students need to think critically and creatively, and apply various concepts and strategies (Janah et al., 2019).

Indonesia's low PISA scores in all three areas—which require students to think critically and creatively—are consistent with findings from a survey of 103 twelfth-grade high school students in Lampung. The survey found that 59% of students felt their teachers had not encouraged them to think critically. Most teachers only delivered the material, asked students to discuss it, and then present in front of the class. Many students still rely on memorizing concepts, taking notes from lectures, and rarely use prior knowledge to support learning activities (Harahap et al., 2020; Sulawanti et al., 2019; Utama et al., 2014). This situation causes students to become passive in the learning process, as their activities are limited (Sutama et al., 2014). Student engagement remains low, with most acting only as passive listeners. Additionally, teachers often rush through the material without giving enough attention to students' understanding or critical thinking development.

Based on the explanation above, it is clear that the low level of students' critical thinking skills is mostly due to ineffective teaching practices. Learning in classrooms still tends to follow conventional methods, mainly dominated by lectures and simple question-and-answer sessions (Anita et al., 2019; Lisnawati et al., 2022). Teachers often rely solely on direct instruction and do not encourage active student participation (A. Anggraeni et al., 2020). This traditional approach is less effective because the information delivered is often stored only in short-term memory, making it easy to forget and resulting in less meaningful learning (Mertayasa, 2012; Utama et al., 2014). In lecture-based (teacher-centered) methods, students tend to memorize information without engaging in deeper thinking (working memory). As a result, students become passive and have fewer opportunities to develop their thinking skills (Ramdhayani et al., 2023). Therefore, improving critical thinking skills is essential to help students solve problems and draw conclusions effectively from various possibilities (Sulistiani et al., 2016).

Choosing the right learning model plays an important role in the success of the learning process and helps achieve learning objectives more effectively (Asmara et al., 2019; Doyan et al., 2020; Prasetyawati, 2021). Therefore, teachers are expected to select learning models that suit both the lesson content and students' needs (Doyan et al., 2023; Siswono, 2011). One model

that focuses on problem-solving and improving students' critical thinking skills is the Inquiry-Based Learning model (Harahap et al., 2021; Kelana et al., 2022; Pujani, 2022; Samadun et al., 2023; Santoso et al., 2021). Inquiry-Based Learning is a teaching approach that emphasizes critical and analytical thinking, encouraging students to search for and discover answers to problems on their own (Hulu et al., 2023; Januarti et al., 2024; Lestari et al., 2019; Nurwahid et al., 2021; Susilawati et al., 2021). This model focuses on how students use learning resources to identify and formulate problems (Prasetyo et al., 2020; Ramdhayani et al., 2023).

Every student has unique interests, talents, and cognitive abilities, which are influenced by their environmental and cultural backgrounds. As a result, each student has different learning needs (Bronfenbrenner, 2019; Faiz et al., 2022; Khasanah et al., 2019; Mukhtar et al., 2024). Therefore, it is essential for teachers to understand the individual characteristics of their students, as this knowledge can guide the planning and strategies used in the teaching process (Anggarwati et al., 2023; Farid, 2022; Kartini et al., 2019). One effective approach to designing and implementing instruction based on students' needs and characteristics is differentiated instruction (Farid, 2022; Rosyida et al., 2023). Differentiated instruction is a teaching strategy that accommodates, serves, and responds to students' needs in terms of their readiness to learn, learning profiles, and interests (Aprima et al., 2022; Faiz et al., 2022; Komalasari, 2023). The key features of differentiated instruction include effective classroom management, clearly defined learning goals, a supportive learning environment, ongoing assessment, and responsive teaching (Kusadi, 2022; Kusumaningpuri, 2024).

Education is reflected in the implementation of an effective and efficient teaching and learning process in the classroom, supported by adequate facilities and resources, including quality learning materials (Nurulsari et al., 2017). One type of learning material that can help guide students according to their individual characteristics and learning needs is the student worksheet or LKPD. LKPD (Lembar Kerja Peserta Didik) is a teaching resource used by both teachers and students to make learning activities more effective and efficient (Hekmah et al., 2019; Sujarwo et al., 2021). It serves as a guide for students during the learning process and consists of tasks or activities that students must complete (Rezki et al., 2024). Therefore, LKPD plays an important role in learning by helping students explore concepts creatively and develop scientific skills, so that learning objectives can be successfully achieved (Umbaryati, 2016).

Many teachers still use the same teaching materials without adjusting them to students' different needs and abilities. As a result, students often find it hard to follow

lessons because their existing knowledge and skills are not considered. Even though teachers use student worksheets (LKPD), they are mostly used just to present information, not to develop students' potential or higher-level thinking (Jalmo, 2009; Tiaradipa et al., 2020; Umutlu et al., 2020; Yusra et al., 2023). This situation limits students' chances to improve their critical thinking skills. A study of 50 high school biology teachers in Lampung Province showed that all of them used LKPD, but only 46% (23 teachers) included activities that support understanding and critical thinking. Meanwhile, only 34% (17 teachers) used LKPD with tasks like research or observation. This shows that many teachers still don't include activities that train critical thinking in their LKPD. In reality, many biology teachers still depend on lectures and only occasionally use LKPD, without guiding students to learn through scientific investigation.

The lack of variety in activities that help students understand the material and think critically in student worksheets (LKPD) makes it difficult for students to follow the learning process effectively. Many students struggle to understand certain topics because the learning materials are not tailored to their needs or interests. The LKPD used by teachers is often the same for all students, even though each student has different needs, motivations, and learning styles. In fact, the Merdeka Curriculum is designed to be more flexible and focused on essential content, with the goal of supporting students' individual abilities and unique potential. It encourages independent learning through differentiated instruction (Marlina et al., 2019; Rahayu et al., 2018).

Based on the ideas described above and as an effort to solve the problems identified, the researcher plans to develop a differentiated student worksheet (LKPD) based on Inquiry-Based Learning. This LKPD is expected to help students learn according to their individual needs, including their learning styles, readiness levels, and interests. In addition, this development is also expected to support teachers in improving students' critical thinking skills through differentiated instruction.

## Method

This research is guided by the 4-D instructional development model (Thiagarajan et al., 1974), namely Define, Design, Develop, and Disseminate. The define stage involves preliminary analysis of students and teachers through a preliminary study questionnaire. The design stage includes the development and validation of instruments and the preparation of a storyboard design. The develop stage includes evaluation, expert validation, limited testing for practicality, and extensive testing for the effectiveness of the LKPD. The disseminate stage involves the publication of LKPD

products. This product development procedure includes 4 stages with a research flow diagram shown in Figure 1.

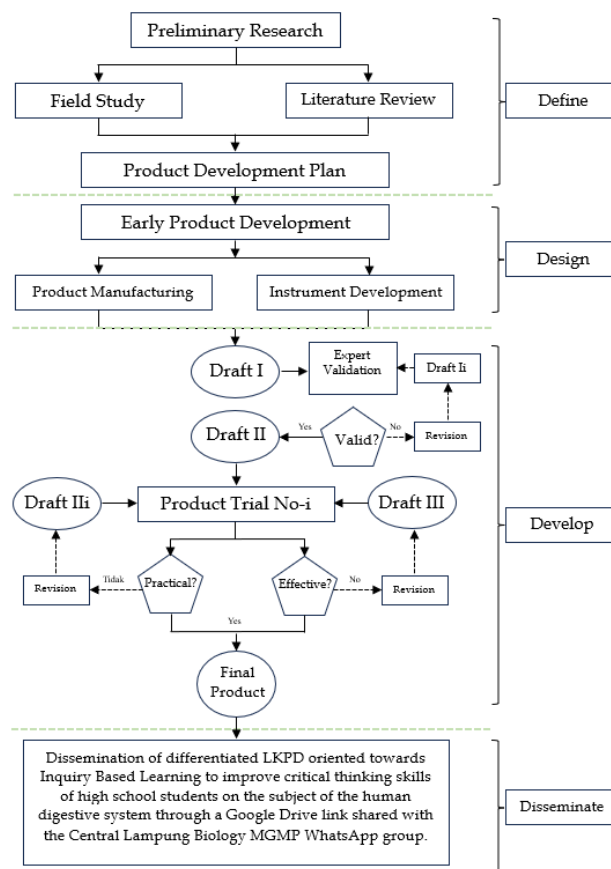


Figure 1. Research procedure (Sunyono, 2014)

### Define

The define stage consists of two stages, namely field study and literature review, which are conducted with the aim of analyzing the needs of educators and students, such as analyzing the needs of student worksheets. As material for conducting analysis, data was collected regarding the biology learning process, as well as the availability of student worksheets used in previous learning. This data collection was conducted on 50 biology teachers and 103 students at the high school level in Lampung Province.

### Design

The results of the analysis in the define stage are used as a reference in preparing differentiated LKPD. At this design stage, researchers determine the learning outcomes to be developed, namely critical thinking skills, determine the material framework, and create research instruments. After all the materials were available, the researchers create a storyboard to provide an overview of the product being developed.

Develop

The development stage in this research consists of two main stages: expert appraisal and development testing. Expert appraisal is carried out to validate or assess the feasibility of the product design by experts in the field. The validation process involves content and design experts, including university lecturers with doctoral degrees and practitioners such as Guru Penggerak (teacher leaders). Once the product is declared valid, development testing is conducted. This includes a limited trial involving 15 students and 2 biology teachers to assess the practicality of the product, followed by a wider trial to evaluate its effectiveness. The trial uses a quasi-experimental design, specifically the Nonequivalent Pretest-Posttest Control Group. This design is used to determine whether there is a difference in students' critical thinking skills after using the developed differentiated LKPD. The population in this study consists of grade XI students at SMA Negeri 1 Seputih Surabaya in the 2024/2025 academic year. The

sample was selected using the cluster random sampling technique, resulting in two classes experiment group and control group (33 students in the experimental group and 33 students in the control group).

Disseminate

The dissemination stage includes packaging, diffusion, and adoption of products so that differentiated LKPDs can be utilized by other biology teachers. LKPDs are uploaded to Google Drive and shared through MGMP Biology for further development and use.

Data collection instruments include: needs analysis questionnaires, validity questionnaires, practicality questionnaires, learning implementation observation sheets, and pretest-posttest tests. Data analysis techniques for validity and practicality use descriptive percentage analysis, while data analysis for effectiveness uses statistical analysis. Data collection and data analysis techniques are shown in Table 1.

Table 1. Data Collection Techniques

Research Variable		Instruments Used	Target	Data Analysis
Effectiveness		Pretest and Posttest	Students	N-Gain, Independent Sample T-Test, Paired Sample T-Test, One Way ANOVA
Practicality	Product assessment questionnaire by teachers and students, learning effectiveness observation sheet		Students Biology Teacher	Percentage analysis and descriptive analysis
Validity	Expert questionnaire on material testing, design testing, and practitioner testing	Two expert lecturers from Lampung University Practitioner (high school biology teacher)		Percentage analysis

Result and Discussion

This research focuses on the development of differentiated student worksheets (LKPD) based on Inquiry-Based Learning to improve the critical thinking skills of grade XI high school students on the topic of the human digestive system. The development process follows the 4-D model by Thiagarajan & Semmel (1974), which consists of four stages: Define, Design, Develop, and Disseminate as the final stage. The results of each development stage are summarized as follows.

Define

Based on the field study analysis, there is a clear gap between the ideal learning conditions and what actually happens in the classroom. The LKPD currently used by teachers does not yet meet the diverse learning needs of students. Many students struggle to understand the worksheets because they are not aligned with their learning styles, readiness, or interests. The activities in the LKPD also do not fully encourage students to think critically or deeply. When LKPD does not address students' individual differences—such as learning

styles, ability levels, and interests—it can hinder the development of critical thinking skills. This happens because students are not given appropriate challenges to stimulate deeper thinking. As a result, they tend to follow instructions mechanically, without analyzing, evaluating, or reflecting on the content. Without a differentiated approach in the LKPD, the learning process becomes less meaningful. Students lose the opportunity to engage actively in problem-solving and decision-making, which are key elements of critical thinking. Based on this analysis, the researcher developed an LKPD that considers the diverse learning needs of students, so that the materials and activities provided can encourage higher cognitive engagement, such as critical thinking. A responsive and contextual LKPD provides challenges that match students' abilities, encouraging them to think analytically, reflectively, and creatively in completing their learning tasks.

Design

At the design stage, the researcher designed a differentiated LKPD based on the analysis of both teacher and student needs, with a focus on learning



styles. The LKPD accommodates different learning styles, including visual, auditory, and kinesthetic learners. It is developed using the Inquiry Learning model to help enhance students' critical thinking skills.

After designing the differentiated learning, the researcher distributed a questionnaire via Google Form to identify students' learning styles. The questionnaire consisted of 30 statements with three answer choices: A for visual learning style; B for auditory learning style, and C for kinesthetic learning style. Students were then grouped based on their dominant learning style. The most frequently selected response was used as the basis for determining each student's learning style. After distributing the questionnaire and grouping students based on their learning styles, the next step was to design the student worksheet (LKPD). This design stage aimed to produce an initial draft of the differentiated LKPD by selecting appropriate media and determining the worksheet format. The initial design of the differentiated LKPD was developed based on a storyboard created by the researcher, resulting in the first draft of the differentiated LKPD product.

#### Develop

The result of the development stage is a differentiated LKPD product designed to improve students' critical thinking skills. This stage includes two parts: expert appraisal and development testing. The LKPD was validated by two Biology Education experts from the University of Lampung, both holding doctoral degrees, and by a biology teacher as a practitioner. The content expert was Dr. Dewi Lengkana, M.Sc., the design expert was Dr. Dina Maulina, M.Si., and the practitioner validator was Siti Fatimah, S.Pd., Gr. All three validators have more than 15 years of teaching experience and provided suggestions to improve the LKPD. The results of the product validity assessment (expert appraisal) are presented in Table 2.

**Table 2.** Validation Results of LKPD

No.	Validation Type	Results (%)	Criteria
1.	Design Expert	98	Highly Valid
2.	Material Expert	93	Highly Valid
3.	Practitioner	92	Highly Valid
Average		94	Highly Valid

Based on Table 2, the validation results from the content expert, media expert, and education practitioner show that the product meets the "very valid" criteria. This means that the developed product is suitable for product testing. The product trial was conducted to assess the practicality of the developed differentiated LKPD and its effectiveness in improving students' critical thinking skills. The validated differentiated LKPD was then tested on a small group to determine its practicality in the learning process. The practicality of using the LKPD was assessed through questionnaires

completed by two biology teachers and 15 students in a limited trial. The practicality of LKPD can be seen in Table 3.

**Table 3.** The Practicality of LKPD

No	Indicator	Percentage	Criteria
1.	Teacher Response	94.28%	Very High
2.	Student Response	96.33%	
3.	Implementation of Learning	92.24%	
Average		94.28%	Very High

Based on Table 3, the overall practicality score of the developed differentiated LKPD reached 94.28%, categorized as Very High. Therefore, the LKPD product is ready to be tested in a large-scale trial to evaluate its effectiveness using pretest-posttest instruments. The comparison of critical thinking skills scores between the control class and the experimental class can be seen in Table 4.

**Table 4.** Comparison of Pretest-Posttest

Group	$\bar{x} \pm sd$	
	Pretest	Posttest
Experiment	38.03 $\pm$ 5.96	84.47 $\pm$ 9.18
Control	36.89 $\pm$ 5.02	67.65 $\pm$ 6.92

Based on Table 4.11, the posttest scores of students in the experimental class were higher than those in the control class. After calculating the pretest and posttest scores, an N-Gain analysis was conducted to determine the improvement in critical thinking skills in both classes. The results are presented in Table 5.

Based on Table 5 above, the average N-Gain score in the experimental class was 0.75, which falls into the "High" category, while the control class scored 0.49, categorized as "Moderate." The percentage increase in scores indicates that the differentiated LKPD was effective in improving students' critical thinking skills. Based on the average results, it can be concluded that the critical thinking skills of students in the experimental class were higher than those in the control class.

**Table 5.** N-Gain

Group	$\bar{x}$ N-Gain $\pm$ sd		$\bar{x}$ N-Gain $\pm$ sd	Criteria
	Pretest	Posttest		
Experiment	38.03 $\pm$ 5.96	84.47 $\pm$ 9.18	0.75 $\pm$ 0.11	High
Control	36.89 $\pm$ 5.02	67.65 $\pm$ 6.92	0.49 $\pm$ 0.13	Medium

Furthermore, to determine whether there is a significant effect of the implementation of differentiated LKPD in the experimental and control classes based on the N-Gain data, an Independent Sample T-Test was conducted. The results of the Independent Sample T-Test are presented in Table 6.

Based on Table 6, the results of the Independent Sample T-Test show a significance value (2-tailed) of 0.00 < 0.05, which indicates that there is a significant

difference between the average N-Gain scores of the experimental class and the control class. This means that the null hypothesis ( $H_0$ ) is rejected, and there is a

significant difference in N-Gain between the experimental and control classes.

**Table 6.** Independent Sample T-Test Result

Critical Thinking Skill	T-Test for Equality of Means					
	t	df	Sig. (2 Tailed)	Std. Error Difference	95% Confidence Interval of the Difference	
					Lower	Upper
	8.128	64	0.000	0.03173	0.19450	0.32126

After conducting the Independent Sample T-Test, the next step was to perform an effect size test to determine the magnitude of the influence of the differentiated LKPD in improving students' critical thinking skills. Based on the effect size calculation using the formula by Cohen et al. (2007), an effect size value of 0.99 was obtained, which falls into the "large" category. This effect size value indicates that the difference in the average posttest scores between the experimental and control classes is due to the implementation of the differentiated LKPD in the learning process. Therefore, it can be interpreted that there is a strong relationship between the implementation of the differentiated LKPD and students' critical thinking skills, meaning that the improvement in critical thinking skills is influenced by the use of differentiated LKPD.

After conducting the Independent Sample T-Test, the next step was to perform the Paired Sample T-Test. The purpose of the Paired Sample T-Test is to determine whether there is a significant difference in the average improvement between pretest and posttest scores in the experimental class based on students' learning styles. The results of the Paired Sample T-Test analysis are presented in Table 7.

**Table 7.** Paired Sample T-Test Result

Learning Styles	N	$\bar{x}$ Pretest $\pm$ sd	$\bar{x}$ Posttest $\pm$ sd	Sig.
Visual	11	35.91 $\pm$ 5.62	85.00 $\pm$ 5.47	0.000
Auditory	11	39.55 $\pm$ 4.58	85.91 $\pm$ 8.75	0.000
Kinesthetic	11	38.64 $\pm$ 4.79	81.82 $\pm$ 7.33	0.000

Based on the analysis results presented in Table 7, the average posttest scores were higher than the pretest scores in each learning style group. The results of the Paired Sample T-Test analysis showed a Sig. (2-Tailed) value of  $0.000 < 0.05$  for visual, auditory, and kinesthetic learning styles. This indicates that after the implementation of the differentiated LKPD in learning, there was a significant increase in students' critical thinking skills for each learning style group, thus  $H_0$  is rejected and  $H_1$  is accepted. Based on these results, the use of differentiated LKPD in each learning style group is highly effective.

After conducting the Paired Sample T-Test, a One-Way ANOVA statistical test was then carried out. The One-Way ANOVA test was used to determine whether there were significant differences in the mean N-Gain

scores among the visual, auditory, and kinesthetic learning styles in the experimental group. The results of the normality test and the One-Way ANOVA test in this study are summarized in Table 8.

**Table 8.** One-Way Anova Result

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.032	2	0.16	1.151	0.330
Within Groups	0.413	30	0.14		
Total	0.445	32			

Based on Table 8, the significance value obtained was 0.330. Since the significance value is greater than 0.05, it can be concluded that there is no significant difference in the average critical thinking skills scores among the different learning style groups (fail to reject  $H_0$ ).

Based on the research findings and product trials, the developed differentiated LKPD has been proven to improve students' critical thinking skills. The improvement in students' critical thinking skills is evident from the posttest scores, which show a higher average compared to the pretest scores in the experimental class (Table 4). The increase in critical thinking skills is also clearly reflected in the N-Gain results, which fall under the "high" category in the experimental class, while the control class is categorized as "medium" (Table 5). The statistical analysis using the Independent Sample T-Test (Table 6) shows a significance value (Sig.) less than 0.05 in the experimental class, indicating that  $H_1$  is accepted—there is a significant difference in N-Gain between the experimental and control classes.

The differentiated LKPD is effective in improving critical thinking skills in the topic of the human digestive system. In the experimental class, students' critical thinking skills showed a significant improvement before and after using the differentiated LKPD (Table 4). This finding is supported by the effect size value of 0.99, which falls into the "large" category, indicating that the differentiated LKPD is effective and has a strong influence on enhancing students' critical thinking skills. Furthermore, the statistical analysis using the Paired Sample T-Test (Table 7) yielded Sig. values  $< 0.05$  for visual, auditory, and kinesthetic learning styles. This

result supports the acceptance of  $H_1$ , indicating a significant increase in students' critical thinking scores across all learning style groups, and confirms the high effectiveness of the LKPD for each group. Meanwhile, the One-Way ANOVA test (Table 8) showed a Sig. value of  $0.330 > 0.05$ , indicating no significant difference in the average critical thinking scores among the different learning style groups (accept  $H_0$ ).

The developed LKPD is equipped with clear and systematic instructions, making it easy to use independently by both teachers and students. This is in line with the findings of Safitri et al. (2023), who stated that LKPDs containing learning instructions can assist teachers in the learning process and help students construct their own knowledge through independent learning. Therefore, the instructions in the LKPD serve not only as a guide but also support students' autonomy and learning effectiveness.

The developed LKPD is aligned with students' needs based on their learning styles. This is because the LKPD includes a barcode scan feature that links to activities presenting phenomena or problems differentiated according to students' learning styles, thereby supporting their understanding. This finding is supported by Putra et al. (2020), who stated that LKPD is a highly useful tool in facilitating students' learning needs. By designing diverse and effective LKPDs, teachers can help each student reach their full potential effectively.

Students gave positive responses toward the differentiated LKPD used. These responses help assess the extent to which the learning product is accepted and understood, while also serving as a basis for evaluating the feasibility and effectiveness of the product (Arikunto, 2013). Student feedback also provides insights regarding the clarity of language, visual appeal, and the alignment of the LKPD with their characteristics and needs (Febrianto et al., 2020). This feedback becomes an essential component in the ongoing product development process, as it can be used to refine the design and content of the LKPD to better support student engagement, comfort, and the overall effectiveness of their learning experience in the classroom. Meanwhile, the presence of the LKPD greatly assists teachers in managing classroom learning, as it simplifies the process of organizing instructional steps. Consequently, teachers can focus more on facilitating learning, while students are given the opportunity to construct their understanding independently (Maulani et al., 2022; Pasani et al., 2021; Risandi et al., 2015).

The implementation of classroom learning using the developed differentiated LKPD was carried out very well. A learning instrument is considered to have practical quality if it meets the criteria of being clear and very clear (Nissa et al., 2017). The implementation of the learning process falls under the "very good" category

because the applied learning tools include the syntax of the guided inquiry model (Dahlia et al., 2018). The clarity of the learning implementation is attributed to the active participation of students during online learning through the application of guided inquiry in the E-LKPD (Sari, 2020).

The experimental class taught using the differentiated LKPD obtained higher posttest scores compared to the control class. This is because the learning process not only applied the syntax of Inquiry Learning, which encourages students to conduct investigations, but also enabled them to think critically. Students' critical thinking skills can also be considered to have improved, as they were able to achieve several indicators of critical thinking (Mubarokah, 2019).

According to Vygotsky as cited in Santrock (2010), social interaction within and between groups in the inquiry learning model can enhance students' potential development levels, thereby expanding their zone of proximal development. Active student engagement in inquiry-based learning can improve the retention of information in long-term memory, thus enhancing concept mastery (Nisa et al., 2018). Similarly, findings supported by Jatmiko et al. (2016) indicate that learning experiences and experiments are effective in improving concept mastery, problem-solving skills, and decision-making abilities.

The effectiveness of the differentiated student worksheet (LKPD) developed in this study supports students' critical thinking skills tailored to their diverse learning styles. Identifying learning styles in the learning process allows students to engage in learning through different approaches, which in turn stimulates their critical thinking abilities. Critical thinking is a reflective process aimed at examining a situation, phenomenon, question, or problem in order to formulate a hypothesis or conclusion that integrates all available information and can be confidently justified (Rosidi, 2023). There are several benefits for students who possess critical thinking skills, such as being able to solve problems easily, understand their own abilities, become more open-minded, communicate effectively, foster collaboration, produce high-quality work, and resolve conflicts (Chen et al., 2024).

By using differentiated student worksheets (LKPD) tailored to students' diverse learning styles, it is possible to create a learning environment that supports the development of relevant skills applicable across various contexts. This is in line with the research of Wahyuni et al. (2020), which states that differentiated LKPD is a comprehensive, relevant, and effective instructional tool in supporting differentiated learning. Differentiated instruction accommodates students based on their learning needs to optimize learning opportunities, including through their individual learning styles (Marlina et al., 2019). Differentiated learning enhances



students' overall abilities by modifying content, process, and product, and has a significant impact in addressing student diversity (Magableh et al., 2020).

## Conclusion

The results of the development research indicate that differentiated student worksheets are highly valid (94%); differentiated student worksheets are practical for improving students' critical thinking skills in terms of learning implementation; differentiated student worksheets were effective in improving students' critical thinking skills with a large effect size (0.99). The conclusion is that differentiated worksheets on the human digestive system have been developed that can improve students' critical thinking skills. Based on the results of data analysis and discussion, the differentiated student worksheet (LKPD) on the topic of the human digestive system that was developed has been validated as effective in enhancing students' critical thinking skills. This LKPD is also considered practical for use in the classroom, as evidenced by the high level of implementation and its ease of use, attractiveness, and usefulness—all of which contribute significantly to improving students' critical thinking. Furthermore, the differentiated LKPD on the human digestive system has proven to be effective in promoting students' critical thinking skills. Based on these results, the LKPD is declared to be capable of enhancing students' critical thinking abilities.

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## Author Contributions

All authors identified problems related to the availability of teaching materials, drafted the research instruments, developed the differentiated LKPD oriented towards Inquiry Based Learning, writing the initial drafts, providing ideas, reviewing and editing the manuscript. They also monitored research progress and provided feedback throughout the study. All authors contributed equally to the content of this article. We have read and approved the published version of the manuscript.

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