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Article

Enhancing critical thinking through guided discovery learning in distance medical education in Papua

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ABSTRACT

Medical education in Papua faces unique challenges, especially in enhancing students' critical thinking through distance learning. This study aimed to develop a Guided Discovery Learning (GDL)-based student worksheet and evaluate its effectiveness in improving critical thinking skills. Employing a Research and Development (R&D) design with a mixed-method approach that integrated both quantitative and qualitative data. The study involved 184 first, third, fifth, and seventh-semester medical students in Papua. Instruments included validated critical thinking tests based on Facione's indicators, worksheet assessment rubrics, and student response questionnaires. Data were analyzed using paired sample t-tests and thematic analysis. The results showed a significant increase in student's critical thinking post-test scores (mean = 62.45) compared to pre-test scores (mean = 37.00). Students also gave positive responses to the GDL-based worksheets. This indicates that GDL-based worksheets are effective instructional tools for fostering critical thinking in remote education settings. The study contributes to educational practice by introducing an adaptable method suitable for under-resourced regions. However, limitations include infrastructural barriers and a small sample size, which may affect generalizability. Future research should involve a broader population and explore long-term impacts.

Keywords:

Critical thinking
Distance learning
Guided discovery learning
Papua
Student worksheet

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Introduction

Education is a key component of national development and is essential to the formation of skilled, critical thinkers in the medical field. It is crucial to have a thorough understanding of critical thinking from a variety of theoretical angles. While Bronkhorst et al. (2020) highlights the significance of logical reasoning and the examination of arguments, Facione (2013) defines critical thinking as deliberate, self-regulatory judgment. Understanding critical thinking from various perspectives relevant to the medical context is essential. Critical thinking is the ability to deeply investigate information, critically evaluate arguments and evidence, and make rational fact-based decisions. This includes the ability to recognize and overcome biases, identify underlying assumptions in arguments, and construct coherent arguments (Molerov et al., 2020).

Developing critical thinking skills in the medical field has significant implications for both the educational processes and clinical practice. Critical thinking in medicine involves the ability to

analyze information, evaluate evidence, make accurate diagnoses, and formulate effective treatment plans (Scott et al., 2021). In order to successfully navigate complicated clinical circumstances, medical students need to be able to combine their academic knowledge with practical skills and have good analytical ability. In order for medical students to evaluate complex data, make precise diagnoses, and deliver evidence-based care, there has been an increasing focus on teaching them critical thinking abilities on a global scale.

The move to digital and remote learning in Indonesia, especially in the wake of the COVID-19 pandemic, has brought attention to regional differences in educational outcomes and access (Azhari & Fajri, 2022). However, not every location faces the same difficulties in developing critical thinking abilities, especially in isolated places like Papua. Existing educational inequities have been made worse by the COVID-19 epidemic, and distance learning has emerged as a viable solution to address infrastructure and geographic constraints (Kennedy et al., 2022). However, it is still up for debate whether distant learning helps medical students enhance their critical thinking abilities. Factors such as limited direct interaction between instructors and students and lack of adequate learning resources often hinder the achievement of optimal learning outcomes.

Effective distant learning in Papua is severely hampered by inadequate infrastructure. Internet access, which is necessary for online learning, is hampered in about 40% of Eastern Indonesian regions, including Papua, by inadequate signal reception (Sidauruk et al., 2025). Additionally, the digital gap in Maluku and Papua is highlighted by the fact that just 25% of localities have a robust internet signal. Students' struggles to buy internet data and their restricted access to educational materials and supportive learning environments exacerbate these issues (Kartiasih et al., 2023).

Papua, a geographically remote and infrastructure-challenged province, exemplifies this educational disparity. The quality of remote education in the area is greatly impacted by teacher shortages, inadequate educational facilities, and restricted internet connection. Students' capacity to participate in advanced learning activities like critical thinking is hampered by these limitations. Targeted, context-sensitive interventions are still scarce despite national policy initiatives to increase educational equity (Ferri et al., 2020).

From the standpoint of educational psychology, critical thinking entails autonomous, reflective thought that incorporates analysis, inference, explanation, and assessment (Facione, 2013; Bronkhorst et al., 2020). Integrating clinical reasoning with ethical decision-making and evidence-based practice is crucial in medical education. The scanty literature seems to suggest that not much work has been done in applying systematic learning designs, such as guided discovery learning, to develop critical thinking in under-resourced areas like Papua.

Through organized investigation, guided discovery learning (GDL) has demonstrated promise in promoting active learning and empowering students to build knowledge under supervision. Although GDL has been investigated in a number of fields, its application in student worksheets created especially for distance learning in medicine is still in its infancy (Yousaf et al., 2023). There is a study deficit on the use of GDL in digital or remote settings in underserved areas because prior studies frequently concentrate on traditional learning contexts.

In this context, this study aims to develop and evaluate the effectiveness of using GDL-based Student Worksheets to improve the critical thinking skills of medical students in Papua through distance learning. It is expected that this research will not only contribute theoretically to the literature on medical education but also provide practical solutions to the challenges of learning in regions with limited access, such as Papua.

Methods

This study employed a research and development design using quantitative and qualitative approaches to produce and test the effectiveness of the product. The developed product is a Guided Discovery Learning (GDL)-based Student Worksheet created based on GDL principles while

considering the needs and characteristics of medical students in Papua. The development of the Student Worksheet involved identifying learning objectives, designing learning activities, and preparing relevant materials for distance learning to enhance the critical thinking skills of medical students at the Faculty of Medicine, Cenderawasih University, Papua. The development model used was the Rowntree model, which consists of three stages: planning, development, and evaluation (Melinia et al., 2021). The evaluation stage is modified with Tessmer's (1998) formative evaluation model, which generally includes five types: self-evaluation, expert review, one-to-one evaluation, small-group evaluation, and field test.

Participants and Sampling

The study involved 184 students from the Faculty of Medicine, Cenderawasih University, Papua. Participants were drawn from first-, third-, fifth-, and seventh-semester cohorts, with an age range of 18 to 24 years and a relatively balanced gender distribution. All participants had a senior high school educational background. The sampling technique employed was convenience sampling. Inclusion criteria consisted of active students willing to participate throughout all stages of the study, while exclusion criteria included students on academic leave, those who had withdrawn, or those who discontinued their studies during the research period. Participants were divided into two intervention groups: Group A (GDL with mentor) and Group B (GDL without mentor), each comprising 17 students.

Intervention Design

The GDL-based worksheets were implemented over a three-week period, with one worksheet per week. Each worksheet followed the syntactic steps of Guided Discovery Learning: (1) providing stimulus, (2) identifying problems, (3) collecting and processing data, (4) verification, and (5) drawing conclusions. Each worksheet included case-based tasks, reflective questions, and guided instructions, and was delivered in three sessions per week. Figure 1 presents the layout of the Guided Discovery Learning-based student worksheet developed in this study to support a systematic and interactive distance learning process.

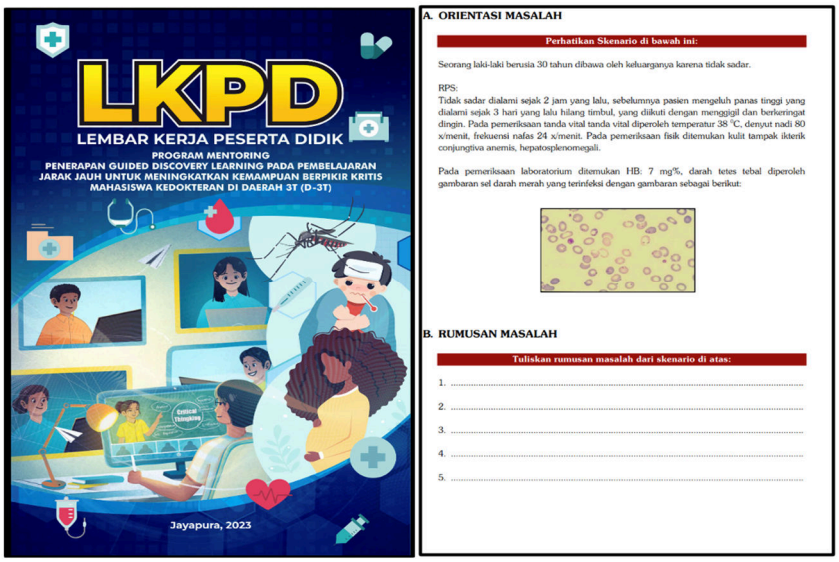

Figure 1 Guided Discovery learning based Student Worksheets Display

Instrument Development and Validation

The Student Worksheet (LKPD) underwent a comprehensive validation process involving six experts: one from Poltekkes with a master's in medical education, and five from the Faculty of Medicine (experts in tropical diseases, internal medicine, anatomy, histology, and public health). Validation included assessments of content, didactic quality, language, presentation, and time allocation. This process involved expert reviews, one-to-one testing, and small-group evaluations. Revisions were made based on expert feedback to enhance clarity, relevance, and usability.

The critical thinking test instrument was developed based on Facione's (1990) framework, encompassing six core skills: interpretation, analysis, inference, evaluation, explanation, and self-regulation. The instrument consisted of open-ended questions with scoring rubrics developed for each operational indicator. Validity and reliability tests were conducted to ensure instrument quality.

Data Collection and Analysis

Students completed a pre-test on critical thinking skills prior to the intervention and a post-test afterward. Quantitative data were analyzed using the Wilcoxon signed-rank test and Friedman test. To enhance interpretation, effect sizes (e.g., Cohen's d or r) were calculated to assess the magnitude of the observed effects.

Qualitative data were collected through focus group discussions (FGDs) and semi-structured interviews with students and mentors. Data credibility was ensured through source triangulation, methodological triangulation, and member checking. Thematic analysis was conducted to identify patterns and insights that supported quantitative findings, and representative participant quotes were included to illustrate key themes.

Control Group Consideration

While no traditional control group was used, the two intervention groups (with and without mentor) served as comparative groups to examine the variation in outcomes. The decision to omit a pure control group was based on ethical considerations, ensuring all students received beneficial learning experiences.

Results and Discussion

Research Result

Essay Test Instrument

The research instrument measuring students' critical thinking skills is an essay test comprising three questions designed to assess the critical aspects of thinking in a medical context. Test instrument development refers to six critical thinking aspects according to Facione: interpretation, analysis, evaluation, explanation, inference, and self-regulation (Facione et al., 2013). Validity and reliability tests are crucial for assessing a test's quality (Sürücü & Maslakci, 2020). The validity test results of the developed essay test instrument are as follows in Figure 2. Figure 2 below presents the sequence of stages in the implementation of research designed to measure the effectiveness of Student Worksheets (LKPD) based on Guided Discovery Learning in improving the critical thinking skills of medical students.

Figure 2 Test Item Validity Data

This study began with a pre-test to measure participants' initial critical thinking skills (CTCs) before being given treatment. Next, participants underwent learning intervention treatment using three different types of LKPD coded X1, X2, and X3. Each LKPD represents a specific learning approach developed according to the principles of guided discovery. After all stages of treatment were completed, a post-test was conducted to evaluate the development of participants' critical thinking skills after the intervention. This series of stages was designed to test the instrument's validity and the effectiveness of each LKPD in improving learning outcomes, thus allowing for comparative analysis between treatments. This visualization helps to systematically map the intervention flow and clarify the experimental design used in the study.Figure 2 below presents the sequence of stages in the implementation of research designed to measure the effectiveness of Student Worksheets

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From the analysis, $r$calc > $rtab$, indicating that the three essay test questions developed are valid. The following are the reliability test results for the essay test instrument developed to measure critical thinking skills.

Instrument of the Student Worksheets

The following are the validity test results of the Student Worksheet instrument used in the treatment to measure critical thinking skills. Table 1 presents the validity test results of critical thinking test items derived from student worksheets, categorized into three main questions. Each question consists of six components that reflect core critical thinking skills: Interpretation, Analysis, Evaluation, Inference, Explanation, and Self-regulation. The statistical validity of each item was evaluated using the correlation coefficient (rCalc) and compared to the critical value (rTab) of 0.304.

All items across the three questions have rCalc values higher than rTab, indicating that each item has a statistically significant correlation with the overall test score and is therefore considered valid. For instance, in Question 1, the Analysis and Evaluation items showed particularly strong correlations (r = 0.871), suggesting high consistency with the overall test construct. Even the lowest rCalc value, such as 0.441 (Self-regulation in Question 3), still exceeds the rTab threshold, confirming its validity.

Table 1. Validity Results of Student Worksheets Test Items

Question	Item	r_{Calc}	r_{Tab}	Decision
Question 1	1. Interpretation	0.812	0.304	Valid
	2. Analysis	0.871	0.304	Valid
	3. Evaluation	0.871	0.304	Valid
	4. Inference	0.781	0.304	Valid
	5. Explanation	0.805	0.304	Valid
	6. Self-regulation	0.580	0.304	Valid
Question 2	1. Interpretation	0.656	0.304	Valid
	2. Analysis	0.537	0.304	Valid
	3. Evaluation	0.479	0.304	Valid
	4. Inference	0.553	0.304	Valid
	5. Explanation	0.779	0.304	Valid
	6. Self-regulation	0.746	0.304	Valid
Question 3	1. Interpretation	0.849	0.304	Valid
	2. Analysis	0.849	0.304	Valid
	3. Evaluation	0.843	0.304	Valid
	4. Inference	0.928	0.304	Valid
	5. Explanation	0.831	0.304	Valid
	6. Self-regulation	0.441	0.304	Valid

These results demonstrate that the test items effectively measure the intended critical thinking constructs and can be reliably used for evaluating student performance in the context of Guided Discovery Learning (GDL)-based student worksheets.

Following the validity test of the student worksheet instrument, a reliability test was conducted. The results of the reliability test for the student worksheet assessment instrument developed to measure critical thinking skills are as follows in Figure 3. As part of the instrument quality test in this study, reliability testing was conducted on three essay test devices used to assess students' critical thinking skills. This reliability test uses Cronbach's Alpha coefficient, a standard indicator for assessing the internal consistency of a measurement instrument.

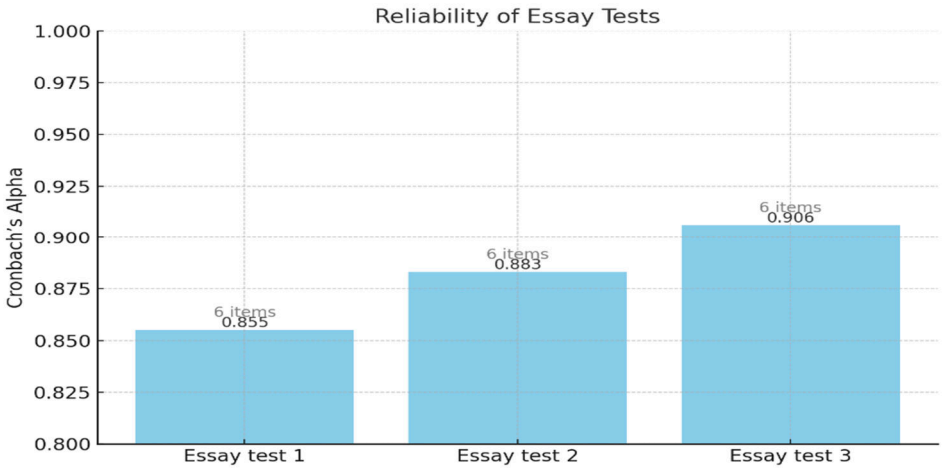

Figure 3 Friedman Test Results to compare the effect of Student Worksheets

Figure 3 illustrated the reliability value of each essay test: Essay Test 1 has an alpha value of 0.855, Essay Test 2 is 0.883, and Essay Test 3 is 0.906. All three show a high level of reliability because all values are above the threshold of 0.7, which is generally considered to reflect adequate internal consistency. Each test consists of 6 questions designed to measure critical thinking indicators. The high Cronbach's Alpha value indicates that the instrument used in this study can be relied on to measure critical thinking skills consistently among participants, strengthening the validity of the findings resulting from measurements using the instrument.

From the Friedman test results table comparing the effects of the three different types of Student Worksheets, we interpret and discuss the results: (1) Mean Rank: student worksheets 1 has the lowest mean rank (1.56), student worksheets 2 has a middle mean rank (1.91), and student worksheets 3 has the highest mean rank (2.53); (2) Friedman Test Significance: (a) The chi-square value was 30.185, with a degree of freedom (df) of 2; (b) The significance value (Asymp. Sig.) was .000, indicating that the overall Friedman test results were statistically significant; (3) Differences Between Student Worksheets. Based on the mean ranks, Student Worksheet 3 had the most significant impact compared with Student Worksheets 1 and 2. This suggests that LKPD3 tends to yield better or more influential results than Student Worksheets 1 and 2 do. Student Worksheet 1 ' slowest mean rank indicates that it may have a less significant or effective impact compared to the others; (4) Statistical Significance. The very low significance value (0.000) indicates that there is a significant difference between at least two of the three types of Student Worksheets tested; (5) Recommendation. Based on these results, Student Worksheet 3 might be a better choice for achieving the desired outcomes in the context of student worksheet use. Further analysis could be conducted to understand the factors that make Student Worksheet 3 more effective than others, such as content design or usage methods.

Thus, these results can provide valuable insights for decision-makers in selecting the most suitable student worksheet for their goals.

Hypothesis Testing

Ho: The development of Guided Discovery Learning-based Student Worksheets is ineffective in improving critical thinking skills. Ha: The development of Guided Discovery Learning-based Student Worksheets is effective in improving students' critical thinking skills.

Analysis of the pre-test and post-test results indicated a significant improvement in students' critical thinking skills in both groups. The mean post-test score of Group A (GDL with mentoring) was significantly higher than that of Group B (GDL without mentoring). The Wilcoxon test revealed a p-value < 0.05 in both groups. These results suggest the effectiveness of the GDL approach in distance learning, particularly when accompanied by mentoring support.

It is simple to exaggerate how the results should be interpreted. Make sure your interpretation of the findings doesn't deviate from what the data supports. Nothing more or less than the facts are what they are. Please refrain from overinterpreting the results, speculating unnecessarily, exaggerating the significance of the findings, bringing up irrelevant topics, or overemphasizing the significance of your study. Table 2 show the comparison test of pre-test dan post-test scores.

Table 2. Comparison Test of Pre-test dan Post-test Scores

Test	Min	Max	Mean	Std. Dev
Pre-test	24	78	37.00	7.836
Post-test	30	91	62.45	12.231

Table 2 reveals the difference according to descriptive statistical analysis of the pre-test and post-test scores of the students in realize Guided Discovery Learning (GDL)-based worksheets. Such data come with an overall increased mark of student achievement: an increase in the mean score from 37.00 on pre-test to 62.45 on post-test. This means that considerable improvement regarding the students' critical thinking ability may have been noted after the intervention. The minimum and maximum scores also increased, respectively, from 24 and 78 on the pre-test to 30 and 91 on the post-test scores, indicating a general upward trend across all levels. The standard deviation, also, increased from 7.836 to 12.231, a wider distribution of scores achieved during the post-test due to differences among individual students' improvements. Overall, these results are indicative of GDL-based worksheets working well with students in improving their critical thinking skills.

The first output shows a comparison of the critical thinking skills before and after mentoring. There was one individual with lower critical thinking skills after mentoring; one remained the same, and 42 individuals showed improvement compared to before mentoring.

Table 3. Test Statistics[a]

Test Statistic Wilcoxon Signed Ranks Tests[a]			
	Student worksheet of 2- Student worksheet of 1	Student worksheet of 3- Student worksheet of 1	Student worksheet of 3- Student worksheet of 2
Z	-2.434[b]	-4.005[b]	-3.090[b]
Asymp. Sig. (2-Tailed)	0.015	0.000	0.002

The results indicate that the data in the sample were not normally distributed. Therefore, to compare the treatment and control groups, a non-parametric Wilcoxon test was performed. Wilcoxon test results showed a significant difference between the two groups, confirming the effectiveness of the treatment method on the observed variables.

The Z-value is a negative statistic (-5.701), indicating that the median difference between the post-test and pre-test conditions was below zero, suggesting a significant decrease or change after the intervention or treatment. The low significance value (0.000) indicates that the difference between the post-test and pre-test conditions was statistically significant at the 0.05 significance level. This demonstrated the effectiveness of the intervention or treatment in producing the desired change in the observed variable in the tested sample.

Qualitative Analysis

Qualitative data from the focus group discussions (FGDs) revealed five main themes: improved self-regulation, effective interaction during discussions, reflective awareness of the material, clarity of the Student Worksheet (LKPD) structure, and positive perceptions of using GDL in distance learning.

Several narrative excerpts reflected an enhanced ability to analyze and independently draw conclusions. Qualitative data were obtained from the results of focus group discussions (FGD). The data analysis model is illustrated in the Figure 4.

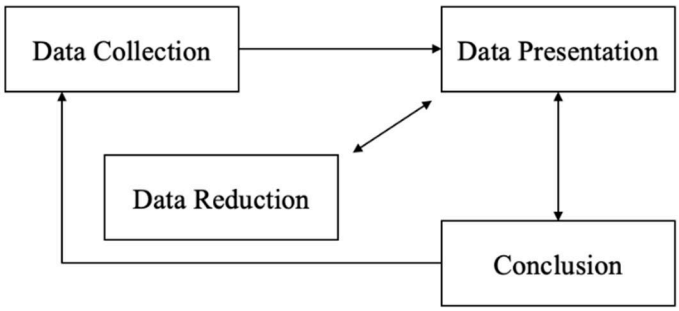

Figure 4 Miles and Huberman Data Analysis Model

The qualitative data analysis model by Miles and Huberman is explained as follows:

Data Reduction

The data collected from the field were extensive. As research progresses, the volume of data will increase, becoming more complex. Reducing data entails condensing, picking out the most crucial elements, concentrating on significant problems, spotting trends and themes, and eliminating irrelevant information. This stage gives the reduced data a more lucid appearance, making it easier for researchers to continue data collection and locate the necessary information when needed.

Data display

In quantitative research, data can be presented in tables, graphs, pie charts, pictograms, and similar formats. Through data presentation, the data are organized and structured in a pattern of relationships, making them easier to understand. Presenting the data facilitates understanding of what is happening and planning the next steps based on the understood information. Presenting data in narrative text as well as in graphics, matrices, networks (work networks), and charts is recommended.

Conclusion drawing/verification

The initial conclusions may be tentative and subject to change if no strong supporting evidence is found in the subsequent data-collection phases. The results are trustworthy, nevertheless, if they are backed up by reliable and consistent data when the researcher goes back to collect data. Thus, conclusions in qualitative research may answer the research questions formulated at the beginning, but they may also evolve as research progresses in the field.

Theme determination was formed from the data analysis process derived from seven intervention and control group participants through FGDs. The next step was to identify existing transition units (keywords), determine their meaning, and then group them into categories and themes. The qualitative analysis identified three themes: monitoring programs, distance learning, and learning monitoring programs.

Theme 1: Monitoring Program. The program monitoring theme consisted of four categories: implementing critical thinking aspects, training critical thinking skills, increasing critical thinking skills, and enhancing learning abilities. Details of this theme are presented in Table 1.

Implementing Critical Thinking Aspects. This category describes the implementation of critical thinking in the learning process. Some informants conveyed that having a mentor helped them apply critical thinking aspects significantly. As mentioned, "It was very doctor-like because in our learning process, being part of the intervention group, we had a mentor who consistently reminded us to delve deeper, for example, yesterday's malaria case" (Participant # Doctor of education on interventional level 1). "In this mentoring, I certainly used critical thinking aspects to answer the guided tasks from the doctor. It was very necessary." (Participant # Medical Education Group B.3).

Training Critical Thinking Skills. This category describes the training in critical thinking skills during learning. Some informants mentioned that they significantly improved their critical thinking skills. "It was very doctor-like because what I did not know before was clarified by the doctor, so we could learn and want to know more, which was very evident in the training" (Participant # Doctor of education on interventional level 1). "It was sufficient training through the tasks taught by the doctor, which were guided. Initially, it was very training, especially for questions such as disease-related questions." (Participant # Medical Education Group B.3).

Increasing Critical Thinking Skills. This category describes an increase in critical thinking skills after participation in monitoring activities. Some informants reported an increase in knowledge and skill enhancement. As stated, "Perhaps it increased, doctor, because from everything we followed, we gained knowledge from what the doctor or mentor gave us." (Participant # Doctor of Education at Interventional Level 1). "In this mentoring activity, it significantly enhanced my and my friend's critical thinking abilities, with numerous questions and materials provided that required deeper thought." (Participant # Medical Education Group B.3).

Enhancing Learning Abilities. This category describes the impact of monitoring on enhancing learning abilities in class. Some informants mentioned that it was very doctor-like and helpful. As noted, "It was very doctor-like because what we did not know became clear after searching from various sources or journals, so we could understand the symptoms and apply them." (Participant # Doctor of Education at Interventional Level 1). "Yes, very helpful. Especially in mentoring, we got a preview of what it is like to be a doctor in the future." (Participant # Medical Education Group B.3).

Theme 2: Distance Learning. The distance-learning theme consists of four categories: Internet utilization, readiness, obstacles, and effectiveness. Details of this theme are presented in Table 1.

Implementation. This category describes the implementation of distance learning using the internet. Some informants mentioned that they did not prefer it because of network issues and difficulty understanding. As stated, "In my opinion, distance learning via the Internet may be liked by some, but not by others. Personally, I find it challenging due to network issues and prefer face-to-face explanations." (Participant # Medical Education Group B.2). Other informants found this to be quite efficient. As noted, "For the internet, it has been quite efficient because we can schedule sessions flexibly around our work." (Participant # Medical Education Group B.3).

Readiness. This category describes instructors and students readiness to participate in distance learning. Some informants mentioned finding a place and being prepared for it. As stated, "From the schedule, we know when we have classes, so before going online, I find a place with a good network." (Participant # Medical Education Group B.3). "It depends on the situation and conditions. Personally, I am ready with a stable Wi-Fi network, WhatsApp always on, and a comfortable space for mentoring." (Participant # Medical Education Group B.3).

Obstacles. This category describes the challenges in implementing distance learning. Some of the informants mentioned network issues and noise. As noted above, " network issues." (Participant # Medical Education Group B.2). "Unavoidable network issues and noise." (Participant # Medical Education Group B.3).

Effectiveness**.** This category describes the effectiveness of participation in distance learning. Some informants mentioned understanding the material and being able to do so. As stated, "For the mentoring activities, I quite understand because we usually gather, exchange opinions, so I feel I can understand even in distance learning." (Participant # Medical Education Group B.2).

Theme 3: Learning Monitoring Program, the learning program monitoring theme consists of four categories: experience, ability before and after, benefits, changes, impact, and commitment.

Experience. This category describes the experience of participating in learning-program monitoring. Some informants mentioned having many experiences, initially being confused but gradually becoming accustomed. As noted, "The experience was extensive. Initially, I was confused, but gradually I got used to it." (Participant # Medical Education Group B.5).

Ability Before and After. This category describes the ability before and after participating in monitoring. Some informants mentioned initially struggling, but eventually adapting and finding it beneficial for critical thinking. As stated: "Initially, in STUDENT WORKSHEET 1, I found it difficult, but in student worksheet of 2, I got used to it and found it helpful for critical thinking." (Participant # Medical Education Group B.5).

Benefits. This category describes the benefits of monitoring. The informants mentioned the significant benefits. As noted, "The benefits were extraordinary, especially when applying the learned material to real-life situations, such as identifying malaria symptoms in a friend." (Participant # Doctor of Education at Interventional Level 1).

Changes. This category describes the changes that are experienced during mentoring. Some informants mentioned being able to think more deeply about problems, staying calm, and controlling their responses. As stated, " these changes were statistically significant. I became more thoughtful and controlled in response to the situation." (Participant # Medical Education Group B.4).

Impact. This category describes the impact of participating in monitoring. The informants mentioned becoming more knowledgeable and timelier in completing tasks. As noted, "I felt a significant impact in understanding how to complete tasks on time without procrastinating." (Participant # Medical Education Group B.3).

Commitment. This category describes commitment after participating in the monitoring. Some informants mentioned being more diligent in studying and taking a higher initiative for independent learning. As stated, "My commitment is to study harder and be more diligent ." (Participant # Medical Education Group B.5).

Discussion

In the context of remote learning, this study sought to assess how using student worksheets based on guided discovery learning (GDL) affected the development of critical thinking abilities among Papuan medical students. The findings showed that students' critical thinking skills were considerably enhanced by the use of GDL-based student worksheets.

Worksheet 3 demonstrated the greatest improvement in students' critical thinking scores out of the three GDL-based worksheets that were assessed. Its instructional features, which prioritized open-ended clinical situations, increased learner agency, and iterative reflection, could account for this result. Worksheet 3 included more exploratory activities than Worksheets 1 and 2, and it pushed students to improve critical thinking skills by having them come up with hypotheses, weigh their options, and defend their choices. The less structured but cognitively demanding exercises in Worksheet 3 may have challenged students more successfully, resulting in deeper engagement and higher-order thinking, whereas Worksheet 1 concentrated on core information and Worksheet 2 provided more guided steps.

The use of GDL-based Student Worksheets in distance learning provides opportunities for students to actively engage in the learning process (Kibirige & Maake, 2021). Using the guidance provided in the worksheets, students are given the freedom to explore learning materials independently, identify problems, and seek solutions autonomously (Sari & Cahyo, 2020). This not only increases student engagement in learning but also strengthens their critical thinking skills. Thus, it is possible to think about the assumed increase in critical thinking by the students as a function of the cognitive scaffolding present in the GDL model. This scaffolding, in turn, harmonizes with Vygotsky's notion of the zone of proximal development (ZPD). Here, student activity and structured intervention allow for the internalization of very complex reasoning. The autonomy and problem-solving aspects of the worksheets could also be seen to trigger higher-order thinking skills, per the Bloom taxonomy.

The use of GDL-based Student Worksheets is helpful in improving the critical thinking abilities of medical students in Papua New Guinea, as evidenced by the notable changes in the critical thinking test scores before and after the intervention. These outcomes are in line with earlier studies that

shown how active learning strategies like GDL can improve students' capacity for critical thought (Fauzi & Respati, 2021).

In the context of medical education in Papua, where access to learning resources is often limited, the use of technology in distance learning using approaches such as GDL is highly relevant. This learning method not only provides wider access to learning resources but also promotes student independence and engagement in the learning process. These findings have important implications for medical education in remote areas such as Papua. The use of GDL-based Student Worksheets in distance learning can be an effective alternative for improving students' critical thinking skills. This approach provides opportunities for students to actively engage in the learning process, thereby increasing their engagement and motivation to learn (Apriyanti, 2020). Furthermore, the use of technology in distance learning allows access to a broader range of learning resources, enriching students' learning experiences.

However, this study has several limitations, such as limited access to research subjects and infrastructure supporting distance learning in Papua. Therefore, future research should involve more medical education institutions in Papua and explore other factors that may influence the implementation of GDL-based Student Worksheets in distance learning.

The qualitative analysis in this study was strengthened by applying a systematic open coding approach to the interview transcripts. Three primary theme areas emerged from this process: (1) opinions regarding the worksheets' structure and clarity, (2) the cognitive techniques students used to learn, and (3) thoughts on the growth of critical thinking abilities. To guarantee consistency and dependability, inter-coder agreement was used to validate each theme. In order to show how students' learning experiences were connected to mechanisms that improve critical thinking, these findings were also mapped onto pertinent theoretical frameworks, such as guided discovery learning and constructivist learning theory. This method deepens analysis and reaffirms how qualitative information may support and clarify quantitative findings.

Based on the results of the Focus Group Discussion (FGD) for first-semester students, a summary of the discussion on the effectiveness of Guided Discovery Learning in distance education to enhance the critical thinking skills of medical students in Papua was obtained, focusing on the themes of the monitoring program, distance learning (PJJ), and learning through the monitoring program: (1) Monitoring Program. The monitoring program enhanced the critical thinking skills of first-semester medical students. Additionally, they trained their critical thinking skills and improved their classroom learning abilities; (2) Distance Learning. The implementation of distance learning for first-semester medical students, facilitated through internet use, has been relatively successful. However, some students were dissatisfied because of poor network quality and noise issues. First-semester medical students are generally well prepared for distance learning, often finding a suitable location before going online. Furthermore, distance learning has proven to be highly effective in helping first-semester medical students to understand and comprehend the material during the monitoring program; (3) Learning through the Monitoring Program. First-semester medical students gain extensive experience through monitoring programmes. They reported significant benefits after participating in the mentoring program. The changes observed during the mentoring program included a deeper understanding of issues, increased calmness, better self-control, more study time, and increased reading.

The qualitative results from the Focus Group Discussion (FGD) offer additional insights into how and why the worksheets based on Guided Discovery Learning (GDL) were successful in the context of distance education, in addition to the quantitative gains seen in students' critical thinking test scores. Three main topics emerged from the thematic analysis of the FGD data: the monitoring program, the experience of remote learning, and the actual learning process.

First, students emphasized that the monitoring program significantly contributed to the development of their critical thinking skills. This qualitative insight supports the quantitative result

showing post-test gains, as students reported that structured guidance during the program encouraged reflective thinking, self-assessment, and problem-solving.

Second, problems including inadequate internet access and outside distractions were noted as barriers in distant learning, even though students generally adjusted well and took initiative in managing their learning settings. These contextual factors highlight the significance of taking environmental mediators into account when evaluating the success of remote learning and help explain some of the individual score differences seen in the data.

Third, the monitoring program's learning theme provided more in-depth contextual validation. Students reported feeling more at ease, having better self-control, and having more structured study habits–all of which are strongly linked to metacognitive abilities and cognitive preparedness, which are the cornerstones of critical thinking. This supports the idea that GDL-based therapies promote affective and behavioral changes that support deeper learning in addition to being intellectually challenging.

The study offers a more nuanced view of the factors that promote growth in critical thinking, especially in distant and resource-limited educational settings, by combining these qualitative insights with the quantitative results. In distance learning settings, this kind of integration also emphasizes the educational benefits of combining GDL with continuing mentorship.

The research findings indicate that the monitoring program enhanced the critical thinking skills of first-semester medical students. Additionally, the monitoring program not only improved critical thinking but also augmented classroom learning abilities. This underscores that, in medical education, critical thinking is an essential skill required to support a doctor's professional competence in making better decisions and solving problems.

The findings also revealed that the implementation of distance learning for first-semester medical students, facilitated through Internet usage, is generally effective. However, some students face challenges due to poor network quality and noise. First-semester medical students are adequately prepared for distance learning and often seek a suitable location before going online. Distance learning is highly effective, as it enables students to understand and grasp the material well during the monitoring program. Despite its effectiveness, distance learning has some drawbacks, particularly in 3T areas (underdeveloped, frontier, and outermost regions), where technology quality is not fully optimal because of poor network conditions and noise.

Several important factors must be considered to enhance the effectiveness of distance-learning systems. These include the level of attention (concentration) from both students and instructors, the confidence of the instructors, their experience and creativity in the teaching process, understanding of Internet or e-learning usage, and their ability to interact effectively with students (Iilonga et al., 2020).

The research findings also showed that first-semester medical students gained substantial experience from the monitoring program. After participating in the monitoring program, students reported significant benefits, such as being able to delve deeper into cases when their classmates fell ill with malaria. The changes observed during the mentoring program included a deeper understanding of issues, calmness, control, increased study time, and more reading. The positive impact of the monitoring program is evident as it helps students learn to complete tasks promptly. This demonstrates that mentoring, which includes learning activities, aims to support individuals in overcoming challenges by strengthening and developing new and better mechanisms for maintaining self-control and restoring adaptive balance, enabling them to seek higher levels of independence and make autonomous decisions.

According to (Mullen & Klimaitis, 2021), several educational functions in mentoring activities include improving skills, identifying and solving life problems, and enhancing the ability to face life transitions. For short-term purposes, counseling helps individuals clarify values, become more

assertive, control anxiety, improve interpersonal communication skills, decide on life directions, and cope with loneliness, among other things.

Overall, the findings of this study make a significant contribution to the literature on medical education, especially in the context of education in remote areas, such as Papua. The results of this study can serve as the basis for developing more effective and inclusive teaching methods in the future. The implementation of guided discovery learning in distance learning in 3T areas is hindered by issues such as poor network quality and noise.

As evidenced by the higher post-test scores, the results demonstrate that GDL-based student worksheets considerably enhanced students' critical thinking abilities. It is important to recognize the various limitations of this study. First, a higher standard deviation for the post-test results indicates that individual responses differed, which could be because of differences in prior knowledge, learning contexts, or access to online resources. Second, the study only included first-semester medical students from a single Papuan university, which would limit how broadly the findings can be applied. Lastly, a more thorough comprehension of students' learning experiences is restricted by the exclusive dependence on quantitative data devoid of qualitative insights. These drawbacks emphasize the necessity of more studies using a variety of methodologies and larger sample sizes.

The implications of this research are crucial in the context of medical education in remote areas, such as Papua. The use of technology in distance learning, particularly with approaches that emphasize active student engagement such as GDL, can be an effective solution to overcome the challenges of accessibility and quality of education in remote areas. Thus, this research not only contributes to the academic literature on medical education, but also provides practical insights and solutions for improving the quality of medical education in remote areas, particularly in Papua. Although this study sheds light on how well worksheets based on Guided Discovery Learning (GDL) can foster critical thinking in medical students in a remote region of Papua, the results shouldn't be extrapolated to all underserved or remote learning environments. The outcomes vary depending on the local learning environment, student traits, and setting-specific institutional factors. As a result, wider applicability is yet uncertain. Future research is advised to duplicate this intervention in other isolated areas with different cultural, educational, and infrastructure circumstances in order to increase external validity. To evaluate the GDL-based approach's scalability and flexibility across a range of populations, such cross-contextual validations are crucial.

The significant improvement in post-test results reinforces the finding that the GDL approach is effective in the context of distance learning (PJJ) in 3T areas (underdeveloped, frontier, and outermost regions). Mentor support contributed to strengthening self-regulated learning and reflective thinking abilities. Although no pure control group was included, the two variations of the intervention provided a meaningful comparison.

The main limitation of this study is the lack of a control group without intervention. However, ethical considerations and the need for equitable access to education make this approach relevant. To strengthen the interpretation of results in the future, the use of effect size and advanced statistical methods such as ANCOVA to control for confounding variables is recommended.

Conclusion

The results of the study show that the implementation of Guided Discovery Learning-based Student Worksheets is significantly effective in improving students' critical thinking abilities, as evidenced by the increase in the critical thinking test scores of medical students in Papua. Worksheet 3 showed the biggest average gain, although quantitative results showed significant gains in post-test scores across all three worksheets, indicating that some instructional formats might be better suited to encouraging critical thinking. Although some students initially had trouble adjusting to self-directed exercises and digital distribution methods, qualitative study showed that students responded well to the

worksheets' exploratory and introspective nature. These results show that although GDL-based worksheets show promise as a teaching tool, learner preparedness, delivery environment, and content structure all affect how effective they are. Therefore, both the cognitive and contextual aspects of instructional design should be taken into account in educational policy and practice in isolated or underprivileged locations. To achieve wider application and sustainability, future research is recommended to investigate cross-regional replication and GDL model development.

Limitations and Recommendations for Future Research

Despite the positive impact of using GDL-based Student Worksheets in improving the critical thinking skills of medical students in Papua, this study has some limitations. One of these is the limited access to research subjects and support infrastructure for distance learning in Papua, which may affect the widespread implementation of this learning method.

Therefore, future research should continue on a larger scale and involve more medical education institutions, particularly in remote areas. Further studies should evaluate other aspects of distance learning using GDL-based Student Worksheets, such as its effects on learning motivation, student engagement, and overall academic performance. Additionally, future research should include a non-intervention control group and expand the study to educational institutions outside Papua. The development of more adaptive GDL digital modules, which are responsive to the challenges of limited connectivity, should also be prioritized. Thus, the findings of this study can make a greater contribution to the development of high-quality medical education in remote areas, such as Papua.

Ethical Considerations

The study obtained approval from the Ethics Committee of the Faculty of Medicine, Cenderawasih University (No: KE/FK/1131/EC/2022), along with consent from the relevant institutions.

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