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Analysis of the Guided Discovery Learning Model Based on Video Learning on the Students Problem-Solving Abilities

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Abstract: This study aims to analyze the profile of students' problem-solving abilities taught using the guided discovery learning model. This model involves a process in which students discover new knowledge, which ideally should be facilitated by teachers who provide initial guidance to create new knowledge from the teacher's existing knowledge and students' active experiences. Thus, the Guided Discovery Learning learning model is believed to be able to improve students' cognitive abilities, one of which is problem-solving ability. The indicators of the problem-solving ability profile used in this study are formulating problems, formulating hypotheses, testing hypotheses, and conclusions. The sample in this study was 72 students at a public school in Yogyakarta that was accredited A in the odd semester of the 2023/2024 academic year. This study uses quantitative descriptive. Students are first given chemical bonding material taught using the Guided Discovery Learning learning model with video learning media. After that, data collection was carried out through posttest questions consisting of 10 descriptive questions on the chemical bonding material. The results of the study stated that the indicators of students' problem-solving abilities were very high. Meanwhile, the indicators for formulating students' hypotheses were in the high category. Meanwhile, the indicators of hypothesis testing and student conclusion formulation are in the sufficient category. This study concludes that the profile of students' problem-solving abilities is in the sufficient category of 38.9%.

Keywords: Chemical bonds; Guided discovery learning; Problem-solving abilities

Introduction

The essence of the Independent Curriculum is to provide freedom and flexibility for students to pursue their aspirations and future according to their abilities, without coercion or pressure that could undermine their self-confidence. The concept of independent learning fundamentally means that what is taught by teachers should not be regarded as the sole truth for students, but should involve a collaboration between teacher and student perspectives, allowing the teacher's role in the classroom to encourage exploration of truth and reasoning based on the students' knowledge and capabilities (Anwar, 2022). Thus, the Independent Curriculum can be described as inclusive, involving students physically, academically, and socially. The challenges in implementing an inclusive curriculum are not only related to integrating various perspectives but also in incorporating students' voices and experiences as teaching resources (Mukminin et al., 2019). A significant issue in the application of the Independent Curriculum is that teachers may lack an understanding of contextual integrated learning, posing a unique challenge in developing teaching materials (Elfitra et al., 2023). Therefore, it is crucial to implement learning models that support the concept of learning promoted by the Independent Curriculum.

The current chemistry education model in Indonesia must comply with the principles of the Independent Curriculum. The implementation of the education model must also consider the characteristics of the subject matter being taught. One model that is considered appropriate is the Guided Discovery Learning model. This model involves a process in which

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students discover new knowledge, which ideally should be facilitated by teachers who provide initial guidance to create new knowledge from the teacher's existing knowledge and students' active experiences (Permatasari & Laksono, 2019). This approach allows students to respond to specific open-ended questions from the teacher (Eggen & Kauchak, 2012).

Problem-solving ability is defined as the capability of an individual to use existing knowledge to find solutions to current problems through appropriate steps (Akuba et al., 2020). It is a fundamental skill for 21st-century learning, which emphasizes analytical thinking, cooperation, and collaboration among students to solve problems (Puspa Juwita & Ariani, 2020). Problem-solving skills can be enhanced by engaging students in applying previously learned concepts and procedures in new, unfamiliar situations (Chinofunga et al., 2024). Effective problem-solving processes in education help students identify strategies or plans that support their ability to construct and present knowledge (Kaitera & Harmoinen, 2022). A challenge faced by students in applying problem-solving skills is the difficulty in connecting or integrating ideas and demonstrating how these ideas are interrelated as they seek solutions (Reinholz, 2020).

Understanding chemical bonding is essential for drawing conclusions about the relationship between structure and function in chemical compounds and for relating it to other topics such as thermodynamics (Hunter et al., 2022). The representation of chemical bonding at three levels—submicroscopic, macroscopic, and symbolic—presents significant learning challenges for students who have difficulty connecting these representations, often leading to memorization of concepts from textbooks or other sources, which can reduce the meaningfulness of chemistry education (Li & Arshad, 2014). To address this issue, efficient and effective representational media are needed in teaching chemical bonding, including gestural, concrete, static visual (diagrams, graphs, mathematical and chemical equations), dynamic visual (dramas, animations, simulations), and auditory and verbal representations (Gilbert & Justi, 2016). Educational videos, categorized as dynamic visual media, have been shown to be beneficial, allowing for the adjustment of pauses and plays to suit the pace of students' understanding of bonding concepts (Gillette et al., 2017).

Active learning has been shown to reduce misconceptions in chemistry and improve achievement in preventing misconceptions and improving analytical thinking skills, which cannot be learned in teacher-centered education (Sesen & Tarhan, 2011). Other studies have shown that the learning process carried out in the guided discovery learning model significantly improves students' cognitive abilities (Lyu & Wang, 2018). In addition, another study stated that good learning media such as educational videos can be used to motivate and formulate problems, following (Schweiker et al., 2020), who also used educational videos in organic chemistry learning, recorded a significant increase in students' cognitive scores of 17.87% after implementing video-based learning. Therefore, this study is very important to be carried out to integrate the Guided Discovery Learning learning model with video learning so that it can increase the cognitive effectiveness of students in the learning process. So that the final goal of this study, namely improving students' problem-solving abilities with the help of the guided discovery learning model based on video learning, can be achieved.

Method

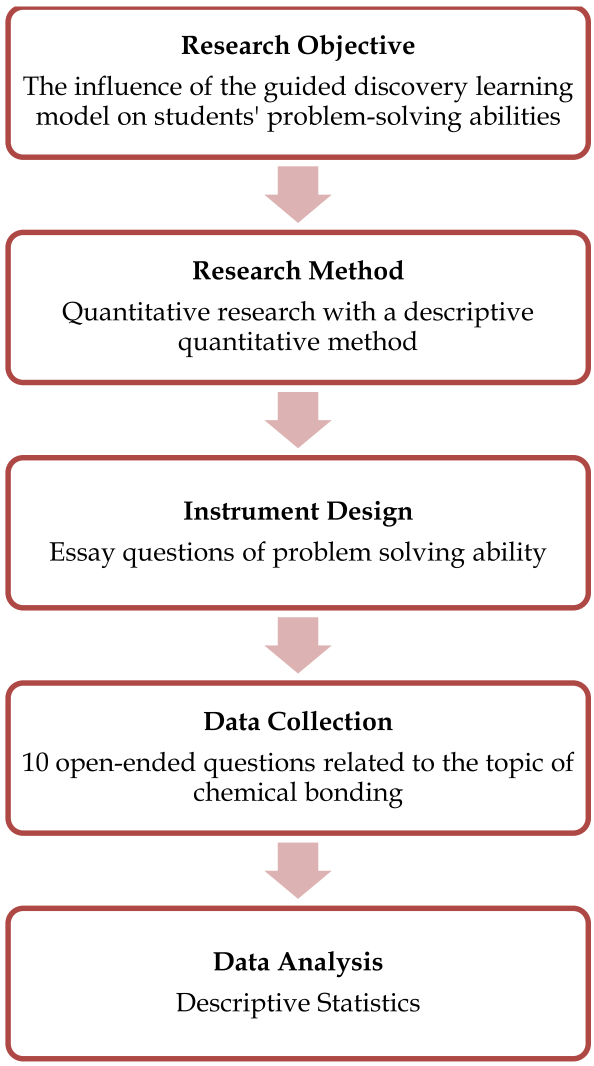

Figure 1. The Research Flow

This study employs quantitative research with a descriptive quantitative method. It was conducted in October 2023 at SMAN 9 Yogyakarta, utilizing four class samples consisting of 144 students. The objective of this research is to determine the profile of problem-solving abilities among eleventh-grade students at SMAN 9 Yogyakarta.

Data collection techniques in this study involved 10 open-ended questions related to the topic of chemical bonding, which were linked to indicators of the students' problem-solving abilities. These indicators were derived from the problem-solving ability indicators by Brookhart & Nitko (2018) which include identifying problems, providing strategies for problem resolution, solving problems, and conducting evaluations—and Carlgren (2013) which involve proposing alternative solutions, listing solutions, applying solutions, and evaluating solutions. Subsequently, a synthesis was performed by the researchers to develop indicators that include formulating problems, formulating hypotheses, testing hypotheses, and drawing conclusions.

The data obtained from the research instruments were then analyzed quantitatively by calculating the overall score percentages and assessing the scores achieved for each indicator. The categorization to assess the problem-solving ability profile was divided into five categories, according to the classification by Widoyoko (2017).

Table 1. Categories Evaluation Ability Solution Problem

Average Participant Score Educate	Category
$X > \bar{X}_i + 1.8 \times Sb_i$	Very high
$\bar{X}_i + 0.60\ Sb_i < X \leq \bar{X}_i + 1.80\ Sb_i$	High
$\bar{X}_i - 0.60\ Sb_i < X \leq \bar{X}_i + 1.80\ Sb_i$	Enough
$\bar{X}_i - 1.80\ Sb_i < X \leq \bar{X}_i - 0.60\ Sb_i$	Low
$X \leq \bar{X}_i - 1.80 \times Sb_i$	Very low

Result and Discussion

Problem-solving ability is defined as an individual's capacity to solve issues by engaging critical, logical, and systematic thinking aspects. It is crucial to teach problem-solving skills to students because these skills play a significant role in an individual's life when faced with problems (Jayadiningrat & Ati, 2018). However, the fact in the field is that students' problem-solving abilities in chemistry learning are still relatively low. This deficiency may also be attributed to teacher-centered learning environments that do not sufficiently engage students in the learning process (Rejeki et al., 2015).

The data profile on problem-solving ability was obtained from the post-test scores of students in both experimental and control classes. These post-test data were analyzed using quantitative descriptive methods to determine the level of students' problem-solving ability profiles. The students' problem-solving ability was measured using a 10-item descriptive instrument covering four problem-solving aspects: formulating problems, formulating hypotheses, testing hypotheses, and drawing conclusions. These questions were designed based on the Learning Outcomes (CP) and Learning Objectives Flow (ATP) of the Independent Curriculum on the subject of chemical bonds. The problem-solving instrument was tested at the end of the learning session through a post-test. The description of the post-test results on problem-solving ability is presented in Table 2.

Table 1. Posttest Results for Problem Solving Ability

Class	Number of Students	Average Score	Lowest Score	Highest Score
Class A	36	67.43	47.5	90
Class B	36	68.13	45	92.5

Based on table 2, the scores obtained by students are satisfactory. However, it can be improved if students are accustomed to learning with a guided discovery learning model based on learning videos to train their problem-solving skills in other chemical materials. Problem-solving skills can be improved by involving students in applying previously learned concepts and procedures in new, unfamiliar situations (Chinofunga et al., 2024). The problem that occurs is that students are not accustomed to active learning models that can improve students' problem-solving abilities. Research by Yerimadesi et al (2019) shows that while 66.7% of teachers still use conventional teaching methods, 27.3% have implemented the Discovery Learning model. However, 87.9% of teachers find it difficult to apply this model in chemistry education. The guided discovery learning process encourages active student participation in discovering and planning their knowledge, supported by the teacher as a facilitator (Janssen et al., 2014). A study by Yerimadesi et al (2023) found that students' cognitive scores increased after the implementation of guided discovery learning using e-modules.

An effective problem-solving process in education helps students identify strategies or plans that support their ability to build and present knowledge (Kaitera & Harmoinen, 2022). The challenges students face in applying problem-solving skills are difficulties in connecting or integrating ideas and showing how these ideas are related as they seek solutions (Reinholz, 2020). The problem-solving abilities of students were also analyzed for each indicator. The problem-solving profile includes four indicators: formulating problems, formulating hypotheses, testing hypotheses, and conclusions. The results of this analysis are generally as shown in Table 3.

Table 3. Results of Analysis of Problem Solving Ability Indicators

Indicator	Average Score	Category
Formulating Problems	9.68	Very High
Formulating Hypotheses	6.71	High
Testing Hypotheses	4.71	Enough
Conclusions	6.01	Enough

According to Table 3, the problem formulation indicator falls into a very high category. The hypothesis formulation indicator and the hypothesis testing indicator are categorized as high and enough category, respectively. The conclusion formulation indicator also falls into the enough category.

Problem-solving abilities are also analyzed for each student based on the same five categories as before. For the indicator of problem formulation, the analysis results are shown in Figure 1.

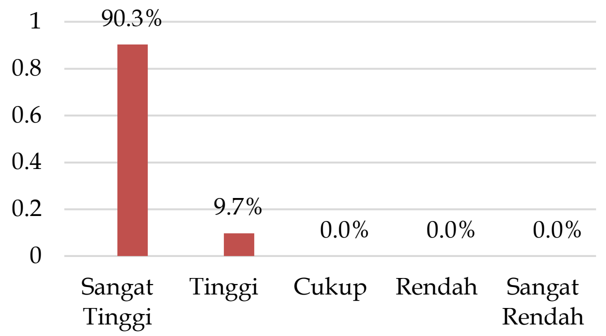

Figure 2. Categorizing Indicators to Formulate Problems

Figure 2 indicates that the very high category percentage for students is 90.3%. The high category is 9.7%, and the percentages for the enough, low, and very low categories are 0%, indicating that no students fall into these categories. Based on this data, the problem formulation category is very satisfactory and should be maintained. Students who can formulate problems correctly are able to identify the issues they need to resolve based on the given problems.

The second indicator is formulating a hypothesis. For the hypothesis formulation indicator, the analysis results are shown in Figure 2.

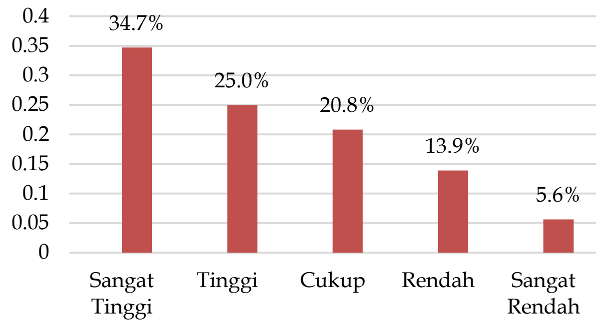

Figure 3. Categorizing Indicators Formulating Hypotheses

Figure 3 shows that the percentages for very high, high, enough, low, and very low categories for the hypothesis formulation indicator are 34.7%, 25%, 20.8%, 13.9%, and 5.6%, respectively. Most students only need reinforcement in improving the aspect of formulating hypotheses. The third indicator is the indicator of testing the hypothesis. The hypothesis testing indicator's results are shown in Figure 3.

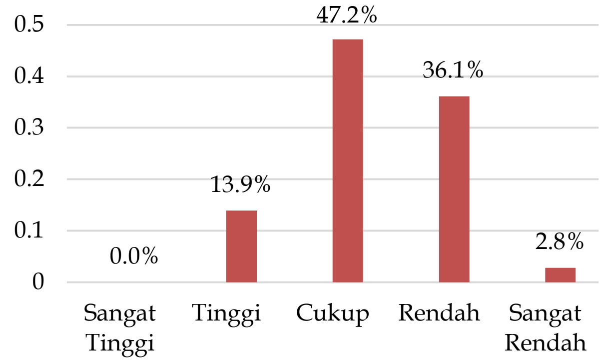

Figure 4. Categorization of Indicators Tests Hypotheses

Figure 4 indicates that the percentages for very high, high, enough, low, and very low categories are 0%, 13.9%, 47.2%, 36.1%, and 2.8%, respectively. Most students require improvement in the hypothesis testing aspect. Therefore, teachers should pay more attention and encourage students to practice this indicator. The indicator of formulating a hypothesis and the indicator of testing a hypothesis on problem solving abilities are two interrelated indicators. Students who are able to formulate hypotheses and test hypotheses can have good scientific thinking because they are accustomed to carrying out scientific methods in solving problems (Liandari et al., 2017). The fourth indicator is the indicator of formulating conclusions. The conclusion formulation indicator's results are presented in Figure 4.

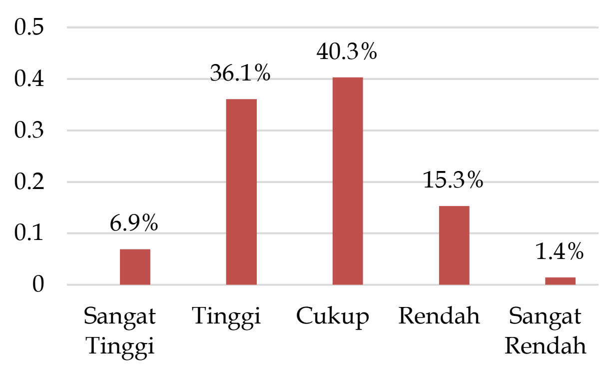

Figure 5. Categorizing Indicators Formulates Conclusions

Figure 5 shows that the percentages for very high, high, enough, low, and very low categories are 6.9%, 36.1%, 40.3%, 15.3%, and 1.4%, respectively. Most students just need reinforcement to be able to draw correct conclusions. A small number of them need more attention to practice drawing accurate conclusions. Errors in drawing conclusions are usually due to students incorrectly summarizing answers or the results of hypothesis testing previously conducted (Ferdianto & Yesino, 2019). This is also based on the fact that students taught using guided discovery learning are often trained to summarize problem-solving results because there is a generalization stage in the guided discovery learning model used.

The difficulties experienced by students in this learning process are related to the topic of chemical bonds being taught. The topic of chemical bonds is challenging for students because of its abstract concept (Fahmi & Irhasyuarna, 2017). When teaching chemical bonds, teachers need to understand the relationship of the curriculum to the subject, including concepts that students have previously learned (e.g., atoms, molecules, and ions) and concepts that will be learned according to the formal curriculum (e.g., ionic bonds, covalent bonds, metallic bonds). In addition, teachers must be aware of the curriculum resources needed to teach these topics, such as textbooks, educational videos, demonstrations, etc (van Dulmen et al., 2022). Common misconceptions during the learning process about bonds include misunderstandings about ionic bonds, which are often thought to only form between metal and nonmetal elements, although not all ionic bonds are formed between these types of elements, as seen in compounds such as $BeCl_2$ which are covalently bonded. Other misconceptions include the belief that non-metals cannot form cations, although there are exceptions, such as HCl molecules that can ionize in water to form H+ and Cl- ions (complete ionization) (Prodjosantoso et al., 2019). Factors related to chemical bonding material are also problems for several students who are research samples.

Conclusion

The problem-solving ability of students based on the category of each indicator is as follows: the problem formulation indicator falls into a very high category with an average score of 9.68. The hypothesis formulation indicator is categorized as high with an average score of 6,81. The indicators for testing hypotheses and drawing conclusions are categorized as enough with average scores of 4,71 and 6,01, respectively. Overall, the average score of students' problem-solving abilities is 27,11, which falls into the enough category.

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Author Contributions

Conceptualized the research idea, analyzed the data, coordinated the implementation of research activities and wrote the article, A.A.Z. Guided and validated the instruments used in the research, S. Helped formulate the research methodology design and assisted with data analysis, D.N.S.

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Conflicts of Interest

The authors declare no conflict of interest.

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