The Analysis of Problem Solving Ability in Natural Sciences and Life Skills through Guided Discovery Learning in the View of Student Learning Independence in the Subject Matter of Changes in Energy Forms

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Abstract: The purpose of this study was to examine the effect of guided discovery learning on science problem solving ability and life skills in terms of student learning independence in the form of energy in grade IV elementary school. Method: The research design used quasi experiment with factorial design. The research sample was 50 fourth grade students from 2 elementary schools. Participants were tested using a problem solving ability test with essay form (pretest and posttest) and student life skills data using observation sheets. Data were analyzed by one way manova test followed by BNT test. Results: The guided discovery learning method ($M = 67.8$; $SD = 14.0$) had significantly better problem solving ability than the conventional learning method ($M = 57.8$; $SD = 13.6$), [$F_{(5; 44)} = 10.53$, $p = 0.000$, $\eta p2 = 0.55$]. The guided discovery learning method ($M = 74.9$; $SD = 10.9$) had significantly better life skills than the conventional learning method ($M = 65.3$; $SD = 9.2$); [$F_{(5; 44)} = 40,49$, $p = 0.000$, $\eta p2 = 0.821$].

Keywords: Guided discovery learning; Learning independence; Life skills; Problem solving ability

Introduction

Natural phenomena that occur in living things and inanimate objects are objects of study in Natural Sciences, which use a scientific method to investigate them. Through learning activities, knowledge and skills in natural science must be developed through scientific processes and attitudes. According to Rusman (2014) learning activities become meaningful when students are given opportunities to ask questions and problems, conduct investigations, collect data, and draw conclusions through a discussion process. Students' ability to apply the scientific method must be developed through solving real-world problems. Science is not only studying natural surroundings systematically, but also as a discovery process to gain an in-depth understanding of the natural surroundings (Kemendikbud, 2014).

Science learning by prioritizing science process skills for scientific investigations can help students in the discovery process (Qomariyah et al., 2014). one of ways to improve the quality of education and science teaching is through selecting a strategy for delivering subject matter such as by guiding students to be actively involved in the learning process according to their intellectual level. it can strengthen the understanding of the concepts being taught. The guided discovery strategy is a learning strategy that does not present the complete material to develop students' ability to understand the material through teacher explanations, so that it can encourage active student involvement (Kistian et al., 2017).

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The guided discovery learning model encourages students to participate in forming concepts by involving students' mental processes, through the use of objects to demonstrate experimental procedures, discovery is a student-centered approach. By shifting the focus from teacher-centered teaching to student-centered teaching, the discovery learning model seeks to transform the passive student learning environment into an active learning environment (Karim, 2017; Rosyidah et al., 2021). Guided discovery learning will encourage students to be more involved in learning so that they can develop cognitive, affective, and psychomotor abilities.

The independence of student learning plays an important role in determining the success of implementing learning and the achievement of student learning outcomes. Good learning independence of students can motivate the students to develop their own abilities without the help of others (Rafika & Bachtiar, 2017). The student learning independence is needed in problem solving. The problem solving ability is important because it shows the ability of students to understand, choose approaches, solve strategies and solve problems (Bernard et al., 2018). Poor problem-solving skills lead to not achieving predetermined learning goals (Ramdan et al., 2018). Problem solving ability as an action is useful for solving problems by utilizing their ability to solve problems until a solution is found through the problem solving stages. The problem solving in science learning is very important, because the completion process allows the students to gain experience through the skills they have. Through the problem solving activities, the aspects of science such as applying rules, finding patterns, concluding communication can develop well.

The results of the author's direct observations in class IV of State Elementary School 2 of Sidorejo in February 2022 on student and teacher activities during science learning, it is known that teachers still do not involve students optimally so that the implementation of learning is still not varied. The conventional teacher teaching pattern by relying only on textbooks and student worksheets with one-way communication does not give students opportunities to play an active role in learning. The learning activities in class IV of State Elementary School 2 of Sidorejo, Brangsong District, Kendal Regency are still dominated by teachers, teachers only provide mastery of facts and concepts, but do not train students' thinking skills to solve problems related to science. The learning does not give students the opportunity to develop independently. The teacher is always focused on solving procedural problems rather than developing students' understanding of science. In this situation the teacher immediately gives answers without asking students' difficulties in solving the problems or providing guidance to students.

The results of the test to measure students' natural science problem-solving abilities at State Elementary School 2 of Sidorejo, show the percentage of students' problem-solving aspects in the low category including aspects of understanding the problem, planning the solution, carrying out the solving plan and re-examining the solution below 20% he low aspect of understanding problem is not because the students do not understand the meaning of the questions but the students do not write down what is known and what is asked on their answer sheets which is one aspect of the assessment. This low planning aspect of solving is because most students do not interpret he solutions they get regarding the given problem material and there are still some students who write the wrong formula and substitute known values. In the aspect of carrying out a solving plan, there were also many student errors in the calculation of improper completion. In the aspect of re-examining the solution, the students do not check the correct answers obtained or draw conclusions.

The teacher also explained that students still had difficulty understanding contextual problems. As a result, the students are not able to model the problem in a mathematical form. The students are also less skilled in interpreting contextual questions. Th students do not have ability to analyze and solve problems in various ways, students are not able to express their ideas, and vice versa. Students have not been able to interpret a problem from a question into a solution, students have not understood the meaning of the questions especially those related to non-routine questions, and the students are not able to understand and interpret problems in the form of story questions and students who have more abilities do not want to share their understanding with other students.

The results of interviews with class teachers (MH) said that another factor that causes low student problem-solving abilities is the lack of motivation, interest and student learning independence. In terms of independent learning, he added, when students were given homework, students tended to do these assignments at observing this, it is necessary to have an innovation in learning in order to achieve the desired learning objectives. Specifically, the problems found were students who were less active in learning, less independent, guidance that was not well directed, lack in solving problems independently. In order to solve various kinds of problems and challenges in the future as an effort to improve the quality and relevance of education, education is needed to develop the basic potential of students so that they have the courage to face the problems they face in everyday life. The pattern

of education is designed to equip students to develop competencies and life skills so that they are able to solve problems including creating jobs in the future (Mujakir, 2012).

The students can learn how to solve their own problems through education that focuses on life skills. The purpose of teaching life skills to the students is not to replace the existing curriculum, but to reorient it so that it truly reflects real world values. Life skills are an attempt to bridge the gap between curriculum and societal needs, not change the entire curriculum or program. The existence of life skills indicates the need to modify curricula or educational programs that are not in accordance with the actual conditions of society.

In order not to be left behind, every generation must have life skills. Someone will be able to deal with problems in life naturally, then proactively and creatively undergo and find solutions to be able to overcome them with the life skills they have. These life skills are useful in life. The ability of life skills can make the younger generation personal experts in mastering life skills. The students need to be taught life skills since they are in elementary school so they can develop their own potential to overcome challenges at the young age (Mujakir, 2012). In line with the results of Lindawati's research (2016) which shows teaching materials based on life skills can actually help to develop students' life skills. Education equips students with various life skills, especially by creating a relevant learning environment and process, in addition to focusing on acquiring knowledge (Noor, 2015). According to Abonyi et al., (2014), students must be able to express their opinions effectively during class presentations or small group discussions. Students must learn to collaborate with other students. Students must accept or pay attention to other people's suggestions, help friends who have problems, and complete assignments in groups.

Life skills can be implemented in all subjects including natural sciences (IPA). Developing life skills and appropriate learning methods can produce optimal student abilities. According to Jauwad & Supriyono (2015) discovery learning is a way of teaching that controls students in acquiring knowledge that they do not yet know not through the delivery of educators, but discovery learning teaching science encourages students to be actively involved in finding out for themselves, procedures, principles and concepts involved in any topic, and this will further assist them in carrying out problem solving in any topic (Akani, 2017). Using guided discovery learning can foster students' abilities in discovery, exploring situations, problem solving, creation and discovery through creative learning so that students are able to build their knowledge independently (Shieh & Yu, 2016).

The findings of this study are supported by the findings of Sucilestari & Arizona (2018), who found that students who were trained in proficiency progressed rapidly when they participated in a series of experiments as part of their science education. The guided discovery learning model is not only developing intellectual abilities but also all potentials that a person has, including emotional and thinking skills (life skills). Based on the description above, this research was conducted to determine the ability to solve science problems and life skills in terms of student learning independence with guided discovery learning on the material of changes in energy forms.

Method

The research method used is a quasi-experimental method with a factorial design. The research subjects were 50 class IV of State Elementary School 2 of Sidorejo. The determination of the sample is using random sampling technique. The participants were divided into two groups, namely groups with high, medium and low independence, then grouped again into groups with guided discovery and conventional learning methods.

The instrument used to collect the data was a closed questionnaire consisting of 30 questions with Likert model rating scale, providing four possible answers, namely strongly agree (SS), agree (S), disagree (ST) and strongly disagree (STS). The student learning independence questionnaire was prepared based on several indicators, namely studying diligently, being independent, being able to control emotions, having self-confidence, learning discipline and having a responsibility to learn (Febriastuti et al., 2013; Hidayati & Listyani, 2010; Mudjiman, 2011). The results of the validity and reliability tests show that this questionnaire has a good level of validity and reliability. The validity moves from 0.423 to 0.832 and the reliability is 0.945. For the problem-solving ability data, the researcher used problem-solving ability test in the form of description, using Likert model rating scale by providing four choices of answer criteria, namely very good (SB) for score of 4, Good (B) for score of 3, Fairly Good (CB) for score of 2 and Not Good (KB) for score of 1. The teacher life skills data are measured using action test through stimulation, performance/identification tests. The rating scale ranges from very good (3), good (2), quite good (1) and not good (0). The aspects of the skills assessed are self-recognition skills, rational thinking, cooperation and communication skills. The aspects of life skills in this study are self-identification skills, thinking skills during learning, communication skills and cooperative skills (Ahmadi, 2013).

The research data was checked by the researcher before the data was analyzed. The researcher used Microsoft Excel and SPSS software to analyze the data. On the research variable data, the researcher calculated the average and standard deviation based on the respondent achievement score. After the respondents get scores according to the provisions in the data collection procedure section, the data is then analyzed using one way Manova analysis followed by the BNT test. Before the data was analyzed using Manova, the researcher conducted a data normality test with the Shapiro Wilk test, a linearity test from the matrix scatter plot, a homogeneity test with the Box-M test and a multicollinearity test by looking at the Tolerance and VIF values.

Result and Discussion

Table 1 shows the description of the sample group with six treatments. The results of the first group, the group with the guided discovery learning method and high independence, it is known that from 6 respondents the value of problem solving ability is obtained ($M = 86.1$; $SD = 3.4$, $min = 83.0$; $max = 92.0$) and life skills score ($M = 92.1$; $SD = 3.5$, $min = 87.0$; $max = 96.0$). The second group with the guided discovery learning method and moderate level independence is known that from 11 respondents the value of problem solving ability ($M = 63.3$; $SD = 6.4$, $min = 50.0$; $max = 75.0$) and life value skills ($M = 71.9$; $SD = 3.4$, $min = 67.0$; $max = 79.0$). The third group with the guided discovery learning method and low self-reliance found that from 8 respondents the value of problem solving ability was obtained ($M = 60.4$; $SD = 14.9$, $min = 71.0$; $max = 83.0$) and life skills values ($M = 66.2$; $SD = 5.5$, $min = 59.0$; $max = 73.0$) Based on the description above, it is known that the group of students using the guided discovery learning method has average value of problem solving abilities 67.8 ($M=67.8$; $SD=14.0$) and average life skills 74.9 ($M= 74.9$; $SD = 10.9$).

Table 1. Summary of Independence Data and Learning Methods

Independence (B)	Guided Discovery (A_1)		Conventional (A_2)		Total
	Problem solving skill	Life Skill	Problem solving skill	Life Skill	
High (B_1)	$\Sigma X_1 = 517.0$ $X_{1rata} = 86.1$ Min = 83.0 Max = 92.0 SD = 3.4 n_1 6	$\Sigma X_1 = 553.0$ $X_{1rata} = 92.1$ Min = 87.0 Max = 96.0 SD = 3.5 $n_1 = 6$	$\Sigma X_1 = 304.0$ $X_{1rata} = 76.0$ Min = 71.0 Max = 83.0 SD = 5.2 $n_1 = 4$	$\Sigma X_1 = 324.0$ $X_{1rata} = 81.1$ Min = 76.0 Max = 89.0 SD = 5.8 $n_1 = 4$	$\Sigma Xb_{1KPM} = 821.0$ $Xb_{1\,rata} = 82.1$ $nb_1 = 10$ $\Sigma Xb_{1LS} = 877.0$ $Xb_{1\,rata} = 87.7$ $Nb_{1LS} = 10$
Moderate (B_2)	$\Sigma X_1 = 696.0$ $X_{1rata} = 63.3$ Min = 50.0 Max = 75.0 SD = 6.4 $n_1 = 11$	$\Sigma X_1 = 791.0$ $X_{1rata} = 71.9$ Min = 67.0 Max = 79.0 SD = 3.4 $n_1 = 11$	$\Sigma X_1 = 863.0$ $X_{1rata} = 57.5$ Min = 38.0 Max = 75.0 SD = 10.1 $n_1 = 15$	$\Sigma X_1 = 984.0$ $X_{1rata} = 65.6$ Min = 61.0 Max = 71.0 SD = 2.9 $n_1 = 15$	$\Sigma Xb_{1KPM} = 1558.0$ $Xb_{1\,rata} = 59.9$ $nb_{1\,KPM} = 26$ $\Sigma Xb_{1LS} = 1775.0$ $Xb_{1\,rata} = 68.3$ $nb_{1\,LS} = 26$
Low (B_3)	$\Sigma X_1 = 483.0$ $X_{1rata} = 60.4$ Min = 38.0 Max = 79.0 SD = 14.9 $n_1 = 8$	$\Sigma X_1 = 530.0$ $X_{1rata} = 66.2$ Min = 59.0 Max = 73.0 SD = 5.5 $n_1 = 8$	$\Sigma X_1 = 279.0$ $X_{1rata} = 46.5$ Min = 25.0 Max = 58.0 SD = 12.8 $n_1 = 6$	$\Sigma X_1 = 324.0$ $X_{1rata} = 54.1$ Min = 51.0 Max =58.0 SD = 3.3 $n_1 = 6$	$\Sigma Xb_{1KPM} = 763.0$ $Xb_{1\,rata} = 54.5$ $nb_{1KPM} = 14$ $\Sigma Xb_{1KPM} = 854.0$ $Xb_{1\,rata} = 61.0$ $nb_{1KPM} = 14$
	$\Sigma Xk_1 = 1696.0$ $Xk_{1rata} = 67.8$ $nk_1 = 25$	$\Sigma Xk_1 = 1873.0$ $Xk_{1rata} = 74.9$ $nk_1 = 25$	$\Sigma Xk_1 = 1446.0$ $Xk_{1rata} = 57.8$ $nk_1 = 25$	$\Sigma Xk_1 = 1633.0$ $Xk_{1rata} = 65.3$ $nk_1 = 25$	$\Sigma Xk_{1KPM} = 3142.0$ $Xk_{1rata} = 62.8$ $nk_1 = 50$
Total					$\Sigma Xk_{1LS} = 3506.0$ $Xk_{1rata} = 70.1$ $nk_1 = 50$

The fourth group with conventional learning methods and high independence is known that from 4 respondents the value of problem solving ability ($M = 76.0$; $SD = 5.2$, $min = 71.0$; $max = 83.0$) and the value of life skills ($M = 81.1$; $SD = 5.8$, $min = 76.0$; $max = 89.0$). The fifth group with conventional learning methods and moderate level independence is known that from 15 respondents, the value of problem solving ability ($M = 57.5$; $SD = 10.1$, $min = 38.0$; $max = 75.0$) and the value if life skills ($M = 65.6$; $SD = 2.9$, $min = 61.0$; $max = 71.0$). The sixth group with conventional learning methods and low independence, it is known that from 6 respondents the value of problem solving ability ($M = 46.5$; $SD = 12.8$, $min = 25.0$; $max = 58.0$) and life skills values ($M = 54.1$; $SD = 3.3$, $min = 51.0$; $max = 58.0$). Based on the description above, it is known that the group of students using conventional learning methods has an average problem-solving ability score of 62.8 ($M=62.8$; $SD=14.6$) and the average life skills 70.1 ($M=70, 1$; $SD = 11.1$).

Table 2. The effect of Guided Discovery Learning on Problem Solving Ability and Life skills in terms of Student Learning Independence

	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Pillai's Trace	0.89	7.05	10.00	88.00	0.000	0.45

The results of the multivariate test indicated that there were significant differences in the problem solving abilities and life skills of students from different learning and independence groups, $F (10; 88) = 7.05$, $p <0.001$; $Wilk's \lambda = 0.89$, $\eta p2 = 0.45$. The multivariate tests proved that the two teaching methods had the same ability to influence the problem-solving abilities and life skills of science students in the matter of energy changes simultaneously (influenced on average).

The univariate results show that the differences in learning methods and independence lead to significant differences in the problem solving abilities [$F (5; 44) = 10.53$, $p = 0.000$, $\eta p2 = 0.55$], and cause significant differences in the student life skills [$F (5; 44) = 40.49$, $p = 0.000$, $\eta p2 = 0.82$]. The further test to determine the differences in the effect between cells were carried out with the BNT test. Complete calculations can be seen in the attachment, while the summary is shown in Table 4 as follows.

Table 3. Summary of One Way Manova Calculation Results

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Group	Problem solving skill	5636.64	5	1127.33	10.53	0.000	0.55
	life skills	4952.35	5	990.47	40.45	0.000	0.82
Error	Problem solving skill	4711.04	44	107.07			
	life skills	1076.23	44	24.46			

The results of the BNT test in table 4.7 show that the interactions A1B1, A1B2, A1B3, A2B1, A2B2 and A2B3 have different notations, this means that the problem solving abilities in these interactions are significantly different. The interactions A1B1, A1B2, A1B3, A2B1, A2B2 and A2B3 have different notations, this means that the life skills in these interactions are significantly different. The interactions between A1B3, A2B1, A2B2 and A2B3 have the same notation, this means that the problem solving skills in these interactions are not significantly different. The same is true for the interactions between A1B2, A1B3, A2B1 and A2B2 which have the same notation, this means that the life skills abilities in these interactions are not significantly different.

Table 4. Research Sample Group Interaction

	Group	Average	SD	Notation LSD			
Problem solving skill	A1B1	86.17	3.76	A			
	A1B3	68.25	14.29		B		
	A1B2	63.45	6.51		B	C	
	A2B2	59.53	11.45		B	C	
	A2B1	53.25	7.27			C	
	A2B3	46.50	12.58			C	
Life skills	A1B1	92.17	3.43	A			
	A1B3	74.00	9.65		B		
	A1B2	71.91	3.47		B		
	A2B1	67.75	2.98			C	
	A2B2	65.20	3.48			C	
	A2B3	54.33	3.07				D

The descriptive statistical data showed that the application of the guided discovery learning model has a different performance from conventional methods in improving student problem solving abilities. The experimental class students who were taught using the guided discovery model had higher problems solving abilities than control class students who were taught with the conventional learning model. This is because the guided discovery learning model provides opportunities for students to search and find the information they need on their own. During the discovery phase, the students receive an assistance or directions from the instructor to improve their concentration, thereby successfully applying the knowledge gained and achieving goals. Soenarko, et al. (2022)research, conveyed that learning with guided discovery methods makes students involved in learning. This finding is consistent with the findings of Salwan and Rahmatan (2017), which show that the use of inquiry-based learning improves student learning outcomes.

According to Ratumanan (2002), the purpose of teacher guidance in this case is to help students understand the purpose of activities and provide instructions about work procedures that must be followed during learning activities. Similar research also shows that the ability of fourth grade elementary school students in solving math problems increases as a result of the successful application of the guided discovery learning model (Abali, Y., & Kaan, 2018). Another research also shows that students' problem solving abilities are positively influenced by the guided discovery learning model (Nahdi, 2018). In line with that, the research conducted by Nupita shows that the guided discovery learning model has a beneficial effect on the science problem solving abilities of fifth grade elementary school students (Nupita, 2013).

The research hypothesis of student life skills through guided discovery learning is better than conventional learning in terms of student learning independence. This happens because the guided discovery learning method gives students a large space to be actively involved in the learning process The students are free to ask questions, make hypotheses, look for answers to a problem, find answers to the problems they face, discuss and conclude the findings of the problems. Thus, students actually experience a deep and meaningful learning process, according to what Vygotsky said in the zone proxima development theory. According to Vygotsky quoted by Tedjasaputra (2001), the development of a person's abilities is divided into two levels, namely the level of actual development and the level of potential development.

In line with the research of Azizmalayeri Kyumars' which states that the guided discovery learning method has a significant influence in improving students' critical thinking skills. The guided discovery learning method turned out to provide a higher increase in students' critical thinking compared to students who used conventional methods (Azizmalayeri Kiumars, Ebrahim MirshahJafari, Mostafa Sharif, Mohammad Asgari, 2012). The open and convergent question phase in the class with the guided discovery learning method makes students actively involved in exploring questions and discussing. Not so with the control class that uses conventional methods. As said by Gholamian (2013) the guided diacovery learning method has a significant influence on fluency, creativity and the development of meaning when compared to traditional methods.

Conclusion

Based on the results of the research and discussion, problem solving abilities and life skills through guided discovery learning are proven to be significantly better than learning using conventional methods in terms of student learning independence.

Author Contributions
The authors of this article consist of three people i.e M, T.J.R, and W. The roles of the authors in this research are divided into executor and advisor in this research.

Conflicts of Interest
The authors declare no conflict of interest.

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