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The Logan Avenue Problem Solving-Heuristic Learning Model: Impact on Students' Higher-Order Thinking Skill

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ABSTRAK

Pembelajaran masih berfokus pada penguasaan materi dengan guru sebagai pusatnya. Selain itu, indikator kemampuan berpikir yang sering dilatih pada siswa hanya terbatas pada indikator C4 (analisis). Akibatnya, siswa pasif dalam menerima informasi dan kemampuan berpikir tingkat tinggi siswa menjadi terhambat. Tujuan penelitian ini adalah untuk menganalisis pengaruh model pembelajaran Logan Avenue Problem Solving-Heuristic terhadap keterampilan berpikir tingkat tinggi siswa. Penelitian ini menggunakan pendekatan kuantitatif. Metode penelitian yang digunakan adalah eksperimen semu dengan desain penelitian pretest-posttest control group design. Sampel dalam penelitian ini adalah siswa kelas XI IPA sebanyak 70 siswa yang dipilih menggunakan teknik cluster random sampling. Teknik pengumpulan data yang digunakan adalah tes uraian sebanyak 10 soal kemudian diukur menggunakan uji t dua sisi sampel bebas. Hasil penelitian menunjukkan bahwa model pembelajaran Logan Avenue Problem Solving-Heuristic berpengaruh signifikan terhadap keterampilan berpikir tingkat tinggi siswa. Penelitian ini dapat menjadi alat evaluasi bagi guru untuk meningkatkan kualitas belajar siswa, khususnya dalam mengingkatkan keterampilan berpikir tingkat tinggi siswa.

ABSTRACT

Learning still focuses on mastering the material, with the teacher as the center. Aside from that, the thinking ability indicators that are frequently trained on students are confined to the C4 (analyze) indicator. As a result, students are passive in receiving information, and their higher-order thinking skills are hampered. The aim of this research is to analyze the influence of the Logan Avenue Problem Solving-Heuristic learning model on students' higher-order thinking skills. This study uses a quantitative approach. The research method used was a quasi-experiment with a pretest-posttest control group design. The sample in this study was 70 science students in class XI who were selected using cluster random sampling techniques. The data collection technique used was a description test of 10 questions, which was then measured using the free sample two-tailed t-test. The research results show that the Logan Avenue Problem Solving-Heuristic learning model has a significant effect on students' higher-order thinking skills. This research can be an evaluation tool for teachers to improve the quality of student learning, especially by improving students' higher-order thinking skills.

1. INTRODUCTION

Science is knowledge obtained from systematic investigations of nature through observing, classifying, experimenting, analyzing data, and organizing data (Taangahar & Okwori, 2022). One branch of science that studies natural phenomena that exist in the surrounding environment and the interactions of these natural phenomena is physics. Until now, they still saw physics lessons as very difficult lessons (Bøe, 2023; DeWitt et al., 2019; Serhane et al., 2020). This is because when students study physics, they must simultaneously deal with differences in representations, such as experiments, formulas and calculations, graphs, and conceptual explanations. Students must carry out transformations between them, for example, transferring graphical representations to mathematical representations (Lusiyana et al., 2019). As a scientific discipline, physics requires students to use various strategies for understanding and translating from one to the other, including words, tables of numbers, graphs, equations, and diagrams (Munfaridah et

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al., 2021). Only a few students are interested in studying physics at school (Mallari, 2020), even though physics is a crucial subject for understanding because physics encompasses more than just imparting knowledge about concepts, facts, and laws from natural phenomena that have been studied. Learning physics helps students to develop critical thinking, logical reasoning, systematic thinking, and problem-solving abilities.

Students can develop critical, logical, and systematic thinking skills and can solve problems if they have higher-order thinking skills. Higher-order thinking skills (HOTS) are the ability to act based on facts, analyze, use data and ideas to find different meanings and implications, draw conclusions from these facts and ideas, connect them with new information, and make judgments to produce solutions or ideas for new ways to solve problems and enable students to overcome challenges in the current information era (Muhibbuddin et al., 2023; Supeno et al., 2019; Venkatraman et al., 2022). Higher-order thinking is characterized by complexity, a non-algorithmic nature, producing many answers, and applying various criteria (Kosasih et al., 2022). The HOTS indicators utilized in this study refer to the Revised Bloom's Taxonomy, which is congruent with the achievements of physics learning (Johansson, 2020; Saepuzaman et al., 2022). The Revised Bloom's Taxonomy categorizes cognitive processes from basic to advanced (very critical and creative thinking), which functions as a reference for the thinking skills that students want to achieve (Gul et al., 2020; Prakash & Litoriya, 2022). Therefore, HOTS is one of the 21st-century skills that students must train by integrating it into learning activities (Ginting & Kuswandono, 2020; Kosasih et al., 2022; Siagian & Iskandar, 2020). However, in reality, educators have not optimally implemented learning activities aimed at improving HOTS. This is because teachers still focus on mastering the material without incorporating practical exercises in class. As a result, learning activities rely solely on the teacher, and students passively receive information, hindering the development of their higher-order thinking skills (Anggraini et al., 2019). Thus, there is a need for learning that can improve students' higher-order thinking skills.

One effort to improve students' higher-order thinking skills is to use the Logan Avenue Problem Solving-Heuristic learning model in physics learning. The Logan Avenue Problem Solving (LAPS)-Heuristic learning model is a problem-solving learning model used to solve non-routine problems. A non-routine problem is one that is not routine and for which the person does not know how to solve it. They sought a solution to find a solution to the problem (Asfar, Asfar, and Sulastri, 2021). The LAPS-Heuristic learning model comes from a modification between Polya's problem-solving strategy and Marier's pure discovery model, known as "Heuristic" (Fatimah, 2020). Heuristics are a series of guiding questions to make fast, economical, and accurate decisions (Gigerenzer, et, al, 2022). We use heuristics when the problem is unclear, when the problem found does not have an algorithm available to solve it, or when the problem found does not provide all the information needed to solve it (Luan, et al, 2019).

In using the LAPS-Heuristic learning model, there are four stages in the learning process: understanding the problem, planning problem-solving, implementing the problem-solving plan, and re-examining the results that have been obtained (Putri & Hariyanti, 2022). At the stage of understanding the problem, students analyze the problem that the teacher gives them in order to write down what they know about the problem. At the problem-solving planning stage, participants learn to analyze appropriate problem-solving plans, then they prepare solutions to the problem-solving plans and evaluate the problem-solving plans that they have prepared in groups. In the implementation phase of the problem-solving plan, students carry out the problem-solving plan that was prepared in phase 2 in groups. At the stage of re-checking the results that have been obtained, students evaluate the results that have been obtained and conclude the results of solving the problem.

Researchers have widely conducted research in various learning fields using the LAPS- Heuristic learning model. Some of this research, shows that the LAPS-Heuristic learning model influences students' problem-solving abilities in mathematics learning (Fatimah, 2020). The LAPS-Heuristic learning model had a positive impact on enhancing students' mathematical and creative thinking abilities (Ningsih *et al.*, 2021).

The LAPS-Heuristic learning model influences students' higher-order thinking skills in biology learning (Haka *et al.*, 2020). Learning to use the LAPS-Heuristic learning model can arouse motivation, curiosity, activeness, creativity, critical thinking, and the ability to analyze a problem, so students' problem-solving abilities become better (Asfar et al., 2021; Ningsih et al., 2021). Higher-order thinking skills can improve if students was directed to think creatively and solve issues (Purba et al., 2021). Therefore, in this study the researchers integrated the LAPS- Heuristic learning model with higher order thinking skills.

The material of temperature and heat is one material in physics that is widely applied in everyday life and is one of the fundamental concepts for comprehending other physics concepts (Komikesari et al., 2020; Sari et al., 2023). In the material on temperature and heat, various concepts are discussed, such as temperature, expansion, heat, and heat transfer. Temperature and heat materials can develop students' critical thinking abilities (Aminudin *et al.*, 2019). However, many students have difficulty understanding temperature and heat materials (Komikesari et al., 2020; Sari et al., 2023). Usually, the concepts of temperature and heat are difficult to differentiate, so many students believe that they are the same (C. Anwar et al., 2019). Therefore, in this material, students are required to be able to analyze the relationship between temperature and heat and then developed the ability to use these two concepts with other concepts (Sari et al., 2023). Based on this, temperature and heat materials can be used to hone students' higher-order thinking skills, so students can build a deep understanding and relating it to applications in everyday life.

This research aims to analyze the influence of the Logan Avenue Problem Solving-Heuristic learning model on students' higher-order thinking skills. By applying the LAPS-Heuristic model as a problem-solving learning model, we expect students to acquire higher-order thinking skills. From the results of the literature, general research regarding the LAPS-Heuristic learning model, which uses two groups with different treatments, applies the LAPS-Heuristic learning model in the experimental group and conventional learning in the control group, so the research results show significant differences. Different from previous research, in this research, researchers used a different treatment in the control group, namely by applying the problem-solving learning model. Furthermore, researchers incorporated new materials, specifically temperature and heat materials, which had not been utilized in previous research on the application of the LAPS-Heuristic learning model in physics learning.

2. METHOD

In this research, we used a quantitative approach. A quantitative approach is an approach that involves systematic investigation and exploration using statistical calculations based on numerical data (Sastypratiwi & Nyoto, 2020; Smith & Hasan, 2020). The research method used is quasi-experimental with a research design, namely pretest-posttest control group design. Using this research design, the researchers administered a pretest to both the experimental group and the control group to determine any differences between them. Then, the researchers gave the experimental group treatment using the LAPS-Heuristic learning model, while they gave the control group treatment using the Problem-Solving learning model. After being given treatment to the two groups, a last test (posttest) was carried out on the experimental group and the control group. We show the design of this research in Table 1.

Table 1. Research Design

Group	Sample	Pretest	Treatment	Posttest
Experimental Group	Random	O_1	X_1 (Logan Avenue Problem Solving-Heuristic learning model)	O_2
Control Group	Random	O_3	X_2 (Problem-Solving learning model)	O_4

Sample and Data Collection

In this research, we employed cluster random sampling techniques to select 70 students as respondents, comprising 46 female and 24 male. We categorized the respondents into two groups based on criteria: 36 students in the experimental group and 34 students in the control group. Researchers use the cluster random sampling technique to separate the population into different groups, known as clusters (Sumantri et al., 2022). We chose this technique due to the restrictions of analyzing every individual in the study population at the same time. This study used a test known as a description test as its technique for gathering data. This test is used to gather information about higher-order thinking skills as answers to the problems formulated. The quantitative data that has been obtained is processed using descriptive statistics. To measure students' higher-order thinking skills, we used 10 essay questions containing indicators of higher-order thinking skills, namely analyzing (C4), evaluating (C5), and creating (C6). The instrument used has been validated with a reliability coefficient of 0.687 (high category). Table 2 displays the HOTS indicators, operational verbs, question indicators, and the number of questions for each HOTS indicator.

Table 2. Distribution of Higher-Order Thinking Skills Test Questions

HOTS Indicator	Operational Verbs	Question Indicators	Amount
C4 (Analyze)	Analyze	- Presented data from length expansion experiments using different materials, students can analyze data from length expansion experiments on different materials - Presented with tables of specific heat, mass, and heat capacity, students can analyze the heat	4

HOTS Indicator	Operational Verbs	Question Indicators	Amount
		capacity values for copper, alcohol, and water and the largest and smallest heat capacities	
	Choose	- An activity and a table of the specific heat of each substance are presented, and students can choose the type of substance used during the experiment - It presented a table containing the types of glass doors and their specifications. Students can choose glass with a smaller increase in area expansion under the concept of area expansion	
C5 (Evaluate)	Compare	- A temperature measurement activity using a Fahrenheit thermometer, a Celsius thermometer, and a Y thermometer is presented. Students can compare the temperatures measured using a Celsius thermometer and a Y thermometer	3
	Providing Arguments	- Presented with an event and a table of the specific heat of each substance, students can provide arguments regarding the opinions expressed by students who try to calculate the specific heat value	
	Check	- When two events of mixing hot and cold water in making coffee and tea are presented, students can check whether the events carried out are correct or not related to the use of Black's Principle	
C6 (Create)	Designing	- Presented with a picture of a bimetal thermostat and a table of linear expansion coefficients, students can design materials that are suitable for making bimetal thermostats - A case is presented, namely Hilma and her group, who are experimenting by mixing two substances that have different temperatures, and they want to produce a final temperature of 20 °C. Students can design the experiment to produce a final temperature of 20 °C - Presented with an event and quantity related to area expansion, students can design a glass using the concept of area expansion	3

This study's data analysis involves statistical tests. Statistical tests are used to test hypotheses (using the free sample two-tailed t-test) and determine the significance of the relationship between the LAPS-Heuristic learning model and higher-order thinking skills. The free sample two-tailed t-test can be carried out if the research data is normally distributed and the research sample is homogeneous. We carried out statistical tests using data obtained from description tests. The score for each test item uses a tiered scale, namely a maximum score of 4 and a minimum score of 0. The percentage of scores that have been obtained is then categorized according to each indicator based on the International Center for the Assessment of Higher Order Thinking, as shown in Table 3.

Table 3. Categorization of Higher-Order Thinking Skills

Percentage (%)	Category
0 – 20	Very Less
21 – 40	Less
41 – 60	Enough
61 – 80	Good
81 – 100	Very Good

Then, to determine the magnitude of the influence of the learning model on students' higher- order thinking skills, we used the effect size test based on formula (C. Anwar et al., 2019; Rajput et al., 2023). The effect size values obtained are then categorized based on criteria (C. Anwar et al., 2019), showed in Table 4.

Table 4. Effect Size Value Criteria

Effect Size Value	Criteria
$ES < 0.2$	Low
$0.2 \leq ES \leq 0.8$	Medium
$ES > 0.8$	High

3. RESULT AND DISCUSSION

Result

The average pretest and posttest scores for the experimental group were 17.75 and 5.56, indicating that the average completion score for the experimental group had increased, as seen in Table 5. Meanwhile, the increase in the average pretest and posttest scores for the control group was 9.68 and 5.03, as seen in Table 6. Thus, the learning of the experimental group, which used the LAPS-Heuristic learning model, was better than the learning of the control group, which used the Problem-Solving learning model.

Table 5. The Recapitulation of Pretest and Posttest Scores in the Experimental Group

Pretest	Statistics Data	Posttest
12	Highest Score	31
1	Lowest Score	2
5.56	Average Score	17.75
2.51	Standard Deviation	5.53

Table 6. The Recapitulation of Pretest and Posttest Scores in the Control Group

Pretest	Statistics Data	Posttest
11	Highest Score	16
1	Lowest Score	1
5.03	Average Score	9.68
2.96	Standard Deviation	3.92

By calculating the percentage of the average pretest and posttest scores for each indicator of higher-order thinking skills, we can explain the pretest and posttest data for both the experimental group and the control group in more detail. This percentage was obtained from the results of the pretest and posttest, which consisted of 10 essay questions that included indicators C4 with 4 questions, C5 with 3 questions, and C6 with 3 questions. Table 7 and Table 8 show the results of the percentage calculation.

Table 7. Percentage of Pretest Data on Higher-Order Thinking Skills

HOTS Indicator	Experimental Group		Control Group	
	Pretest Percentage	Category	Pretest Percentage	Category
C4 (Analyze)	20.49%	Less	13.97%	Very Less
C5 (Evaluate)	17.59%	Very Less	12.01%	Very Less
C6 (Create)	2.08%	Very Less	9.31%	Very Less

Table 8. Percentage of Posttest Data on Higher-Order Thinking Skills

HOTS Indicator	Experimental Group		Control Group	
	Posttest Percentage	Category	Posttest Percentage	Category
C4 (Analyze)	46.70%	Enough	27.94%	Less
C5 (Evaluate)	45.60%	Enough	27.45%	Less
C6 (Create)	45.14%	Enough	13.24%	Very Less

Based on Table 7, the percentage of pretest data for higher-order thinking skills between the experimental group and the control group is not much different. Although the average pretest percentage for indicators C4 and C5 obtained by the experimental group was superior to the average pretest percentage for indicators C4 and C5 obtained by the control group, the average pretest percentage for indicators C6 obtained by the experimental group was lower. However, the average pretest percentage for the C6 indicator obtained by the experimental group was smaller than the average pretest percentage for the C6 indicator obtained by the control group, and most of the pretest average percentages were in the very less category. After being given treatment to both the experimental group and the control group, the average percentage of higher-order thinking skills for each indicator, namely indicators C4 (analyzing), C5 (evaluating), and C6 (creating), increased, as seen in Table 8. Overall, the posttest average percentage for indicators C4, C5, and C6 in the experimental group was superior to enough category for all indicators. Meanwhile, the average posttest percentage for indicators C4, C5, and C6 in the control group was in the categories of less, less, and very less. In general, the experimental group still outperforms the control group in terms of the percentage of higher-order thinking skills indicators among the three mentioned indicators.

Based on the normality test and homogeneity test that we carried out, we obtained results that show both samples have a normal distribution and are homogeneous. So next, we carried out hypothesis testing using the free sample two-tailed t-test.

Table 9. Hypothesis Test

Test Result	α	t_{count}	t_{table}	Conclusion
Pretest and Posttest experimental groups	0.01	12.04	2.65	$t_{count} > t_{table}$ = H_a is accepted
Pretest and Posttest control groups	0.01	5.52	2.65	$t_{count} > t_{table}$ = H_a is accepted

Based on Table 11 for the experimental group with a significance level of α = 0.01, t_{count} = 12.04 and t_{table} = 2.65 were obtained. The results of these calculations show that $t_{count} > t_{table}$ (12.04 > 2.65), leading to the conclusion that the LAPS-Heuristic learning model has an influence on students' higher-order thinking skills in the temperature and heat material. Then, for the control group with a significance level of α = 0.01, t_{count} = 5.52 dan t_{table} = 2.65 were obtained. From the results of these calculations, we can see that $t_{count} > t_{table}$ (5.52 > 2.65) so we can conclude that there is an influence of the Problem-Solving learning model on students' higher-order thinking skills in temperature and heat material. From the two data points, we can see that the experimental group's t_{count} is greater than the control group's t_{count}. Thus, the experimental group learning that used the LAPS-Heuristic learning model had more influence on students' higher-order thinking skills than the control group learning that used the Problem-Solving learning model. According on Table 12, the effect size value is 1.81, so the magnitude of the influence of the learning model on students' higher-order thinking skills is high.

Table 10. The Effect Size Data of the Experimental Group and Control Group

Mean of Experimental Group	Mean of Control Group	Effect Size	Category
17.75	9.68	1.81	High

Discussion

The results of previous research state that the LAPS-Heuristic learning model improves higher-order thinking skills with an N-Gain value of 0.72 and falls into the high improvement category (Haka et al., 2020). In that study, Haka et al. used the LAPS-Heuristic learning model in biology learning and applied the Discovery Learning model in the control class. In this research, we applied the LAPS-Heuristic learning model in physics learning and used the Problem-Solving learning model in the control class. Indicator C4 (analyzing) in the experimental group has a greater percentage than the control group because two syntaxes of the LAPS-Heuristic learning model, namely the syntax of understanding the problems and the syntax of planning to problem-solving, facilitate it; the syntax of planning to problem-solving and the syntax of re-checking the results facilitates indicator C5 (evaluating); and the syntax of planning to problem-solving and the syntax of implementing a problem-solving plan facilitates the C6 indicator (creating). The average score percentage of indicators C4 (analyzing), C5 (evaluating), and C6 (creating) in the control group is lower than the experimental group because even though problems are given in syntax or phase 1, namely formulating the problem and facilitated by syntax or the phase of diagnosing the problem and syntax or the phase of determining and implementing strategies, students have not fully analyzed the problems given well and have not been optimal in implementing problem-solving strategies.

In phase 1 of understanding the problem of facilitating indicators of higher-order thinking skills, namely indicator C4 (analyzing). This phase encourages students to be active in analyzing concepts from the material because, at the beginning of learning, there is a problem that they must solve. When students can respond to the problems given by analyzing these problems, they can improve their critical thinking abilities (Rahayuni, 2016; Surat, 2021). When pupils' critical thinking skills improve, their higher-order thinking skills can improve as well. In phase 2 of planning to problem-solving facilitates indicators of higher-order thinking skills, namely indicators C4 (analyzing), C5 (evaluating), and C6 (creating). In this phase, students are encouraged to analyze suitable problem-solving plans and then prepare their own plans, which they can evaluate. When students can think critically when solving problems, they will think critically, and higher-order thinking skills will work, so that students can initiate ideas to solve problems appropriately with the indicators used, namely C4, C5, and C6 (Nurlaily et al., 2019; Susanti et al., 2016). In this phase, the teacher divides students into six groups based on the students' abilities and distributes LKPD based on the Logan Avenue Problem Solving-Heuristic as instructions for conducting experiments when implementing a problem-solving plan, which is of course related to phase 2, namely planning problem-solving. Students in this phase engage in problem-solving, focusing on devising solutions for previously assigned problems.

In phase 3 of implementing the problem-solving plan facilitates indicators of higher-order thinking skills, namely indicator C6 (creating). This phase of the problem-solving plan requires students to design an experiment as a means of encouraging them to engage in the process of experiment design. Solving problems requires critical thinking, creative thinking, and effective communication skills so that students can create something new as a solution (Majeed et al., 2021; Simanjuntak et al., 2021). If students can think critically, then higher-order thinking skills will work, so that students can solve problems according to the C6 indicators used (Y. Anwar et al., 2020; Susanti et al., 2016). One experiment that students designed was an area expansion experiment. By designing an area expansion experiment, apart from being able to train students' abilities to design an experiment, it also trains students to prove their understanding of theory and practice. After carrying out the experiment, students present the experimental data they have obtained by writing it on the LKPD, analyzing the data, and holding discussions regarding the results they have obtained in order to solve the problem.

In phase 4 of re-checking the results obtained facilitates indicators of higher-order thinking skills, namely indicator C5 (evaluating). This phase requires students to evaluate the results they have obtained and conclude the results of solving the problem. In indicator C5 (evaluating), students can determine whether the conclusions obtained follow the observed data or not. When the conclusions obtained are in accordance with the desired goal, namely being able to solve problems, then students can be said to have the ability to evaluate (Y. Anwar et al., 2020; Aswanti & Isnaeni, 2023; Susanti et al., 2016). In this phase, the teacher instructs students to double-check their results, namely regarding the experimental data obtained as well as the problem-solving plan that has been prepared and implemented with the problems given in Phase 1. The experimental data obtained can answer the problem given or not, so that in the end, students can conclude the results of solving the problem. After the students double-check the results, they have obtained and concluded the results of solving the problem. Group representatives are asked by the teacher to present the outcomes of their group work and provides an opportunity for questions and answers with the groups that did not present. When gathering information, question-and-answer sessions can help pupils develop their critical thinking and attention skills (Linh & Thanh, 2022; Suciningsih et al., 2023). From the presentation of the results of group work and questions and answers, conclusions were drawn on problem solving, and actual concepts were obtained.

In the experimental group, each indicator experienced a significant increase, especially the C6 indicator, where the C6 indicator is the top indicator in the Revised Bloom's taxonomy (Ladin et al., 2021; Tulljanah & Amini, 2021). Even though the C6 indicator is the most difficult indicator to improve (Agustihana & Suparno, 2019; Nurhidayat et al., 2023; Widyaningsih et al., 2021), in the application of the LAPS-Heuristic model, this indicator can be facilitated by the syntax of planning for problem-solving and the syntax of implementing the solution plan problem. In both syntaxes, students have the opportunity to explore themselves by designing experiments in groups. This is considered sufficient to encourage students to be involved in the experimental design process so that ultimately students can solve problems and create something new as a solution (Simanjuntak et al., 2021). In addition, because group learning is seen as an effective and enjoyable learning environment for actively developing information, this is considered sufficient to minimize challenges in understanding HOTS. Engaging in fun learning will increase students' understanding of learning material (Finnegan & Ginty, 2019; Nurhidayat et al., 2023). These results are in line with research conducted by Haka et al. 2020, which shows that the LAPS-Heuristic learning model can improve the C6 indicator significantly.

The LAPS-Heuristic learning model is able to improve every indicator of higher-order thinking skills because alternatives guide the LAPS-Heuristic model, which is a problem-solving model, in formulating problems as questions known as heuristics. In learning, heuristics function to guide students in solving problems (Szabo et al., 2020). Then, the LAPS-Heuristic learning model presents ill-defined problems, namely problems that do not provide all the information needed to solve the problem (Luan, Reb, Gigerenzer, 2019). Because in the LAPS-Heuristic learning model, the problems presented are ill-defined problems, the solutions to the problems are different. This can improve students' critical thinking skills in solving problems. When students think critically, higher-order thinking skills will work, so that students can initiate ideas to solve them (Susanti et al., 2016).

Even though the Logan Avenue Problem Solving-Heuristic learning model has many advantages in learning activities, this model also has disadvantages, namely: First, learning to use the Logan Avenue Problem Solving-Heuristic learning model requires quite a long time. The learning process, which starts with small group discussions and then continues with large group discussions, requires a longer time allocation, especially when presenting problems in the form of ill-defined problems. This, of course, raises many questions and requires separate answers, so the time required is also much longer than usual learning. Second, student activity does not immediately increase. This occurs because students are not yet familiar with problem-solving in class, so they are hesitant to implement the problem-solving plan and require more guidance from the teacher during their initial implementation. Students will be more used to it in the second and subsequent meetings.

This research can contribute to improving students' problem-solving abilities and critical-thinking abilities. By using a learning model that emphasizes problem-solving abilities and critical thinking skills, students can elaborate on problem-solving, gain a deeper understanding, and improve higher-order thinking skills. The purpose of this research is to show how learning models influence students' higher-order thinking skills. When research shows that the learning model implemented is effective and successful, the research can be a guide for teachers and policymakers in developing learning activities that focus on improving students' higher-order thinking skills. This study may have limitations in certain samples and environments. Therefore, it is important to highlight whether teachers and policymakers can apply the findings of this study widely to a larger group of students.

4. CONCLUSION

Based on the described discussion, we can conclude that the Logan Avenue Problem Solving-Heuristic learning model significantly affects students' higher-order thinking skills in temperature and heat material. This is evidenced by the higher average post-test score and the average percentage of post-test scores per indicator of higher-order thinking skills among students who use the Logan Avenue Problem Solving-Heuristic learning model, compared to students who use the Problem-Solving learning model. Increasing higher-order thinking skills with the LAPS-Heuristic learning model produces high improvement. This research has an impact on developing students' higher-order thinking skills, such as the ability to analyze, evaluate, and create. This skill is important for students to support 21st-century skills. In addition, teachers can use the Logan Avenue Problem as an alternative in choosing a learning model that is more creative and innovative and can improve students' higher-order thinking skills. This research has limitations that affect the research results. Therefore, researchers recommend that teachers get used to presenting problems in the form of ill-defined problems that focus on students' higher-order thinking skills. Apart from that, researchers also suggest that future research uses a larger sample with different materials to determine its general significance.

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