

Effect of Guided Inquiry Learning Model Through Ice Cream-Making Experiments on Students Higher Order Thinking Skills (HOTS)

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Abstract: Developing Higher Order Thinking Skills (HOTS) has become an important focus in elementary science education because students are expected not only to understand concepts but also to analyze, evaluate, and create solutions to real-life problems. This study aims to examine the effect of a guided inquiry learning model implemented through ice cream-making experiments on the Higher Order Thinking Skills (HOTS) of fourth-grade elementary school students. The research employed a quantitative approach with a nonequivalent control group quasi-experimental design. The participants were 53 fourth-grade students, including 25 in the experimental class and 28 in the control class. The experimental class received guided inquiry-based experimental learning, while the control class was taught using conventional methods. Students' higher-order thinking skills were assessed using essay exams that focused on three areas of advanced thinking: analyzing, evaluating, and creating. These tests were given before and after the learning period to measure progress. The data were checked for normality and homogeneity before conducting the independent-samples t-test. The results showed that the data followed a normal distribution and had similar variability, meeting the requirements for hypothesis testing. The t-test results showed a very low significance value of 0.000, which is less than 0.05. This indicates a significant difference in HOTS scores between the treatment and control groups. The experimental group scored higher, on average, in HOTS (88.10) than the control group (77.86). The average difference of 10.24 points shows a big improvement in the experimental group's ability to think critically and solve complex problems. The results show that using the guided inquiry learning method with ice cream-making experiments helps students improve their higher-order thinking skills in a meaningful way. Therefore, guided inquiry-based experiments can be an effective and relevant way to help students develop higher-order thinking skills in elementary science classes.

Keywords: Elementary Science Education; Experiment-Based Learning; Guided Inquiry Learning; HOTS.

Introduction

Student learning outcomes in Natural and Social Sciences (IPAS) are expected to develop scientific competencies that enable students to apply knowledge in everyday life and respond to environmental and technological developments [1]. IPAS education also plays an important role in developing critical and creative thinking skills so that students are prepared to face global challenges in the 21st century [2]. Therefore, IPAS learning in primary schools should not only emphasize conceptual understanding but also promote higher-order thinking skills (HOTS) such as analysing, evaluating, and creating.

Higher-order thinking skills (HOTS) are more complex thinking abilities that involve analysing, evaluating, and creating. These skills are part of Bloom's revised taxonomy [3]. These skills help students find solutions, make decisions based on facts, and generate fresh ideas in a smart and creative way. However, past studies show that learning in primary schools still focuses mostly on basic thinking skills like remembering, understanding, and applying, which can prevent students from developing more advanced thinking abilities [4].

One approach that can support the development of HOTS is the discovery-based learning model. Discovery-

based learning encourages students to actively investigate problems, formulate hypotheses, conduct experiments, analyse findings, and draw conclusions independently [5]. Among the various discovery approaches, guided inquiry is considered more suitable for primary school students because it provides structured guidance while still allowing students to actively explore scientific problems [6].

Science learning at various levels of education, including elementary schools, still predominantly uses lecture-based instruction, which makes students passive recipients of information and limits their active involvement in the learning process [7]. This condition is often influenced by factors such as limited time, inadequate learning facilities, and teachers' limited understanding of active learning strategies [8].

Science learning in elementary schools still focuses on low-level cognitive domains, namely remembering (C1), understanding (C2), and applying (C3), while higher-level thinking skills such as analyzing (C4), evaluating (C5), and creating (C6) are still underdeveloped [9]. As a result, students often achieve good results in lower cognitive domains but struggle with analytical and evaluative thinking.

To address these challenges, more interactive and student-centred learning approaches are needed so that students can actively investigate problems, conduct

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experiments, and discuss scientific concepts in meaningful ways [10]. One approach that can support the development of HOTS is inquiry-based learning. Inquiry learning encourages students to investigate problems, formulate hypotheses, collect data, and draw conclusions through scientific processes [11]. Among the various types of inquiry learning, guided inquiry is considered more suitable for elementary school students because it provides structured guidance from teachers while still allowing students to actively explore scientific concepts [12]. This model aligns with the characteristics of elementary school students who still require clear directions during the learning process and, therefore, can produce more structured and optimal learning outcomes [13].

The syntax of guided inquiry learning generally consists of several stages, including orientation, problem formulation, hypothesis development, data collection, conclusion formulation, and reflection [14]. These stages are closely connected to how HOTS indicators develop. The steps of identifying a problem and forming a hypothesis help develop analytical thinking (C4). Analyzing and interpreting data helps build evaluative thinking (C5). Designing experiments and sharing results help improve creative thinking (C6). Guided inquiry learning offers a clear way for students to build stronger thinking skills through scientific investigation.

The integration of experimental activities in guided inquiry learning can further strengthen students' conceptual understanding and scientific reasoning. Through experiments, students directly observe scientific phenomena and connect theoretical knowledge with real experiences [15]. Empirical studies also indicate that integrating guided inquiry and experimental learning positively affects students' learning outcomes and thinking skills. For example, research conducted by Hidayat and Andromeda reported that the use of guided inquiry-based modules integrated with experiments resulted in a higher N-gain in the experimental class (0.73) compared to the control class (0.57) [16]. Similarly, Faujiati et al. found that the implementation of experiment-based guided inquiry learning significantly improved students' learning outcomes, with an average N-gain of 0.69 in the experimental class compared to 0.39 in the control class [17]. This study confirms that the experiment-based guided inquiry learning model is effective in improving concept mastery and actively involving students in the learning process. These two studies confirm that guided inquiry through experiments has great potential to influence science learning outcomes among elementary school students.

Previous research shows that both guided inquiry learning models and experimental methods affect science learning outcomes. For example, the study found that experimental methods are effective for student learning outcomes. This can be shown through the hypothesis testing conducted in this study, which states that the hypothesis in this study is accepted, where the calculated t value obtained is greater than the t -table value, namely $t\text{-count } 2.811 > t\text{-table}$, which is 2.007 at a significance level of 5% with 50 degrees of freedom [18]. This shows that applying experimental methods in science learning affects student learning outcomes. Likewise, the guided inquiry learning model can be seen from previous research, which shows that a study on fifth-grade elementary school students regarding the

hydrological cycle reported that the group following the guided inquiry learning model obtained an average score of 75.71 and cognitive. Meanwhile, free inquiry provides more space for students to think creatively and independently, especially for students who already have more mature skills of 76.42, compared to 64.28 and 65.17 in the control class, showing a significant difference that benefits the guided inquiry learning model [19].

The application of the multimedia-assisted guided inquiry learning model can significantly influence HOTS and elementary school students' science learning outcomes, with an increase in learning completion from 65.51% to 89.65% [20]. The guided inquiry model has a positive effect on students' higher-order thinking skills in the aspects of analysis, evaluation, and creation [21]. These findings collectively indicate that guided inquiry learning and experimental activities are effective strategies for developing students' higher-order thinking skills through structured scientific investigation.

However, most previous studies examine guided inquiry learning models and experimental methods separately or focus primarily on secondary school contexts [16], [17], [18], [19]. Research that integrates guided inquiry learning with experimental activities in elementary school contexts, particularly for fourth-grade students, is still limited [22]. This gap highlights the need for studies that explore how guided inquiry, combined with experimental activities, can systematically support the development of HOTS in elementary school science. This study offers a novel contribution by integrating guided inquiry learning with an ice cream-making experiment as a contextual science activity to foster elementary students' Higher Order Thinking Skills (HOTS).

Therefore, this study aims to analyse the effect of implementing the guided inquiry learning model through an ice cream-making experiment on the Higher Order Thinking Skills (HOTS) of fourth-grade elementary school students. Based on this objective, the research hypothesis is that the guided inquiry learning model implemented through ice cream-making experiments has a significant positive effect on students' HOTS.

Research Methods

This study uses a quantitative approach because the aim is to measure the impact of the experiment-based guided inquiry learning model on student learning outcomes by analyzing numerical data. Quantitative research is a scientific method based on rational, empirical, and systematic characteristics, and produces numerical data that can be analyzed using statistical procedures [23].

The research design is a quasi-experiment because the researcher cannot randomly assign students to experimental and control groups; instead, the researcher works with existing school groups. The design used is a Nonequivalent Control Group Design because this study has two groups, namely the experimental and control groups, both of which receive pre- and posttests [23]. The pretest was administered to assess students' initial abilities and to ensure the two groups were equivalent before the treatment. Meanwhile, the posttest was used to measure differences in learning outcomes after the experimental group received treatment

with the experiment-based guided inquiry learning model, while the control group received conventional learning.

This study uses two variables: the independent and dependent variables. The independent variable in this study is the experimental-based guided inquiry learning model (Variable X), while the dependent variable is student learning outcomes focused on HOTS (Variable Y).

To ensure the treatment was followed correctly, the experiment-based guided inquiry learning model was implemented through a structured lesson plan applied consistently across sessions. The learning activities followed the steps of guided inquiry, including getting started, formulating a problem, making guesses, conducting experiments, examining the results, and then figuring out the answers. The researcher used the same learning materials, worksheets (LKPD), and steps for the experiment in every session to make sure the treatment was consistent across all meetings. An observation checklist was also used to track the implementation of each part of the learning model.

Table 1 Research Design

Class	Pretest	Treatment	Posttest
Experiment	O ₁ ^[a]	X ^[b]	O ₂ ^[c]
Control	O ₃ ^[a]	-	O ₄ ^[c]

Information:

[a] O₁ and O₃: Test the beginning given to the second group, namely, group experiments and group control, before the learning process starts. Meanwhile, free inquiry provides more space for students to think creatively and independently, especially for those with more mature skills. [b] X: The learning process carried out, namely implementing the learning models Inquiry Guided, with the method of experimenting with making ice cream. [c] O₂ and O₄: Test the end given to the second group after the learning process finishes, to see the results. Study the student after accepting the intervention.

The population in this study consisted of all fourth-grade students at the UPT Satuan Pendidikan SDN Kejawanan IV Gempol, which comprised two parallel classes: class IVA with 28 students and class IV B with 25 students. The sampling technique used in this study was purposive, as the two classes did not show significant differences. So the researcher chose samples (classes) that already existed in the school according to the research objectives, without randomizing students. Purposive sampling is a way of selecting samples based on certain considerations [23]. The considerations used in this study were the equality of students' initial. Meanwhile, free inquiry provides more space for students to think creatively and independently, especially for those with more mature skills based on the previous semester's exam scores, the suitability of the lesson schedule, and the ease of access for researchers in conducting the treatment. By considering these things, class IVA was designated as the control group and class IVB as the experimental group.

The instrument used was a learning outcomes test in the form of essay questions that included indicators of science learning on the material, Changes in the Form of Objects. The question grid was arranged based on the indicators of basic competencies, the cognitive domains of analyzing (C4), evaluating (C5), and creating (C6), and the

learning objectives [24]. The following HOTS indicators were used for the research instrument.

Table 2. HOTS Indicators [24]

Cognitive Level	Definition	Explanation
C4	Breaking down material into parts and determining the relationships between parts.	Analyze the process of changing the state of a liquid to a solid through experiments.
C5	Make assessments based on criteria/standards by checking or criticizing.	Evaluate factors that influence the change in state of a liquid to a solid.
C6	Arranging elements into new patterns or products, planning or producing new works/ideas.	Creating simple products by changing the state of liquid to solid and compiling reports.

The test instrument was first validated by requesting expert judgment. Validity testing was conducted with two experts to assess the instrument's validity. The validator assessed the suitability of the questions to the indicators using a Likert scale (e.g., 1–5). Then, the assessment results were calculated using Aiken's V, with a V value of ≤ 0.40 being less valid, 0.40–0.80 being quite valid, and > 0.80 being very valid [25]. The validation results showed that the learning module obtained an Aiken's V value of 0.875, the teaching materials obtained a value of 0.916, the student worksheets (LKPD) obtained a value of 0.958, and the pretest and posttest questions obtained a value of 0.916. These values indicate that all instruments fall within the valid category and are suitable for use in the learning process and data collection.

After that, content validity was also assessed through a trial of the instrument outside the research sample to ensure that the questions reflect the learning objectives. The results will be calculated by correlating item scores with the total score using Pearson's Product-Moment correlation. If the calculated r value $> r_{table}$ (at a significance level of 5%), then the question is valid [26]. Instruments that require content validity are tests used to measure student learning achievement or to evaluate the program's effectiveness and objectives [23]. Validity was assessed using 10 descriptive questions and tested on 27 respondents who were class VA students at UPT Satuan Pendidikan SDN Kejawanan IV Gempol. Based on the results of the content validity test, all instrument items were declared valid because the calculated r value for each item was greater than the table r value of 0.381. The calculated r value ranged from 0.423 to 0.757, which indicates that each item has a sufficient to strong correlation with the total score. This indicates that all items measure aspects consistent with the established indicators and are suitable for use as research instruments.

The instrument's reliability in this study was assessed using Cronbach's Alpha, as it consists of 10 descriptive

questions that measure cognitive competence in the material on Changes in the Form of Objects. Cronbach's Alpha is used to assess the extent to which the questions consistently measure the same construct. If the reliability calculation for this instrument yields $\alpha \geq 0.70$, the instrument is considered reliable and can be used in research [27]. Based on the reliability test, a Cronbach's Alpha of 0.773 was obtained with 10 items. This value exceeds the minimum limit of 0.70, indicating that the research instrument has a good level of reliability. Thus, the instrument is declared consistent and can be trusted for use in measurements in this study.

Written Learning Outcomes Test (achievement test) in the form of an essay. The test was made with indicators of analyzing (C4), evaluating (C5), and creating (C6) according to Bloom's Taxonomy [24]. This test was given to both classes: the control and the experimental. Questions were administered as a pretest (before treatment) and a posttest (after treatment), under the same conditions, to make the results more objective.

The HOTS essay responses were evaluated using an analytical scoring rubric. Each item was scored on a scale of 1–4 based on the correctness of the answer, conceptual understanding, reasoning ability, and completeness of the explanation. Higher scores indicate a higher level of higher-order thinking skills demonstrated by the students. The detailed scoring rubric is presented in Table 3.

Table 3. Scoring Rubric

Score	Criteria
4 (Very Good)	The answer is completely correct, shows deep understanding of the concept, includes clear reasoning, and provides accurate explanations or examples related to the question.
3 (Good)	The answer is mostly right and shows a good grasp of the idea, but the explanation isn't thorough enough or is missing some parts.
2 (Fair)	The response shows some understanding of the topic, but there are several mistakes in the explanation, or it isn't clear enough.
1 (Poor)	The response has a very poor grasp of the topic, is mostly wrong, or the explanation doesn't relate to what was asked.

The pretest and posttest data were analyzed using descriptive and inferential statistical techniques. Before conducting the hypothesis test, the data were first tested for normality and homogeneity. The normality test used the Shapiro–Wilk test because the sample sizes in each group were fewer than 50 students, making it more appropriate. If the significance p -value $< \alpha$ (0.05), then H_0 is rejected and the data are declared not normally distributed, and if the significance p -value $\geq \alpha$ (0.05), then H_0 is accepted and the data are stated to be normally distributed [28]. The homogeneity test uses Levene's Test because it can compare variances across two or more groups and is more robust to violations of the normality assumption. Levene's Test is recommended in educational research with small to medium sample sizes. The decision-making criteria are if the significance value of p -value $\geq \alpha$ (0.05) then H_0 is accepted and the variance between groups is declared homogeneous, whereas if the p -value $< \alpha$ (0.05) then H_0 is rejected and the

variance between groups is declared inhomogeneous [29]. After the data meet the requirements, a hypothesis test is conducted using an independent two-sample t -test because the data consist of two unpaired groups: the experimental and control groups. Each student is included in only one group, so the data across groups are independent. This test is used to determine differences in learning outcomes between the experimental and control classes. These three tests were carried out using SPSS Statistics 25.

Ethical considerations were also applied in this study. Permission to do the research was given by the school principal and the classroom teachers. Students participated in their usual school activities, and the information gathered was used solely for research. The students' privacy and secret identities were protected throughout the research process.

Results and Discussion

During the research, learning in the experimental class was conducted in two meetings using a guided inquiry learning model, in accordance with the designed syntax: orientation, problem formulation, hypothesis formulation, data collection, conclusion formulation, and reflection. In the first meeting, learning began with orientation activities that conveyed the learning objectives and showed students a video about the differences in ice cream-making. In the problem formulation stage, students were directed to ask questions related to the ice cream freezing process, especially the effect of adding salt. Next, in the hypothesis formulation stage, students formulated provisional assumptions about the experiment's results.

Then, in the second meeting, students carried out the data collection stage through experimental activities: making ice cream with and without salt in groups using Student Worksheets (LKPD), during which they observed the freezing time and changes in the dough texture. The results of the observations were then analyzed, so that students and the teacher could conclude that salt can accelerate the freezing process. The learning activity ended with a reflection to evaluate the learning experience and encourage students to think creatively.



Figure 1. Ice Cream Making Experiments

Figure 1 shows an example of the learning process during the Ice Cream Making Experiment conducted in the experimental class. Students worked collaboratively in groups by mixing the ingredients, adding ice and salt, shaking the container, and observing the freezing process while discussing the scientific principles behind the

phenomenon. This experimental activity allowed students to directly observe the change of matter from liquid to solid while actively engaging in scientific inquiry.

Meanwhile, learning in the control class was conducted through conventional instruction, dominated by lectures and question-and-answer sessions. The differences in syntax and learning activities indicate that the experimental and control classes received different treatments during the research. Each class will be given a pretest and a posttest. The following data shows the pretest and posttest results for the experimental and control classes.

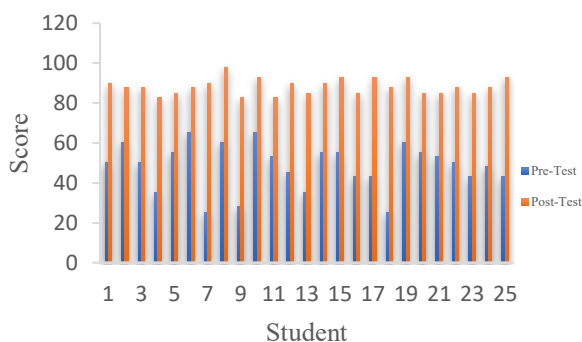


Figure 2. Experimental Class Grade Data

The experimental class's score graph compares pretest and posttest scores for 25 students. The graph shows that the posttest scores were higher than the pretest scores for all students. Previously, most students scored in the moderate to low range. However, after using the inquiry learning model in the experimental class, their posttest scores improved significantly, with most students in the high category.

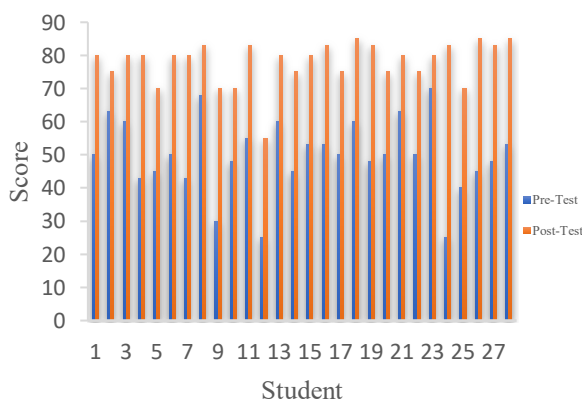


Figure 3. Control Class Value Data

The Control Class Score Data Graph shows a comparison of the pretest and posttest scores of 28 students. The graph shows that scores increased from the pretest to the posttest, but the increase wasn't very consistent, and the improvement wasn't as large as in the experimental class. The test scores in the control group before the lesson were low to medium, and after the lesson, scores rose slightly, but most remained in the medium range.

After obtaining the data, the researcher conducted a normality test. In this study, normality was assessed using the Shapiro–Wilk test. The normality test is used to determine whether the data is normally distributed. Data is

considered normally distributed if the significance p-value $\geq \alpha$ (0.05). The following are the results of the data normality test:

Table 9. Normality Test Results

Class	Statistics	df	Sig.
Pretest Control Class	.949	25	.240
Posttest Control Class	.947	25	.210
Experimental Class Pretest	.939	25	.141
Experimental Class Posttest	.932	25	.096

Based on Table 9, the Shapiro–Wilk test showed a significance value (Sig.) of 0.05 or greater for all data, both in the pretest and posttest of the control and experimental classes, indicating normality. Next, a homogeneity test is performed using Levene's Test, which can be used to compare the variances of two or more groups and is more robust to violations of the normality assumption. Data can be declared homogeneous if the significance value of the p-value $\geq \alpha$ (0.05), then H_0 is accepted [29]. The following are the results of the homogeneity test:

Table 10. Results of Homogeneity Test

	Levene Statistics	df1	df2	Sig.
Based on Mean	3,720	1	51	.059
Based on Median	1,257	1	51	.267
Based on Median and with adjusted df	1,257	1	36,451	.270
Based on the trimmed mean	2,797	1	51	.101

Based on the results of the homogeneity test using Levene's Test presented in Table 10, a p-value of 0.059 $>$ 0.05 was obtained, so there was no significant difference in variance between the two groups, and the data was declared homogeneous. Thus, it can be concluded that both groups have the same variance, thereby fulfilling one of the prerequisites for conducting an independent two-sample t-test to determine significant differences in learning outcomes between the experimental and control classes.

Table 11. Results of the Independent Sample T-Test

Analysis Aspect	Value
Levene's Test Sig.	0.059
Variance Assumption	Homogeneous
t-value	-6.893
df	51
Sig. (2-tailed)	0.000
Mean Difference	-10.243
Experimental Class Mean	88.10
Control Class Mean	77.86

Based on Independent Sample T-Test results assuming equal variances, the obtained p-value is 0.000, which is smaller than 0.05. This is a show. There is a real difference between skill, thinking level, and tall students in class experiments and class control. On average, students' HOTS scores in the class experiment are 88.10, while in the class control, 77.86. The mean difference of 10.243 points indicates that students who learned through the guided

inquiry model, supported by the ice cream experiment, achieved substantially higher HOTS scores than those in the conventional learning group. This quantitative difference confirms that the experimental treatment significantly improved students' higher-order thinking skills.

The increase in students' higher-order thinking skills in the experimental class happened because they used a guided inquiry learning method that puts the students at the center and encourages them to actively participate in the learning process. These stages of inquiry give students a chance to think in ways that involve analyzing, evaluating, and creating, which are the main parts of Higher Order Thinking Skills (HOTS).

This finding is in line with the research, which shows that the application of context-based guided inquiry influences students' critical thinking skills through structured scientific activities [30]. The ice cream-making activity, as a learning context, provides a real experience that helps students understand the concept of changing a substance's state of matter from liquid to solid. The use of contextual experiments allows students to connect theoretical scientific concepts with real-life experiences, thereby facilitating deeper conceptual understanding and strengthening higher-order cognitive processes.

Experimental activities, such as making ice cream, are effective in improving students' HOTS because they encourage students to address real problems and solve them using scientific processes. Through experimentation, students observe phenomena, identify influencing factors, and discuss their findings collaboratively. Group discussions and data analysis activities enable students to evaluate information, compare observations, and formulate evidence-based conclusions. These activities play an important role in developing analytical (C4) and evaluative (C5) thinking skills as part of HOTS indicators [31].

Besides improving analytical and evaluative abilities, the ice cream-making experiment also helps build creative thinking skills (C6). Students need to predict what will happen in an experiment, develop ideas about how things work, and plan the steps to carry out the experiment. These activities help students generate ideas, propose alternative explanations, and reflect on their results, all key components of creative thinking in the HOTS framework.

Although the experimental class showed greater improvement, the control class also increased its HOTS scores. This improvement could be due to several reasons. Traditional learning methods included teachers explaining things and having discussions where students could ask questions. This helped develop students' basic critical thinking skills. Students might have gained more knowledge about the subject and become accustomed to the test question types, which could lead to better results on the posttest.

Even though the results are good, there are some important points to consider. A potential threat to internal validity is the teacher effect, which occurs when differences in how teachers teach and interact with students affect students' involvement in learning. Another limitation is the relatively short duration of the intervention, comprising only two learning meetings. Future studies could use longer inquiry-based programs to better see how much these approaches help students develop their higher-order thinking skills over time.

In real classroom situations, conducting experiments in elementary school requires proper setup of materials, effective classroom management, and clear instructions from the teacher so that every student can participate and learn by asking questions and exploring.

This study also supports previous findings that guided inquiry learning, combined with experimental methods, can improve students' learning outcomes and higher-order thinking skills (HOTS). Although this is the case, research on this unique aspect is lacking because combining inquiry models guided by a method-experiment in context learning for fourth-grade elementary school students hasn't been widely discussed before. With teachers' help, elementary school students can follow the inquiry steps smoothly and without feeling overwhelmed, making learning easier and more meaningful.

Therefore, the use of a guided inquiry learning model, supported by the ice cream-making experiment, has been shown to positively impact fourth-grade students' HOTS. This model not only helps students understand science concepts more effectively but also trains students to think critically and creatively, which is required in the face of contemporary learning challenges. Based on that, a learning model inquiry-guided experiment is recommended as a method for fostering learning innovation that can be used by science and science teachers in elementary schools to improve the quality of student learning outcomes.

Conclusion

This study concludes that implementing a guided inquiry learning model through an ice cream-making experiment significantly improves fourth-grade elementary school students' Higher Order Thinking Skills (HOTS). The statistical results showed a significant difference between the experimental and control classes ($p < 0.05$), with the experimental class achieving a higher mean score (88.10) compared to the control class (77.86). This finding indicates that the guided inquiry learning model, supported by contextual experimental activities, is more effective than conventional learning methods at improving students' analytical (C4), evaluative (C5), and creative (C6) thinking skills. The mean difference of 10.243 points between the experimental and control classes indicates a substantial improvement in students' HOTS after participating in guided inquiry-based experimental learning. From a pedagogical perspective, this study implies that teachers can design simple contextual experiments, such as the ice cream-making activity, to facilitate active learning and to align classroom activities with HOTS indicators. Students are guided through steps such as identifying the problem, testing ideas, conducting experiments, and reflecting on what they learned. This helps them build their own understanding and improves their ability to think deeply and critically. Therefore, integrating guided inquiry learning with contextual experimental activities can be an effective instructional strategy for improving elementary school students' critical and creative thinking skills in science. For future research, similar studies should be conducted for a longer period and with more participants to yield more complete and reliable results. Future research could also use a mix of methods to examine not only how guided inquiry learning affects students' thinking, but also how it impacts

their interest, involvement, and feelings about learning science.

Author's Contribution

A.S. Putri: contributed to conceptualization, methodology, investigation, data curation, formal analysis, and writing the original draft; F. Wulandari participated in the supervision, validation, review, editing of the manuscript, and processing of the article submission for publication. All authors have read and approved the published version of this manuscript.

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