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The Effect of Guided Inquiry Model Assisted by Interactive PowerPoint Media on High School Students' Learning Outcomes in Chemical Bonding Material

Avella Anastasya Gonti Sidebang*, Herlinawati

Chemistry Education Study Program,
Faculty of Mathematics and Natural Sciences, State University of Medan,
Jl. Willem Iskandar Pasar V, Medan Estate, Kec. Percut Sei Tuan, Kab. Deli Serdang.

*Correspondinge-mail: avellaanastasya@gmail.com

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Abstract: The Effect of Guided Inquiry Model Assisted by Interactive PowerPoint Media on High School Students' Learning Outcomes in Chemical Bonding Material. This study aims to determine the effect of guided inquiry learning model assisted by interactive PowerPoint media on learning outcomes and to determine differences in students' conceptual understanding of chemical bonding material. This study used a quasi-experimental method with a non-equivalent control group pretest-posttest design. The population in this study were all grade X students of SMA Negeri 1 Lubuk Pakam in the 2025/2026 academic year. The research sample consisted of two classes selected by cluster random sampling, namely the experimental class using guided inquiry learning model assisted by interactive PowerPoint and the control class using conventional learning assisted by regular PowerPoint, each totaling 36 students. Data collection techniques were carried out through learning outcome tests in the form of pretests and posttests. Data analysis techniques used included normality tests, homogeneity tests, N-Gain tests, and hypothesis tests using two-tailed t-tests. The results showed that the average value of student learning outcomes in the experimental class was higher than the control class. The average N-gain value of the experimental class was 73.25% (high category), while the control class was 62.55% (medium category). The results of the hypothesis test indicate that there is a significant influence of the use of a guided inquiry learning model assisted by interactive PowerPoint media on student learning outcomes. Based on the results of the study, it can be concluded that the guided inquiry learning model assisted by interactive PowerPoint media is effective in improving student learning outcomes and conceptual understanding of chemical bonding material.

Keywords: guided inquiry, interactive PowerPoint, learning outcomes, conceptual understanding, chemical bonds.

Abstrak: Pengaruh Model Inkuiri Terbimbing Berbantuan Media PowerPoint Interaktif terhadap Hasil Belajar Siswa SMA pada Materi Ikatan Kimia. *Penelitian ini bertujuan untuk mengetahui pengaruh model pembelajaran inkuiri terbimbing berbantuan media PowerPoint interaktif terhadap hasil belajar serta untuk mengetahui perbedaan pemahaman konsep siswa pada materi ikatan kimia. Penelitian ini menggunakan metode quasi eksperimen dengan desain non-equivalent control group pretest-posttest. Populasi dalam penelitian ini adalah seluruh siswa kelas X SMA Negeri 1 Lubuk Pakam Tahun Ajaran 2025/2026. Sampel penelitian terdiri dari dua kelas yang dipilih secara cluster random sampling, yaitu kelas eksperimen yang menggunakan model pembelajaran inkuiri terbimbing berbantuan PowerPoint interaktif dan kelas kontrol yang menggunakan pembelajaran konvensional berbantuan PowerPoint biasa, masing-masing berjumlah 36 siswa. Teknik pengumpulan data dilakukan melalui tes hasil belajar berupa pretest dan posttest. Teknik analisis data yang digunakan meliputi uji normalitas, uji homogenitas, uji*

N-Gain, dan uji hipotesis menggunakan uji t dua pihak. Hasil penelitian menunjukkan bahwa nilai rata-rata hasil belajar siswa pada kelas eksperimen lebih tinggi dibandingkan kelas kontrol. Rata-Rata Nilai N-gain kelas eksperimen sebesar 73,25% (kategori tinggi), sedangkan kelas kontrol sebesar 62,55% (kategori sedang). Hasil uji hipotesis menunjukkan bahwa terdapat pengaruh yang signifikan penggunaan model pembelajaran inkuiri terbimbing berbantuan media PowerPoint interaktif terhadap hasil belajar siswa. Berdasarkan hasil penelitian dapat disimpulkan bahwa model pembelajaran inkuiri terbimbing berbantuan media PowerPoint interaktif efektif dalam meningkatkan hasil belajar dan pemahaman konsep siswa pada materi ikatan kimia.

Kata kunci: *inkuiri terbimbing, PowerPoint interaktif, hasil belajar, pemahaman konsep, ikatan kimia.*

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INTRODUCTION

In the 21st century, education has undergone significant transformations along with advances in science and technology. Education emphasizes not only mastery of material but also the development of critical, creative, collaborative, and communicative thinking skills as part of 21st-century competencies (Malikah & Wafroturrohmah, 2022). Therefore, the learning process needs to be designed to encourage students to actively construct knowledge through meaningful learning experiences.

In line with this, the implementation of a constructivist-based curriculum requires student-centered learning. From a constructivist perspective, students are expected to construct knowledge independently through interactions with the learning environment (Suryati et al., 2023). This requires teachers to use innovative learning models and utilize media that can increase student engagement in the learning process.

However, in practice, chemistry learning still faces various obstacles. Abstract chemistry material, such as chemical bonds, is often difficult for students to grasp, leading them to memorize without deeply understanding the concepts (Mulyanti, 2015). Furthermore, the use of less varied learning methods leads to students being passive and less interested in participating in the learning process.

One way to address this issue is by implementing a guided inquiry learning model. This model encourages students to actively participate in the investigation process, enabling them to discover concepts independently and systematically. Guided inquiry can also improve students' critical thinking skills and conceptual understanding, particularly in abstract material (Musliman & Kasman, 2022; Munandar, 2022).

In addition to learning models, the use of learning media also plays a crucial role in improving the quality of learning. Interactive learning media, such as interactive PowerPoint presentations, can help visualize abstract concepts, making them easier for students to understand (Surur, 2021; Shoffa et al., 2023). Previous research has shown that the use of guided inquiry-based interactive PowerPoint presentations is effective in improving student learning outcomes (Salma & Aini, 2023; Nurfalah & Aini, 2023).
Based on this description, a learning innovation is needed that integrates the guided inquiry learning model with interactive PowerPoint media to improve student learning outcomes, especially in chemical bonding material. Therefore, this study aims to determine the effect of the guided inquiry learning model assisted by interactive PowerPoint media on high school students' learning outcomes.

METHOD

Population and Sample

The population in this study was all 360 students of grade X of SMA Negeri 1 Lubuk Pakam in the 2025/2026 academic year, spread across 10 classes. The sample was taken using a cluster random sampling technique, considering that students' academic abilities were relatively homogeneous and there were no superior classes. Based on the results of the lottery, two classes were obtained as research samples: class X-B as the experimental class using a guided inquiry learning model assisted by interactive PowerPoint media and class X-C as the control class using conventional learning assisted by regular PowerPoint. Each class consisted of 36 students.

Research methods and design

The research method used was a quasi-experimental design with a non-equivalent control group pretest–posttest. In this design, both groups were given a pretest to determine students' initial abilities, then given different treatments according to the applied learning model, and concluded with a posttest to measure learning outcomes after the treatment.

Research Variables

The variables in this study consist of independent variables, dependent variables, and control variables. The independent variable is the learning model, namely a guided inquiry model assisted by interactive PowerPoint media in the experimental class and conventional learning in the control class. The dependent variable is student learning outcomes in chemical bonding. Meanwhile, the control variables include the similarity of learning materials, learning time, teaching teachers, and evaluation instruments used in both classes.

Research Instrument

The research procedure was carried out in three stages: preparation, implementation, and final. In the preparation stage, the researcher developed learning materials, prepared interactive PowerPoint media, and developed test instruments. The instruments used were first tested for their suitability through validity, reliability, difficulty level, discriminating power, and distractor tests.

In the implementation stage, both classes were given a pretest to determine students' initial abilities, followed by the administration of appropriate treatment for each group. After the learning process was completed, both classes were given a posttest. In the final stage, the data obtained were analyzed to draw conclusions from the study. Data collection used a multiple-choice test consisting of 20 questions, administered in pretest and posttest formats. The instrument was tested for validity and reliability using the Kuder-Richardson (KR-20) formula, thus confirming its suitability for use in the research.

Data Analysis Techniques

Data analysis techniques included a normality test using the Chi-Square (χ^2) method, a homogeneity test using the F-test, and a hypothesis test using a two-sample independent t-test at a significance level of 0.05. Furthermore, an N-gain analysis was

conducted to determine the improvement in student learning outcomes after the treatment. The N-gain value was calculated using the following formula:
The N-gain value was calculated using the following formula:

$$<g> = \frac{\%\ Skor\ Pretes - \%\ Skor\ Pretes}{100\% - \%\ Skor\ Pretes}$$

The average N-gain value was then calculated for each class, both the experimental and control classes. The average N-gain was then interpreted based on the criteria presented in Table 1.

Table 1. N-Gain Criteria

Criteria <g>	Category
<g> ≥ 0,7	High
0,3 ≤ <g> < 0,7	Medium
<g><0,3	Low

■ RESULT AND DISCUSSION

Normality Test

The normality test in this study was conducted using the Chi-Square (χ^2) test at a significance level of $\alpha = 0.05$. The test was carried out by grouping the data into class intervals, then comparing the empirical frequency with the expected frequency. Data were declared normally distributed if the calculated $\chi^2_{value} < \chi^2_{table}$.

Table 2. Results of the Normality Test of Learning Outcomes

Class	Data	X^2_{value}	X^2_{table}	Description
Control	Pretest	4,08	11,07	Normally Distributed
	Posttest	6,88	11,07	Normally Distributed
Experiment	Pretest	6,13	11,07	Normally Distributed
	Posttest	8,96	11,07	Normally Distributed

Based on the analysis results in Table 2, it was found that in the control class, the χ^2_{value} pretest value was 4.08 and the posttest value was 6.88. Meanwhile, in the experimental class, the χ^2_{value} pretest value was 6.13 and the posttest value was 8.90. All of these values are smaller than the χ^2_{table}, so it can be concluded that the learning outcome data in both classes are normally distributed.

Table 3. Data for Normality Test of Concept Understanding

Class	X^2_{value}	X^2_{table}	Description
Control	8,01	11,07	Normally Distributed
Experiment	8,66	11,07	Normally Distributed

Furthermore, the normality test for the conceptual understanding data in Table 3 shows that the calculated χ^2_{value} for the control class was 8.01 and the experimental class was 8.66. Both values are also smaller than the calculated χ^2_{value}, indicating that the conceptual understanding data are normally distributed.
Thus, the assumption of normality, a prerequisite for using parametric statistics, has been met.

Homogeneity Test

The homogeneity test aims to determine the similarity of variance between the experimental group and the control group. The test is conducted using the F test at a significance level of $\alpha = 0.05$, with the criterion that the data is declared homogeneous if $F_{value} < F_{table}$.

Table 4. Homogeneity Test of Learning Outcomes

Class	Varians	F_{value}	F_{table}	Description
Control	42,123			Homogeneous
Experiment	24,821	1,697	1,757	Homogeneous

Based on the results of the analysis in Table 4, the calculated F_{value} was 1.697, while the critical F_{value} was 1.757 at a degree of freedom of 35, 35. Since the calculated F_{value} is less than the critical F_{value}, the variances in learning outcomes between the two groups are considered homogeneous.

Table 5. Test of Homogeneity of Conceptual Understanding

Class	Varians	F_{value}	F_{table}	Description
Control	43,266			Homogeneous
Experiment	45,952	1,062	1,757	Homogeneous

The results of the homogeneity test on the conceptual understanding data in Table 5 show a calculated F_{value} of 1.062, which is also smaller than the critical F_{value} of 1.757. Thus, the variance in conceptual understanding between the experimental and control classes is deemed homogeneous.

These results indicate that the two groups have equivalent variance characteristics, making it appropriate to conduct a hypothesis test using parametric statistics.

Gain Test (N-Gain)

N-Gain analysis is used to measure the effectiveness of instructional interventions in improving student learning outcomes. The calculation is based on the difference between the normalized pretest and posttest scores

Table 6. N-Gain Test of Learning Outcomes

Class	Average % N-Gain	Category
Control	62,55%	Currently
Experiment	73,25%	High

The analysis results in Table 6 show that the experimental class obtained an average N-Gain score of 73.25%, which is in the high category, while the control class obtained a score of 62.55%, which is also in the medium category. Although both classes experienced significant improvements, the higher average N-Gain score in the experimental class indicates that the applied learning model provided more optimal effectiveness. In essence, this difference indicates that the implementation of a guided inquiry model supported by interactive PowerPoint is capable of improving the quality of learning more significantly than conventional methods.

The Effect of the Guided Inquiry Model on Learning Outcomes

The results of the data analysis show that the average student achievement in the experimental class was 85.417, while in the control class it was 77.639. This difference indicates that the use of a guided inquiry model aided by interactive PowerPoint yields higher learning outcomes compared to conventional instruction. Learning outcomes were analyzed using N-Gain, with the experimental class achieving a score of 73.25% (high category), while the control class achieved 62.55% (medium category). Although both classes experienced improvement, the higher average N-Gain score in the experimental class indicates that the treatment was more effective in improving student learning outcomes. The results of the prerequisite tests showed that the data were normally distributed and homogeneous, so the hypothesis test could be conducted using a two-tailed t-test. Based on the results of the hypothesis test, the calculated t-value (t_{value}) of 5.706 was greater than the critical t-value (t_{table}) of 1.994 at a significance level of 0.05. Thus, H_0 was rejected and H_1 was accepted, meaning there is a significant effect of the guided inquiry learning model assisted by interactive PowerPoint on student learning outcomes in the subject of chemical bonding.

These findings indicate that the guided inquiry model is effective in enhancing students' active engagement in the learning process. Students do not merely receive information passively but are actively involved in discovering concepts through scientific activities such as formulating problems, proposing hypotheses, collecting data, and drawing conclusions. These activities enhance students' cognitive engagement, leading to a deeper understanding of the material. Furthermore, the use of interactive PowerPoint presentations plays a role in helping to visualize abstract concepts in chemical bonding material, such as the formation of ionic and covalent bonds. This visualization makes it easier for students to understand the relationships between macroscopic, submicroscopic, and symbolic representations—a challenge that has long been a barrier in chemistry learning. The results of this study align with constructivist theory, which states that knowledge is actively constructed by students through learning experiences. Furthermore, these findings also support previous research indicating that the guided inquiry model can improve learning outcomes by encouraging students to think critically and actively engage in the learning process.

Differences in Students' Understanding of Concepts

In addition to learning outcomes, this study also examined students' conceptual understanding of chemical bonding. The results of the analysis indicate that students in the experimental class demonstrated better conceptual understanding than those in the control class. Based on the results of the second hypothesis test, it was found that there was a significant difference between the conceptual understanding of students in the experimental class and the control class. Thus, H_0 was rejected and H_1 was accepted, indicating that the guided inquiry learning model assisted by interactive PowerPoint is more effective in improving students' conceptual understanding compared to conventional learning. Students in the experimental class demonstrated better ability in explaining the concept of chemical bonding, connecting the concept to relevant phenomena, and solving problems requiring analytical skills. This indicates that the implemented learning approach not only improved learning outcomes quantitatively but also enhanced the quality of students' conceptual understanding. This difference can be explained by the characteristics of the guided inquiry model, which emphasizes the process of conceptual discovery. In this approach, students are given the opportunity to

explore and discover concepts independently with teacher guidance. This process allows students to build a more meaningful understanding rather than simply memorizing information.

Interactive PowerPoint media also contributes to enhancing conceptual understanding. Through the use of animations, images, and interactive quizzes, students can directly observe the process of chemical bonding formation. This helps students concretize abstract concepts, making them easier to understand. These findings support previous research stating that the integration of interactive media with active learning models can improve students' conceptual understanding, particularly regarding abstract material. Additionally, inquiry-based learning has also proven effective in developing higher-order thinking skills, such as analysis and evaluation.

General Discussion

Overall, the research findings indicate that the use of a guided inquiry model supported by interactive PowerPoint presentations has a positive impact on students' learning outcomes and conceptual understanding. This can be explained through several factors. First, the guided inquiry model promotes student-centered learning, making students more active in constructing knowledge. Second, interactive PowerPoint serves as an effective visual aid in explaining abstract concepts in chemistry. Third, the combination of the model and the learning media creates a more engaging, interactive, and dynamic learning environment, thereby enhancing students' motivation to learn. The results of this study indicate that learning that integrates active models and interactive media aligns with the demands of 21st-century learning as well as the implementation of the Merdeka Curriculum, which emphasizes active, creative, and student-centered learning.

Research Implications

The findings of this study have important implications both theoretically and practically. Theoretically, this study reinforces the body of research on the effectiveness of the guided inquiry model in improving students' learning outcomes and conceptual understanding, particularly in abstract chemistry topics. Practically, this study can serve as a reference for teachers in selecting innovative learning models and media to improve the quality of learning. Teachers are advised to integrate the guided inquiry model with interactive media to make learning more effective, engaging, and meaningful. Furthermore, the results of this study can also serve as a basis for schools in developing learning innovations that align with students' needs and advancements in educational technology.

■ CONCLUSION

The guided inquiry learning model assisted by interactive PowerPoint significantly influenced students' learning outcomes and conceptual understanding of chemical bonding, as indicated by the rejection of H_0 and acceptance of H_a. The implementation of this model was proven to be more effective than conventional learning because it was able to increase student engagement and help them understand abstract concepts more meaningfully.

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