

## The Effect of Explosion Box Media within a Discovery Learning Model on Students' Chemistry Learning Outcomes

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### ABSTRACT

This study aimed to examine the effect of explosion box media integrated into a discovery learning model on the chemistry learning outcomes of Grade XI students at SMA Negeri 14 Gowa in the 2024/2025 academic year, specifically on the topic of reaction rates. The study employed a posttest-only control group design. The population consisted of three Grade XI chemistry classes, from which samples were selected using random sampling. The selected classes were XI.C1 (34 students) as the experimental group and XI.B1 (36 students) as the control group. The independent variable was the use of explosion box media, while the dependent variable was students' learning outcomes. Data were collected through a learning achievement test and analyzed using both descriptive and inferential statistical techniques. The results of descriptive analysis showed that the mean score of the experimental group (84.12) was higher than that of the control group (76.25). The prerequisite test indicated that the data were homogeneous but not normally distributed; therefore, hypothesis testing was conducted using the Mann-Whitney U test. The results revealed that  $Z_{\text{calculated}} > Z_{\text{table}}$ , leading to the acceptance of  $H_1$  and rejection of  $H_0$ . In conclusion, the use of explosion box media within the discovery learning model has a significant effect on improving students' chemistry learning outcomes on the topic of reaction rates.

## INTRODUCTION

This research investigates the efficacy of integrating explosion box media into a discovery learning framework to enhance chemistry learning outcomes among high school students, specifically focusing on its impact on cognitive achievement and conceptual understanding. The study employs a quasi-experimental design to compare student performance in an experimental group using the explosion box media with a control group exposed to conventional discovery learning without this innovative tool (Abeng et al., 2024). The primary objective is to ascertain whether the tangible, interactive nature of the explosion box media significantly contributes to a more engaging and effective learning environment, thereby facilitating deeper comprehension of complex chemical concepts and improving overall academic performance.

This approach is predicated on the theoretical framework that active manipulation of learning materials, characteristic of explosion boxes, can stimulate higher-order thinking skills and reinforce the constructivist principles inherent in discovery learning (Simanjuntak & Silalahi, 2022). This exploration is particularly relevant given documented challenges in student engagement and suboptimal learning outcomes in science, often attributed to teacher-centered approaches and limited use of interactive media (Jannah et al., 2026). Therefore, this study posits that the integration of explosion box media can bridge this gap by providing a hands-on, inquiry-based learning experience that aligns with the principles of discovery learning, potentially leading to improved cognitive and affective learning outcomes in chemistry (Irham et al., 2024).

Previous research has shown that discovery learning models, particularly when augmented with interactive media, can positively influence student motivation and learning outcomes in chemistry (Pristiana et al., 2024; Ummah et al., 2025). However, the specific impact of innovative, tangible media like explosion boxes within this pedagogical approach, especially in the context of Indonesian secondary education, remains underexplored (Nuril Hidayatul Khuma'iroh & Rodi Edi, 2025). This study aims to bridge this research gap by providing empirical evidence on the effectiveness of explosion box media in fostering chemistry learning within a discovery learning paradigm, thereby contributing to the development of more engaging and effective instructional strategies.

This approach builds upon findings that emphasize the importance of interactive and visual learning methods in making abstract chemistry concepts more concrete and enhancing student understanding (Cañete & Mutya, 2025). Specifically, the guided discovery approach, which allows students to actively and independently construct concepts, can be further optimized by incorporating such tactile learning aids to strengthen their analytical skills and understanding (Handayani et al., 2021). This is particularly crucial in chemistry education, where students often struggle with abstract concepts, such as material classification and changes, due to a lack of prior in-depth exposure and underdeveloped critical thinking skills (Rahmawati et al., 2021).

Thus, fostering higher-order thinking skills through innovative learning tools is paramount to improving students' capacity for analyzing, evaluating, and

synthesizing chemical information (Ulfa et al., 2021; Yerimadesi et al., 2023). This becomes especially pertinent when considering the documented challenges in teaching complex topics like colloidal systems, where student engagement is often low due to perceived complexity and technical terminology, despite the application of discovery learning models (Haetami et al., 2024). To address these challenges, this research proposes that explosion box media, through its interactive and multi-sensory design, can serve as a potent tool to demystify intricate chemical concepts, thereby enhancing student engagement and promoting deeper conceptual understanding within a discovery learning framework. This investigation will therefore contribute to the existing pedagogical literature by empirically evaluating the efficacy of integrating explosion box media within a discovery learning model to enhance high school students' chemistry learning outcomes, particularly in the context of Indonesian educational settings.

Furthermore, the study aims to offer insights for educators and policymakers regarding the implementation of innovative learning media to support the 2013 chemistry curriculum in Indonesian high schools, thereby fostering students' ability to construct scientific explanations (Laliyo et al., 2023). The effectiveness of such media is rooted in constructivist learning theories, where students actively build knowledge through hands-on experiences and self-reflection (Agustina et al., 2023). This pedagogical approach is particularly vital given the abstract nature of many chemical concepts, which often necessitates concrete representations to foster robust conceptual understanding (Hamid et al., 2024)

The current educational landscape often relies on conventional, teacher-centered methodologies that inadequately cultivate critical thinking skills and active student participation, leading to suboptimal chemistry learning outcomes (Santayasa et al., 2021) Against this backdrop, this study seeks to empirically assess the integration of explosion box media into discovery learning as a means to overcome these limitations, evaluating its capacity to boost student engagement, foster higher-order thinking skills, and elevate chemistry learning outcomes in Indonesian high schools. This research will employ a quasi-experimental design to compare the learning outcomes of students taught with explosion box media in a discovery learning setting against those taught using conventional methods.)

## **METHODOLOGY**

This study employed a quasi-experimental design using a posttest-only control group design to examine the effect of explosion box media integrated into a discovery learning model on students' chemistry learning outcomes. The research was conducted at SMA Negeri 14 Gowa during the first semester of the 2024/2025 academic year.

The population of this study consisted of three Grade XI chemistry classes. The samples were selected using simple random sampling, resulting in two classes: one experimental group (n = 34) and one control group (n = 36). The experimental group was taught using explosion box media within a discovery

learning model, while the control group was taught using the discovery learning model without the media.

The independent variable in this study was the use of explosion box media, while the dependent variable was students' learning outcomes on the topic of reaction rates. Learning outcomes were measured using a multiple-choice test consisting of 20 validated items assessing students' cognitive abilities.

Data were collected through a posttest administered after the instructional treatment. The instrument had been previously tested for validity and reliability, ensuring its appropriateness for data collection. In addition, classroom implementation was monitored using an observation sheet to ensure the consistency of the instructional process.

Data analysis was conducted using both descriptive and inferential statistics. Descriptive statistics were used to determine the mean scores of both groups. Prior to hypothesis testing, prerequisite tests including normality and homogeneity tests were conducted. Since the data were found to be homogeneous but not normally distributed, the hypothesis was tested using the Mann-Whitney U test at a significance level of 0.05.

## RESEARCH RESULT

The results of students' learning outcomes were analyzed using descriptive and inferential statistics based on posttest scores.

### Descriptive Analysis of Learning Outcomes

The descriptive statistics showed a difference in learning outcomes between the experimental and control groups. The experimental group obtained a higher mean score compared to the control group. Specifically, the average score of the experimental group was 84.12, while the control group achieved an average score of 76.25. The following table 1 shows the results of the descriptive statistical analysis of student learning outcomes in the experimental group and the control group.

**Table 1.** The Results Of The Descriptive Statistical Analysis Of Student Learning Outcomes In The Experimental Group And The Control Group

<b>Statistic</b>	<b>Experimental Group (n = 34)</b>	<b>Control Group (n = 36)</b>
Highest Score	100	95
Lowest Score	50	25
Mean	84.12	76.25
Median	87.22	78.67
Mode	90	80
Standard Deviation	12.09	16.01

In addition, the highest score in the experimental group reached 100, while in the control group it was 95. The lowest score in the experimental group was 50, whereas in the control group it was 25. These findings indicate that students taught using explosion box media tended to achieve better academic performance. Furthermore, the experimental group achieved classical completeness, while the control group did not meet the completeness criteria.

This suggests that the use of explosion box media contributed to improving students' mastery of the learning material.

### Inferential Analysis of Learning Outcomes

Prior to hypothesis testing, prerequisite tests were conducted. The results indicated that the data were homogeneous but not normally distributed. Therefore, the Mann-Whitney U test was used to test the hypothesis.

**Table 2.** Mann-Whitney U Test Results for Learning Outcomes

Test	Z Value	p-value	Decision
Mann-Whitney U Test	$Z_{count} > Z_{table}$	$p < .05$	$H_0$ rejected, $H_1$ accepted

The hypothesis testing results showed that  $Z_{count} > Z_{table}$ , leading to the rejection of  $H_0$  and acceptance of  $H_1$ . This indicates that there is a significant effect of explosion box media integrated with the discovery learning model on students' learning outcomes.

## DISCUSSION

The findings of this study demonstrate that the use of explosion box media integrated into the discovery learning model significantly improves students' learning outcomes on the topic of reaction rates. The higher average score achieved by the experimental group indicates that integrating interactive media into student-centered learning can enhance students' conceptual understanding and retention. This result confirms that learning is more effective when students are actively engaged in constructing knowledge rather than passively receiving information.

One possible explanation for these findings lies in the nature of the explosion box media itself, which provides an **interactive, multimodal, and engaging learning environment**. The media integrates various instructional components such as short videos, worksheets (LKPD), summaries, and quizzes, which encourage students to actively participate in each stage of the learning process. This supports the principles of **constructivist learning theory**, which emphasize that knowledge is constructed through active exploration, interaction, and reflection. In this context, students are not merely recipients of information but become active learners who explore, analyze, and synthesize concepts.

Furthermore, the **visual and multimedia features** embedded in the explosion box play a crucial role in facilitating understanding of abstract chemistry concepts, particularly reaction rates. Concepts such as collision theory, concentration effects, and rate equations are inherently abstract and often difficult for students to grasp. The integration of visual aids, animations, and structured content presentation helps transform these abstract concepts into more concrete representations. This finding is consistent with previous research indicating that interactive media enhances students' conceptual understanding and learning outcomes by improving engagement and cognitive processing (Indartiwi et al., 2020).

In addition, the findings are supported by empirical evidence from previous studies. For instance, Husnah et al. (2021) reported that students taught

using explosion box media achieved significantly higher learning outcomes compared to those taught using conventional methods. Similarly, studies on multimedia learning suggest that combining text, visuals, and interactive elements can improve information processing and long-term memory retention (Mayer, 2021). These findings reinforce the argument that well-designed instructional media can significantly enhance the effectiveness of the learning process.

Another important aspect to consider is the role of the **discovery learning model** in supporting these outcomes. Discovery learning emphasizes active student involvement in identifying problems, collecting data, processing information, and drawing conclusions. This process fosters higher-order thinking skills such as analysis, evaluation, and synthesis. Previous research has shown that discovery learning improves students' critical thinking and problem-solving abilities, which ultimately contributes to better learning outcomes (Maryani et al., 2014). In this study, the integration of explosion box media into the discovery learning stages (stimulation, data collection, verification, and generalization) further strengthens the effectiveness of the model by providing structured and engaging learning support.

Moreover, the results show that the experimental group achieved higher mastery across several learning indicators compared to the control group. This suggests that the combination of interactive media and discovery learning not only improves overall achievement but also enhances students' understanding of specific subtopics. The presence of instructional videos and guided materials in the explosion box supports students in achieving learning objectives more effectively. This is consistent with findings by Agang et al. (2021), who reported that video-based learning significantly improves students' comprehension of complex concepts.

From a pedagogical perspective, these findings highlight the importance of **integrating innovative instructional media into active learning models**. The explosion box media creates a learning environment that is not only informative but also engaging and motivating. Students are encouraged to explore content independently, collaborate with peers, and actively participate in problem-solving activities. This aligns with modern educational approaches that emphasize student-centered learning and the development of 21st-century skills.

However, despite these positive findings, several limitations should be acknowledged. First, this study was conducted within a limited sample size and specific context, which may affect the generalizability of the results. Second, the study focused only on cognitive learning outcomes, without examining other important aspects such as long-term retention or affective outcomes. Future research is recommended to explore the effectiveness of explosion box media in different contexts, subjects, and learning domains, as well as to investigate its impact on other variables such as motivation, engagement, and critical thinking skills.

Overall, the results confirm that the integration of **explosion box media within the discovery learning model** creates a more meaningful and effective learning experience. Students become more actively involved in the learning

process, develop a deeper understanding of concepts, and ultimately achieve better learning outcomes.

## **CONCLUSIONS**

This study concludes that the integration of explosion box media within the discovery learning model has a significant positive effect on students' chemistry learning outcomes, particularly on the topic of reaction rates. Students in the experimental group demonstrated higher achievement compared to those in the control group, indicating that the use of interactive and visually engaging media enhances students' conceptual understanding.

The findings suggest that combining innovative instructional media with student-centered learning approaches can create a more effective and meaningful learning environment. The explosion box media supports active learning by facilitating exploration, visualization, and engagement, which are essential for understanding abstract chemistry concepts. Therefore, the integration of such media into discovery learning can be considered an effective strategy to improve students' academic performance.

## **RECOMMENDATIONS**

Based on the findings of this study, several recommendations can be proposed. First, teachers are encouraged to incorporate innovative and interactive media, such as explosion box, into their instructional practices to enhance student engagement and learning outcomes. The use of such media should be aligned with appropriate learning models, particularly those that emphasize active student participation, such as discovery learning.

Second, schools and educational institutions should support the development and implementation of creative learning media by providing training and resources for teachers. This will enable educators to design more engaging and effective learning experiences.

Third, future researchers are recommended to conduct further studies involving larger sample sizes and different educational contexts to improve the generalizability of the findings. In addition, future research may explore the impact of explosion box media on other variables, such as learning motivation, critical thinking skills, and long-term retention.

Finally, it is important to continuously evaluate and refine the use of instructional media to ensure its effectiveness in supporting students' learning processes and outcomes.

## **ADVANCED RESEARCH**

This study has several limitations. First, it was conducted with a limited sample size in a single school, which may limit the generalizability of the findings. Second, the study focused only on students' cognitive learning outcomes, without considering other aspects such as motivation, critical thinking, or long-term retention. Third, the relatively short duration of the intervention may not fully reflect the sustained impact of the use of explosion box media.

Based on these limitations, future research is recommended to involve larger and more diverse samples across different contexts. Further studies may also examine the effect of explosion box media on other variables, such as motivation, critical thinking skills, and retention. In addition, longitudinal and mixed-method studies are suggested to better understand the long-term impact and learning processes associated with this instructional approach.

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