



Effectiveness of Discord Instructional Media Integrated with Flipped Classroom and Guided Inquiry Learning on Reaction Rates on Students Learning Outcomes

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Abstract: This study aims to determine the effectiveness of Discord instructional media integrated with flipped guided inquiry learning on reaction rates on students' learning outcomes. The instructional media has been tested for its validity and practicality prior to the study. The study was conducted using quasi-experimental with pretest-posttest non-equivalent control group design. Sample consists of 72 students from SMA Negeri 13 Padang participated in this study, with class F1 and F2 as the experiment and control group respectively. Students' learning outcomes were assessed with instrument consisting of multiple choices questions. Results shown the higher N-gain value from experimental group with 0.70 compared to control group with 0.33. Furthermore, the t-test results yielded a value of $t\text{-count} = 8.11 > t\text{-table} = 1.99$, indicating that the means were statistically significant. These findings suggest Discord instructional media integrated with flipped guided inquiry learning was effective to improve students' learning outcomes.

Keywords: Discord instructional media; Effectiveness; Flipped classroom; Guided inquiry learning; Reaction rate

Introduction

Chemistry holds profound significance as a field that explore the knowledge behind the structure, properties, composition, and transformation of matter, playing a foundational role in various scientific fields and many applications. However, the nature of chemistry often makes its concepts were challenging for learners. The microscopic realms of atoms, molecules, and chemical reactions lies beneath direct experience, requiring students to grasp with abstract concepts. Concepts like chemical bonding, molecular structures, and especially reaction rates demand student to able navigate complex processes and relate it with mathematical expressions. Reaction rates deals with the concept of reaction rate itself, collision theory, factors that affects the rate, reaction order, and rate constant. Understanding concept of reaction rates poses a significant challenge for learners due to its dynamic and

quantitative aspects. This were also a challenge for teachers to create a learning approach to learn such abstract concepts. Teacher must able to develop a creative way to illustrate these concepts and fostering an environment that encourage active engagement by the learners (Holme et al., 2015). Blended learning has been considered to meets the mentioned needs.

Blended learning is a learning approach that particularly advantageous in tackling abstract concepts and engaging students in the process by combines different learning conditions. Blended learning combines traditional face-to-face learning with online elements, providing a flexible and dynamic environment. There are four types of blended learning models, one of them is flipped classroom (Low et al., 2021). Flipped classroom designed so that the discussion stage in the learning model is carried out asynchronously, this provides opportunities for students to discuss and interact between their peers and

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the teacher (Divjak et al., 2022). This approach allows students to access learning resources that equipped for visualize abstract concepts, such as reaction rates, through animations and simulations. In the traditional classroom setting, teachers could reinforce the students understanding through discussions or hands-on activities, caters to both abstract and concrete aspects of learning. Blended learning through flipped classroom offers versatile platform for teachers to address the issue of approaching abstract concepts and ensuring an engaging learning experience (Zai et al., 2023).

Flipped classroom, along with other blended learning models, only provides teachers with an approach to how learning will be carried out, so the flipped classroom must be equipped with learning methods that suit the characteristics of the material. Guided inquiry learning or guided inquiry is one of the most popular learning models in chemistry learning because it can be applied in understanding concepts and carrying out experiments. In line with flipped classroom, guided inquiry learning also encourages students to actively engage with the learning process. Instead of passively receiving information, students are guided to explore, question, and investigate, enabling a deeper understanding of the concepts (Orosz et al., 2023; Sokolowska, 2018). Guided inquiry learning focuses on the development of conceptual understanding rather than mere memorization. Guided learning model also helped students to develop their critical thinking skills (Khairunnisak et al., 2023; Ulfa et al., 2022). Lastly, guided inquiry learning involves collaboration between students through discussion by sharing ideas and solving problems collectively (Rambe et al., 2020) (Rambe et al., 2020). By combining these two approaches, teachers able to carried guided inquiry learning syntaxes synchronously and asynchronously through flipped classroom (Siregar et al., 2022).

Nonetheless, there is challenges in implementing blended learning, such as the lack of available media (Lalima et al., 2017). Although various available learning management systems, such as Google Classroom, Edmodo and Moodle, still faces limitations like need for fast internet access, lack of communication features, unsupported by browser, and some of them require payment. As a results, teachers resort to combining different methods and media, like utilizing two applications that have different uses. This method was deemed unpractical and the needs of a media that able to facilitating blended learning persist. Discord is among the available platforms that can provide solutions to this issue (Handri et al., 2023; Wahyuningsih et al., 2021).

Discord emerges as a potential medium for blended learning due to its real-time communication capabilities, integration of multimedia, and collaborative spaces

(Lauricella et al., 2024). Discord encompasses integrated features such as text chat, voice calls, video calls, and screen sharing (Barnad, 2021). Additionally, the channel feature facilitates the needs for sharing learning materials and group discussions, eliminating the need for external groups. Discord's user-friendly interface and security feature contribute to ensuring a dynamic and secure online environment. Besides that, Discord is accessible across various devices and operating system, including browser access, making students able to participate learning activities from anywhere with internet connection (Arifianto et al., 2021; Kruglyk et al., 2020). With such feature, Discord is able to accommodates various learning styles including blended learning (Ghazali, 2021).

Several instructional media that utilized Discord as medium and applied flipped classroom and guided inquiry learning approach for chemistry learning has been developed within a year, such as thermochemistry (Delfianza et al., 2023), chemical equilibrium (Ananda et al., 2023) and reaction rate (Tuti et al., 2023). In spite of this, none of the developed prototypes has been tested for its effectiveness. Effectiveness is an important stage in Plomp development research model due to its role to determine whether the designed instructional media is able to meets the curriculum outcomes (Plomp et al., 2013). With validity and practicality values of 0.87 and 0.90 respectively, the developed media has met the quality criteria to be tested to the next stage. Therefore, this research aims to determine the effectiveness of Discord instructional media integrated with flipped classroom and guided inquiry learning for reaction rate

Method

This study is a continuation from previous studies using Plomp model of educational research design. The effectiveness stage was conducted through quasi-experiment with pretest-posttest non-equivalent control group design (Plomp, 2013). Sampling was performed by purposive sampling technique with total of 72 students from 11th Grade Phase F SMA Negeri 13 Padang academic year 2023/2024, whereas control and experimental groups were chosen based on certain criteria. The research design and diagram can be seen in Table 1 and Figure 1. Where O1 is the experiment class pretest, O2 is the experiment class posttest, O3 is the control group pretest, O4 is the control group posttest, and X is the given treatment.

Table 1. Non-equivalent Control Group Research Design (Cohen et al., 2018)

Group	Pretest	Treatment	Posttest
Experimental	O ₁	X	O ₂
Control	O ₃		O ₄

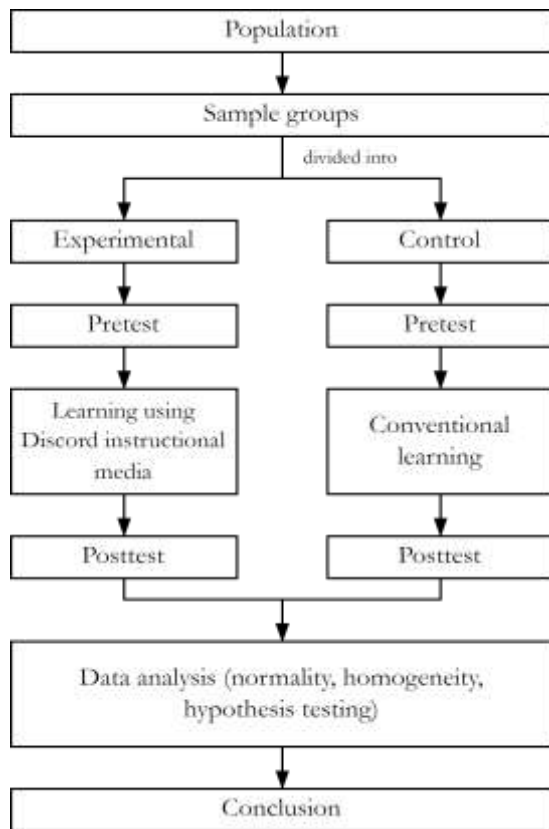


Figure 1. Research method diagram

To assess students' learning outcomes, an instrument consists of 20 multiple choices questions were used. Previously, the instrument has been tested for reliability, validity, difficulty index, and discrimination index to several student. The cognitive level of the instruments ranged from C1 to C5, in accordance to Bloom's revised taxonomy of knowledge. The collected pretest and posttest data were analyzed with N-gain, normality test, homogeneity test, and hypothesis testing.

Result and Discussion

Data on cognitive domain learning outcomes were collected through pretest and posttest scores. The difference for the pretest score were relatively moderate at 1.11. However, there is a significant contrast in the posttest scores, with the experimental group averaged 74.72 compared to the control group with 44.86, resulting in a notable margin of 29.86 (Figure 2). The N-gain value was calculated to compare the students' level of concept inventory. The average N-gain in the experimental group is 0.70, which interpreted as high level of gain. In contrast, the control group show an average N-gain value of 0.33, which is a medium level of gain.

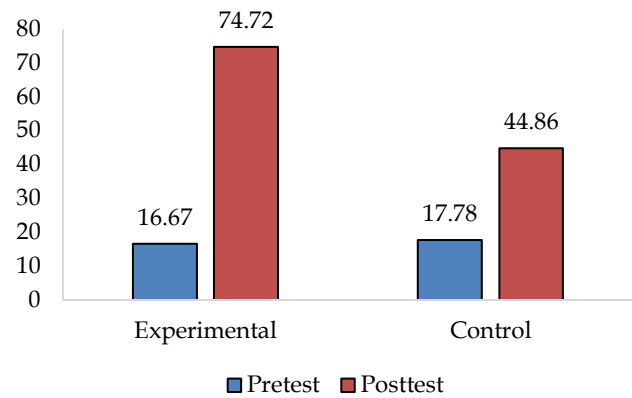


Figure 2. Chart of pretest and posttest average score

Prior to hypothesis testing, the collected data were tested for its distribution. Two tests were done to test normality, using Shapiro-Wilk test, and homogeneity, using F-test. Shapiro-Wilk test resulting to W value of 0.9549 and 0.9379 for experimental and control group, respectively. Compared to value of W-table (N = 36, $\alpha = 0.05$), the W-count values were higher. Meanwhile, the F-test for comparing both experimental and control groups variance resulting to a value of F-count = 0.67 < F-table (N = 36, $\alpha = 0.05$) = 1.75, as the F-table value is higher. Thus, the sample data was distributed normally and had equal variances.

After the distribution and homogeneity of the data are known, the hypothesis test is conducted, with assumption data is normally distributed and the variances are equal. The results of the t-test are presented in Table 4. The test was conducted as a two-tailed analysis with a significance level (α) set at 0.05. The t-count value is 8.11 exceeds this acceptance range, leading to the rejection of the null hypothesis. Consequently, it can be inferred that the average posttest scores differ significantly between the experimental and control classes.

Table 2. Hypothesis Test Results

Group	df	t-count	t-table	Decision
Exp.	35	8.11	1.99	Accept H_0
Cont.	35			

Based on the description of the results above, it appears that the Discord instructional media integrated with flipped classroom and guided inquiry learning used in the experimental class is effective in improving student learning outcomes. This is reflected on the N-gain value of the experimental class (N = 0.70). Students were able to understand the concept more thoroughly when using the Discord instructional media. The scores obtained by students reflect the concepts obtained after learning (Coletta et al., 2020).

These findings align with previous similar studies that utilized flipped classroom approach combined with guided inquiry learning using e-module in junior high science subjects resulted an N-gain value of 0.66 (Katauhi et al., 2022). Another study measured the effectiveness of guided inquiry based flipped classroom learning on acid-base resulted N-gain value of 0.73 (Lenggogeni et al., 2022). Additionally, research on the use of Discord to enhance learning outcomes for seventh grade students in science subject shown an N-gain value of 0.80 (Zannah et al., 2022). These previous findings used flipped classroom, guided inquiry, or Discord as variables, consistently resulted medium to high N-gain values. Therefore, the outcomes of this research are consistent and supported by prior research.

Discord instructional media with flipped guided inquiry learning, or FGIL for short, incorporates two learning conditions: asynchronous and synchronous. Asynchronous learning occurs outside of school hours,

allowing students to engage with materials and exercises shared via Discord (Tuti et al., 2023). This mode of learning empowers students to independently develop their own inquiry by answering solving a simple problem first. Subsequently, during synchronous learning at the class, student can apply these prior acquired concepts to more complex or advanced problems (Eichler, 2022). This approach not only create a meaningful learning but also highlight a learner-centered approach, aligned with the current curriculum demands.

Apart from flipped classroom, the guided inquiry model also plays a role in improving students' learning outcomes in reaction rate material (Hasanah et al., 2020). This learning model centers the educational experience around students, guiding them through keys question to facilitate deeper understanding of the concept. This approach promotes active learning and helps minimize misconceptions among students (Mamombe et al., 2021).

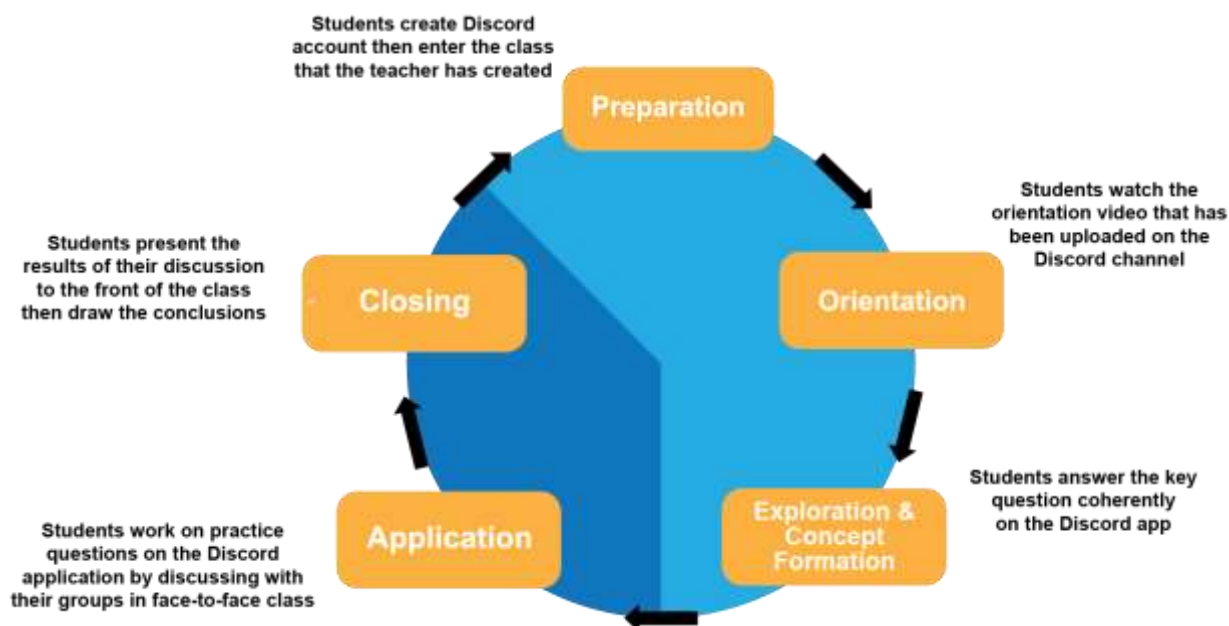


Figure 3. Discord instructional media with flipped guided inquiry learning model stages (Tuti et al., 2023)

Guided inquiry involves five steps: orientation, exploration, concept formation, application, and closing (Figure 3). In this model, orientation until concept formation were done asynchronously. Students can access learning materials through Discord and continue to answers key questions provided in the same server. The provided key questions are designed from low to high cognitive level and interrelated. Key questions hold a great role in order to guide students understanding toward the concept (Montilla et al., 2020; Rands et al., 2021). Students are expected to be able to follows the inquiry to grasp the concept thoroughly (Tuti et al., 2023). Additionally, model equipped with chemistry multiple representation visual media helped student in

understanding the concept (Putri et al., 2022). The model has to include the three chemistry representations, which is macroscopic, submicroscopic, and symbolic representation. The combination of these three components is crucial for students to grasp the concept (Pahriah et al., 2019; Waer et al., 2021).

For instance, Figure 4 illustrates the model used in the sub material about the concept of the effect of concentration on reaction rate. By observing the model, students can visually comprehend the dynamics of a reaction that have high and low concentration of reactants. The students also could connect this concept with previous concept they learn before, such as amount of substance, concentration, collision theory, and

effective collision (Jespersen et al., 2015). In order to show the students way of observing the model, sample of answer from exploration and concept formation stages were presented in Table 3.

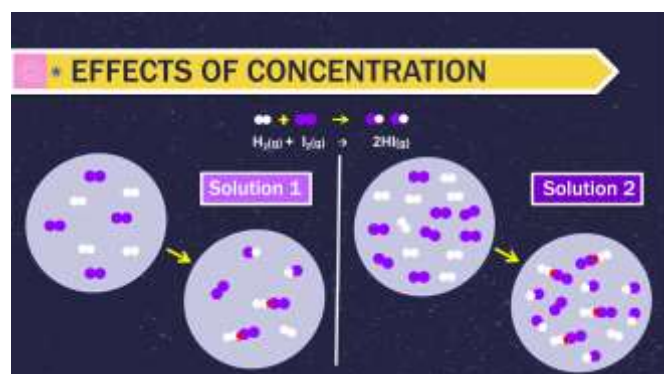


Figure 4. Model for effect of concentration to the reaction rate

Student 1's answer is in accordance with the concept of effect of concentration to reaction rate but there is a lack of connection to the previous concepts mentioned. Meanwhile, student 2 and student 4 successfully connect their answer with almost all the concepts mentioned, although the concept of effective collision was not included. Similarly, student 3 has not established a connection with the concept of amount of substance. At last, student 5 able to connect all of the concepts. Moreover, student 4 and 5 manage to include the opposite effect of low concentration to the reaction rate. Based on the sampled answers, it can be seen that the concept built on previous stages were able to guide students into the understanding of concept.

Table 3. Sample of Answer from the Students

Student	Answer
Student 1	As the concentration increase, the reaction rate also increases
Student 2	As the concentration of the reactant increase, then the amount of substance increase, making the number of collisions increases, thus the reaction rate increases.
Student 3	As the concentration of the reactant increase resulted to an increase of effective collision between the particles. Thus, as the concentration of the reactant increase, the reaction rate increases.
Student 4	As the concentration increase, then the amount of particle increase, thus the reaction rate increases, and vice versa
Student 5	As the concentration increase, the frequency of collision is higher because the amount of particle increases thus increasing the reaction rate, and vice versa.

In the application and closing stage, learning was carried out synchronously in the classroom. With the

acquired concepts, students work in groups to answer questions at the application stage. The questions provided have a higher level of difficulty than the key questions at the exploration and concept formation stage. At this stage, students can work together through discussion to answer questions given under the guidance of the teacher (Yulianis et al., 2022). Students in experimental class were divided into six groups with each group consists of six students. Students were instructed to discuss the problems provided in the application channel together. This approach made students able to use their previously built concept and applied into more advanced problem. By carried it in small groups, students are expected to carried out learning collaboratively with their peers (Rodriguez et al., 2020). Collaborative learning through guided inquiry has been proven to improve students' cognitive outcomes and creative thinking skills by actively engaged in the learning process (Delawanti et al., 2022; Nugraheni, 2022).

Conclusion

According to the findings, the incorporation of synchronous and asynchronous learning through flipped classroom with guided inquiry learning enables students to acquire their own understanding of the concept and reinforce it during face-to-face class. Equipping it with thorough keys question and model with multiple representation also plays a role in this approach. Based on the study, the experimental class showed a high-category N-gain value of 0.70 while the control class showed a medium N-gain value of 0.33. The hypothesis test resulted a t-count = 7.89 > t-table = 1.99 indicates a great significant difference of means of learning outcomes between experimental and control group. Hence, it can be concluded that Discord instructional media integrated with flipped classroom and guided inquiry learning on reaction rate effective in improving students' learning outcomes.

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Author Contributions

Conceptualization, M.M. Methodology, M.M, A.R. Validation, M.M, U.A. Formal analysis, A.R. Investigation, A.R. Resources, A.R. Project administration, A.R. Writing - original draft, A.R. Writing - review & editing, M.M, A.R, A.F.Q. Supervision, M.M. Project administration, A.R.

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Conflicts of Interest

The authors declare no conflicts of interest.

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