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The Effectiveness of Discord Learning Media Integrated with Flipped Classroom Based on Guided Inquiry on Chemical Equilibrium Material on Student Learning Outcomes

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Abstract
This study aims to determine the effectiveness of Discord learning media integrated with flipped classroom based on guided inquiry on chemical equilibrium material on student learning outcomes. This research is an advanced research from the Plomp model development research with the type of quasi-experimental research with Non-equivalent control group design. This study involved two sample classes, namely the experimental class and the control class with 71 students selected through purposive sampling techniques. Based on the research results obtained, the experimental class has an average N-gain value of 0.72 with a high category, and the control class with an average N-gain of 0.55 with a moderate category. For hypothesis testing using the t-test, the t-count value is 0.79 and the t-table is 1.994. The results of data analysis show that Discord learning media integrated with flipped classroom based on guided inquiry on chemical equilibrium material effectively improves student learning outcomes.

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Keywords: Discord, Flipped Classroom, Guided Inquiry, Chemical Equilibrium

1. Introduction

The industrial revolution in 4.0 in its application brings influence in all aspects of human life, where all aspects are integrated with technology and information, both in terms of social, political, cultural, and education (Wibawa & Meyta, 2020) [41]. One of the characteristics of the industrial revolution 4.0 that occurs in the educational aspect is characterized by the application of IT (information and technology) which is very much in line with the current condition of students who are very attached to the digital world and the internet (Rakhmawan dkk., 2020) [23]. To address the challenges in the era of the industrial revolution in 4.0 in the world of education, not only knowledge is an important factor, but skills also play a major role in 21st century learning. (Mardhiyah dkk., 2021) [18]. In the world of education, there are several skills that are currently needed by students in the 21st century or what is often referred to as the 4C term (Creativity, Critical Thinking, Communication, Collaboration). (Suryanti & Wijayanti, 2018) [34]. In 21st century learning, the challenge for teachers in preparing students to master these skills is to adjust teaching strategies, models, and methods that are suitable and appropriate to achieve the desired goals (Sumantri, 2019) [33]. he Merdeka Curriculum is present as an answer to comprehensive transformations in various fields, especially in realizing human resources that can compete and adapt to the times (Syafe'i *et al*., 2023) [35]. This curriculum is also considered a form of adaptation to 21st century education which requires the integration of knowledge (knowledge) and technology (technology) in teaching and learning activities (Indarta *et al*., 2022) [14].

Flipped Classroom is an approach where teaching and learning activities are reversed from the traditional. Where students are given the opportunity to study previous lesson topics at home before entering class, and as for learning activities in the classroom in the form of discussions, assignments, or solving problems that they still do not understand(Gaja & Mawardi, 2021) [8]. By using the flipped classroom method, students have the flexibility to learn the material whenever they want, not limited to class time (Wulandari, 2017) [42].

Learning with a flipped classroom, at first the learning material is delivered through a learning video that students must watch from their respective homes (Murtiasih, 2022) [20]. he application of the flipped classroom system in learning can motivate students to increase their independence, take responsibility, and explore their own abilities, consequently having an impact on improving the learning outcomes obtained by students (Syakdiyah *et al*., 2020) [37]. His concept is in accordance with the objectives of the independent curriculum which implements a learning process in which students actively discover learning concepts themselves. To realize this by applying an innovative learning model such as the guided inquiry learning model (Hamna & Ummah, 2023) [9].

Guided inquiry is a learning approach that directs students to actively participate during the learning process (Marsella *et al*., 2024) [19]. The guided inquiry model naturally triggers students to develop their own critical thinking and work on their own accord in discovering concepts directly (Harjilah *et al*., 2019) [12]. There are five stages of learning that are followed, namely orientation, exploration, concept formation, application, and closing. One of the materials suitable for guided inquiry models is chemical equilibrium.

Chemical equilibrium is considered difficult material in chemistry learning materials by students, therefore a concept or idea that can change the point of view of students is needed. The results show that the Flipped-Guided inquiry Base Learning model on chemical equilibrium material is more effectively applied because it is able to improve student learning outcomes by getting an N-gain value for the experimental class of 0.78 and 0.68 for the control class.

Efforts to improve the education system that is able to adopt and implement technology integration into the learning process in the 4.0 era by using a guided inquiry-based flipped classroom learning system require an application by utilizing social media in its implementation, one of which is the Discord application (Tuti *et al*., 2023) [38]. Discord application is utilized as a means to support the success of flipped classroom learning, functioning as a platform to implement guided inquiry syntax (Uong *et al*., 2022) [39]. Discord application offers excellent features that support learning such as channels or special rooms, which are not owned by other applications. Discord app has excellent features that can be utilized for learning, such as special channels or spaces, which are not found in other apps. This division of space (channel) is very effective for learning because it can be used to store learning materials, activity schedules, group discussion rooms, and general discussion rooms for one class Discord application, with features that allow users to interact in real time using text, such as voice or video chat, and file sharing, gives learners access to self-learning before classroom learning activities begin (asynchronous) as well as interacting directly with teachers and fellow learners (synchronous) (Ridho *et al*., 2021) [25]. Discord can be accessed on various operating systems such as Windows, iOS, Android, Linux, and Mac. This Discord application offers various communication facilities that are not available in other applications. One of the prominent features is the ability to communicate similar to a telephone, allowing teachers to convey material freely to students (Rakhmawan *et al*., 2020) [23]

According to the results of observations of chemistry teachers and students of SMA Negeri 1 VII Koto Sungai Sarik, Padang Pariaman Regency, it was found that the application of student centered learning in the Merdeka Curriculum was not optimal, because in the implementation of learning it still applies conventional learning methods where learning is still teacher centered or teacher-centered. Based on the results of observations, it is also known that the use of technology and learning media has not been maximized. Where the use of social media is only limited to WhatsApp to send source material in learning and the use of infocus during presentations is still rarely used, so that it does not meet the demands of learning in the era of the industrial revolution in 4.0. It can be seen that teachers really need a learning system that can support the industrial revolution 4.0 to run learning smoothly and encourage active students during learning.

The development research "Learning with a flipped classroom system based on guided inquiry using Discord on chemical equilibrium material" has been conducted by Restu Ananda, and has been validated and tested in small groups with very high validity and practicality categories. However, this research has not been tested for effectiveness, thus it is necessary to test the effectiveness of research developed by previous researchers because the quality of a product developed is seen from three criteria, namely validity, practicality, and effectiveness. Therefore, researchers intend to test the effectiveness of learning media that has been developed on student learning outcomes.

2. Method

Research Design

The type of research applied to research is quasi experiment (pseudo research). The research design used by researchers is Pretest-Posttest Non-equivalent control group Design. Where there are two classes involved, namely the experimental class that receives treatment and the control class that does not receive treatment or as a comparison. The type of research applied to research is quasi experiment (pseudo research). The research design used by researchers is Pretest-Posttest Non-equivalent control group Design. Where there are two classes involved, namely the experimental class that receives treatment and the control class that does not receive treatment or as a comparison. In the control class, the learning process uses the existing learning system at school, while the experimental class will be given a certain treatment, namely applying "Learning with the Flipped Classroom System Based on Guided Inquiry Using Discord on Chemical Equilibrium Material Class XI SMA / MA" which has been developed by Restu Ananda, which has passed the validity and practicality tests. This research design can be seen in Table 1.

Table 1: Research Design (Cohen *et al*., 2018)

Class	Pretest	Treatment	Posttest
Experimental	O_1	X	O_2
Control	O_3		O_4

Note:
X: Learning treatment with a flipped classroom system based on guided inquiry using Discord in the experimental class
O_1: pretest for experimental class.
O_2: pretest for control class.
O_3: posttest for the experimental.
O_4: posttest for control class.

Population and sample

Selection of samples and populations with non-probability

sampling techniques, namely by making certain considerations or by using purposive sampling techniques. The population of this study were all students of class XI SMA Negeri 1 VII Koto Sungai Sarik who took chemistry subjects totaling 143 people who were divided into 4 classes. The sample in this study were students of class XI.F1 as the experimental class and XI.F3 as the control class.

Research procedures

The procedure in this study consists of three stages, including 1) The preparation stage includes determining the research location, observation, determining the population and sample, testing questions, and preparing lesson plans. 2) The implementation stage begins with the procurement of pretests in experimental and control classes, the implementation of teaching and learning activities where the experimental class uses discord learning media integrated with guided inquiry-based flipped classroom while the control class uses the existing learning system at school. 3) The completion stage of procuring posttests in both sample classes, processing data, and drawing conclusions from the results that have been obtained.

Data Sources and Research Instruments

The instrument in this study is a knowledge test instrument in the cognitive domain. The instrument is in the form of multiple choice questions totaling 20 items, where each question consists of five answer choices that are adjusted to the indicators of competency achievement in chemical equilibrium material. Previously the instrument had been tested for reliability, validity, discriminant index, and difficulty index on several students. In this study using primary data, namely the learning outcomes of students obtained from pretest-posttest scores on chemical equilibrium material.

Data Analysis

Data analysis techniques to obtain research results include the N-gain test to determine how effective the learning media used. Normality test was conducted to determine whether the sample distribution was normal, Lilliefors test was used to test normality. The homogeneity test is used to determine whether the variance in the data from the two samples is homogeneous, the F test is used to evaluate homogeneity. Hypothesis testing aims to determine whether the research hypothesis can be accepted or rejected. Hypothesis testing is done with the t test.

3. Results and Discussion

This study aims to determine the level of effectiveness of Discord learning media integrated with flipped classroom based on guided inquiry on chemical equilibrium material on student learning outcomes. The results of the study were obtained from the learning outcomes of students in the cognitive domain. After conducting research at SMA N 1 VII Koto Sungai Sarik, primary data in the form of learning outcomes were obtained. In the learning process, the experimental class used Discord learning media integrated with flipped classroom based on guided inquiry on chemical equilibrium material, while the control class used the existing learning system at school with conventional methods, namely lectures, discussions and questions and answers. The learning outcomes consisted of test scores. The test is in the form of multiple choice questions as many as 20 questions with each question given a score of 5 for the correct answer, for the wrong answer given a score of 0. The following are the average pretest and posttest results from both samples.

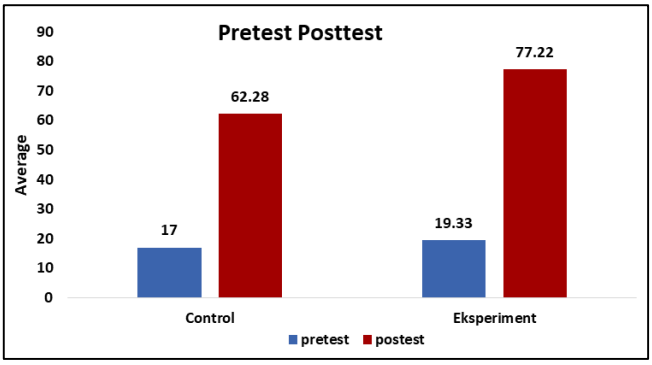


Fig 1: Graph of pretest and posttest scores of experimental and control classes

From the figure it can be seen that the comparison of the learning outcomes of the experimental and control classes can be seen from the difference in pretest and posttest scores. The average pretest score of the control class was 16.42 and the experimental class was 19.33. For the average posttest score in the dick class 62.28 and the experimental class 77.22. Comparison of the increase in learning outcomes of control and experimental classes can be seen from the results of the difference in pretest and posttest scores.

The N-Gain value aims to determine the effectiveness of the treatment given to the sample class as for the treatment given in the form of Discord learning media integrated flipped classroom based on guided inquiry on chemical equilibrium material. The average N-gain test results can be seen in Table 2.

Table 2: Average N-gain Test Results

Class	N	Average N-gain	Category
Control	35	0,55	Low
Experiment	36	0,72	High

Which falls into the high category. As for the control class, the average N-gain value is 0.55 which falls into the medium category. The N-gain value describes the comparison between the concepts obtained by students during the learning process. So Discord learning media integrated flipped classroom based on guided inquiry on chemical equilibrium material has a higher level of effectiveness than learning using conventional models.

Normality test is conducted to determine whether the data obtained is normally distributed or not. The normality test was carried out using the Liliefors test. Data is normally distributed if the value of L0 < Lt, while the data is not normally distributed if L0 > Lt. for the real level (α) is 0.05. The results of the normality test on the sample class can be seen in Table 3.

Table 3: Liliefors Test Results for Normality

Test	Class	N	L_0	L_t	Distribution
Pretest	Experiment	36	0,138	0,147	Normal
	Control	35	0,139	0,149	Normal
Posttest	Experiment	36	0,126	0,147	Normal
	Control	35	0,067	0,149	Normal

From the results obtained that the pretest L-count value in the experimental class was 0.138 and the control class was 0.139, while the posttest L-count in the experimental class was 0.126 and the control class was 0.067. Where L-table (n = 35, α = 0.05) is 0.149 and L-table (n = 36, α = 0.05) is 0.147. This shows that L-count < L-table. So it shows that the four data are normally distributed.

The homogeneity test is carried out to find out whether what is obtained has a homogeneous variance or not. The homogeneity test was carried out with the F test. Data is said to be homogeneous if the value of F-count < F-table. The results of the data homogeneity test of the two samples can be seen in Table 4 below.

Table 4: F Test Results Homogeneity

Test	Class	Df	S^2	f_{count}	f_{table}	Information
Pretest	Experiment	36	66,58	0,96	1,76	Homogeneous
	Control	35	70,88			
Posttest	Experiment	36	47,77	0,62	1,76	Homogeneous
	Control	35	124,03			

Table 4 shows the results of the homogeneity test of learning outcomes data from both samples. The F-count obtained on the pretest data is 0.96 and on the pretest value is 0.62 with an F-table value (N = 31, α = 0.05) of 1.76. From the results obtained, it is stated that the F-count value < F-table, so it is concluded that the pretest and posttest data from the two samples have the same data distribution.

After it is known that the data from both samples are normally distributed and homogeneous, the two data proceed to the hypothesis test. The hypothesis test carried out is the t test. The hypothesis is seen whether the research hypothesis is accepted or rejected. Data on the results of hypothesis testing can be seen in Table 5 below.

Table 5: T-test Result

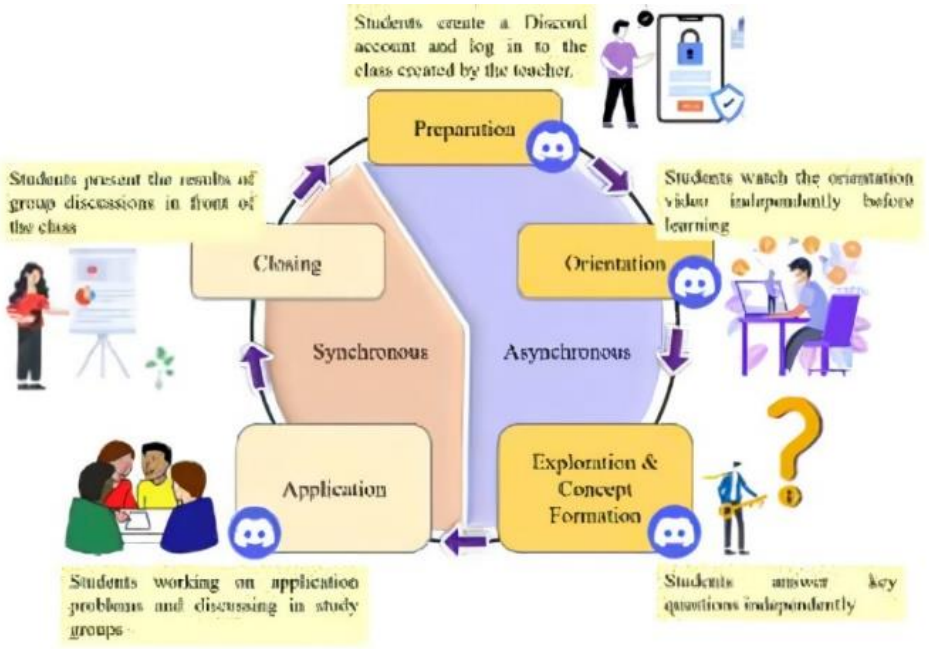
Test	Class	Df	Average	S^2	T_{count}	t_{table}	Information
Pretest	Experiment	36	18,57	68,67	0,79	1,994	H_0 accepted
	Control	35	17				
Posttest	Experiment	36	77,28	84,76	6,78	1,994	H_0 rejected
	Control	35	62,28				

The null hypothesis of the t test is that the average scores of the experimental and control classes are the same and are accepted if t count < t table. For pretest value data, the t count = 0.79 with t table 1.994 is obtained, where t count < t table so that H0 is accepted and H1 is rejected. In the t test of posttest values, obtained t count = 6.78 with a t table of 1.994, meaning that t count> t table so that H0 is rejected and H1 is accepted from the results of the data obtained it can be seen that the difference in pretest and posttest values of the experimental class is greater than the control class. Thus the learning outcomes of the experimental class using Discord learning media integrated flipped classroom based on guided inquiry is greater than the learning done conventionally.

This research is in line with previous research using Discord learning media based on flipped guided inquiry learning on reaction rate material which is effective in improving student learning outcomes where the results of the N-gain value in the experimental class were 0.70 while in the control class were 0.33 (Akmar *et al*., 2024) [19]. There is similar research on Flipped-Guided inquiry learning on acid-base material with an N-Gain value of 0.80 (Lenggogeni & Mawardi, 2022) [17]. Other relevant research also uses the same learning system on buffer material and is declared effective (Hartandi & Mawardi, 2022) [13]. Another study that proved the effectiveness of the FGIL-based learning model on chemical equilibrium material also proved effective (Dini & Mawardi, 2023) [6]. Research related to the use of discord in learning is also in line with research by Rakhmawan (2020) [23] which states that Discord can be used as an optimal learning tool. As for research conducted by Rizal & Aesthetika (2022) [26], Discord applications effectively improve learning outcomes. These studies applied flipped classroom, guided inquiry, or Discord application as the variables and all the findings showed the amount of N-gain in the medium and high categories. Given these findings, the results obtained in this research are in line with previous findings. This finding implies that Discord learning media with FGIL on chemical equilibrium material is effective in the teaching and learning process.

Discord learning media integrated with flipped classroom based on guided inquiry combines two learning conditions, namely asynchronous and synchronous (Tuti *et al*., 2023) [38]. Asynchronous learning occurs outside of school hours allowing students to engage with materials and exercises shared through the Discord application (Khairunnisak *et al*., 2023) [16]. This approach allows optimal time efficiency in learning, so that the teaching and learning process can run more effectively (Fani & Mawardi, 2022) [7]. This learning model empowers students to independently develop their own questions by answering simple problem solving first (Handri *et al*., 2023) [10]. Furthermore, during synchronous learning in class, students can apply previously acquired concepts to more complex concepts or advanced problems. His approach not only creates meaningful learning but also highlights a learner-centered approach, adapted to the demands of the current curriculum (Siregar & Mawardi, 2022) [31].

In addition to the flipped classroom, the guided inquiry model also plays a role in improving student learning outcomes on chemical equilibrium material (Dini & Mawardi, 2023) [6]. His learning model is learner-centered, where learners are guided through key questions to facilitate deeper concept understanding (Syafei & Mawardi, 2022) [36]. This approach encourages active learning and helps minimize misunderstandings and is able to increase the level of engagement, motivation, and learning outcomes of students (Rizkivany & Mawardi, 2021) [27].



***Source 1*:** (Ananda *et al*., 2023)

Fig 2: FGIL System Chart Using Discord

Guided inquiry plays a role in guiding students in finding concepts with learning stages (Ningsih, Setia & Mawardi, 2024). There are five stages of activity in guided inquiry learning, namely: orientation, exploration, concept formation, application, and completion.

The key questions provided are designed from low to high cognitive levels and are interrelated. Key questions play a big role in guiding students' understanding of a concept (Rands *et al*., 2021). Students are expected to be able to follow the inquiry to understand the concept thoroughly (Tuti *et al*., 2023) [38]. In addition, a model equipped with chemical multi-representation visual media helps students in working on concepts that have not been understood (Putri & Martini, 2022). The model must include three chemical representations, namely macroscopic, submicroscopic, and symbolic representations. The combination of these three components is very important for students to understand concepts (Waer *et al*., 2021). understanding concepts at three levels of chemical representation can be explained using symbols, numbers, formulas, and reaction equations (Sukeimi, 2022). understanding chemical concepts at three levels of chemical representation and the ability to connect them is known as a mental model. Mental models are formed and developed during the learning process (Katmiati & Rahmi, 2021). Here is the relationship between chemical multi-representation in the formation of mental models.

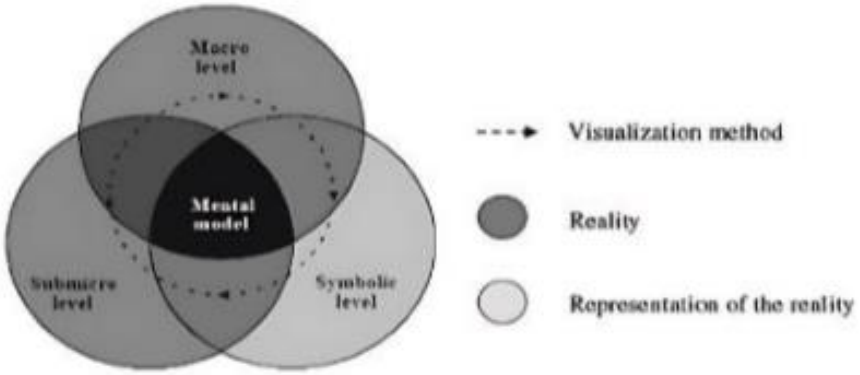


Fig 3: The Relationship between Mental Models and Representations

The following are examples of chemical representations contained in the Discord learning media integrated with flipped classroom based on guided inquiry on chemical equilibrium material.

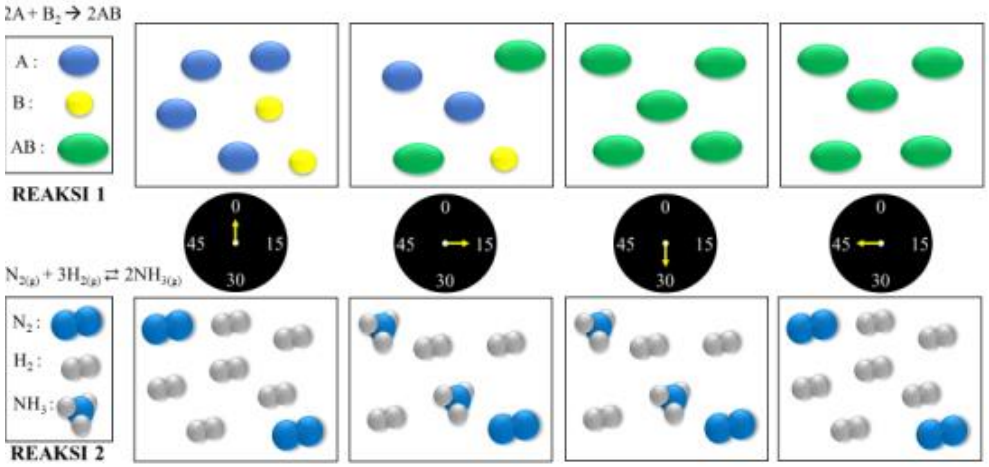


Fig 4: One Model of Exploration and Concept Formation

For example, Figure 3 illustrates the model displayed at the exploration and concept formation stage. In this model students visually observe the difference between reversible and irreversible reactions. Students can also connect this concept with previously learned concepts. To show how students observe the model, examples of answers to the exploration and concept formation stages are presented in Table.

Table 6: Student Answer Analysis

Student	Answers
Student 1	Reversible reactions: are chemical reactions that take place in 2 directions Irreversible reactions: are reactions that take place in one direction only
Student 2	Reversible reaction: reaction back and forth / can return to the original state. Irreversible reaction: unidirectional reaction, cannot return to the original state.
Student 3	Reversible reactions: reactions that take place in two directions where the reaction can turn back to form reactants. Irreversible reaction: reactions that take place in one direction, do not reverse / cannot return to form reactants.

Based on the learners' answers, learner 1 has been able to distinguish irreversible and reversible reactions but only to the extent that the direction of the reaction takes place. In the answers of learners 2, learners are able to explain irreversible and reversible reactions but only to the extent that the reaction can be reversible or unidirectional. Whereas in the answer of learner 3, learners are able to explain the reversible and irreversible reactions perfectly as evidenced by learners being able to distinguish and explain how the direction of the reaction.

After learners answer key questions in the exploration and concept formation stages. Furthermore, the application and closing stages, at this application stage are carried out synchronously in the classroom, they have the opportunity to analyze more complicated situations, to transfer the knowledge gained with other knowledge. (Rusiani Js *et al*., 2019) [29]. In this section there are several exercises related to the topic. Learners are instructed to discuss the questions contained in the application menu in Discord (Delfianza *et al*., 2023) [5]. At this stage students can work together through discussion to answer the questions given under the guidance of the teacher. (Yulianis & Mawardi, 2022). The exercises provided are aimed at enabling learners to build confidence in situations that are familiar to the concepts acquired (Rodriguez *et al*., 2020) [28]. Furthermore, the closing part is also carried out synchronously, namely carried out in class. At this stage, group representatives convey the results of the discussions that have been obtained and then conclude the learning that has been carried out (Yani *et al*., 2020) [43]. After the conclusions are conveyed by the students, the teacher confirms the results of the discussion and corrects the wrong concepts (Sari & Mawardi, 2022) [30]. Collaborative learning through guided inquiry has been proven to improve cognitive outcomes and creative thinking skills of students by actively engaging in the learning process (Delawanti & Lutfi, 2022) [4].

Meanwhile, in the control class, the learning process was carried out conventionally through lecture, discussion, and assignment methods using chemistry textbooks in accordance with the Merdeka curriculum. Before starting learning activities, students are asked to read and understand the material on chemical equilibrium first. During class meetings, students are asked to deepen their understanding, discuss with classmates, and then the teacher presents the material through lectures and holds discussions with students. After learning the concepts taught, the teacher gives example problems and explains them on the blackboard. The learning is then continued with assignments, where students have to do the problems at home and submit them at the next meeting.

4. Conclusion

Based on the results of the study, the N-gain value was 0.72 in the experimental class with a high category and 0.55 in the control class with a medium category. The t-test with the results of normal and homogeneous distributed data analysis provides a t-count value = 6.78> t-table = 1.994 which means that the average learning outcomes of the experimental class and control class are significantly different. Thus, it can be concluded that Discord learning media integrated with flipped classroom based on guided inquiry on chemical equilibrium material effectively improves student learning outcomes.

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