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The development of Adobe Flash media uses the guided discovery learning model for learning activities and learning outcomes in the buffer solution material

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ABSTRACT

The background of this research is the low student learning outcomes and the need for more activeness and motivation of students in learning chemistry. The development of guided discovery-based Flash media is crucial for supporting student learning outcomes and enhancing their understanding of chemical concepts. This study aims to determine students' and teachers' feasibility, effectiveness, and responses to the developed Flash media. Purposive sampling was used to select two classes for this research. These classes were chosen because the members were selected from the population based on the teacher's recommendation after evaluating the material covered in the sample class. The Guided Discovery model with Adobe Flash media made Class XI MIA 1 an experimental class. In contrast, the Direct Instruction learning approach made Class XI MIA 2 a control class. The results of research conducted at SMA Negeri 9 Medan can be concluded that there is an influence on student learning outcomes and activities when using Guided Discovery Based Adobe Flash media on class XI Buffer Solution material. These student activities contribute to aligned learning outcomes of 18.1 %. At the same time, 81.9% was caused by a lack of student interest in participating in teaching and learning activities, time allocation for implementation, and teacher willingness. The application of Guided Discovery learning media with Adobe Flash media can improve student learning outcomes in the experimental class compared to students taught with the Direct Instruction model.

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INTRODUCTION

Countries facing current global challenges need human resources (HR) who are skilled and able to compete in the mastery of science and technology (IPTEK). The acquisition of science and technology is mainly determined by the knowledge of basic sciences such as mathematics and science, which are natural sciences. Therefore, from elementary school to higher education, it is necessary to master the basic sciences as much as possible, including improving the quality of education (Muntari & Sukib, 2019; Rachmadtullah et al., 2020).

Education is a form of dynamic human culture and fully embodies this development. As a result, educational reforms and innovations must reflect shifts in popular culture. To benefit modern society, it is necessary to make changes to improve education at all levels (Ardianto et al., 2013; Townley, 2020). Education is aimed at developing the innate possibilities that exist in students. These potentials are anticipated to develop and mature following the societal values and cultural norms prevailing in the country. As a result, learning is essential to human happiness throughout the lifespan. The search for growth, prosperity, and happiness cannot coexist without education (Ferri et al., 2019; Susanto & Mardhika, 2022).

Chemistry is taught in some schools as a subject. Since chemistry is a basic science necessary for technological progress, chemistry education is critical. Because of this, many students struggle with chemistry and see it as a challenging topic. These problems stem from concepts, materials, and calculations related to chemistry. Moreover, unlike most adults, students do not see this as entertainment but as a chore (Gomollón-Bel, 2019; Sari et al., 2020). Students' interest in learning chemistry is very low, students have different learning speeds, the contents of books are less enthusiastic, students have their learning styles, and the material presented has nothing to do with everyday life. Therefore, the learning experience of students will be small.

The success of a learning process can be measured by how much students learn. The inability to use learning models in the classroom properly and the selection of learning models unsuitable for the delivery of subject matter contribute to poor learning outcomes for students (Muhsin et al., 2020; Supena et al., 2021). Such a learning process is unlikely to develop students' skills. From the explanation, it is clear that learning is needed to actively guide students to learn chemistry (Wulandari et al., 2023). According to Henningsen and Stein, quoted from Jaswandi & Kartiani (2022), classrooms are most effective when students are actively involved in various relevant tasks. Students must take the initiative to learn rather than passively imitating others without understanding the context.

One of the student-centered learning methods is the discovery method. Bruner in Dahar (1996) believes that learning how to find aligns with people's active search for knowledge (Maknun, 2020). We only seek to find solutions to problems and the knowledge that accompanies them, producing knowledge that is truly meaningful for students. Finding a problem means that most students generally need basic concepts to find anything, so students find these concepts through teacher guidance and guidance (Munthe et al., 2022). According to Abel and Smith (1994), quoted from Silitonga (2022), educators have the greatest influence on the academic growth of their students. In the guided discovery method, the teacher acts as a facilitator, directing students through questions designed to foster meaningful connections between previously learned material and new information. Formulating hypotheses independently and conducting analyses based on the material provided by the teacher to discover concepts, principles, or techniques is highly recommended (Kartini et al., 2021; Laeni et al., 2022).

In this way, teachers encourage students to make assumptions, intuition, and experiment. Through guesswork, intuition, and trial and error, it is hoped that students will not only embrace the concepts, principles, or procedures developed in their educational and learning activities but also be more focused on the aspects, principles, or procedures of discovery that are being developed, to create, students must be able to express their thoughts. Students can make these connections more straightforward using various visual and written communication forms. Indirectly, students familiar with guided discovery are used to providing facts, data, or expertise to make discoveries (Abdullah et al., 2021; Medani et al., 2022).

In addition, Borthick and Jones (2000), quoted from Stoffová (2020), learned that the discovery method characterizes problems and solutions, searches for relevant information, develops strategies to find solutions, and implements the chosen strategy. In other words, the discovery method also introduces students to problem-solving activities, increasing their ability to solve various problems. Understanding chemistry concepts is challenging due to the focus on mathematics and abstract material. Teachers should make the learning process fun and encourage student involvement to achieve the essence of a scientific approach consisting of 5M (observing, asking, gathering information, reasoning, and communicating).

Students develop knowledge, dispositions, and abilities in chemistry through direct experiential learning, including critical thinking. The Minister of National Education of the Republic of Indonesia Number 54 of 2013 emphasizes using Graduate Competency Standards (SKL) in abstract and real fields, fostering independent learning at all levels. Schools that promote creative thinking skills are essential to equip students with lifelong skills, making critical thinking necessary for scientific exploration and understanding of nature. Educational media is essential to engaging and inspiring students (Dita, 2022). Adobe Flash, a software product, is being developed to generate interest in chemistry through various media, including text, photos, video, sound, and animation. Its application aims to provide a strong foundation for students to build their knowledge and skills by understanding the concept of support structures, thereby increasing their understanding of the subject matter.

The guided discovery model is a teaching strategy that encourages independent learning and improves students' critical thinking, analytical skills, and agency, as stated by Mayu (2021). This approach encourages active learning, correct understanding of concepts, and satisfaction with the answers received, making it an effective teaching approach. According to Arifin (2020), the guided discovery learning model, a cognitive educational approach that allows teachers to investigate material independently, aims to provide students with a comprehensive understanding. This approach fosters a two-way dialogue between the instructor and students, cultivating a two-way perspective. When students encounter problems, the teacher asks guided questions to help them understand key concepts and formulate their own rules. This approach reduces the teacher's tendency to lead the class, increasing student engagement.

Among others, research by Gustika et al. (2019) shows that this learning paradigm improves student learning outcomes. Applying the guided discovery learning model shows that learning outcomes can be enhanced regarding student knowledge, as evidenced by an increase in cycle I or learning integrity. Aspects of knowledge 50%, then increased to 71% in cycle II and 88.24% in cycle III. The results showed that student learning outcomes increased each cycle, with an average achievement indicator of success in cycle III. They are rated 69.16 or successful.

Adobe Flash is popular among animators because it is a vector-based animation program. Adobe Flash software allows for the creation of multimedia learning materials, as stated by Merdekawati et al. (2014). Adobe Flash is a computer-based multimedia technology that enables the creation of educational materials and allows for easy animation development, integration of audio and graphics, and simplified operation. Its native capabilities for multimedia presentation benefit animators by incorporating sound and visuals into their work. Adobe Flash also includes assessment and guided exploration into learning content, cultivating positive attitudes toward chemistry and enhancing students' visualization skills through interactive simulations. This approach encourages discovery learning and increases students' understanding of the problem and the answer (Siburian et al., 2020).

Education, especially in chemistry, is crucial for technological progress. However, students often find chemistry challenging and lack interest, highlighting the need for a strong foundation in science and technology. A skilled workforce is essential for global competitiveness. Research emphasizes equipping students with skills to address global challenges like environmental issues, healthcare advancements, and technological innovations. Effective teaching methods like the guided discovery model must prepare students to tackle these challenges. Urgent research is needed to find innovative ways to make chemistry subjects engaging and relevant to students' lives. Therefore, the urgency of this research lies in its potential to address educational challenges, increase students' interest and proficiency in science and technology, and equip them with the skills needed to overcome global challenges and remain competitive in a rapidly changing world.

This study aims to determine students' and teachers' feasibility, effectiveness, and responses to the developed Flash media. This research can provide alternative learning models so that the chemistry learning process is more interesting and varied and can help overcome learning problems. In addition, it can also facilitate students' understanding of concepts in buffer solution material, make students prefer chemistry lessons, and increase students' active role in the learning process. This research contributes to the theoretical understanding of this pedagogical approach and its application in various subjects beyond chemistry. In addition, this study may have implications for multimedia learning theory, which states that interactive and visually attractive materials can enhance the learning experience. These theoretical implications suggest that the findings of this study go beyond the specific context of chemistry education and have relevance for broader educational theory, teaching strategies, and the integration of technology in teaching and learning. Researchers and educators can utilize these implications to refine existing theories and develop new theories in the field of education.

RESEARCH METHODOLOGY

This research will be conducted at SMA Negeri 9 Medan, located at Jalan Sei Mati Number 799, Medan Labuhan District, Medan City, in the Even Semester of the 2019/2020 Academic Year. This research was conducted from December 2019 to March 2020. The population in this study consisted of the chemistry lecturer population at Medan State University, the teacher population, namely all public high school chemistry teachers, and all XI MIA class students at SMA Negeri 9 Medan who used the 2013 curriculum. Class XI students specializing in MIA at SMA Negeri 9 Medan totaling 6 classes. Each class has an average of 30 students. Purposive sampling was used to select two classes for this study. These classes were chosen because the members were selected from the population based on the teacher's recommendation after evaluating the material covered in the sample class. The Guided Discovery model with Adobe Flash media made Class XI MIA 1 an experimental class. In contrast, the Direct Instruction learning approach made Class XI MIA 2 a control class.

RESULTS AND DISCUSSIONS

The research was carried out at SMA Negeri 9 Medan involving classes XI IPA 1 and XI IPA 2. The stages carried out in this research were a) analysis of the syllabus according to the curriculum used, b) analysis of the books used, c) design and development of learning media, and d) validation of questions by lecturers and teachers.

Syllabus Analysis

Subject/learning materials, learning activities, and competency achievement indicators for assessment are all described in the syllabus. The syllabus is a modification of the current curriculum, implemented in 2013. The syllabus analysis stage aims to identify the topics to be taught and in what order. The acid-base curriculum follows the 2013 curricular syllabus regarding the topics discussed: 1) development of components of acid buffer solutions and essential buffer solutions, 2) indicators, and 3) pH of weak acids and weak bases.

Analysis of Chemistry Books by Researchers

The results obtained based on the analysis and review of the three chemistry books used for teaching materials in class XI IPA of the high school where the study was conducted are presented in Table 1.

Table 1.
Types of chemistry books used in learning development

No.	Book Code	Reasons for Choosing a Book
1	A	Books that are often used as teaching materials at the high school level
2	B	Books that are often used as teaching materials at the high school level
3	C	Books that are often used as teaching materials at the high school level

The analysis was carried out in terms of the contents of the book and its sub-topics. From the results of the analysis and book review of books A, B, and C, it was found that there were several deficiencies and weaknesses. Book A: It contains no answer key. In the sub-topics, some images are few and not colored. Book B: In the content section, the book components are incomplete; namely, there is no periodic table of elements and answer keys. Book C: It contains no answer key.

In addition to analyzing the material, content, and sub-subjects of teaching materials in the three books, the three books were also analyzed using the BSNP instrument to see the feasibility of the content, language feasibility, presentation feasibility, and graphic feasibility. A check mark (✓) is made in the appropriate column for the analysis. Furthermore, the data obtained from the analysis results are tabulated to determine the content, language, presentation, and graphic feasibility level. The average analysis results were calculated after analyzing books A, B, and C. The analysis results of the three books based on all components of the assessment carried out can be seen in Table 2 and Figure 1.

Table 2.
Results of analysis of three chemistry books by researchers

Textbook	Average Material Appropriateness Standard Score				Average
	Content Eligibility	Language Eligibility	Eligibility of Presentation	Graphic Eligibility	
A	2,33	3,20	3,44	3,48	3,30
B	3,08	3,50	3,44	3,33	3,33
C	3,25	3,00	3,33	3,51	3,27

With description:
3.26 – 4.00 = Valid and does not need to be revised
2.51 - 3.25 = Quite valid and does not need to be revised
1.76 - 2.50 = Invalid; some of the contents of teaching materials need to be revised
1.00 – 1.75 = Invalid and need total revision

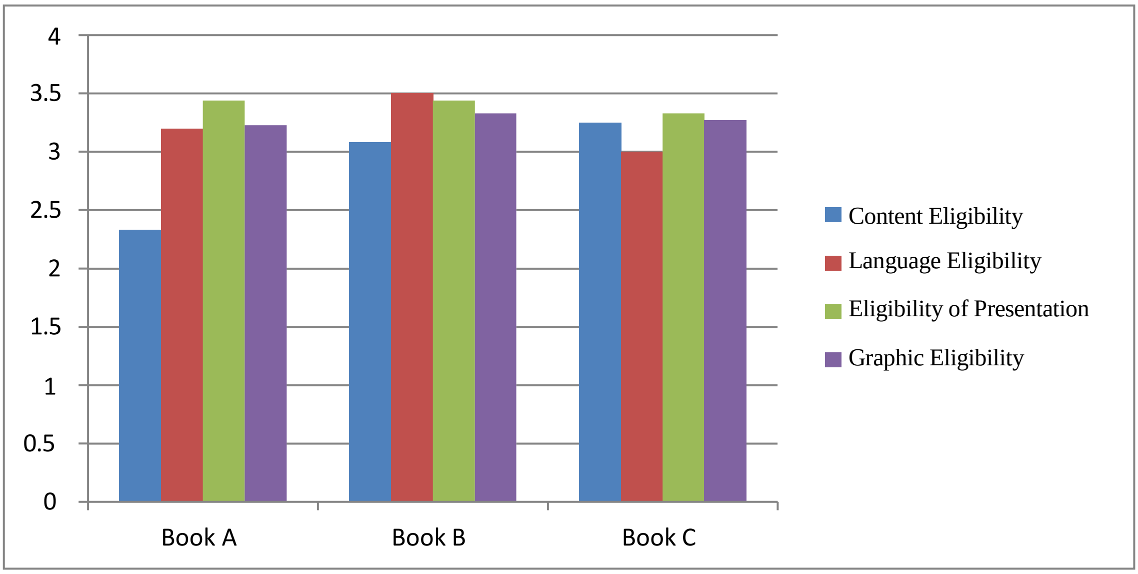

Figure 1. Results of analysis of three chemistry books by researchers

Based on data from the analysis of the three chemistry books used, each book gave different results in terms of content feasibility, language feasibility, presentation feasibility, and graphic feasibility.

Analysis of Media Needs by Researchers

Based on the test results, the media used before the study still has deficiencies. The first step in producing educational materials is an in-depth examination of the topics covered. The needs assessment started with a field visit to the SMA Negeri 9 Medan Research Institute. Analysis of needs to find out the needs of learning media at SMA Negeri 9 Medan in learning buffer solution material so that it makes it easier and provides comfort in the learning process more interesting. Observational evidence suggests that computer-based instructional media, as opposed to traditional teaching methods, are the most attractive options for students.

Media Design and Development

After analyzing the needs, proceed with multimedia design and development. The instructional media design is based on chemistry books and the needs analysis results according to the material components. The media design will be developed through a needs analysis, where the media design will be made in the form of a virtual lab. This media will present learning objectives and teaching materials related to the buffer solution material. This media will also display evaluation questions about learning material. The instrument used in this study was an analytical questionnaire according to the BSNP standards and a test instrument in the form of multiple-choice questions.

Content eligibility, language eligibility, presentation feasibility, and graphic eligibility are all included in the chemistry book assessment questionnaire (teaching materials) for lecturers and instructors. The following options are available on the Likert scale used to assess questionnaire responses: 1) Number 4 means very good/very interesting/very clear/very precise; 2) Number 3 means good/valid/interesting/easy/clear/accurate; 4) Number 2 means not good/not interesting/not easy/not clear/not quite right; and 5) Number 1 means very unfavorable/very unattractive/very unclear/very inaccurate.

Test Instruments

Before starting the research, the researcher developed a multiple-choice acid-base test instrument with 40 questions and five answer choices (a, b, c, d, and e) to cover all measured variables. A chemistry lecturer at FMIPA Unimed is an instrument expert validator before the instrument is used. After the test instrument was declared valid, item validation was carried out on 26 class XII SMA Negeri 9 Medan students. The aim is to do item validation to determine validity, reliability, level of difficulty, and discriminatory power. The following are the results of testing the validity, reliability, difficulty level and differentiating power.

The Product Moment formula measures item validity. The criterion in this validity test is if r-count> r-table, then the item is said to be "valid." For N = 34 at the significance level ∝ = 0.05, an r-table of 0.388 is obtained. Based on the data, 24 questions were found to be valid, while 16 were invalid. It is impossible to conduct research using invalid questions. The valid item items used in the study are questions number 1, 2, 4, 5, 7, 9, 11, 12, 14, 17, 18, 20, 21, 23, 25, 26, 28, 30, 31, 33, 34, 35, 39, and 40. Then, 20 of the 24 valid questions were selected as test instruments for the pre-test and post-test, taking into account the instrument's requirements, indicators, level of difficulty, and differential power.

This study used Kuder Richardson-20 (KR-20) to ensure the validity of the questionnaire. The table of product-moment values shows that the r-table value for N = 32 and at α = 0.05 is r-table = 0.349 while the r-count value = 0.811. The reliability of the item items can be calculated by comparing the r-count and r-table values; because r-count > r-table, it can be concluded that the 23 questions collectively have a high level of reliability, so this test is reliable.

Put, a good rating item balances too easily and too challenging. A test item is said to meet the requirements if the P value ranges from 0.20 to 0.80. If P < 0.20, the test is too difficult; if P > 0.80, it is too easy. The test item difficulty level test results showed that out of 23 valid questions, 4 were obtained as difficult questions, and 19 were moderate.

Descriptive Research Results Data

Before being given each treatment, the two samples were given a pre-test to determine the initial abilities of each student in both classes and to determine the normal distribution and homogeneity of the two classes. In addition, the experimental class learned with the help of the Guided Discovery Adobe Flash Media model, while the control class learned with the help of the Direct Instruction model. Students will take a final exam (post-test) at the end of the learning process to assess their progress after receiving treatment. Table 3 is the result of the pre-test and post-test data normality test.

Table 3.
Pre-test and post-test data normality test

No.	Data	X^2 Count	X^2 Table	Conclusion
1	Experiment Class Pretest	7,466	11,07	Normal
2	Control Class Pretest	10,508	11,07	Normal
3	Experiment Class Posttest	7,471	11,07	Normal
4	Control Class Posttest	10,610	11,07	Normal

Based on Table 3, it is known that the pre-test data normality test for experimental class students obtained (X^2)-count for the pre-test 7.466 by taking the significance level α = 0.05 and dk 5 is 11.07 from the visible data (X^2)-count < (X^2)-table, meaning that the student pre-test data is normally distributed. The pre-test normality test for control class students obtained (X^2)-count for the pre-test 10.508 by taking the significance level α = 0.05 and dk 5 is 11.07 from the data seen (X^2)-count < (X^2)-table, meaning that the data pre-test normally distributed. The normality test for experimental class student learning outcomes obtained (X^2)-count for the post-test 7.471 by taking the significance level α = 0.05 and dk 5 is 11.07 from the data seen (X^2)-count < (X^2)-table, meaning that the data on student chemistry learning outcomes is normally distributed. The normality test for control class student learning outcomes data was obtained (X^2)-count for the post-test 10.610 by taking the significance level α = 0.05 and dk 5 is 11.07 from the data seen (X^2)-count < (X^2)-table, meaning that the data on student chemistry learning outcomes is normally distributed.

Learning Activity Data Normality Test

The results of the calculation of the normality test for learning activity data for both classes are normally distributed or not, so a Chi-Square test is carried out at a significant level a = 0.05; db = 5; $\chi2$ = 11.07 as Chi-square table, with the criteria χ2count < χ2table, then the data is normally distributed. Data from normality test calculation results in both classes can be seen in Table 4.

Table 4.
Normality test of learning activity data

Class	X^2 Count	X^2 Table	α	Information
Experiment	9,14	11,07	0,5	Normal Distribution
Control	9,96	11,07	0,5	Normal Distribution

Based on Table 4, the data from the two experimental classes shows that the value of X2count is smaller than X^2table. In the normality test, if the results of X^2count <X^2table where X^2table is at a significant level α = 0.05; db = 5; X^2 = 11.07, it can be concluded that learning activities in both classes are normally distributed.

Homogeneity Test

The calculation results for the homogeneity test for pre-test and post-test data for both Experimental and Control classes by comparing Fcount and Ftable can be seen in Table 5 below.

Table 5.
Sample homogeneity test

Data source	Class	S^2	F-count	F-table	Information
Pre-test	Experiment Control	159,538 89,370	1,785	1,80	Homogeneous
Post-Test	Experiment Control	30,126 41,890	1,391	1,80	Homogeneous

For the pre-test and post-test values of the experimental class and control class based on the table of values for the F distribution with a significant level α = 0.05 and the numerator, db is 34 and the denominator db is 34 so that the F-table F0.05 (34.34) = 1.80. Because the value of F-count <F-table, it can be concluded that the pre-test and post-test data of the two classes are homogeneous.

The homogeneity test aims to see whether the two data on student learning activities from different samples are homogeneous. Data from the results of homogeneity test calculations can be seen in Table 6.

Table 6.
Homogeneity test of student learning activity data

Class	S^2	F-count	F-table	Information
Experiment Control	43,907 57,049	1,299	1,80	Homogeneous

Based on the table, the value for the F distribution with a significant level of α = 0.05 and the numerator dk 34 and the denominator dk 34 (F-table 34.34) obtained the F-table value of 1.80. The data in Table 6 above shows that both the pre-test and post-test values for Fcount show a smaller number than the F-table, which is 1.299 <1.80. The data is said to be homogeneous if the F-count value <F-table. From the table above, it can be concluded that the pre-test and post-test results in both classes are homogeneous.

Hypothesis Testing

The alternative hypothesis (Ha) for hypothesis I is that the effect of Adobe Flash learning media based on the Guided Discovery model on student learning outcomes is higher than the influence of the Direct Instruction model learning model on learning outcomes in the cognitive domain. Data from the calculation of the first hypothesis test can be seen in Table 7.

Table 7.
Data on hypothesis test results for increased learning outcomes

Class Data		t-count	t-table	Information
Experiment	Control			
$\bar{G}$ = 0,82 S^2 = 0,097	$\bar{G}$ = 0,74 S^2 = 0,118	3,088	1,667	Ha is accepted, Ho is rejected

Based on the hypothesis testing criteria, reject Ho if the t-count is in the critical area. The critical measurement is at t > 1.667. From this calculation, it is obtained that t-count increases learning outcomes by 3.088 and is located in a critical area, then Ha is accepted, and Ho is rejected. This means that the learning outcomes of students who receive Adobe Flash media learning based on the Guided Discovery model are higher than those who use the Direct Instruction model on Buffer Solution material. The study found that the increase in student learning outcomes (gain) in the experimental class was 82%, while in the control class, it was 74%. The result of the difference in increasing learning outcomes between the two classes is 8%.

Table 8.
Results of hypothesis testing activity value data

Class Data	t-count	t-table	Information
Experiment X = 78,690 S = 6,626 S^2 = 43,907 Control X = 69,531 S = 7,553 S^2 = 57,049	5,393	1,668	Ha is accepted, Ho is rejected

Table 8 shows that the t-distribution data obtained t-table = 1.668 while based on calculations obtained t-count = 5.393, meaning that Ho is rejected and Ha is accepted. Based on this analysis, Adobe Flash media is influenced based on the Guided Discovery model on student activities in the Buffer Solution material.

Table 9.
Correlation test of student activities against learning outcomes

Class	Class Data	r-count	r-table	Information
Experiment	ΣX = 2945 $ΣX^2$ = 248825 ΣY = 2754,171 $ΣY^2$ = 218220 Σ XY = 232271,195 N = 35	0,426	0,334	Ha is accepted, Ho is rejected

Table 9 obtains r-count = 0.429 while the r-table at α = 0.05 (N = 35) is 0.334. Because r-count> r-table, Ho is rejected, which means Ha is accepted, meaning that there is a positive and significant correlation between student activity on learning outcomes and the application of Adobe Flash learning media based on the Guided Discovery model on Buffer Solution material. Based on the coefficient, the rcount l;esxf obtained is 0.429, so the meaning of high correlation.

Discussion of Research Results

This research was conducted in class XI MIA 1 and XI MIA 2, SMA Negeri 9 Medan using different treatments, where the learning process in the experimental class (XI MIA 1) uses Adobe Flash media based on Guided Discovery and the control class (XI MIA 2) uses the Direct Instruction learning model.

In the experimental class, students are introduced to challenges they will complete in small groups before being introduced to the Adobe Flash media learning environment and guided exploration methodology. A group of students, guided by their teacher (researcher), will conduct independent research and explore existing material to find answers to the questions posed on the problem analysis sheet. The topic of discussion is the responsibility of each group. Researchers have shown that, at first glance, students are not actively involved in class discussions. This could be because students still need to question how the topic is practiced. To work around this, the teacher facilitates class discussions when students share and analyze the information they get from their groups. The instructor instructs the class about the value of working together and how to maximize their learning in a small group setting.

Classes treated with the Direct Instruction learning approach consist of traditional lecture, discussion, and question-and-answer formats. With this learning paradigm, professors often use it in their lectures. First, a pre-test was given to all students in the experimental and control classes to determine the comparison between the two groups. A homogeneous sample was obtained by selecting items with the same average score from the experimental and control groups in the pre-test. After that, the researcher randomly assigned each class to a unique treatment for four sessions. After students participate in the learning activity, a post-test is administered to evaluate their progress. There was an increase in learning outcomes in the experimental class by 82% compared to the rise of 74% in the control class. Based on these findings, the average learning outcomes of students taught using Adobe Flash media in the Guided Discovery model were greater than those of students acquainted with the Direct Instruction approach.

This is consistent with previous research findings that incorporating Adobe Flash media into the classroom can help students better understand the idea of buffer solutions. The average N-Gain value of the experimental class is 0.65 (Medium Category) compared to the control class value of 0.34 (Medium Category). Students learn more effectively when they develop their knowledge and reasoning through their problems, as required by the Adobe Flash medium; that's how they learn about buffer solution materials and how to apply them to real-world situations.

After the pre-test and post-test were carried out in both classes, prerequisite tests were carried out, namely the Normality and Homogeneity tests on the data obtained. Based on the data normality test carried out using the Chi-Square test, it was found that the pre-test and post-test values of the two sample groups had data (X^2)count <(X^2)table at a significant level of 0.05 and N = 35, so it can be concluded that the data is normal. Then, a homogeneity test was carried out on the results of the pre-test and post-test data for both classes by comparing the F-count and F-table. The F-count pre-test value is 1.785 < F-table 1.80, and the F-count post-test value is 1.391 < F-table 1.80. Because the value of F-count <F-table, it can be concluded that the pre-test and post-test data of the two classes are homogeneous. After the prerequisite test was carried out, hypothesis 1 was tested using a two-party t-test to determine whether there was an effect on learning outcomes using Adobe Flash media based on the Guided Discovery model. From the t-distribution data obtained, t-table = 1.667. Based on the calculations obtained, t-count = 3.088. Therefore, the conditions for

testing the t-count hypothesis are met. This means that Ho is rejected, Ha is accepted, which means that there is an increase in the learning outcomes of students who are taught chemistry using Adobe Flash media based on the Guided Discovery model with students who are taught with the Direct Instruction learning model.

Researchers are interested in using the Guided Discovery paradigm by students in class, and they plan to do this by observing their interactions with Adobe Flash media. Four sessions are dedicated to mastering Adobe Flash media through guided discovery. Because at the first meeting, the experimental class had separated students into small groups and discussed the learning objectives of the buffer solution, participation in visual and verbal activities was still low. Students became more engaged after the second meeting when the instructor presented the material needed to make the buffer solution and answered their questions. The enthusiasm for learning was higher in both the first and second meetings, and students were more involved in class by paying attention to explanations, asking questions, expressing opinions, and listening to the views of their writing partners. In the third meeting, students were still active in discussing, giving responses, and answering questions from friends. In the fourth meeting, the students gave feedback on how the reaction process of the buffer solution occurs in the human body.

The average assessment of student activity obtained an average of 4 meetings for the experimental class of 78.690 for the control class of 69.531. In hypothesis 2, namely knowing whether the use of Adobe Flash media based on the Guided Discovery model has an effect, a hypothesis test is carried out. Based on the hypothesis test obtained from the t-distribution data, t-table = 1.668. While the calculation received a t-count = 3.088, the results obtained by Ho was rejected. Ha was accepted, meaning Adobe Flash media was influenced based on the Guided Discovery model on student activity in the Buffer Solution material.

In hypothesis 3, a correlation test was carried out on Adobe Flash learning media based on the guided discovery model. Thus, r-count = 0.429 was obtained, while the r-table at $\alpha = 0.05$ (N = 35) was 0.334, so Ha was accepted. This means a relationship exists between activity and student learning outcomes with Adobe Flash learning media application based on the Guided Discovery model on Buffer Solution material. It is evident from the involvement of students in teaching and learning activities that their scientific literacy is encouraged and increased; many students are interested in the content offered because it is always relevant to their lives. Student activity accounts for only 18.1% of the variance in learning outcomes, while other variables contribute to the remaining 81.9%. This is supported by the significance of the correlation coefficient r = 0.426. The researchers said the student's high cognitive abilities and clear, easy-to-understand presentation of material played a role in students' final grades.

Therefore, based on the results of research conducted at SMA Negeri 9 Medan, it can be concluded that there is an influence on learning outcomes and student activities when using Guided Discovery Based Adobe Flash media on Buffer Solution material for class XI, and these student activities contributed to a consistent learning outcome of 18.1%. Meanwhile, 81.9% was caused by a lack of student interest in participating in teaching and learning activities, time allocation for implementation, and teacher willingness.

CONCLUSION

The application of Guided Discovery learning media with Adobe Flash media can improve student learning outcomes in the experimental class compared to students taught with the Direct Instruction model. The Guided Discovery learning model with Adobe Flash media can influence student activity in the experimental class compared to students taught using the Direct Instruction model. The relationship between student activity and learning outcomes by applying the Guided Discovery model with Adobe Flash media is highly correlated. One of the primary contributions of this research is the demonstration that the application of the Guided Discovery learning model with Adobe Flash media can significantly improve student learning outcomes student learning outcomes in complex subjects such as chemistry. This research emphasizes the importance of technology integration in education, highlighting the role of multimedia tools in enhancing the learning experience. This study also underscores the need for student motivation and involvement in the learning process. These findings suggest that policymakers should provide student-centered learning models and technology integration resources to improve the quality of education. The effectiveness of this model shows the potential for long-term impact on student understanding and retention of chemistry concepts.

Teachers and prospective teachers should master the Guided Discovery learning model with Adobe Flash media, manage time effectively, and have more observers to provide a more mature assessment of student activities. Several research limitations and suggestions for future research include: First, this research was conducted in a specific school and focused on chemistry education. Future studies should consider diverse educational institutions, student populations, and subjects to improve the generalizability of the guided discovery model with Adobe Flash across various settings. Second, the research measured learning outcomes in a relatively short period. Future research should explore the long-term retention of knowledge and skills acquired through the guided discovery approach to assess its sustainability over time. Third, the research utilized Adobe Flash, a technology that has become less prevalent due to evolving standards and the discontinuation of Flash support. Future research should explore the effectiveness of newer educational technologies and platforms to stay current with technological advancements. Fourth, while the research addressed student activity, it did not delve deeply into student motivation. Future research could explore the role of motivation and its impact on learning outcomes when using the guided discovery approach.

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