Application of Scientific Approach-Based Learning Assisted by Question Cards and Ladder Snake Media for Evaluating Learning Outcomes

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Abstract: This study aims to determine the differences in student learning outcomes by applying to learning using question cards and snakes and ladders media through a scientific approach to the topic of acid-base discussion. Ultimately, the evaluation of improving the learning outcomes of students by learning using question cards and ladder snake media through a scientific approach to the topic of acids and bases is reported in this study. The population in this study were all students of class XI MS SMA Negeri 20 Medan, total three classes. The sample was taken by purposive sampling in two classes. The first class was experimental I, taught using a scientific approach using question cards, and the second class was experimental class II, conducted using a scientific approach using snakes and ladders. Each experiment class consists of 32 students. The research instrument was a multiple choices objective test instrument of 25 questions which had been tested for validity, reliability, discriminating power, and level of difficulty for learning outcome data. Test the first hypothesis using a two-party t-test, and SPSS 21 (independent samples t-test) results obtained for experimental class I with a t_{count} value of $32.320 > t_{table}$ 1.70. In contrast, the experimental class II has a t_{count} value of $31.231 > t_{table}$ 1.70 at a significance level of $0.000 < 0.05$. The second hypothesis test using the proper side t-test and in SPSS 21 (paired samples t-test) obtained a mean of 5.000 and a t-test value of 2.648 with a sig value of 0.010 <0.05.

Keywords: Scientific approach; Snakes and ladders media; Topic of acids and bases; Question card media

Introduction

Chemistry learning is one of the fields that is difficult to understand, including concepts and their applications (Anisa, 2012). If analyzed from the characteristics of natural science, chemistry is an experiment-based learning, which means students do not only study by listening and reading (Addiin, 2014). Most students agree that solving problems in chemistry is complex and requires understanding concepts (Tsaparlis, 2020).

Based on the chemistry teacher interviews at SMA Negeri 20 Medan, most of the students' chemistry learning outcomes were still below the minimum completeness criteria, namely a score of 70 for class XI. It probably happened because the students had not fully followed the lesson. In addition, the results of observations in the Field Experience Program at SMAN 20 Medan showed that 90% of teachers still taught conventionally and rarely used instructional media.

The continuous application of conventional learning causes students to only act as listeners, receive all information, and carry out all teacher instructions. Therefore, students are passive in the learning process in class (Djamarah & Zain, 2006). Therefore, one of the reasons for issuing the 2013 Curriculum is to minimize the role of the teacher or school and add the part of students as involved parties in learning activities

(Addiin, 2014). The 2013 curriculum emphasizes a scientific approach to every lesson (Wardani, et al, 2015). The scientific approach is one of the teaching strategies using scientific steps in teaching and is ideally applied in high schools in Indonesia. A scientific approach is an approach that can help students think critically as well as be active in solving a problem, according to the 2013 curriculum targets (Zaim, 2017) dan (Wulandari, et al, 2015). The scientific approach to learning includes components: observing, asking, reasoning, trying to create, and communicating (Priyatni, 2014). Azizah, et al (2014) evaluated that the scientific approach can improve student learning outcomes obtained in cycle I by 62 and increased in cycle II by 71. This shows that the increase in student learning outcomes is due to the application of the scientific approach.

One of the topics of even semester learning for class XI SMA Negeri 20 Medan is acids and bases. Topics about acids and bases studied include the basic theory of acids and bases and calculations of the pH of solutions. Therefore, this fundamental topic of acids and bases is rote and calculating and requires a high conceptual understanding (Lestari, et al, 2014). In this study, the students learned the topic of acids and bases using the media of question cards and snakes and ladders. The application of learning media in games increased student learning motivation (Palupi, et al, 2016). Another study showed that learning using snakes and ladders media increased student activity and learning outcomes (Mulasiwi, 2013). Snakes and ladders game is a board game for children with two or more players (Widiana, et al, 2019). According to Novitasari, et al (2013), each player starts with his piece in the first box (usually the box in the lower left corner) and takes turns throwing the dice. Notably, the use of snakes and ladders media in learning can improve student learning outcomes (Widowati, 2014).

The question card media is equipped with chemistry questions, which students will answer these questions (Rositawati, et al, 2015). The question card media is effectively used to practice questions for students. Students work on the questions on the question cards and then write down the answers on the cards provided. The application of question card media can be referred to as a game in a lesson that will eliminate boredom and create a competitive condition (Astuti, 2012).

Research conducted by Qurniawati, et al (2013) reported that cooperative learning of the numbered head together type with question card media was more effective for increasing student achievement, where the experimental class (59.50) was higher than the mean difference between the post-test and pretest cognitive aspects of the control class (52.68). The study's results Astuti (2012) described that using question card media

increased student achievement in experimental class I by cognitive pretest-posttest scores of 23.24, while experimental class II was cognitive pretest-posttest scores of 27.97. The research of Perdana, et al (2014) also showed that question cards increased student achievement, which can be seen from cycle I 51.85% to 77.78% in cycle II. Amiroh, et al (2015) analyzed that the learning numbered head together accompanied by question cards showed an increase in learning achievement in cycle I by 51.61%, increasing to 77.42% in cycle II. Rositawati, et al (2015) reported that using the TAI model supplemented by question card media increased student achievement from 72.2% in cycle I to 86.1% in cycle II.

Seftina (2012) reported an increase in student learning outcomes of 97.14% by using snakes and ladders media. Moreover, Palupi, et al (2016), analyzing the learning method of team games tournaments equipped with snakes and ladders provides better learning achievement in cognitive aspects. Widowati (2014) also supports this study, who reported that using snakes and ladders media can improve student learning outcomes, in cycle I 68.75% increasing to 81.25% in cycle II. This study reports the application of learning based on a scientific approach assisted by question cards and snakes and ladders media to evaluate differences in learning outcomes on the topic of acids and bases.

Method

Research design

This study used the one group pretest-posttest design. The samples were divided into two groups, namely group I (experiment I) by applying a scientific approach using question cards as media, and group II (experiment II) by applying a scientific approach using snakes and ladders as media, described in detail in Table 1.

Tabel 1. Research design

Grups	Pre-test	Treatment	Post-test
Experiment I	T1	X1	T2
Experiment II	T1	X2	T2

Here, T1 is the initial test of experiments I and II, X1 is learning chemistry with a scientific approach and question card media, X2 is learning chemistry with a scientific approach and snakes and ladders media, and T2 is the final test for experimental classes I and II.

Research participants

This research was conducted in class XI SMA Negeri 20 Medan, North Sumatra. This study's population were all class XI students in the 2016/2017 academic year, total 32 students per class. The sample in

this study was taken using a purposive sampling technique, namely taking two class samples from 3 classes by directly determining the class, namely XI-MS 2 and XI-MS 3 and started by giving a pretest to the two experimental classes. A pretest was conducted one week before the implementation of learning to determine students' initial abilities and the homogeneity of students in the two experimental classes. After taking the sample, the students were then divided into several heterogeneous groups consisting of 4-5 students in each group. The first class was used as the experimental class I, namely learning using question card media through a scientific approach, and the second class was used as the experimental class II, which was carried out using snakes and ladders media through a scientific approach. Students were given student worksheets in both experimental classes to complement learning outcomes.

Research variable

Variables in this study include (1) independent variables: media question cards and snakes and ladders through a scientific approach, (2) dependent variables: student learning outcomes, and (3) control variables: gender, ethnicity, and level of intelligence.

Research tools

Research tools originating from the subjects of the researchers' designs, and reviews of previous research and literature related to research by researchers are an important part of preparing learning materials and test instruments with the topic of acids and bases that will be applied to scientific approach-based learning assisted by question cards and ladder snake media.

1) Educational materials

Question card media is used to increase learning interaction and understanding of the concept of Chemistry topic. The question card media is made using manila paper or the like with a size of 10 cm x 15 cm. The teacher explains the core material following the teaching materials provided. After the teacher explains, students and their groups are given question cards, each containing questions that have been asked. At the end of the lesson, each group presented discussion results for comparison according to their level of understanding.

Snakes and Ladders media is a game that uses dice to determine how many steps a piece must take. Board is a grid picture consisting of 10 rows and ten columns with numbers 1-100, as well as a picture of a snake and a ladder. This snakes and ladders game is light to carry, easy to understand due to simple game rules, and educates and positively entertains kids. The snakes and ladders game helps increase students' physical-motor, language, intellectual, moral, social, and emotional

development so that the games become a fun learning medium and develop students' attitudes about rules.

2) Learning outcomes test

The test instrument used in this study was a test of students' chemistry learning outcomes, namely the pre-test and post-test. The pre-test was given to both sample classes before treatment to know homogeneity and normality or the similarity of the characteristics of student's initial abilities. After the treatment process (treatment), a post-test is given to know the results of students' chemistry learning. The form of the students' chemistry learning outcomes test is multiple choice of 25 questions, which are arranged with five answer choices, namely A, B, C, D, and E. The number of questions used for research is organised based on topic indicators. The scoring technique for the learning outcomes instrument, namely, the correct answer, is given a score of 1, while the wrong answer is given a score of 0, and the assessment is objective. The test items are designed to cover four cognitive areas according to Bloom's taxonomy, namely aspects of knowledge (C1), understanding (C2), application (C3), and analysis (C4). Forty multiple-choice questions were prepared before the item feasibility test to evaluate the quality of the questions. Three expert validators (Lecturers of Chemistry, FMIPA, Universitas Negeri Medan) validated the 40 questions, followed tested on class XII students at SMA Negeri 20 Medan to determine the validity, reliability, difficulty level, and differentiability of the test instrument. The results of testing the validity, reliability, level of difficulty, and differential power of the test are explained in detail.

a) Validity test

Analysis of the validity of the test is used to examine the test instrument from a technical perspective, content and level of accuracy of a trial. In this study, validation of the contents of the test instrument was carried out by an expert validator. Meanwhile, to measure the validity of each test item conducted on students. The number of students (N) who are the object of analysis is 32 people. The validity test was measured by product-moment correlation. It showed that the 28 questions tested were valid, so valid questions were selected to be used in the learning outcomes test instrument.

b) Reliability test

Reliable tests are used to obtain the stability of the measuring instrument, providing consistent results for extended use. After the questions are valid, then do the reliability test. All valid items were tested for reliability using the Kuder and Richardson 20 (KR-20) tests, and an

r count of 0.868 was obtained. A total of 28 questions tested have a high level of reliability.

c) Difficulty Level

Analysis of the test's level of difficulty is used to determine which test items are in the easy, medium or difficult categories. The easy difficulty interval was P of 0.71-1.00, the medium was P of 0.31-0.70, and the difficulty was P of 0.00-0.30. The difficulty level test results showed that eight items were easy and 20 items were medium.

d) Different power test

The different power of the test is the ability of the items to distinguish between proficient and less experienced students. The instrument is declared eligible if the value of D ranges from +0.2 to +1.0. Based

on the calculation of the different power, 28 items were obtained: (1) seven items were classified as having good different power, (2) eighteen items were classified as sufficient different power, (3) three items were classified as poor different power (not used).

Based on the results of testing the validity, reliability, level of difficulty, and different power that has been described, 25 questions are obtained that are valid, reliable, and meet the requirements at the level of difficulty and different power used in this study.

Result and Discussion

The results of calculating statistical data on student learning outcomes in the experimental class I and II are summarized in Table 2.

Table 2. Description of the statistical data of student learning outcomes in experimental class I.

Class	N	Min. score	Max. score	Sum	Mean	Standard deviation	variance
Pretest Experimental I	32	16	44	940	29.38	8.717	75.984
Posttest Experimental I	32	68	100	2736	85.50	7.92	62.71
Gain Experimental I	32	.58	1.00	25.48	.7963	.1078	.012

Table 4.2 clearly shows the mean (average) pretest score of experimental class I students was 29.38 with a standard deviation of 8.71 while for the an average value of posttest data of 85.50 with a standard deviation 7,92. It indicated that in the experimental class I taught with the media of question cards with a scientific approach, the average learning outcomes increased, which can be

seen from comparing students' pretest and posttest scores. Then obtained an increase in student learning outcomes (Gain) with an average of 0.7963 and a standard deviation of 0.1078, indicating an increase in student learning outcomes after being taught with question card media with a scientific approach.

Table 3. Description of the statistical data of student learning outcomes in experimental class II.

Class	N	Min. score	Max. score	Sum	Mean	Standard deviation	variance
Pretest Experimental I	32	16	44	888	27.75	8.617	74.258
Posttest Experimental I	32	64	96	2576	80.50	7.166	51.355
Gain Experimental I	32	.53	.94	23.38	.7306	.09602	.009

Table 3 shows the results of the description of experimental class II student data where the average (mean) pretest score of experimental class II students was 27.75 with a standard deviation of 8.617, while the posttest average value was 80.50 with a standard deviation of 7.166. It shows that the application of learning using snakes and ladders media with a scientific approach increases the average learning outcomes, it can be seen from the comparison of students' pretest and posttest scores. The increase in student learning outcomes (Gain) is 0.7306 with a standard deviation of 0.09602 indicating a significant increase in learning outcomes. The comparison of the average value of students' learning outcomes of experimental classes II and I can clearly be seen in Figure 1. The graph shows that the average value of students' chemistry learning outcomes in experimental class I is

higher than that of experimental class II. These results indicate that teaching acid-base materials at SMA Negeri 20 Medan is better using question cards with a scientific approach compared to using snakes and ladders media.
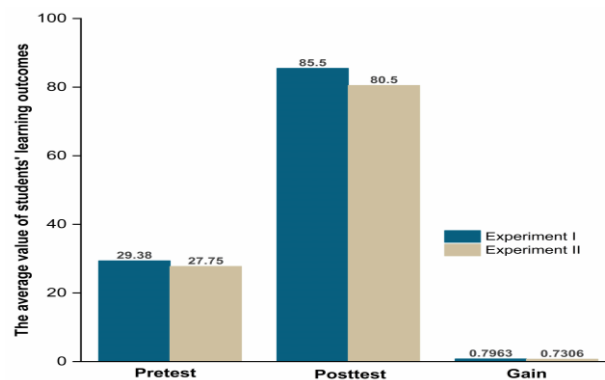
Figure 1. Graph of Students' Chemistry Learning Outcomes

The pretest and posttest data for both sample classes were subjected to the Lilliefors test at the significance level = 0.05 to evaluate the distribution of the data (normal or not), detailed in Table 4.

Table 4. Homogeneity Test of Student Learning Outcomes Data

Data	Classes	s^2	F_{count}	F_{table}	Conclusion
Pre test	Experiment I	75.984	1.023	1.840	Normal Distribution
	Experiment II	74.258			Normal Distribution
Post test	Experiment I	62.710	1.221	1.840	Normal Distribution
	Experiment II	51.355			Normal Distribution

* s^2: the variance

Table 4 describes that (1) at the level α = 0.05 with dF1 = n_1 - 1 = 32 – 1 = 31 and dF2 = n_2 – 1 = 31 from the list of percentiles for the F distribution, it is obtained $F_{0.05 (31;31)}$ or F_{table} = 1.84. Because $F_{count} < F_{table}$ is 1.023 < 1.830, it is concluded that the pre-test data between the two groups of students has a homogeneous variance (standard deviation, SD 1 is the same as SD 2), (2) because $F_{count} < F_{table}$ is 1.221 < 1.830, it is concluded that the posttest data between groups of students taught by the scientific approach using question cards as media (experiment I) and those taught using a scientific approach using snakes and ladders as media (experiment II) have a homogeneous variance (standard deviation, SD 1 is the same as SD 2).

Next, data on student learning outcomes that are normally distributed and homogeneous are tested on the hypothesis using a two-tailed statistical test (supported by SPSS 21). This test used an independent sample t-test. This test determined whether this study's hypothesis is accepted or rejected. Test criteria if $t_{count} > t_{table}$, then the alternative hypothesis is accepted, and the null hypothesis or the null hypothesis is rejected.

Table 5. First hypothesis test on student learning outcomes

Data	Mean	Manual count		Description	Mean	Sig.	SPSS	Description
		t_{table}	t_{test}				t_{test}	
Pretest	1.625	2.00	0.750	H_o	1.625	0.456	0.750	H_o
Posttest	5.000	2.00	2.648	H_a	5.000	0.010	2.648	H_a

From the data in Table 5, the calculated t_{value} is greater than the t_{table}, so H_o is rejected. It means that there are differences in chemistry learning outcomes for students who receive learning using question cards through a scientific approach and snakes and ladders through a scientific approach to acids and bases topic in class XI SMA Negeri 20 Medan.

After evaluating the student learning outcomes data that the data is normally distributed and homogeneous, then a hypothesis test is carried out using one-sided statistical tests, namely the right-sided t-test (supported by SPSS-21). This test was carried out using a paired sample t-test. This test evaluates the hypothesis in this study is accepted or rejected. Test criteria if tcount > ttable, then the alternative hypothesis is accepted, and the null hypothesis or the null hypothesis is rejected (See Table 6).

Because the value of the tcount is greater than the ttable, then Ho is rejected, meaning that there is an increase in the learning outcomes of students who receive learning using the media of question cards through a scientific approach and media of snakes and ladders through a scientific approach to the topic of acids and bases in class XI SMA Negeri 20 Medan.

Table 6. Second hypothesis test on student learning outcomes

Classes	Analysis	Data	
		Manual count	SPSS
Experiment I	Mean	56.125	56.125
	t-test	32.320	32.320
	T_{table}	1.70	-
	Sig.	-	0.000
Experiment II	Mean	52.750	52.750
	t-test	31.231	31.231
	T_{table}	1.70	-
	Sig.	-	0.000

The results of the research data processing showed that (1) the learning outcomes of students in experimental class I, which was taught using the media of question cards and experimental class II, which was taught using the ladder teaching media, showed differences in learning outcomes. The research data shows the mean value was 5.000, and the two-party t-test was 2.648 with a sig value of 0.010. (2) The learning outcomes of students in experimental class I who were taught using the question card media were higher than those taught using the snakes and ladders media in experimental class II. The group of students in the experimental class I has higher learning outcomes than in experimental class II. The result of the t-test for the

right side of the experimental class I was 32.320 with a sig value of 0.000, while the experimental class II had a t-test value of 31.231 with a sig value of 0.000. In addition, the mean and standard deviation values were 56.125 and 9.823 in experimental class I, which were higher than those in experimental class II, which were 52.750 for the mean and 9.555 for the standard deviation.

The use of the question card media shows a more innovative way of student learning because, in the question card media, students are more motivated to answer the questions on the question cards. Different results are shown by the way students learn using snakes and ladders media. Students who use snakes and ladders media are more dominant in playing and tend to be noisier. These results showed that question card media is better than snakes and ladders.

The average student learning outcomes show the success of using the question card media through a scientific approach in experimental class I. Before treatment, the average pretest results obtained by the students were 29.38, while the average pretest scores of students in experimental class II were 27.75. After the learning treatment was carried out with a scientific approach where the experimental class I was taught using the question card media, the student learning outcomes increased by an average of 85.50. At the same time, the learning outcomes of students taught using snakes and ladders media in experimental class II showed an average of 80.50. This result proves that using question cards through a scientific approach is better used in teaching acid-base topics than using snakes and ladders through a scientific approach.

The application of learning with a scientific approach causes students to become more active in learning. These results are by Azizah, et al (2014) which states that the scientific approach can improve student learning outcomes obtained in cycle I by 62 and increased in cycle II by 71. These results are also based on the theory of a scientific approach which emphasizes students providing hands-on experience directly either by observation, experiment, interview or other means so that it is realistic to seek new information and the results can be accounted for. Therefore, this result means that the teacher provides opportunities for students to be more active in learning.

In another study, Qurniawati, et al (2013) stated that cooperative learning of the Numbered Head Together type with question cards was effective in increasing student achievement where the experimental class (59.5000) was higher than the average difference between the post-test and pretest cognitive aspects of the control class (52.6786). The study's results by Astuti (2012) stated that using question cards media could improve student achievement, where the experimental class I had a cognitive pretest-posttest difference of 23.24

while the experimental class II had a cognitive pretest-posttest difference of 27.97. The results of this study conducted at SMA Negeri 20 Medan are almost the results of Perdana, et al (2014), which shows that the use of question cards can improve student achievement, as seen from the first cycle 51.85% to 77.78% in the second cycle II. Amiroh, et al (2015) showed almost the same results as the researcher's research, that Numbered Head Together learning accompanied by question card media showed an increase in learning achievement in the cycle of 51.61%, increasing to 77.42% in the second cycle. This study can be compared to the research results of Rositawati, et al (2015), where the use of the Team Assisted Individualization model supplemented by question cards media increased student achievement seen, from 72.2% in cycle I increased to 86.1% in cycle II.

The results of statistical analysis indicate that learning by using question cards through a scientific approach (experimental class I) further improves student chemistry learning outcomes, rather than learning using snakes and ladders media through a scientific approach (experimental class II), as evidenced by the results of the t-test right side of the experimental class I was 32.320 with a sig value of 0.000. In contrast, the experimental class II had a t-test value of 31.231 with a sig value of 0.000. In addition, the mean or average student learning outcome of 56.125 in the experimental class I was higher than the experimental class II, which was 52.750.

Conclusion

The results of the analysis carried out in this study showed significant differences in the learning outcomes of students who received learning using the media of question cards and snakes and ladders through a scientific approach. The difference in learning outcomes can be seen from the mean of 5.000, t-test value of 2.648 and a sig. value of 0.010. Improving the learning outcomes of students who receive learning using the media of question cards and snakes and ladders through a scientific approach. The experimental class I has a t_{count} of 32.320 > t_{table} of 1.70, while the experimental class II has a t_{count} of 31.231 > t_{table} of 1.70.

Conflicts of Interest
The authors declare no conflict of interest.

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