Effectiveness of Retrieval Practice Learning Strategy in the Memory Storage Process to Improve Students Learning Outcomes on Cell Structure and Bioprocesses

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Abstract: This study aims to determine the effect of the implementation of retrieval practice learning strategies in students learning outcomes on the material Structure and Cell Bioprocesses. The research method used was quasi experimental. The research subject were students of XI IPA, public senior high school in Palembang. The research instruments used were test questions and observation sheets. Learning outcomes data were analyzed with the independent sample t-test on the Statistical Program for Social Science 26 (SPSS version 26). The results showed that both the experimental class and the control class experienced an increase in learning outcomes from the initial test results. The average learning outcomes of the experimental class (retrieval practice) (41.11) are proven to be higher than the control class (32.24). In addition, the N-gain obtained by the experimental class is 0.05 and the control class is 0.10 which is in the low category. Moreover, the results also show that the experimental and control class students have not reached the master learning. These results show that both experimental and control classes get an increase in learning outcomes that are not optimal. However, the retrieval practice learning strategy still provides benefits for improving student learning outcomes.

Keywords: Learning outcomes; Retrieval practice learning strategies; Structure and cell bioprocesses

Introduction

Learning is an effort made by a person in order to be able to obtain changes in new behavior as a whole resulting from his own experience in interacting with the environment (Basir, 2017). Learning is one of the obligations for students to implement it. Students are expected to study well in order to obtain the desired behavior change according to the learning objectives themselves (Parnawi, 2020). In a learning activity there are two important aspects that need to be considered, namely learning outcomes in the form of changes in behavior in students and learning outcomes in the form of a number of intellectual, emotional, and physical experiences in students (Fathurrohman, 2012).

Each individual has different learning abilities (Turhusna et al., 2020) because they are influenced by many factors. One of the factors is that the memory capacity of each individual varies (Anita et al., 2016). This very diverse memory capacity factor must be dealt with by choosing a good learning strategy to minimize unsatisfactory learning outcomes. Good learning strategies should also be of more concern to teachers in carrying out learning and teaching activities (Purwitasari, 2019).

Based on the research results of Zuyadi et al. (2018), it was found that the learning strategies applied by the teacher were too monotonous. The teacher lacks control over classroom management. The teacher's attention is often focused on only a few students. While other students did not get enough attention, so there were

students who took breaks, were negligent, talked to friends and even joked. If this continues to happen in the study room, it will most likely affect student learning outcomes (Pamela et al., 2019).

The teacher as an educator must be able to identify all that is related to the learning process he is carrying out (Yestiani et al., 2020). Things that need to be known such as who will be the students, the various levels of intelligence of students, what background they come from, how motivated, and so on. Educators cannot achieve the learning objectives, namely how students are able to understand all the material that has been presented if they have not identified things about students (Budiastuti et al., 2021). Therefore, educators must prepare and strategize before and after the lesson begins. According to Liansari et al. (2020) learning strategies have meaning as patterns of learning activities that are selected and used by educators contextually, according to the characteristics of students, school conditions, the surrounding environment and the learning objectives that have been formulated. It aims to improve student learning outcomes.

According to Muliyana (2016) student learning success is an indicator of the quality of an education. Learning success can be measured by the extent to which students master the concepts in the material that has been studied (Hasan, 2015). Retention factors or storage of concepts in memory receive less attention (Arianti, 2017). Learning is not measured only in mastery of concepts, but needs to be analyzed whether the concepts being taught can be stored in students' memories or quickly forgotten (Rahman, 2002). Students will be able to store information that is encoded with right in memory (Sujarwo et al., 2017). Stored information with coding which are both easier to access and use to conceptualize or solve problem. Exist close relationship between memory and learning. Process learning involves processing and information storage (Akhiruddin et al., 2020). According to Atkinson et al. (2010) the process of storing in memory human, there three level: (1) The process of processing information in memory starts from the process of encoding information (*encoding*) refers to the way individuals transform information from the environment into a kind of mental representation in memory. (2) Information storage (*storage)* which refers to the way an individual retains information already stored in memory. (3) Re-disclosure of information that has been stored in memory (*retrieval*) refers to how individuals gain access to information already stored in memory.

The third stage of information storage, namely *retrieval* can be used as an effective learning strategy. Effectiveness *Retrieval Practice* in the learning process has been done before by several researchers. Study strategy *retrieval practice* or what is often referred to as *testing effect* has been proven to be effective in increasing student learning outcomes and the ability to store memory in the long term, such as research conducted by Roediger et al. (2006) which states that *repeated-test* and *re-presentation* can improve learning in long-term memory storage when compared to just doing *re-study*. *Retrieval practice* with Quiz improve learning outcomes in the classroom (Agarwal, 2019). Further research on *retrieval practice* and generate that *retrieval practice* with feedback (*feedback)* produce greater benefits for students with lower working memory capacities (Agarwal et al., 2017) learning Strategies *retrieval practice* using HOTS questions combined with fact knowledge questions can improve higher-order thinking skills (Agarwal et al., 2013). Besides that, *retrieval practice* can also increase relative retention for repeat learning (Karpicke et al., 2016).

Based on the description above it is known that *retrieval practice* useful in improving student learning outcomes. However, researchers have not revealed how the implementation *retrieval practice* in improving learning outcomes Biology subjects, especially material on cell structure and bioprocesses. Therefore, researchers are interested in conducting a study entitled **"**Effectiveness of Learning Strategies *Retrieval Practice* in the Process of Memory Storage to Improve Learning Outcomes of Class XI High School Students on Cell Structure and Bioprocesses**"**.

This research was conducted on cell structure and bioprocess materials in KD 3.1 cell structure and bioprocess materials. This material was chosen because the material has many concepts that students need to always remember. This material also contains many terms that need to be understood, and is material that forms the basis for knowledge of biological material. This study aims to determine whether the learning strategy *retrieval practice* can help students in the process of storing memory during the learning process, especially in the structure and function of cells so that it can improve student learning outcomes.

Method

This research was conducted in the eleventh grade of State, a public Senior High School in Palembang (2021/2022). The samples used were 2 class XI SMA for the experimental class and the control class. To determine the research sample using the technique *random sampling*. This study uses a class sample XI IPA 3 as an experimental class that receives treatment using learning strategies *retrieval practice* and class samples XI IPA 4 as a control class that did not receive treatment.

This research is a quantitative study using quasi-experimental methods (*Quasi Experimental Method*). The research design used in this study is *pretest-posttest* which uses an experimental group and a control group or can be called as well *experiment design type prestest postest control group design* done 2 times *posttest.* The design of this study can be described in Table 1.

Table 1. Pretest-Posttest Control Group Design

O_1	X	O_2	O_5
O_3	Y	O_4	O_6

Information:
O : Pretest = Posttest
X : Treatment of learning strategies retrieval practice
Y : Treatment does not use learning strategies retrieval practice

Result and Discussion

This research is quantitative research with quasi-experimental methods (Quasi Experimental Method) by design pretest-posttest. This research was conducted in two XI IPA classes, namely XI IPA 3 as the experimental class and XI IPA 4 as the control class. The research subjects in class XI IPA 3 totaled 27 people and class XI IPA 4 totaled 29 people.

The research aims to find out how the influence of the application of learning strategies retrieval practice in the memory storage process for student learning outcomes in the biology subject of Cell Structure and Bioprocess material at a public Senior High School in Palembang. Application results retrieval practice in learning biology at a public Senior High School in Palembang is described as follows.

Measurement of learning outcomes is done by doing *pretest* and *posttest* in the control class and the experimental class. The questions used were in the form of multiple-choice questions of 20 questions. The average value of student learning outcomes can be seen in Table 2.

Table 2. Average Value of Learning Outcomes

Class	Mark	
	Initial test	Final test
Experiment	36.48	41.11
Control	21.90	32.24

Based on Table 2 it is known that there is an increase in learning outcomes between the initial test scores (pretest) and final test results (posttest) in each class, namely the control class and the experimental class. The results of the initial test in the control class obtained an average learning result of 21.9 while the experimental class was 36.48. In the final test the control class obtained an average learning result of 32.24 while the experimental class was 41.11. The results of the final test showed that both the experimental class and the control class experienced an increase in learning outcomes from the initial test results. The distribution of student scores based on learning outcomes in the control class and experimental class is shown in Table 3.

Table 3. Categories of Pretest and Posttest Scores

Class	Category	Pretest		Posttest I		Posttest II	
		Amount participant educate	%	Amount Participant educate	%	Amount Participant educate	%
Experiment	Very high	0	0	0	0	0	0
	Height	0	0	1	3.70	1	3.70
	Currently	0	0	2	7.40	2	7.40
	Low	5	18.50	7	25.90	8	29.60
	Fail	22	81.40	17	62.90	16	59.20
Control	Very high	0	0	0	0	0	0
	Height	0	0	0	0	0	0
	Currently	0	0	1	3.40	2	6.80
	Low	1	3.40	3	10.30	11	37.90
	Fail	28	96.50	25	86.21	16	55.10

Based on Table 3, the trend of results *pretest* students is in the failed category, both in the experimental class and the control class. In the control class there were 28 people (96.55%), while in the experimental class there were 22 people (81.48%) who were in the failed category. These results indicate that the percentage of students in the failing category is higher in the control class when compared to the experimental class. In the control class there were 3.45% of students who were in the low category while in the experimental class there were 18.52%. In addition, in the control and experimental classes there were no students who were in the very high, high or medium categories.

Different from *pretest*, on the results *posttest* I distribution of data distributed in the category of high, medium. low or fail. The percentage of students in the high category is only found in the experimental class. In the control class there were no students who were in the

high category while in the experimental class there was 1 person (3.70%) who was in the high category. Results *posttest* I, also shows that the percentage of students in the experimental class who are in the medium category (7.40%) is higher when compared to the control class (3.45%), on the other hand the percentage of students in the failed category is found to be higher in the control class (86 .21%). These results indicate that applicability *retrieval practice* further improve student learning outcomes in the experimental class when compared to the control class.

Based on the final test scores, the percentage of students' learning completeness was calculated based on the values applied at a public Senior High School in Palembang Palembang, namely students were said to have completed their studies if they obtained a score of ≥ 75, so in the final test in the experimental class there were no students (0%) who successfully completed.

To measure the ability of students to store information in long-term memory is carried out *posttest* II, with a deadline of one week. Results *posttest* II shows that in the experimental class the percentage of students who are in the high and medium categories are the same as the results found in *posttest* I. While there was a reduction in the number of students in the failed category by 3.7%. These results indicate that students still remember and are able to retrieve information stored in memory regarding Cell Structure and Bioprocess material (Fatmah et al., 2023). Value results *posttest* II shows the average learning outcomes of the experimental class are higher than the control class. The experimental class obtained an average of 44.63 and the control class 43.1. However, the control class got a greater increase in learning outcomes when compared to the experimental class. Even so, the experimental class still had higher learning outcomes than the control class, this indicated that students in the experimental class had the ability to understand Cell Structure and Bioprocess material better than the control class. A comparison picture of the learning outcomes of control and experimental class students is shown in Figure 1.

Figure 1. Comparison of the learning outcomes of the experimental class and the control class

Results of Learning Outcomes Hypothesis Test

Prior to testing the hypothesis to determine the significance of data on student learning outcomes by applying learning strategies *retrieval practice*. First, the normality test and homogeneity test were carried out. If the criteria for the normality test and homogeneity test have been fulfilled, then the test is carried out *Independent Sample T-test* through the SPSS 26 Program .

Normality Test Results

The data normality test was carried out to find out whether the data obtained was normally distributed or not. Data analysis was carried out by testing *Shapiro wilk* using the SPSS application version 26. The results of the normality analysis of learning outcomes data are shown in Table 4.

Table 4. Results of the Normality Test of Learning Outcomes

Class	Shapiro-wilk		
	Statistic	df	Sig.
Experiment	.95	27	.26
Control	.96	29	.39

Based on the data output in Table 4, it is known that the significant value (Sig) for all data is based on the test shapiro-wilk > 0.05. So, it can be concluded that the research data in the experimental class and control class are normally distributed. The next test was carried out homogeneity test.

Homogeneity Test Results

The homogeneity test was carried out using the SPSS version 26 program, namely by using a test Leveine. The homogeneity test has the aim of knowing whether a data variation posttest experimental class and data posttest control class is homogeneous (same) or heterogeneous (not the same). Homogeneity test proves that the data posttest the results of the study of the two groups measured were homogeneous. The results of the analysis of the homogeneity test of learning outcomes data can be seen in Table 5. Based on the output in Table 5, it is known that the significance value (Sig) Based on Mean is 0.19 > 0.05. So, it can be concluded that the variance of the data posttest experimental class and data posttest control class is homogeneous or the same. Therefore, it can be done to test the hypothesis.

After proving that the data from the two groups were normally distributed and homogeneous, a hypothesis test was carried out to prove that the application of learning strategies was carried out retrieval practice significant effect on student learning outcomes with the t-test. The t-test was performed using the SPSS version 26 application.

Table 5. Analysis of Homogeneity Test of Learning Outcome Data

		Levene Statistic	df1	df2	Sig.
	Test of Homogeneity of Variance				
Student Learning Outcomes	Based on Mean	1.71	1	59	0.19
	Based on Median	2.04	1	59	0.15
	Based on Median and with adjusted df	2.04	1	58.569	0.15
	Based on trimmed mean	1.71	1	59	0.19

Hypothesis Test Results

Test the hypothesis using Independent Sample T *Test* to find out whether or not there is a difference in the average value of learning outcomes between the experimental class and the control class. The results of the hypothesis test are shown in Table 6.

Based on the output in Table 6, it shows the value of Sig. On Leven's Test for Equality of Variances is equal to 0.512 > 0.05, it can be concluded that the variance of the data on the value of learning outcomes for the experimental class data and the control class is homogeneous or the same. The results of the t-test are seen based on the table Equal variances assumed because the data is homogeneous.

Based on Table 6 (Equal variances assumed), it is known that the value of Sig. (2-tailed) is 0.018 <0.05. These results showH0 rejected, which means that there is a significant difference in the average learning outcomes of the experimental class when compared to the control class.

Table 6. Results of the T Test Using SPSS Version 26

		Levene's Test for Equality of Variances		t-test for Equality of Mean		
	Independent Samples Test					
			Sig.		df	Sig. (2-tailed)
Student learning outcomes	Equal variances assumed	.436	.512	2.438	54	.018

N-Gain Test Results

Normalized gain (N-gain score) aims to determine the effectiveness of the use of learning strategies retrieval practice. The N-Gain test is carried out after knowing that there is a significant difference between the average values posttest experimental class with control class through test Independent Sample T-Test.

Based on Table 7, it shows that there is a comparison of values between the initial test (pretest) and final test (posttest). The data shows an increase in student learning outcomes in the control and experimental classes. N-gain score of control class obtained was 0.10 (low) and the experimental class was 0.05 (low). This shows that the experimental class and the control class get an increase in learning outcomes that are not optimal. However, learning strategy retrieval practice continue to provide benefits for improving student learning outcomes.

Table 7. Calculation Results of the N-Gain Test

Class	Pretest	Posttest	Gain	N-Gain	Category N-Gain
Experiment	36.48	41.11	4.63	0.05	Low
Control	21.90	32.24	10.34	0.10	Low

Implementation of Learning

The successful implementation of learning strategies *retrieval practice* class was observed with observation guidelines. Observations are carried out by the observer. The results of the observation data analysis are in Table 8.

Table 8. Percentage of Retrieval Practice Learning Process Implementation

Activity	1	2	3	4	Average	Category
	The Meeting					
Introduction	100	100	100	75	93.70	Very good
Core activities	100	88.80	88.80	77.70	86.10	Very good
Closing	100	100	50	50	75	Well
Average					84,95	Very good

Based on Table 8, it can be seen that the implementation of the learning process in the experimental class was carried out very well (84.95%).

The average implementation of learning in the preliminary activities is 93.75%. In core activities, an average of 86.10% was obtained, and closing activities

obtained an average of 75%. So, overall, the learning process both in the preliminary, core, and closing activities obtained an average of 84.95% in the very good category.

Student Activity

The success of a good learning process is also supported by the activities of students in participating in the learning process which are observed using observation guidelines. The results of the observation data analysis are in Table 9.

Table 9. Average Student Activity

Indicator	Average	Category	Notes
Students carry out *prequiz*	100	Very active	-
Students observe powerpoint videos, pictures presented by the teacher	100	Very active	-
Students express curiosity by the way ask	8.30	Very No active	Only a few students involved to ask
Learners by study group literature	100	Very active	-
Students discuss LKPD in groups	100	Very active	-
Learners present the results of the discussion LKPD	20.40	Very No active	Presenting students only group representatives
Learners conclude material that has been studied	2.70	Very No active	Learners who conclude at the first meeting only three people and the next meeting students do not participate active
Students carry out postquiz	100	Very active	-
Students do review to the questionsquiz	100	Very active	-
Average	70.20	Active	

Based on Table 9 it is known that the average activity of students in learning is 70.2 which is included in the active category. The data presented the results of the discussion and concluded that the material was in the very inactive category. This is because students who present are only representatives of the group. Meanwhile, to draw conclusions, only a few students were involved.

Research on the application of learning strategies retrieval practice on the learning outcomes of students in class XI a public Senior High School in Palembang held four meetings in class XI IPA 3 and XI IPA 4. The instrument used to measure student learning outcomes is through pretest and posttest in the control class and the experimental class. The questions used were in the form of multiple-choice questions of 20 questions. Meanwhile, to find out the success of the implementation of learning, namely through observation sheets filled in by observers when learning takes place from the first meeting to the last meeting. Learning is carried out in KD 3.1 Explaining the chemical components that make up cells, structures, functions, and processes that take place in cells as the smallest units of life. Discussion of the material taught includes the definition of cells, cell discoverers, cell structures, cell organelles, substance transport, and protein synthesis.

Based on the value of learning outcomes in Table 5 it is known that there is an increase in student learning outcomes in both the experimental class and the control class. In the experimental class, the average initial test of learning outcomes was 36.48, then there was an increase

in the final test with an average of 41.11. In the control class, the average initial test of learning outcomes was 21.9 and then experienced an increase in the final test, which was 32.24. But average *posttest* the experimental class is higher when compared to the control class. This is also in accordance with what was disclosed by Agarwal et al. (2019) that the test results retrieval practice on the material on Ancient History of Egypt, China, etc. can improve learning outcomes in the experimental class higher than the control class. According to Afandi et al. (2013), learning outcomes are a process of changing intellectual (cognitive) abilities. Elements of cognitive development, namely memory or memories that contain all situations in which individuals store information received all the time (Atkinson et al., 2010). That is, the process of remembering is a process experienced by students in learning that can affect learning outcomes. To help students remember the material being studied, they can use learning strategies retrieval practice where students are faced with prequiz, postquiz, and review quiz during the learning process. So that it allows students to better remember the material being studied because it brings out the information stored in memory. This is in line with the opinion of Karpicke et al. (2008) that learning outcomes can be seen from how students remember the answers to a question regarding previously studied material.

Results of statistical tests of the effectiveness of learning strategies retrieval practice answered that the significance value of the learning outcomes obtained

was 0.018 <0.05 at a significance level of 5% (α = 0.05) (Table 10). This result indicates that the probability is under 0.05 then H0 rejected and H1 accepted, which means that there are significant differences in learning outcomes. This means that the average learning outcomes of the experimental class proved to be higher than the control class. Apart from that value N-gain the experimental class was 0.05 and the control class was 0.10 which was in the low category (Table 11). And also based on the completeness analysis of learning outcomes that there were no students who reached the KKM, both in the experimental class and the control class. These results indicate that the experimental class and the control class get an increase in learning outcomes that are not optimal. However, learning strategy retrieval practice continue to provide benefits for improving student learning outcomes. This shows that although there is a significant influence on the learning outcomes of the experimental class, the learning strategy retrieval practice showed very limited benefits for increasing optimal learning outcomes. This data is supported by learning outcomes on posttest II which is no different from posttest I.

On posttest II, the percentage of students who are in the high and medium categories are the same as the results posttest I. This shows that students are still able to remember and store the information given before. However, when compared with the control class, the results increased posttest II experimental class is lower than the control class. The results of observation and personal communication with students, this is because the control class has a daily repetition schedule for Cell Structure and Bioprocess material that coincides with the implementation posttest II. The existence of a daily test schedule makes students repeat learning material independently (Nurhayu et al., 2023). Students in the control class who have repeated the material (retrieval Practice) experienced an increase in learning outcomes higher than the experimental class. Repetition of material by students in the control class produces stronger memories. Meanwhile, the experimental class which did not repeat learning made the students' memory not decrease. This is because in the learning process retrieval practice cause students to store information in long-term memory (Anggraini, 2023). Note that the control class is not implemented retrieval practice get higher learning outcomes because indirectly the control class does retrieval practice that is, dig up or retrieve information that has been stored and studied material that has not been stored in memory. Learning process retrieval practice conducted by the control class independently shows that retrieval practice able to improve the ability to remember which can affect the improvement of student learning outcomes. This proves

the awareness of students to repeat what has been learned can improve learning outcomes (Sanjaya, 2010; Emda, 2017).

In addition, based on research by Fritz et al. (2015), the limitations experienced in implementing learning strategies retrieval practice occurs due to student errors in processing new information on the material being studied. According to Atkinson et al. (2010) new information that enters will be stored in short-term memory and then transferred to long-term memory, if it is not transferred, the information will be shifted and then lost. The process of transferring information into long-term memory is carried out through the application of syntax retrieval practice that is prequiz, postquiz, and review quiz. Retrieval practice helps to improve memory for what is remembered, but not for material that is omitted (Dempster, 1997; Fritz et al., 2015). This results in a more robust memory that is recalled at times prequiz, postquiz, and review quiz. Because the material feels familiar and has been understood, students think that the material does not need to be processed in depth and meaningful (Mukarramah et al., 2021). According to Krug et al cited by Fritz et al. (2015) when new information enters working memory and then the information is found again at another time, the information is ignored, this process is called the deactivation hypothesis. Deep and meaningful processing of new information plays a major role in determining good memory (Craik et al., 1975; Fritz et al., 2015; Hanley et al., 1987; Johnson-Laird et al., 1978). A good memory can support successful learning.

Learning success is also supported by the implementation of good learning. Study strategy retrieval practice well done. The implementation of learning in the preliminary activities obtained an average of 93.75%, namely there was a shortage at the fourth meeting. At the fourth meeting the teacher did not ask about the readiness of students to start the learning process. In the core activities obtained an average of 86.10%. This happened because in the activities in the second, third, and fourth meetings where students did not participate actively in presenting the results of group discussions and drawing conclusions. In closing activities, an average of 75% was obtained because at the third and fourth meetings where the teacher did not convey the material to be discussed at the next meeting. But overall, the learning process both in the preliminary, core and closing activities obtained an average of 84.95% in the very good category.

Improved learning outcomes are also supported by well-executed learning (Santi, 2023). In the learning process retrieval practice support active students in learning. In the activities of student activities there are 9 namely the first carry out prequiz. The two students

observed the powerpoint video, the pictures presented by the teacher. The third expresses curiosity. The fourth is conducting a literature review. The five discussed in groups. Sixth presented the results of the discussion. Seventh draw conclusions. The eight carry out postquiz. Ninth review quiz. Learning activities require students to be active. According to Akhiruddin et al. (2020) learning is only possible if children actively experience it themselves, therefore in learning it is students who process and digest according to their will, abilities, talents and backgrounds.

Conclusion

Based on the results of this study it can be concluded that learning strategies Retrieval Practice being able to improve student learning. These results indicate that the experimental class and the control class get an increase in learning outcomes. The average learning outcomes of the experimental class (retrieval practice) (41.11) are proven to be higher than the control class (32.24). In addition, the N-gain obtained by the experimental class is 0.05 and the control class is 0.10 which is in the low category. But the results show that both experimental and control classes get an increase in learning outcomes that are not optimal. However, learning strategy *retrieval practice* continue to provide benefits for improving student learning outcomes.

Conflicts of Interest
The authors declare no conflict of interest.

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