Jurnal Inovasi dan Teknologi Pembelajaran
Vol 10, No 2, (2023), page 161-171
https://doi.org/10.17977/um031v10i22023p161
P-ISSN: 2406-8780 E-ISSN: 2654-7953
Open access: http://journal2.um.ac.id/index.php/jinotep/index

Innovation of preview, question, read, reflect, recite, and review method in improving students' long-term memory

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ARTICLE INFO

Article history:
Received: 30-03-2023
Revised: 04-06-2023
Accepted: 08-06-2023

Kata kunci:
Metode Pembelajaran PQ4R;
Memori Jangka Panjang;
Plantae

Keywords:
PQ4R Learning Method;
Long-Term Memory;
Plantae

ABSTRAK

Penelitian ini bertujuan untuk mengetahui pengaruh metode pembelajaran preview, question, read, reflect, recite, dan review (PQ4R) terhadap kemampuan memori jangka panjang siswa pada materi Plantae di kelas X. Sampel diperoleh dengan teknik purposive sampling di mana kelas X IPA C menjadi kelas eksperimen, dan X IPA D sebagai kelas kontrol. Desain penelitian adalah kuasi eksperimen dengan empat kali tes. Instrumen penelitian yang digunakan berupa tes soal berbentuk essay berjumlah 10. Hasil analisis data dengan Uji t menunjukkan bahwa pada kelas eksperimen, nilai signifikansi 0,000 < 0,05 dan t-hitung > t-tabel yaitu 5,037 > 2,03452, yang artinya H_0 ditolak dan H_a diterima. Artinya, ada pengaruh metode PQ4R terhadap kemampuan memori jangka panjang siswa. Pada kelas kontrol, nilai signifikansi 0,088 > 0,05 dan t-hitung < t-tabel yaitu 1,718 < 2,03452, artinya H_0 diterima dan H_a ditolak. Artinya, tidak ada pengaruh metode ceramah, diskusi, dan tanya jawab terhadap kemampuan memori jangka panjang siswa. Dengan demikian, dapat disimpulkan bahwa metode PQ4R mampu meningkatkan kemampuan memori jangka panjang siswa. Penelitian ini dapat dijadikan referensi metode yang tepat untuk meningkatkan kemampuan memori jangka panjang siswa.

ABSTRACT

This study aimed to determine the effect of the preview, question, read, reflect, recite, and review (PQ4R) learning method on students' long-term memory ability on Plantae material in class X. The sample was obtained using a purposive sampling technique where class X IPA C was the experimental class, and X IPA D was the control class. The research design was a quasi-experiment with four tests. The research instrument used essay-shaped test questions totaling 10 questions. From the data analysis with the t-test, it shows that in the experimental class, the significance value is 0.000 < 0.05, and the t-count > t-table is 5.037 > 2.03452, meaning that H_0 is rejected, H_a is accepted, meaning that there is an effect of the PQ4R method on students' long-term memory ability. In the control class, the significance value is 0.088 > 0.05 and t-count < t-table, namely 1.718 < 2.03452, meaning that H_0 is accepted, H_a is rejected, meaning that there is no effect of the lecture, discussion, and question and answer method on students' long-term memory ability. Thus, the PQ4R method can improve students' long-term memory ability. This research can be a reference for the correct method to improve students' long-term memory ability.

INTRODUCTION

In humans, information received by the brain is structured through three memory systems: sensory memory system, short-term memory system, and long-term memory system. Among the three types of memory systems, long-term memory is the one that is needed and plays a significant role in the learning process. Long-term memory has infinite storage time and capacity (Nofindra, 2019). Information received must go through a patterned and meaningful organizational process to be stored in long-term memory (Sandi, 2021). The learning process carried out by students must include reasoning skills, linking knowledge, and interpreting concepts (Setiawati, 2018).

Long-term memory can store much information with unlimited storage (Liu, et al., 2022). Long-term memory is very useful when used in the learning process. Material received by students in learning will be more useful if the material can last a long time in memory (Musdalifah, 2019). Long-lasting memories are possible when information is received in the right way. How a person receives and processes information determines whether or not the data can be retained in the memory. Different methods will have other effects on the brain (Bartsch, et al., 2019)

Learning does not only require students to understand the material taught but as learners, students are required to have the ability to mentally receive and store information or material that has been taught (Hadi, 2020). The learning process must involve reasoning activities, and students must be able to reason the information provided. The reasoning must go through a critical and creative process, starting from forming concepts, then analyzing and applied (Anugrah, et al., 2018). So, students must go through a reasoning process to remember what they have learned. Reasoning activities are necessary to store information from the learning process in students' long-term memory.

The problem in learning is that students need help managing their cognitive abilities. It can happen because the conditions in the classroom do not support students in developing their cognitive skills. If students' cognitive abilities are not well developed, how can students remember what they have learned (Setiawati & Corebima, 2018). In this case, students need directed and systematic learning activities to experience a meaningful learning process. Meaningful learning will encourage the process of reasoning. It will increase students' memory ability (Casnan, et al., 2022). In addition, Brezack, et al. (2023) mentioned that active learning is needed by directly demonstrating the learning material to improve long-term memory.

Wajdi (2021) stated that certain learning methods affect students' biology learning outcomes. Learning with the right method affects better student learning outcomes than conventional learning methods. In line with this, Boye et al. (2023) revealed that students need a certain method to improve a certain ability. A method can improve one or two types of student abilities, but students require many types of abilities. Thus, the right method is needed to improve students' long-term memory ability.

Susanti, et al. (2019) stated that learning methods play a decisive role in how students receive the material presented to keep in memory. Sartika & Hadi (2021) claimed that the PQ4R method (preview, question, read, reflect, recite, and review) helps students remember what they have read, improves understanding of concepts, and helps students learn and create meaningful learning. In addition, Yalindua, et al. (2020) proposed that the PQ4R method could improve concept understanding so that it affects student retention. Gultom (2019) argued that the PQ4R method also encourages students to reason about the reading material given so that it helps in training students' memory.

Based on interviews conducted with one of the biology teachers at SMA Negeri 1 Dolok Masihul, it is known that the learning methods commonly used in the classroom are discussion and question and answer methods. In addition, based on the interview results, it is known that the teacher does not know about the PQ4R learning method and has never applied it in biology learning. Based on the questionnaire, it is known that 92.3% of students are unable to remember the material that has been learned after two weeks, 38.4% of them forget the day after the material is taught, and 42.3% of them are unable to remember the material that has been taught a week earlier. From these data, it can be concluded that the long-term memory ability of students at SMA Negeri 1 Dolok Masihul is still low.

Students' low long-term memory ability indicates that the learning methods used are not appropriate (Siregar, 2020). Inappropriate method selection is a problem that often occurs in learning biology (Azizah & Alberida, 2021). Plant material is one of the many materials in biology that is difficult to understand. Plant material is material that often causes misconceptions for both teachers and students. Misconceptions occur because plant material has a broad scope of material and complicated concepts to understand (Firdaus & Wisanti, 2021). Students at this time generally have difficulty understanding plant material, especially in understanding plant reproduction, such as germination and fertilization. The difficulty of understanding this section is due to the use of traditional methods in its delivery. Students will not understand the process if only explained traditionally. For students to understand plantae material, the right approach and method are needed (González & Franco, 2021). Thus, choosing the right method is crucial to improving long-term memory. This study aimed to see the effect of using the PQ4R learning method in learning biology on Plantae material on students' long-term memory ability. This study also measured the decrease in student retention two and four weeks after being treated at SMA Negeri 1 Dolok Masihul.

METHOD

This research is an experimental research with a quasi-experimental design. The design of the study was a pretest (T0), posttest (T1), retest I (T2), and retest II (T3). The pretest was before treatment, posttest was after treatment, retest I was two weeks after the posttest, and retest II was four weeks after the posttest. The experimental class used the PQ4R learning method, while the control class used the lecture, discussion, and question-and-answer learning methods. This research was conducted at SMA Negeri 1 Dolok Masihul, Jalan Mutiara No. 1, Pekan Dolok Masihul, Dolok Masihul, Serdang Bedagai Regency, North Sumatra. This research was conducted for three months, from January 2023 to March 2023. The population of this study was students of class X IPA SMA Negeri 1 Dolok Masihul, which amounted to 4 classes. The sample in this study was taken using a purposive sampling technique. They were X-IPA-C and X-IPA-D, each of which amounted to 36 people, meaning that the total sample amounted to 72 people. The research design is presented in Figure 1. Learning with the PQ4R method was taught in the experimental class through 4 meetings. The PQ4R method consists of several learning steps: preview, question, read, reflect, recite, and review. Learning with the PQ4R method was based on the PQ4R-based lesson plan and LKPD. Figure 2 shows the stages of learning with the PQ4R method, and Figure 3 shows the implementation and evaluation of learning.

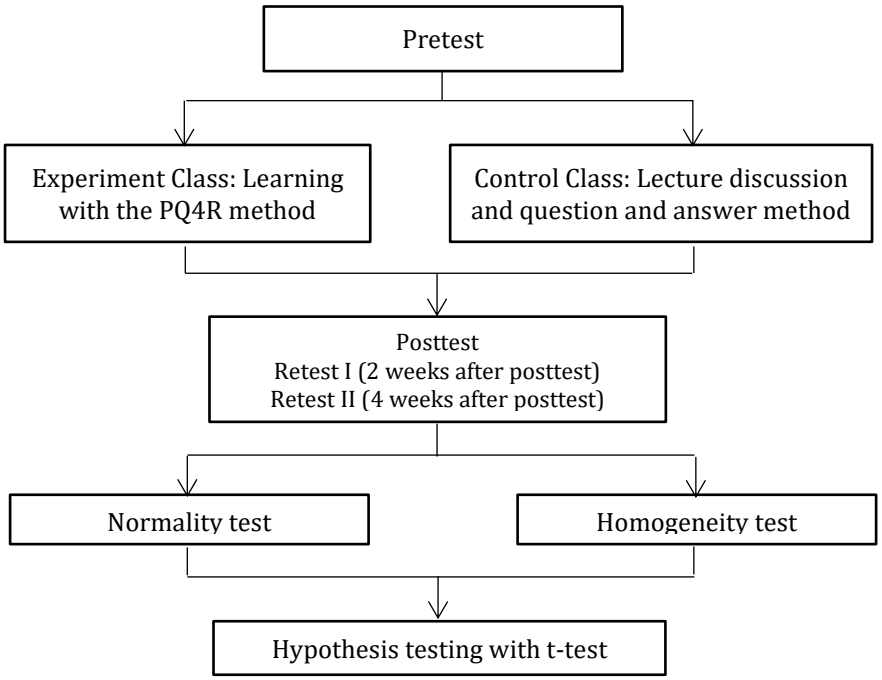

Figure 1. Research design

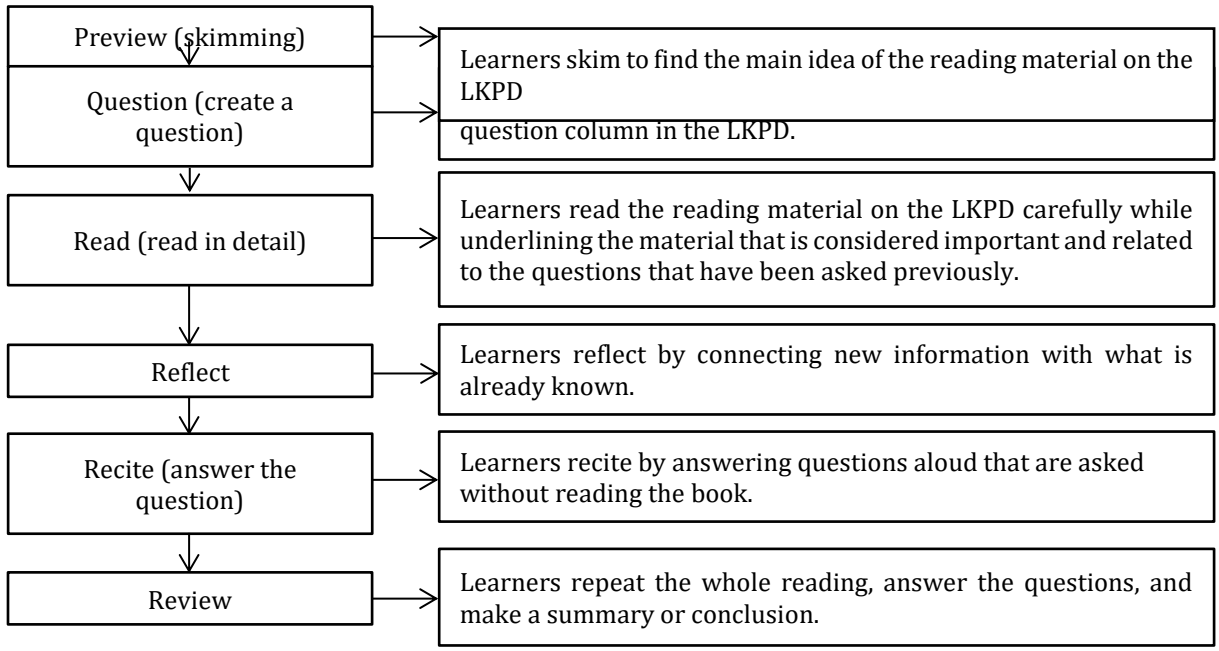

Figure 2. Stages of learning with the PQ4R method

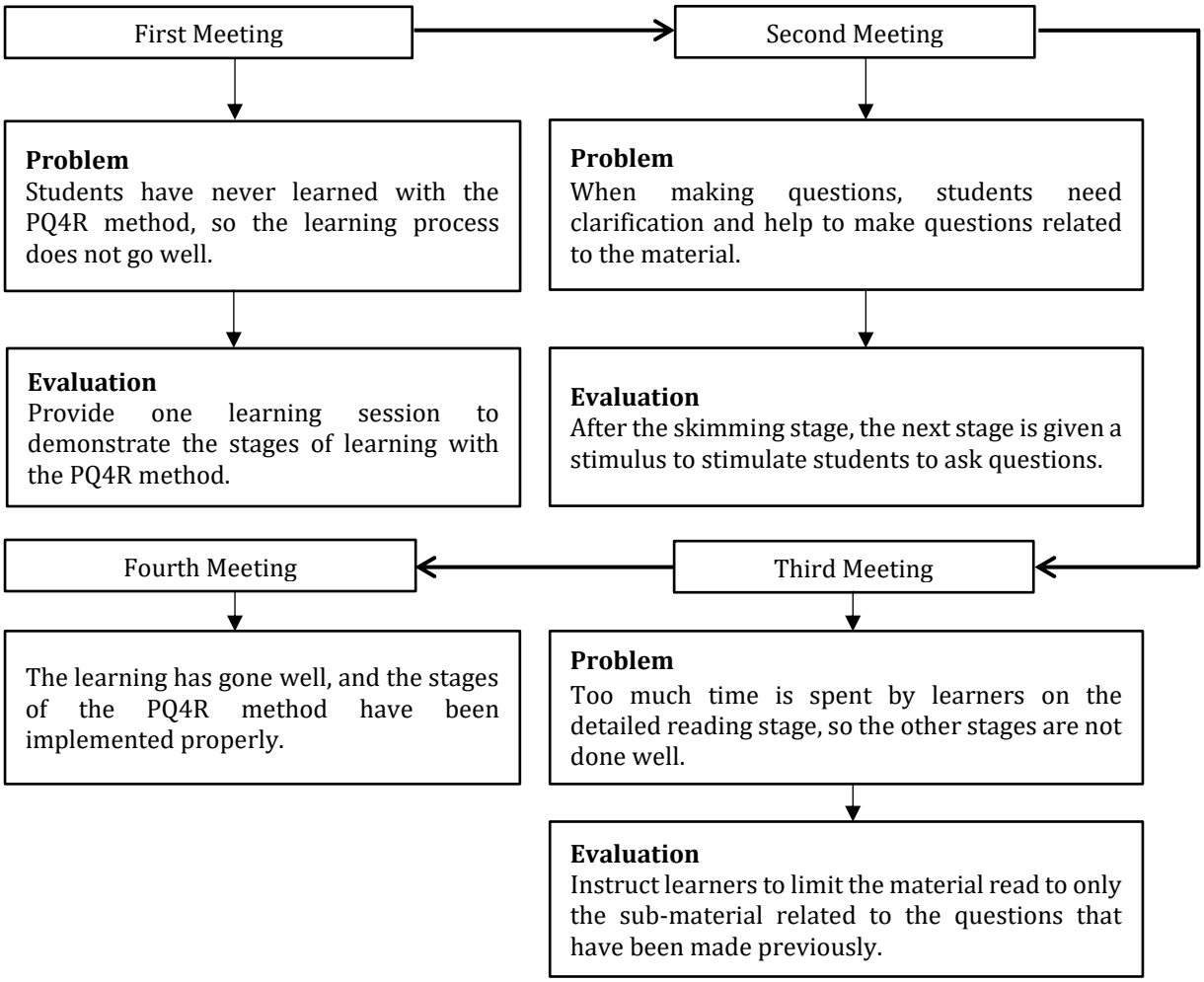

Figure 3. Implementation and Evaluation of Learning with the PQ4R Method

Table 1. Essay test question grid

Competency achievement indicators	Question indicator	C1	C2	C3	C4	C5	C6	Total
Identify the general characteristics of plantae.	Classify plant species based on common characteristics	1						1
Explain the characteristics of mosses, ferns, and seed plants	Explain the characteristics of moss plants					8		1
	Explain the characteristics of ferns							-
	Explain the characteristics of seed plants							-
Explain the body structure, life cycle, and ways of reproduction of moss, fern, and seed plants	Explain the body structure, life cycle, and ways of reproduction of moss plants		2					1
	Explain the body structure, life cycle, and ways of reproduction of ferns			4				1
	Explain the body structure, life cycle, and ways of reproduction of seed plants			6	5			2
Classify moss plants, ferns, and seed plants.	Classify moss plants				3			1
	Classify ferns							-
	Classify seed plants		7				9	2
Explain the role of the kingdom plantae for human life	Explain the role of moss plants			10				1
	Explain the role of ferns							-
	Explain the role of seed plants							-
Total		1	2	3	2	1	1	10

(Modification from Muldayanti, 2020)

The research instrument used was an essay-shaped test question. The material on the test is Plantae, which was taught during the study. The questions were in the form of descriptions, with the number of tests being 10. Before the questions were used, the questions on the test were validated first by the expert validator and tested on students who have studied plantae material at SMA Negeri 1 Dolok Masihul. The preparation of the questions used is based on the level of competence, namely the level of remembering (C1) = 5%, the level of understanding (C2) = 10%, the level of applying (C3) = 45%, the level of analyzing (C4) = 25%, the level of evaluating (C5) = 10% and the level of creating (C6) = 5% (Helmawati, 2019). The question grid is presented in Table 1.

Data analysis was carried out to conclude the treatment given using the t-test. But before that, the data must fulfill the prerequisite data analysis tests, namely the normality and homogeneity tests. The normality test uses the Kolmogorov-Smirnov test, while the homogeneity test uses the Levene test. Conclusions were drawn using the t-test with the decision-making criteria used if the significance value < 0.05, or t count > t table, then H_0 is rejected, and H_a is accepted, meaning that the independent variable on the dependent variable gives an influence. In addition, the decrease in student retention after two weeks and four weeks of treatment was also calculated. The formula used is as follows:

$$\text{Decreased retention} = \frac{T_1 - T_2}{T_0} \times 100 \text{ dan } \frac{T_2 - T_3}{T_0} \times 100\% \quad (1)$$

Based on the retention decline formula, it is known that T_0 is the pretest given before treatment, T_1 is the posttest given after treatment, T_2 is retest I given two weeks after the posttest, and T_3 is retest II given four weeks after the posttest.

RESULT

Research data to measure long-term memory ability was obtained through four tests, namely pretest, posttest, retest I, and retest II, respectively, to the experimental and control classes. In the experimental class, learning treatment with the PQ4R method and four tests were given: pretest, posttest, retest I, and retest II. The test data in the experimental class is presented in Figure 4. Based on the diagram in Figure 4, number 1 is pretest, 2 is posttest, 3 is retest I, and 4 is retest II. It can also be seen in Figure 4 that the average test results, respectively, on the pretest, posttest, retest I, and retest II have decreased and also increased.

At the time of the pretest before being treated, students' initial ability was still quite low, with an average of 36.5. After being treated with the PQ4R learning method, the average student score increased significantly to 83.4. Two weeks after the posttest, retest I was carried out and obtained a score with an average of 79.5. In this case, there was a decrease in the average student score from the posttest score obtained previously. The second retest was four weeks after the posttest, and an average of 77.8 was obtained. This value again decreased from the last test. Meanwhile, the control class was given treatment and four tests, namely pretest, posttest, retest I, and retest II. The test data of the control class is in Figure 5.

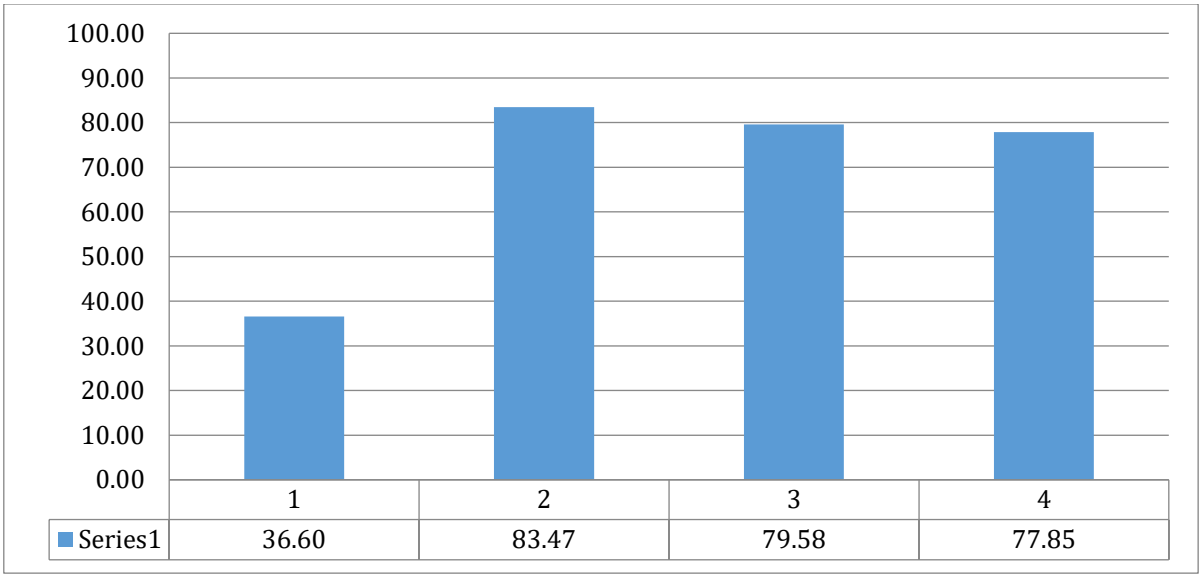

Figure 4. Experimental class test data

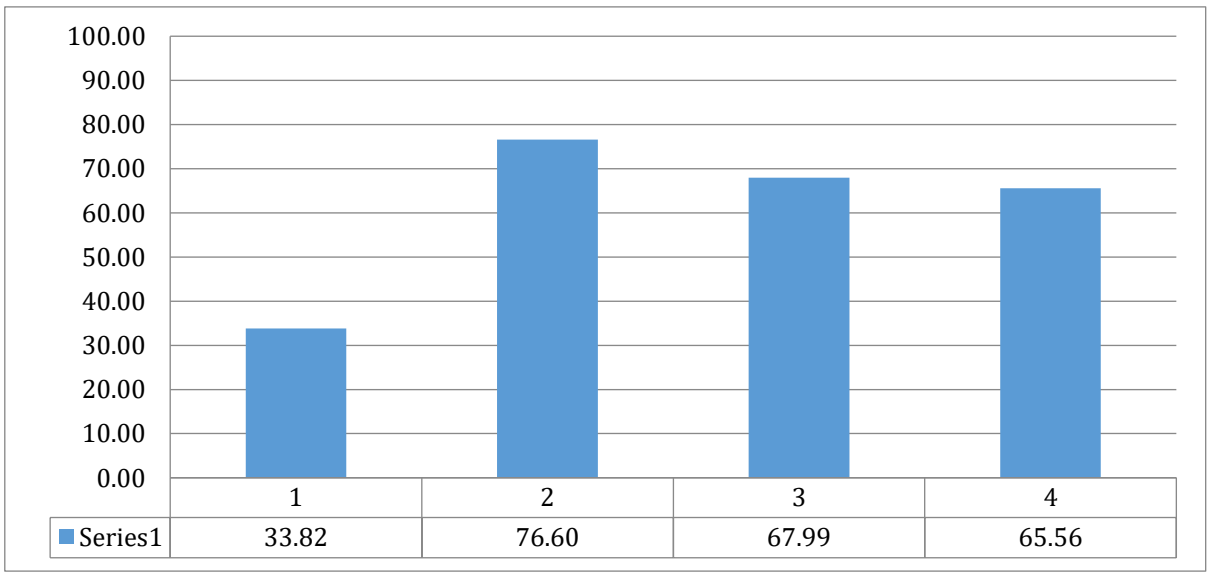

Figure 5. Control class test data

The diagram in Figure 5 reveals that just like the test data in the experimental class, the test data in the control class also experienced an increase and decrease. The average score increased from the pretest to the posttest, from 33.8 to 76.5. After two weeks of the posttest, retest I was conducted. In this test, there was a decrease in the average score to 67.9. Four weeks after the posttest, the average score was 65.5, and this value decreased from the retest I carried out previously. After the data passes the data prerequisite test, is considered feasible, and has met the requirements for data analysis, the data was tested with the t-test to conclude. The t-test results are presented in Table 2.

Table 2. Hypothesis testing (t-test) on experimental and control classes

`No	Class	Significance Value	α (alpha)	t-count	t-table
1	Experiment Class (PQ4R Method)	0.000	0.05	5.037	2.03452
2	Control Class (Lecture, discussion, and question and answer method)	0.088	0.05	1.718	2.03452

Based on Table 2, in the experimental class, the significance value after the analysis test with the t-test is 0.000 < 0.05 (there is a significant influence between the research variables). In contrast, the t-count value is 5.037 > 2.03452 (t-table) in this case, which means that in the experimental class, it can be concluded that there is a significant effect of the PQ4R learning method on the long-term memory ability of students in SMA Negeri 1 Dolok Masihul. A different thing happened in the control class. The significance value was 0.088 > 0.05 while the t-count value was 1.718 < 2.03452, meaning that in the control class, after being treated with the lecture, discussion, and question and answer methods, there was no significant effect on the long-term memory ability of students at SMA Negeri 1 Dolok Masihul.

The decrease in retention needs to be calculated to compare the long-term memory ability of the experimental and control classes. The decrease in retention in each experimental and control class was calculated after two weeks and four weeks of treatment, meaning that the data analyzed was the difference between posttest to retest I and retest I to retest II. The data from the calculation of the decrease in student retention is presented in Table 3.

Table 3. The calculation results in decreased student retention after two and four weeks of treatment

No	Post-treatment time	Class	Large decrease in retention
1	Two weeks	Experiment	10.6 %
		Control	25.4 %
2	Four weeks	Experiment	4.7 %
		Control	7.1 %

The lower the decrease in retention, the better the long-term memory ability of students. The small decrease in retention indicates that there is little information that escapes students' memories. Based on Table 3, in the experimental class, after two weeks, the decrease in retention was 10.6% < 25.4% in the control class, meaning that after two weeks, the long-term memory ability in the experimental class was better than the control class. After four weeks, the amount of retention decrease in the experimental class was 4.7% < 7.1%, meaning that after four weeks, the long-term memory ability of the experimental class was still better than that of the control class.

DISCUSSION

This study's results align with research conducted by Ehsanpur & Razavi (2020), proving that different methods will affect students differently. This study shows the difference between using various methods of learning. The methods used were traditional methods and by utilizing mobile education. The results show that students' memory after learning using the mobile education

method is higher than that of the traditional one. Thus, it can be concluded that using diverse methods affects students' memory.

The difference between posttest to retest I and retest I to retest II is the basis for determining whether students' long-term memory ability is better. The difference can be interpreted as a decrease in student retention, where the smaller the decrease in retention, the better the long-term memory ability possessed by students. The results of this study also support research conducted by Bartsch & Oberauer (2021), which applied elaboration strategies to improve a person's memory ability. The recall abilities focused on in this study are working memory and long-term memory. The samples were grouped by age: young age (average age 24) and old age (average age 70) groups. The results showed that the elaboration strategy increased the sample's long-term memory but had no positive effect on the sample's working memory. The elaboration strategy can be appropriate for improving students' long-term memory. This research can be used as a supporting basis that the PQ4R method can improve students' long-term memory ability. The PQ4R method is one of the methods that apply the elaboration strategy, which is one of its steps, requires students to link the information received with previously received knowledge.

Desman et al. (2022), in their research, successfully proved that the rehearsal strategy could improve a person's long-term memory ability. The results showed no significant decrease in memory in the research sample, which was divided into two groups in each group. After six months, memory only dropped by 6%-9%, indicating that even after six months, very little information had escaped the memory of the study sample. These results support that the PQ4R method has an impact on increasing students' long-term memory. The PQ4R method, in its learning steps, creates a repetitive process of receiving information in learning. The PQ4R method consists of 6 steps: preview, question, read, reflect, recite, and review, each of which encourages students to receive and process information repeatedly (rehearsal).

Apart from the rehearsal strategy, one of the stages of the PQ4R method encourages improving students' long-term memory ability. The stage in question is reflection, which connects newly acquired knowledge with previous knowledge. Nofindra (2019) claimed that a requirement that must be met for information to be stored in a person's long-term memory is the process of connecting knowledge. This process encourages the connection between one memory and another so that these memories can last long. The reflect stage of the PQ4R method fulfills this requirement.

Retention decline is normal as the brain tends to release stored memories. However, several factors encourage retention decrease. The main factor is the large number of students, so learning is carried out in groups. The stages of learning with the PQ4R method are less effective when implemented in groups. Ratnawuri et al. (2018) stated that the PQ4R method would not be effective if implemented in a class with a large number of students and in groups. It is because teachers are limited in guiding learning in the classroom. Moreover, the PQ4R method has six stages of learning which are quite complex.

However, comparing the decrease in retention after two weeks and four weeks also needs to be considered. After two weeks of posttest, the decrease in retention is noticeably high, respectively, in the experimental and control classes, 10.6% and 25.4%. However, after four weeks, the decrease in retention became smaller in value, namely in the experimental and control classes, respectively, 4.7% and 7.1%. The decrease in retention after four weeks is even smaller than the one after two weeks. Suwardi et al. (2021) proved that giving tests repeatedly can improve a person's memory performance. Based on this research explains that there is a testing effect, which is the impact given when working repeatedly. Students can use it to improve their long-term memory. The study also explains that the more often you do the same test, the more it will improve your long-term memory.

This research contributes as a reference for the right learning method to improve students' long-term memory ability. The PQ4R method encourages students to understand concepts, reason, link knowledge, and information from learning to be received repeatedly (rehearsal) to improve students' long-term memory. This research gives teachers an overview of how the PQ4R method affects students' long-term memory. Teachers can apply and even develop and combine

the PQ4R method with other learning methods to maximize the improvement of students' long-term memory ability.

CONCLUSION

The PQ4R (preview, question, read, reflect, recite, and review) learning method affects students' long-term memory ability. It is evident in the experimental class; the difference in the posttest to retest I and retest I to retest II scores is smaller than that of the control class. In addition, after being analyzed with the t-test, it shows that the significant value in the experimental class is < 0.05, while in the control class is > 0.05. It shows that implementing the PQ4R learning method in the experimental class significantly affects students' long-term memory ability. In contrast, in the control class, it is the opposite. Based on the calculation of the decrease in student retention after two weeks and four weeks, the decrease in retention in the experimental class is smaller than in the control class, meaning that in the experimental class, less information escapes from the students' memory than that of the control class. This study has several limitations, including the lack of references from previous studies that have applied the PQ4R method to improve students' long-term memory skills. In addition, the experimental class had never applied the PQ4R method, so a learning session was needed to introduce the method. Students who need to become more familiar with the PQ4R method need help following the learning. For future researchers who want to conduct similar research, provide one or two meetings to demonstrate the PQ4R method in a class. The goal is that students can clearly understand the stages of learning with the PQ4R method so that in the next lesson, students can follow the learning well.

Author contributions

The authors made significant contributions to the study's conception and design. The authors was in charge of data analysis, interpretation, and discussion of results. The final manuscript was read and approved by the authors.

Funding

There was no specific grant for this research from any funding organization in the public, private, or nonprofit sectors.

Conflict of interest

The authors declare that there is no potential conflict of interest.

Data availability statement

All data are available from the authors.

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