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Effect of Problem-based Learning on the Biology Summarizing Ability of Eighth-Grade Students of Zhengzhou No.1 Middle School in the People's Republic of China

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Abstract

Background and Aims: The impact of Problem-Based Learning (PBL) on biology summarizing ability has far-reaching research significance, and this learning method emphasizes the problem-oriented approach to cultivate students' comprehensive ability and innovative thinking through the processes of problem posing. This experimental research aimed to 1) compare biology summarizing ability before and after learning through Problem-Based Learning.2) To compare biology summarizing ability with the criterion set at 70 percent.3) To assess the student's satisfaction with Problem-Based Learning.

Materials and Methods: The sample was 30 students from eighth-grade students from Zhengzhou NO.1 Middle School, People's Republic of China. They come from cluster random sampling. Data on students' biology summarizing ability before and after the implementation of the problem-based teaching method were collected through a questionnaire. SPSS software was used to analyze the collected data, including the mean value of samples, standard deviation, and single-sample t-test.

Result: The results showed that 1) the students' biology summarizing ability after learning through receiving Problem-Based Learning (M= 47.43, SD=4.40) was higher than that before learning (M= 35, SD =5.18) at a significance level of.01(t_{29}=17.58, p=.001); 2) the students' biology summarizing ability after learning through Problem-Based Learning was higher than the determined criterion of 70% at a significance level of.01(M = 47.43 of full scores, 75, SD = 3.41, t_{29}= 28.63, p=.001) and 3) Students were satisfied with the learning management using the Problem-Based Learning method (M = 4.02, SD = 0.77).

Conclusion: The knowledge gained from this study is that 5-step teaching using the problem-based learning approach can be effective in improving the performance of students on the Biology Summative Aptitude Test, and it stimulates students' interest in learning by Step 1: Extract key information Step 2: Concise expression Step 3: Integrate knowledge Step 4: Summary Step 5: Relational thinking. It develops students' independent learning ability and meets their individual learning needs. This is a new trend in the future of education.

Keywords: Problem-based Learning; Biology Summarizing Ability; Biology Course

Introduction

In today's ever-changing world, it is more and more crucial to cultivate students' ability to summarize. In the field of biology education, traditional teaching is not enough to stimulate students' deep interest and motivation to learn independently. Therefore, teachers must embrace personalized teaching strategies that precisely address the diverse needs of students, with a core focus on enhancing students' ability to summarize. Problem-based learning is the preferred path for this transformation. It can not only stimulate students 'enthusiasm for active learning but also cleverly integrate biological knowledge with real-life situations, effectively refine students' critical thinking, enhance their problem-solving ability, and promote the overall improvement of communication and collaboration skills.

1. Status and challenges of education:

In the context of globalization and rapid technological development, the field of education is facing unprecedented challenges. Aslan & Duruhan (2021). There is an urgent need to introduce more effective teaching and learning strategies to equip students with the ability to cope with the complex problems of the future. Particularly in the field of biology education, students not only need to acquire basic biological knowledge but also analytical and critical thinking skills to be able to apply what they have learned to real-world problem-solving. However, traditional teaching methods, such as

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lecture-based teaching, often focus on the inculcation of knowledge while ignoring students 'subjectivity and initiative, making it difficult to stimulate students' interest and creativity in learning, and failing to meet the need to cultivate students' analytical and critical thinking skills.

2. Limitations of traditional teaching methods

Luke et al (2021), although traditional teaching methods, such as teacher-centered lecture teaching, can transfer knowledge to a certain extent, their limitations are also obvious. Firstly, this approach focuses primarily on the transmission of knowledge rather than student engagement and application, making it difficult for students to internalize and apply what they have learned to real-world situations. Secondly, due to the pressure of standardized tests, teachers tend to adopt a 'fill-in-the-blank' teaching method, pursuing short-term memorization of knowledge and neglecting the cultivation of students' long-term thinking and problem-solving abilities. This teaching method is not only difficult to stimulate students 'interest and motivation in learning, but also may lead to students' boredom and resistance to learning.

3. The potential of problem-based learning (PBL)

To address the limitations of traditional teaching methods, Problem-Based Learning (PBL) has emerged as a student-centered teaching method. Barrows (2020) PBL emphasizes the development of critical thinking, problem-solving, and teamwork skills by placing students in real-world problematic situations and allowing them to solve problems through self-directed inquiry and collaborative learning. In biology teaching, PBL can guide students to focus on the nature and laws of biological phenomena and deepen their understanding of biological concepts through in-depth analysis and discussion. At the same time, PBL can also stimulate students' interest and motivation in learning and make them more actively involved in the learning process, to improve the learning effect and biological summarizing ability.

In summary, PBL, as an emerging teaching method, has great potential and advantages in biology teaching. This study aims to explore the effect of PBL on the biology summarization ability of Grade 8 students in Zhengzhou No.1 Middle School through an empirical study, to provide useful references and lessons for biology teaching.

Research questions

1) How can students' biological summary ability before and after learning be managed through problem-based learning?

2) How is the biology summarizing ability compared with the determined criterion set at 70 percent?

3)What is the student's satisfaction with Problem-Based Learning after learning?

Research objectives

1) To compare the biology summarizing ability before and after learning through Problem-Based Learning.

2) To compare biology summarizing ability with the criterion set at 70 percent.

3) To assess the student's satisfaction with Problem-Based Learning.

Literature Review

The literature review of this study is based on a careful analysis of the effects of the practical application of the questionnaire for the development of biology summarizing ability of Grade 8 students in the First Middle School of Zhengzhou City. This questionnaire was designed and implemented to gain an in-depth understanding and assess the improvement of students' biology summarizing ability in the process of biology learning. In this chapter, the researcher not only discusses the meaning and scope of biology summarizing ability, but also clarifies its importance as a key learning skill, and comprehensively analyses the unique advantages, core components, and implementation steps of Problem-Based Learning (PBL), a state-of-the-art teaching model, in developing biology summarizing ability. Problem-based learning emphasizes student-centered learning by posing real-world problems or situations to stimulate students' curiosity and desire to explore, prompting them to actively seek knowledge and solve problems. Under this framework, the development of biological generalization skills is particularly important. It specifically covers a series of key cognitive skills, such as extracting key points accurately from complex

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information, expressing what has been learned in clear and precise language, integrating fragmented knowledge into a systematic body of knowledge, summarizing what has been learned to form one's framework of understanding, and reasoning and analyzing using logical thinking. Together, these skills form the cornerstone of students' ability to learn biology and are essential for deepening understanding and improving learning efficiency. More importantly, the ability to generalize in biology is not limited to the academic field but has a profound impact on the overall development of the individual student. Through the acquisition of these skills, students can explore uncharted territories more independently, cope with learning challenges effectively, and improve their problem-solving abilities, thus becoming more competent in their future studies and lives. For example, when confronted with complex problems in biological sciences, students can quickly identify the crux of the problem and apply what they have learned to come up with a solution, demonstrating a strong ability to innovate and think critically. To promote the development of biological generalization skills more effectively, this study also emphasizes the application of the case teaching method. Case teaching closely combines theoretical knowledge and practical operation by selecting biological cases that are close to students' real life or representative, and guiding students to analyze and discuss them. In the process of a case study, students need to use the biological generalization skills they have learned to analyze the information in the case, distill the key points, form their own opinions, and communicate and share them through group work or classroom presentations. This process not only exercises students' biological generalization skills but also develops their teamwork and communication skills, laying a solid foundation for their future success in academic research and careers.

1. The History and Current Status of Problem-Based Learning Methods Abroad

Almulla (2020) analyzed the advantages of PBL (project-based learning) in engaging students with the topics. The main purpose of the study was to investigate the extent to which PBL could promote collaborative learning, the learning of disciplinary subjects, the learning through iterative processes, and authentic learning, which, eventually, makes for greater student engagement. A survey that would be distributed to 124 teachers employing PBL was the research method. SEM has been deployed in the data analysis. As the outcomes of the study revealed, there is a noticeable link between the PBL approach and collaborative learning, subject knowledge of disciplines, iterative learning, and authentic learning that resulted in students gaining an interest. What is more, through the process of PBL, knowledge sharing happens among students, provoking the sharing of viewpoints and thereby prompting active involvement in the learning process.

Luke et al. (2021) looked into it while focusing on whether PBL is more or less effective as a teaching method than traditional teaching methods in improving dental radiographic interpretation skills among dental students. Their study, published in a research article, Biomed Res Int, found that the students who learned by constructivist teaching methods (PBL) were superior to those with traditional methods of teaching in radiographic interpretation skills acquisition. This fact highlights the power of PBL to stimulate exactly the thing we want science students to learn in classroom learning settings.

Mafarja et al. (2023) carried out a systematic review to identify the effectiveness of reciprocal teaching as an instructional method that is learner-centered in achieving academic performance. If PBL has been nested in the focus of this research, the implications that the authors discovered still signal that there is a possibility of learning through other pedagogical efforts. Apart from pinpointing these factors, the study also shed light on the key role of the student’s active involvement and the collaborative learning processes as the means to improve the academic outcomes related to science education.

2. The history andpresent situation of Problem-Based Learning in China

Deng et al. (2023) investigated the whole scope of the application of problem-based learning (PBL) in China's secondary school science. The purpose of the research was to determine PBL use and whether it could change students' performance in science. This research involved fieldwork and interviews with teachers and students in classrooms where PBL was used. The themes in the data were analyzed. The discovery indicates that the PBL model has been dominant in most Chinese high schools; this has likely increased student participation, which sharpens their critical thinking and problem-solving skills. The core of it (the engaging activity) was based on students' active learning and collaborative nature to enhance their understanding of theoretical matters.

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Zhao et al. (2023) have undertaken the operation of a PBL-integrated model in addition to lecture-based classroom teaching in a Chinese medical college for undergraduates. The study sought to reaffirm the validity of this method in not only enhancing students' learning outcomes but also clinical reasoning skills. The study involved a hybrid methodology that extended to the application of both the surveys, interviews, and the assessment of learners' outcomes According to the study, the use of effective and integrated PBL methods was found to be connected to more profound student engagement, critical thinking skills, and clinical reasoning skills compared to the old traditional lecture-based teaching methods. It was seen that this PBL format incorporated into medical education would be more beneficial for students to have an understanding of the practice of the clinical area through active learning and problem-solving ability.

Research Conceptual Framework

The Independent variable is Problem-Based Learning.

The dependent variables are (1) Biology Summarizing Ability, and (2) Students' Satisfaction.

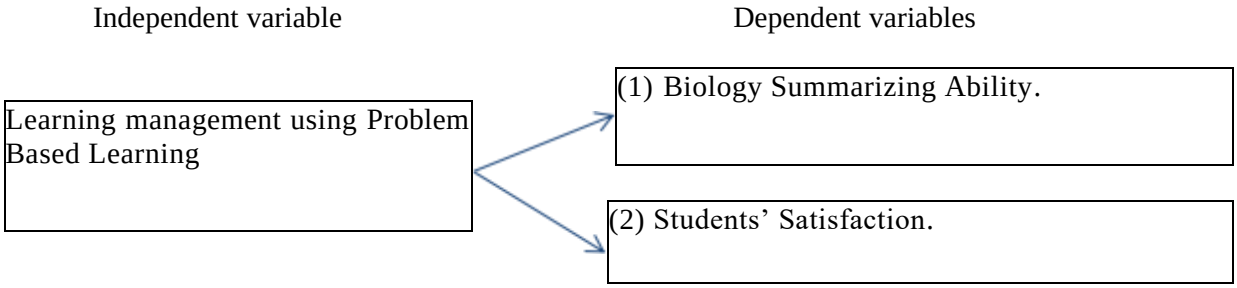

Figure 1 Conceptual Framework

Methodology

1. Population and sample

The population of this study is 60 eighth-grade students in Zhengzhou NO.1 Middle School, the People's Republic of China, during the academic year 2024. The sample of this study is 30 eighth-grade students in Zhengzhou NO. Middle schools in the People's Republic of China during the academic year 2024 were selected by cluster sampling.

2. Research instruments:

The research instruments which were used in this study are (1) Problem-Based Learning Lesson plans. (2) The Biology Summarizing Ability Test. And (3) Questionnaire for students' satisfaction.

2.1 Problem-Based Learning Lesson Plans

The eighth-grade Biology curriculum plan at Zhengzhou No. 1 Middle School consists of a total of 6 lessons, each lasting 2 class hours, for a total of 12 class hours. The specific arrangement is shown in the table below:

Table 1 Course content sheet

Lesson Plan	Topic	Time Duration
1	Animals that live in water	2 hours
2	Land-living animals	2 hours
3	Flying animals in the air	2 hours
4	Movement of animals	2 hours
5	Innate and learning behaviors of animals	2 hours
6	Social behavior of animals	2 hours

The draft lesson plans mentioned earlier are assessed by 3 experiments regarding the appropriateness of each component of the draft lesson plans. The instrument used for evaluating appropriateness is a five-point rating scale that ranges the level of appropriateness from a very high level, high level, moderate level, low level, and very low level.

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The appropriateness data collected from the evaluation form is analyzed by calculating mean scores and assigned the interpretation of appropriateness level as follows:

Table 2 Evaluating appropriateness was a points rating scale Instrument for collecting data

Mean Scores	Interpretation of Appropriateness Level
4.51-5.00	Very high level
3.51-4.50	High level
2.51-3.50	Moderate level
1.51-2.50	Low level
1.00-1.50	Very low level

2.2 The Biology Summarizing Ability Test

The steps of constructing the Biology Summarizing Ability Test;

Step 1: Studying the construction of the achievement test and the relevant documents. Consideration was focused on the purposes, types, and contents of the test. The construction of the test involves item analysis to clarify the item discrimination and item difficulty of the test, as well as the validity and reliability of the test.

Step 2: Analyzing the curriculum contents and the learning objectives by constructing the analysis table of the curriculum regarding the coverage of objectives and content of the curriculum. The test items consisted of five types of cognitive domains: 1) Extract key information; 2) Simple expression; 3) Integrate knowledge; 4) Summarize; 5) Relationship thinking.

Step 3: Prepare a summary Ability test for the 'Grade 8 Biology Curriculum'. The test consists of 30 choice questions and 5 short questions, each with four alternative answers and one correct answer for each alternative.

Step 4: The draft test was presented to thesis advisors for their advice on the appropriateness, precision, accuracy, ambiguity, and wording of the test. After that, the draft test was revised according to the thesis advisors' suggestions. The test and the test evaluation form were offered to the three experts for the content validity check and suggestions, such as the type of questions, accuracy of the test, and wording. The quality of the test was considered from the Index of Item Objective Congruence (IOC) obtained from the achievement test evaluation form.

Step 5: Analyzing the IOC index of the test items. The formula used to calculate the IOC index is as follows:

$$\mathrm{IOC} = \frac{\Sigma R}{N}$$

Where IOC means Index of Item Objective Congruence
ΣR means the Summation of the experts' opinion marks
N means Several experts

If the Index of Item Objective Congruence (IOC) of each item of the test is higher than 0.5, that means it can be used in the test. The result of analyzing the IOC index showed that all test items were appropriate and could be used in the test.

Evaluation forms (achievement tests) are distributed to 5 experts on the course team, including 2 professors and 3 associate professors. 3 test evaluation forms were restored, with a recovery rate of 100%. After a series of mathematical violations, detailed evaluation criteria for lesson plan design tests and test papers were obtained. See the appendix for details.

As can be seen from the appendix, the IOC of the course design test and each project is 0.8-1.0, which is greater than 0.5. The result of analyzing the IOC index showed that all test items were appropriate and could be used in the test.

Step 6: Revise the test according to the experts' comments and suggestions.

Step 7: Measuring the item difficulty (p) and item discriminability (r), including reliability by trying out the test on students who had learned this content.

Step 8: Analyzing each item of the test to find out the item difficulty (p) and item discriminability (r), including reliability. Item difficulty (p) should range from 0.20-0.80, and item discriminability (r) should be more than 0.20. The reliability of the test was computed using the formula of Kuder and Richardson formula 20 and should be more than 0.7

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Researchers use exam papers to test students to get a set of data. This data was then used to measure the item difficulty (p=0.20-0.9), and the reliability of the Academic achievements test is 0.713, with item discriminability (r=0.64-0.91) of the learning Academic achievements test.

As can be seen from the appendix, the difficulty (p) of each item of the Scholastic Achievement Test is in the range of 0.20 to 0.80. The discriminant (r) of each item is greater than 0.2. Therefore, the item difficulty (p) and item discriminability (r) of the examination paper meet the requirements.

In summary, the quality of the test tool was tested from four aspects: validity, reliability, item difficulty, and item discrimination, and the results were all in line with the requirements. Therefore, the test tool meets the requirements.

2.3 Questionnaire for students' satisfaction

The following are the steps for constructing the questionnaires:

Step 1: Research and construct documents related to the survey questionnaire.

Step 2: Constructing a questionnaire consists of three parts: the first part records the personal information of students. The second part is a five-point Likert questionnaire from very high, high, medium, low, and very low. This part of the questionnaire consists of 15 questions or statements asking students for their opinions on teaching. This part of the questionnaire is developed based on the student opinion questionnaire. The third part is open-ended questions that ask students for their opinions on course content, learning activities, teaching materials, evaluations, and evaluations, and provide space for other opinions or suggestions. In short, the items included in the student satisfaction questionnaire are mainly considered from the following four aspects:

1) Student satisfaction with learning objectives
2) Student satisfaction with learning content
3) Student satisfaction with learning methods
4) Student satisfaction with the learning environment

Step 3: Submit the draft questionnaire to the thesis advisor, solicit their suggestions on the suitability, accuracy, ambiguity, and wording of the questionnaire, and conduct content validity tests on the three experts. The objective consistency index (IOC) obtained from the evaluation table considers the quality of the questionnaire.

Step 4: Based on the opinions and suggestions of experts, modify the questionnaire.

Step 5: Analyze the IOC index items in the questionnaire. The formula for calculating the IOC index is:

$$\text{IOC} = \frac{\Sigma R}{N}$$

Directly or canceling the average project goal consistency index
$\sum$ R refers to the total sum of expert opinion markers
N refers to some experts

The project objective consistency index (IOC) of each item in the questionnaire is greater than 0. The analysis of the International Olympic Committee index indicates that all questionnaire items are appropriate and can be used in testing.

Step 6: Analyze each questionnaire to identify its reliability. The researcher attempted to draft a questionnaire with 30 students who were not sampled. The collected data was then analyzed using a statistical package. The program values ranged from 0 to 1, and the alpha values were between 0 and 1, indicating that the questions fully complied with the rules. The reliability coefficient values indicate that the reliability quality of the research data is high, so the questionnaire is suitable for collecting data.

As can be seen from the appendix, the Cronbach Alpha coefficient of the reliability of the student satisfaction questionnaire is 0.714, which is greater than 0.7. Therefore, the reliability of the student satisfaction questionnaire meets the requirements.

To sum up, I have tested the quality of the student satisfaction questionnaire from two aspects of validity and reliability, and the results meet the requirements, so my student satisfaction questionnaire tool meets the requirements.

3. Data collection

The procedures of data collection are as follows:

1) The sample was studied by using problem-based learning management.
2) Evaluation of the sample's biological summarization ability using the biological summarization ability test questions before teaching.
3) The sample was instructed on biological summarization skills using problem-based learning management based on 6 lesson plans (2 hours per lesson, 12 hours in total).
4) Upon completion of the instruction, the sample was evaluated using the same Biological Summarization Skills Test questions.
5) The sample was given a student satisfaction questionnaire.

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4. Data analysis

In this study, the data were analyzed using statistical procedures by the research objectives: 1). Conduct a t-test on the dependent sample to compare the changes in students' summarizing ability before and after using the problem-based learning system; 2) Conduct a t-test on the sample to compare students' summarizing ability with the determined 70% standard;3) The arithmetic mean and standard deviation were used to assess students' satisfaction.

Results

Table 1 The result of the comparison of different biology summarizing abilities before and after learning through problems.

Group	n	Pretest scores		Posttest scores		t	p
		M	S.D.	M	S.D.		
Experimental group	30	35	5.18	47.43	4.40	17.58**	.001

*p＜.01

As presented in Table 7, the mean scores of pretests of students' biology summarizing ability were 35(S.D.=5.18), and the posttest of students' biology summarizing ability was 47.43(S.D. =4.40). In addition, it aims to examine the different scores before and after using problem-based learning to improve biology summarizing ability. The results of this table show that students' biology summarizing ability improved significantly after learning through problem-based learning in the classroom, post-test scores on students' biology summarizing ability were higher than pretest scores at the .01 level of statistical significance (t29 = 17.58, p =.001< .01). The mean scores of the study were increasingly higher than the pretest.

Table 2 The result of comparing the different scores of academic achievements after learning through problem-based learning with the criteria set at 70 percent.

Group	N	Full score	Criteria score	M	S.D.	t	p
Experimental group	30	55	38.5	47.43	4.40	11.12	.001

*p＜.01

As shown in the table, out of a possible full score of 55, the mean score of the students' academic achievement after learning through problems was 47.43 points with a standard deviation of 4.40 points, which is statistically higher than the 70% criterion (t29=11.12, p=.001< .01).

This shows that the biology summarizing ability of the students who received problem-based learning was higher than 70%

According to the research results, we can draw the following conclusions:

Based on the results of the study, we can conclude that the mean scores and standard deviations of students who use problem-based learning in teaching biology courses are higher than the 70% norm and are statistically significant at the 0.05 level. Problem-based learning can improve students' ability to summarize.

Discussion

1. Students' biology summarizing ability improved after problem-based learning compared with before the study. In this study, using the eighth-grade students of Zhengzhou No. 1 Middle School in the People's Republic of China as the research object, the five teaching steps of problem-based learning were adopted, in which the teacher guided the students to solve problems and summarize their knowledge independently by carefully designing the problems and organizing the tasks, and emphasized the in-depth understanding, generalization and summarization of the knowledge in the problem-based learning. This process not only encourages students to think and explore their initiative but also develops their ability to generalize and express themselves. Problem-Based Learning is a problem-oriented teaching and learning strategy that aims to guide students to dig deeper into their knowledge, integrate it, and apply it by solving problems on their own. This teaching strategy not only encourages students to actively acquire knowledge and improve their problem-solving skills but also effectively enhances their ability to summarize.

2. The five teaching steps of this study proved to be very effective and practical:

Step 1: Problem design: Teachers carefully designed inspiring and challenging problems to ensure that they were able to stimulate students' interest and thinking. By guiding students to make initial analyses of the problem, students' curiosity and spirit of exploration are stimulated.

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Step 2: Organizing tasks: Teachers organize specific learning tasks for students based on the questions, with clear objectives and requirements. Students are driven by the tasks to collect information and prepare solutions.

Step 3: Solve the problem: Students use what they have learned and the information they have collected to solve the problem independently or in small groups. In the process of problem-solving, the teacher provides timely guidance and assistance and encourages students to try out different methods and ideas.

Step 4: summarizing and Sharing: Students summarize the process and results of the problem-solving and form their own opinions and conclusions. Groups or individuals share their experiences and ideas with the class. The teacher leads the class in discussion and evaluation to refine the summary.

Step 5: Analysis and reflection: Students reflect on the whole process of problem-based learning and summarize the successes and shortcomings. The teacher summarizes and analyses the whole teaching process, stressing the method and value of problem-based learning. Assign relevant extension tasks to encourage students to continue to deepen their understanding and application of knowledge.

3. After the problem-based learning on the biology summarizing ability of Grade 8 students of Zhengzhou No. 1 Middle School in the People's Republic of China, the students' biology summarizing ability increased by 70% compared with that before the study, and the experiment was statistically significant and feasible. In this study, "The Study of the Effect of Problem-based Learning on Biology Summarizing Ability", the biology summarizing ability assessment questions were used to focus on five aspects, namely 1) the ability to extract key information, 2) the ability to express themselves succinctly, 3) the ability to integrate knowledge, 4) the ability to summarize and conclude, and 5) the ability to think in relation, with a total of 35 items to train and assess the students. It significantly improved students' motivation to learn, increased students' participation in the teaching and learning process, stimulated students' desire to explore, and activated students' summarizing thinking.

4. Guo (2021) Course satisfaction surveys, as a combination of questionnaires and field interviews, are designed to provide insights into students' satisfaction with course content and teaching methods. Through this mechanism, schools can accurately capture students' actual needs and expectations and then optimize teaching strategies and content design to significantly improve students' learning outcomes and overall satisfaction. The results of this survey are in the significantly high-level range, reflecting the stability and positivity of the overall evaluation. The reasons for this may be related to the following:

(1) High level of recognition of the teaching format: students were generally satisfied with the innovation of the teaching format. Teachers skillfully designed problem-oriented teaching activities that prompted students to actively explore and collaborate on tasks and encouraged deep thinking and summary sharing in the process. In addition, the transformation of the teaching evaluation system - from a single examination result to a diversified evaluation focusing on the problem-solving process, student efforts, and progress - has greatly stimulated students' enthusiasm for participation and sense of achievement and made teaching closer to students' individual needs and growth paths.

(2) Precise alignment of course content: The course content is closely focused on the core objective of enhancing students' biology summarizing ability, which is highly relevant and practical, laying a solid foundation for students' in-depth learning and long-term development in the field of biology. This precise positioning not only meets the learning needs of students but also enhances their recognition of the value of the program.

(3) Remarkable learning results: Mohd & Jamaludin (2022) the effective implementation of the problem-based learning model in the biology curriculum directly promotes the remarkable improvement of students' biology summarizing ability. Students not only made progress in knowledge mastery but also demonstrated more mature abilities in problem-solving and critical thinking. This leap in competence is undoubtedly an important source of high student satisfaction, who found that specific teaching styles (e.g., collaborative learning) enhance students' engagement, satisfaction, and competence enhancement, which is also corroborated by the problem-based learning model in this study.

In conclusion, this study firstly improved the biology summarizing ability of Year 8 students in Zhengzhou No. 1 Middle School through five concise but interrelated pedagogical steps of problem-based learning. Then, the learning process was made more attractive through designing problems, organizing tasks, solving problems, summarizing and sharing, and analyzing and reflecting. Students no longer felt burdened in learning but became more active and passionate. They gradually adapted to this new learning method. This method improves students' ability to extract key

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information, express themselves succinctly, integrate knowledge, summarize, and think in a connected way. It improved students' thinking and communication skills, enhanced student engagement, effectively improved students' performance in biological summarization, and significantly increased students' satisfaction with the teaching method.

Conclusion

The impact of Problem-Based Learning on students by comparing and analyzing the pre- and post-test results of the Problem-Based Learning intervention on the biology summarizing ability of 8th-grade students. The conclusions are as follows:

1)Licensed pharmacists qualification examination students used the " problem-based learning" in the course "Pharmaceutical Management and Regulations Course" to take the pre-test of academic achievements. The average pre-test score of students' academic achievements was 35 (S.D.=5.18), and the average post-test score of students' academic achievements was 47.43 (S.D.=4.40). the statistical significance level is .01($t_{29} = 17.58$, $p=.001 < .01$).

2) After adopting " problem-based learning", the academic achievements of Licensed pharmacists' qualification examination students in pharmaceutical administration and regulations courses were higher than the 70% standard, with a statistical significance of .01($M=47.43$, S.D.=4.40, $t_{29}=11.12$, $p=.001< .01$).

3) The overall results of the problem-based learning by students are at a high level with ($M=4.01$, S.D.= 0.77). Thus, it was concluded that students' satisfaction of the students after receiving problem-based learning was high.

Therefore, problem-based learning is feasible for teaching in the pharmaceutical management and regulatory courses of the registered pharmacist qualification exam, which helps to improve the learning effectiveness and academic achievements of students. The experimental results validated the research hypothesis.

This study uses mathematical analysis software to evaluate the satisfaction of problem-based learning in teaching. The results showed that students had the highest satisfaction with problem-based learning. In the teaching process using problem-based learning, students' personalized learning needs are met, students' interest in learning is stimulated, learning efficiency is improved, students' enthusiasm for participating in learning is improved, and it is conducive to improving students' academic achievements and winning. Students love it.

Recommendation

1. Recommendation for implication

Based on the findings from the study, the following recommendations are made:

1.1 Enriching the level of problem design: Teachers should design more questions with levels and gradients, from basic knowledge points to comprehensive application to innovative thinking, to comprehensively improve students' ability to summarize and solve problems. At the same time, the design of the problem should be closely related to the reality of life to improve students' interest and participation.

1.2 Strengthen group cooperative learning: Introducing more group cooperative activities in problem-based learning encourages students to discuss, question, and answer each other's questions, and promotes in-depth understanding of knowledge and the ability to summarize through collective wisdom. At the same time, teachers should play the role of guide and facilitator, giving guidance and feedback at the right time.

1.3 Establishment of personalized evaluation system: Aiming at the different learning characteristics and progress of students, a personalized evaluation system is established, which not only focuses on the quantitative improvement of the summarizing ability but also pays attention to the evaluation of the student's attitudes, methods, and innovative abilities in the learning process. Through diversified evaluation, students are motivated to develop in a well-rounded way.

1.4 Enhance interdisciplinary integration: Combine biological problems with other disciplines (e.g., chemistry, physics, geography, etc.) and design interdisciplinary problem-based learning tasks to broaden students' knowledge horizons and develop interdisciplinary and comprehensive thinking skills. This helps students develop a more comprehensive perspective and deeper insights when summarizing.

1.5 Using information technology to optimize the teaching process: With modern information technology tools (e.g., online learning platforms, intelligent teaching systems, etc.), students are provided with richer learning resources and personalized learning support. At the same time, data analysis is used to understand students' learning situations, adjust teaching strategies in time, and improve the relevance and effectiveness of problem-based learning.

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2. Recommendation for further research

As an important teaching method in the field of education, the problem-based learning method has been widely recognized for its ability to enhance students' learning capabilities. However, with the evolution of educational philosophies and advancements in teaching technologies, the research and practice of questioning methods also face new challenges and opportunities. The following are prospects for future research on problem-based learning methods:

Based on the existing research, more in-depth research can be conducted in the following aspects in the future:

2.1 Expanding the scope of the sample:

This study was conducted only on the eighth-grade students of Zhengzhou No. 1 Middle School, and in the future, the scope of the sample can be expanded to include students in different grades, schools, and even different regions, to verify the general impact of problem-based learning on students' biology summarizing ability.

2.2Extending the research cycle:

This study may be limited by time constraints, and in the future, the research cycle can be extended to conduct a long-term follow-up survey to observe the sustained impact of problem-based learning on the development of students' summarizing ability.

2.3In-depth investigation of influencing factors:

Other factors affecting students' summarizing ability in problem-based learning, such as family background, study habits, motivation, etc., should be further explored to construct a more comprehensive model of influencing factors.

2.4Comparative study of different teaching modes:

Compare and contrast problem-based learning with traditional teaching modes or other new teaching modes, and analyze the different effects of different teaching modes on students' summarizing ability, to provide a more scientific basis for teaching practice.

2.5 Focusing on the synergistic development of students' emotions and cognition:

Focusing on the synergistic development of students' emotions and cognition in problem-based learning, researching how to stimulate students' positive emotions, improve their interest in learning, and self-confidence through problem-based learning, and then promote students' summarizing ability and overall development.

In summary, future research should continue to deepen the understanding of problem-based learning and its impact on students' biology summarizing ability, constantly explore and optimize the teaching mode, and contribute to the cultivation of high-quality talents with an innovative spirit and practical ability.

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