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Strategies and practices for cultivating students' critical thinking in the primary school basic education stage

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Abstract: During the basic education stage of primary school, cultivating students' thinking ability is one of the cores of educational work. With the advent of the information age, simply imparting knowledge is no longer sufficient to cope with the complex and changing social needs. Cultivating students' critical thinking (SCT) has become the key to improving the quality of education. Critical thinking not only helps students think independently and analyze problems in their studies, but also promotes the development of their innovation and lifelong learning abilities. This paper first explores the importance and current status of cultivating critical thinking in primary school students, and then analyzes the shortcomings of existing research. Next, this paper proposes targeted training strategies and verifies the effectiveness of these strategies through experimental design. The experiment includes two main strategies: one is to introduce project-based learning through classroom reform to encourage students to actively explore, question, and reflect; the other is to establish a diversified evaluation system to focus on students' thinking processes and innovation abilities. Finally, the paper discusses the experimental results in detail, demonstrating significant improvements in SCT after the implementation of the strategy. The experimental results show that after adopting the above strategies, students' scores on observation and analysis abilities in critical thinking tests have improved, with their analysis abilities far exceeding those of the control group by about 14 points.

Keywords: *Critical thinking, Primary school basic education, Student thinking, Training strategies.*

1. Introduction

In primary school, which plays a crucial role in students' future development and lays a solid foundation, students' brains are in an extremely active and rapidly developing stage. This is undoubtedly an excellent golden period for cultivating good thinking habits and methods. However, unfortunately, in terms of the current practical situation, the traditional education model has significant limitations to a large extent. This educational model often overly focuses on the one-way transmission and indoctrination of knowledge, blindly emphasizing students' memory and acceptance of knowledge, but to a considerable extent neglects the careful cultivation and attention to students' critical thinking, which is a crucial ability.

The consequences of this lack of critical thinking ability are extremely significant. It often leaves many students feeling helpless and lacking the necessary independent thinking and effective problem-solving skills when faced with complex practical problems. These students often only mechanically and rigidly apply the knowledge they have learned, but are unable to flexibly apply, generalize, and innovate in expanding their knowledge.

This article aims to comprehensively and deeply explore and discuss how to effectively cultivate students' critical thinking in the important stage of primary school basic education. The article will first provide a clear and precise explanation of the core purpose and specific detailed content of this study, which is a critical thinking cultivation strategy tailored specifically for primary school students that is

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solemnly proposed and verified through practical operation. Subsequently, through the practical implementation and execution of these carefully designed strategies, and the extensive and comprehensive collection of various data related to them, a thorough and insightful analysis of the effects generated by their implementation is carried out. Finally, the article will systematically and comprehensively summarize the results of the entire research, clearly and explicitly point out the positive contributions brought by the research as well as the shortcomings that still exist, and propose constructive and highly valuable improvement suggestions and development directions for future research directions and practical operations.

2. Related Work

In recent years, domestic and foreign scholars have conducted extensive research on the cultivation of critical thinking and proposed a variety of teaching strategies and methods. Alsaleh explored the methods and strategies for teaching critical thinking skills through a literature review, pointed out the limitations of existing teaching methods in cultivating critical thinking, and suggested adopting more diversified teaching strategies [1]. Huang et al. focused on the cultivation of key abilities of Chinese students based on AI education, of which critical thinking is an important component. They proposed specific measures to promote the cultivation of critical thinking using AI technology and emphasized the importance of technology in education Huang [2]. Suryana and Yulia [3] designed a teacher questioning skills model to address the issue of critical thinking cultivation in early childhood education in West Sumatra, Indonesia, aiming to develop SCT by improving teachers' questioning skills [3]. Nahar et al. implemented a quantum teaching model to improve students' collaborative thinking skills and found that the model was effective in improving students' critical thinking skills Nahar, et al. [4]. Sari and Prasetyo [5] studied the application of project-based learning in critical reading courses and found that this method can significantly enhance SCT skills [5]. Sun et al. explored the relationship between primary school students' STEM learning attitude and computational thinking skills and found that positive learning attitude can predict higher levels of computational thinking skills, and computational thinking is closely related to critical thinking [6]. Sitopu et al. emphasized the importance of integrating mathematical literacy into primary education curriculum through a literature review, pointing out that this helps to cultivate SCT and problem-solving skills Sitopu, et al. [7]. Zulyusri, et al. [8] studied the impact of science education on students' creativity and critical thinking skills under the project-based learning (PjBL) model and found that the model can effectively improve these skills Zulyusri, et al. [8]. Warsah, et al. [9] focused on the impact of collaborative learning on learners' critical thinking skills and found that the collaborative learning model can significantly improve SCT level Warsah, et al. [9]. Siahaan, et al. [10] conducted a bibliometric analysis of research on critical thinking among pre-service mathematics education teachers in Indonesia from 2015 to 2023, and pointed out the trends and shortcomings of research in this field [10]. Although existing research has achieved certain results, there are still some shortcomings. First, there are relatively few studies on critical thinking cultivation strategies in primary schools, and there is a lack of in-depth research on the characteristics of students of this age group; second, most existing studies focus on theoretical discussions and lack the support of empirical data; finally, there is insufficient evaluation of the long-term effects of strategies after implementation, making it difficult to fully reflect their impact on students' thinking development.

3. Method

3.1. Critical Thinking

3.1.1. Concept

Critical thinking is a rational and reflective thinking process that evaluates thinking through certain standards and improves thinking. It is both a thinking skill and a thinking tendency, which cultivates a way of thinking that is able to think independently, analyze rationally, and seek truth rigorously in order to cope with complex and ever-changing problems and challenges. From a

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philosophical perspective, the concept of critical thinking can be traced back to the works of ancient Greek philosophers such as Socrates, Plato, and Aristotle. They explored the connotation of critical thinking and focused on the qualities and characteristics of a hypothetical critical thinker. Critical thinking requires people to analyze the information they receive rationally, skeptically, and unbiasedly, evaluate factual evidence, and form judgments [11, 12]. Its main purpose is to obtain the most rational and objective judgment as possible, to help people establish a rigorous and solid reasoning structure, and to make their views easier to be understood and recognized by others. In addition, critical thinking also requires overcoming the influence of egocentrism and sociocentrism and possessing effective communication and problem-solving skills. Critical thinking is defined as realistic, rigorous self-reflective thinking that can correctly evaluate existing facts, reasonably propose hypotheses, and verify hypotheses. It not only highlights the critical nature, but also follows the common nature of thinking. The spirit of critical questioning is its characteristic, and the ability of rational thinking is its common nature.

3.1.2. Characteristics

As a high-level cognitive ability, critical thinking has many significant characteristics, which together constitute its unique way of thinking and value.

3.1.2.1. Analytical and Logical Thinking

Critical thinking emphasizes the importance of in-depth analysis and evaluation of information, and strongly requires individuals to fully and effectively apply the scientific methods of logical analysis when facing various types of information or viewpoints, to conduct comprehensive and multi-dimensional in-depth evaluations of the sources, authenticity, accuracy, and reliability of information. Analytical thinking means that individuals need to have the ability to break down and subdivide complex and vast information, be able to keenly and accurately identify the core elements that play a key role, and further explore the inherent connections and interactions between these elements. Through this analytical thinking, individuals are able to sort out clear threads and structures from seemingly cluttered information, thereby better understanding and grasping the essence of the information. Logic imposes strict requirements on individuals in the process of thinking, that is, they must follow rigorous and rigorous logical rules to ensure the rationality and effectiveness of the entire reasoning process. Individuals should organize and integrate their thinking and judgment based on clear logical order and relationships, avoiding situations of logical confusion, self contradiction, or excessive jumping. Only by following strict logical rules can an individual's thinking have coherence and persuasiveness, and the conclusions drawn can withstand scrutiny and testing [13, 14].

3.1.2.2. Openness and Independence

Openness means that individuals can consistently maintain an open, inclusive, and positive attitude throughout the entire process of thinking about problems. Individuals not only need to have the willingness to actively accept different viewpoints and opinions, but also to comprehensively and deeply evaluate these viewpoints and opinions with a fair, just, and objective attitude. This openness has extremely important significance and value in thinking activities. It can effectively help individuals break the inherent thinking patterns that have been formed for a long time, and get rid of those narrow and limited thinking patterns. By accepting different voices and ideas, individuals can greatly broaden their horizons, examine and think about problems from more diverse and rich perspectives, and thus have a more comprehensive and in-depth understanding of the essence and connotation of problems. Independence requires individuals to firmly maintain a state of autonomy and independence throughout the entire thinking process, and not blindly follow the views or conclusions of others [14]. Individuals should rely on their own thinking ability, analytical ability, and judgment ability to gradually form unique and distinctive insights through in-depth thinking and research. This independence is undoubtedly the core element and key to critical thinking. It actively encourages individuals to bravely

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take the step of questioning authority, boldly challenging traditional, possibly outdated, or no longer applicable concepts and ideas. Encourage individuals to examine the world around them with a more rational, objective, calm, and composed attitude, without being misled by appearances, suppressed by authority, or bound by tradition, truly achieving independent thinking and autonomous judgment

3.1.2.3. Reflection and Self-Correction

Reflective thinking requires individuals to continuously and thoroughly examine their hypotheses, reasoning, and final conclusions throughout the entire thinking process. Individuals need to carefully examine whether there are biases, misunderstandings, or logical errors in this series of thinking activities. This process of reflection has extremely important significance and value for the development of individual thinking. It can effectively help individuals discover their potential blind spots in thinking, aspects that have not been fully considered due to personal experience, inherent beliefs, or emotional factors. Through reflection, individuals can promptly detect deviations and deficiencies in their thinking, and quickly adjust their thinking direction and methods to avoid going further down the wrong path. This timely reflection can enable individuals to have a clearer understanding of the essence and key points of the problem, leading to more accurate, reasonable, persuasive, and reliable conclusions [15, 16]. These conclusions have been carefully considered, repeatedly tested, and revised to better address various challenges and problems in reality. Self correction emphasizes the ability of individuals to demonstrate a proactive attitude and strong action to correct and improve their thinking when they discover errors or shortcomings. This ability is not optional, but a crucial component of critical thinking. It makes critical thinking a dynamic process full of vitality, continuous development, and evolution. In this process, individuals do not rigidly adhere to their initial viewpoints and ideas, but continuously improve and perfect their thinking abilities through continuous reflection and correction. Every reflection and correction is an opportunity for growth and progress, allowing individuals to gradually break free from the limitations and misconceptions of their thinking, and analyze and solve problems in a more mature, efficient, and accurate way of thinking.

3.2. Current Status of Cultivation of SCT

In the primary education stage, the current status of cultivating SCT is indeed worrying and is not as ideal as people expect. The root cause of this problem can be mainly attributed to the insufficient attention paid by schools and teachers to the cultivation of critical thinking, as well as the students' own lack of awareness and ability in this regard. First, schools and teachers are still bound by the traditional model in terms of educational concepts. In the traditional teaching model, teachers often play the role of knowledge transmitters, while students are passive recipients. This teaching method focuses on the inculcation and memorization of knowledge points, but neglects the cultivation of students' thinking ability and independent thinking ability. Therefore, in daily teaching, teachers pay more attention to students' mastery of knowledge points, but lack sufficient attention to whether students can use the knowledge they have learned to think critically. Secondly, students themselves lack the awareness of active and critical thinking. In the long process of receiving traditional education, students have become accustomed to accepting teachers' opinions and answers, and lack the ability to question and analyze independently. They often lack confidence, dare not express their different opinions, and dare not conduct in-depth exploration and thinking on the knowledge they have learned. This passive learning method not only limits the development of students' thinking, but also affects their future learning and growth.

In order to improve this situation, this paper needs to start from multiple aspects. First, schools and teachers should change their educational concepts and focus on cultivating SCT and independent thinking abilities. In daily teaching, teachers can stimulate students' interest in thinking and cultivate their critical thinking ability by guiding students to raise questions, analyze problems, and solve problems. At the same time, teachers should encourage students to express their different opinions, respect their individuality and differences, and create a relaxed and free learning environment for them.

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Students should also actively cultivate their own critical thinking ability. They can continuously broaden their knowledge and vision and improve their thinking ability and independent thinking ability through reading, thinking, and practice. At the same time, they should also learn to question and reflect, constantly challenge their own cognitive boundaries, and push their thinking to a higher level.

3.3. Training Strategy Design

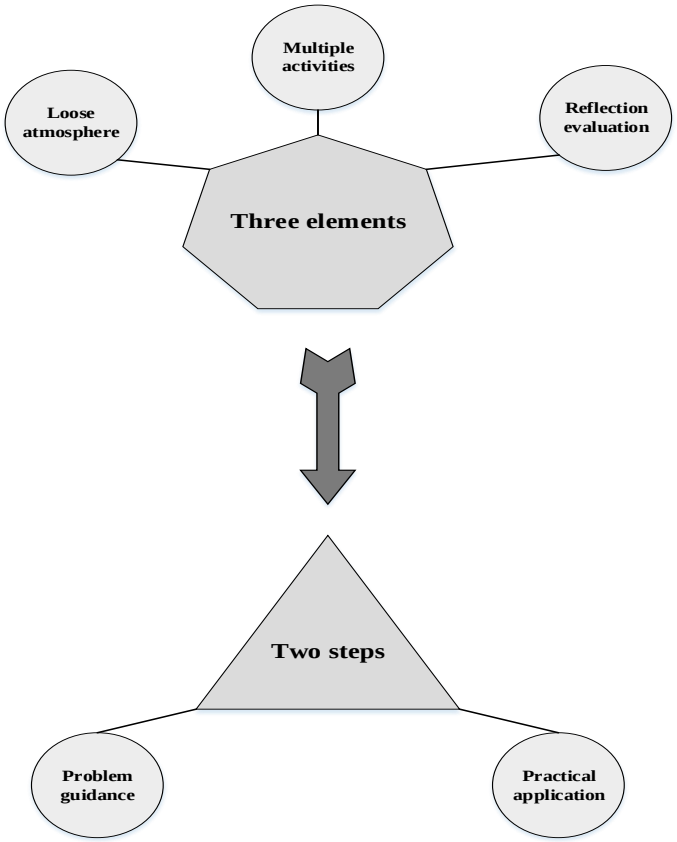

Figure 1.
Applied model of critical thinking cultivation.

In the strategies and practices for cultivating SCT in the basic education stage of primary school, critical thinking needs to apply the following "three elements" and "two steps" training strategies, and its application model is shown in Figure 1. This can guide teaching practice, among which the "three elements" of critical thinking training are:

$$\text{Relaxing atmosphere} + \text{Diverse activities} + \text{Reflective evaluation} = \text{Critical thinking} \quad (1)$$

A relaxed atmosphere means creating an open, inclusive, and questioning classroom environment where students dare to express their own ideas and opinions without fear of making mistakes. Multi-faceted activities refer to the use of heuristic problem solving, mathematical inquiry activities, group discussions, case teaching and other teaching activities to stimulate students' interest in thinking and cultivate their critical thinking ability. Reflective evaluation refers to guiding students to conduct self-evaluation and reflection, allowing them to evaluate their own thinking process and conclusions, summarize experiences and lessons, and continuously improve their thinking ability. The "two-step" strategy for critical thinking is as follows:

$$\text{Question guidance} + \text{Practical applicatio n} = \text{Developmen t of critical thinking} \quad (2)$$

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Teachers ask open-ended questions to guide students to think about problems from different perspectives and cultivate their questioning spirit and independent thinking ability. They also encourage students to apply what they have learned to actual situations and cultivate their critical thinking and innovation abilities through practical operations and problem solving. In teaching practice, teachers can flexibly apply these methods according to specific circumstances, combine students' actual conditions and teaching needs, and formulate targeted teaching strategies and methods to promote the development of SCT.

4. Results and Discussion

4.1. Experimental Design

4.1.1. Experimental Purpose

The purpose of this experiment is to explore in depth the practical and effective strategies for cultivating students' critical thinking in the critical stage of primary school basic education, and to comprehensively and systematically evaluate the effectiveness of these strategies in practical applications. The experimental design carefully divides the experimental group and the control group to form a distinct contrast. Among them, the experimental group students will receive educational interventions based on specific training strategies, while the control group students will learn according to conventional educational methods. Subsequently, a detailed comparative analysis was conducted on the specific performance of the two groups of students in the critical thinking test to verify whether the proposed training strategies can truly play a role and produce positive effects. Specifically, critical thinking tests will cover multiple dimensions and levels. By comprehensively and deeply comparing the scores, answering strategies, and types of errors of the experimental and control groups in these test items, objective, accurate, and persuasive conclusions can be drawn to verify the effectiveness and feasibility of the proposed training strategy in enhancing primary school students' critical thinking ability.

4.1.2. Experimental Subjects

This paper selected students from two classes of fourth and fifth grades in a primary school as experimental subjects, a total of about 160 students. They were randomly divided into an experimental group and a control group, with 80 students in each group, to ensure that there were no significant differences between the two groups in terms of age, gender, and academic performance. The specific number of students is shown in Table 1.

Table 1.
Experimental basic data

Group	Grade	Class	Number of students
Experimental Group A	Fourth grade	Class 1	40
Experimental Group B	Fourth grade	Class 2	40
Control group A	Fifth grade	Class 1	40
Control group B	Fifth grade	Class 2	40

4.1.3. Experimental Strategy

A. Experimental group: Committed to creating a relaxed, free, and vibrant open learning environment. In such an environment, students are strongly encouraged to bravely and freely express their unique viewpoints, actively raise various questions and issues, and engage in lively and in-depth discussions and constructive debates on these viewpoints and issues. By carefully designing a series of open-ended and inspiring questions, students are cleverly guided to delve into the core of the problem for thinking and analysis. Encourage students to have extensive exposure to information from diverse sources and forms, cultivate their ability to evaluate the reliability and authority of information sources, as well as the credibility and accuracy of information content, and help them clearly distinguish significant differences between facts and viewpoints. At the same time, cleverly designing problem

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scenarios with practical significance and real-world challenges allows students to naturally apply critical thinking to analyze problems, propose hypotheses, find solutions, and evaluate and reflect on the results in the specific process of personally solving these problems. And regularly organize reflection activities to guide students to review their experiences, methods, and insights in the learning and thinking process, summarize successful experiences and shortcomings, and further enhance their critical thinking abilities.

B. Control group: Traditional teaching methods are used without specific critical thinking training.

C. Experimental period: The experimental period is one semester, a total of 16 weeks. A special critical thinking training course is arranged once a week, and each course lasts 40 minutes.

4.2. Critical Thinking Test Scores

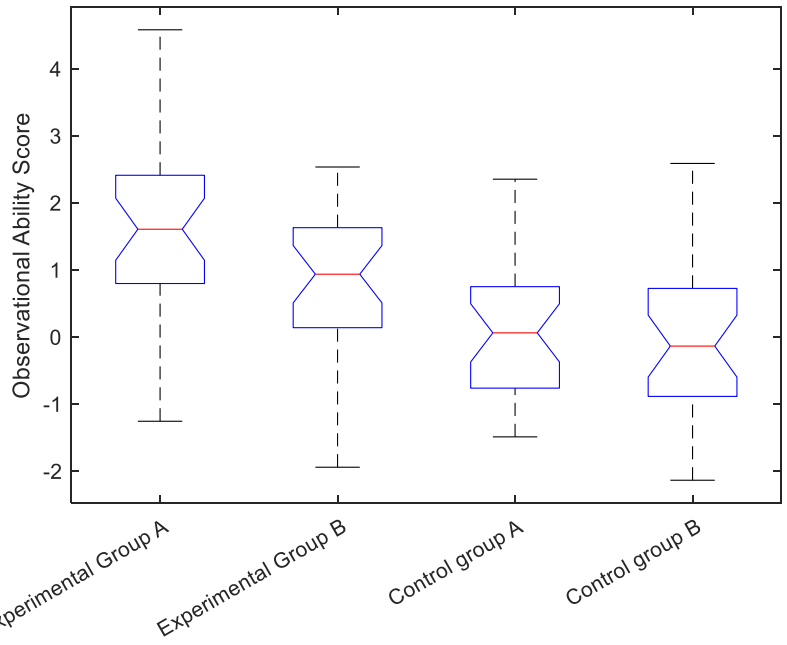

Figure 2.
Observational contrast.

This paper tests the observation ability of the experimental group and the control group, and the scores are shown in Figure 2, with a full score of 5. The average scores of the experimental groups A and B are around 1.5 and 1, which indicates that the observation ability is relatively high; while the average scores of the control groups A and B are around 0.3 and 0, which indicates that the observation ability is relatively low. This suggests that the experimental group has higher observation ability than the control group, and the experimental intervention has successfully improved the experimental group's observation ability and ability to pay attention to details. On the other hand, the control group shows no improvement, suggesting that the observed improvement in observation ability is most likely attributable to the experimental treatment rather than other factors.

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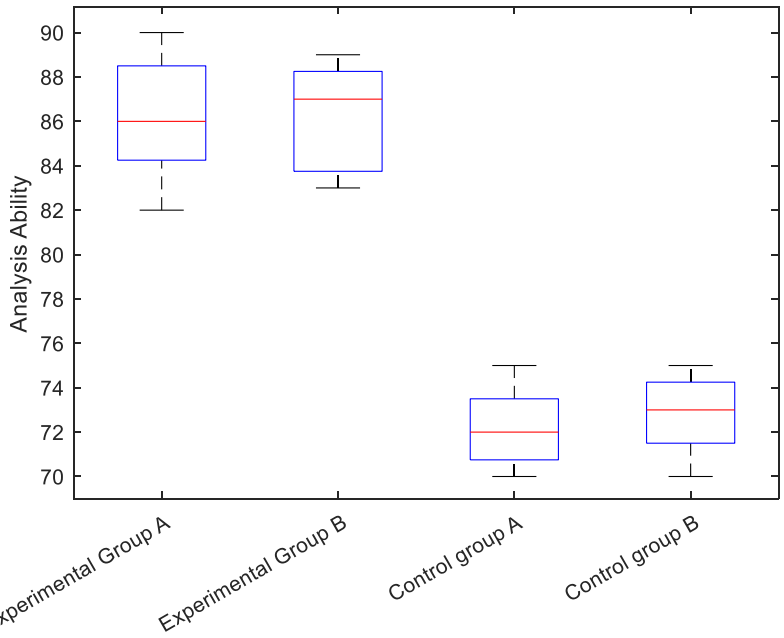

Figure 3.
Analyzing ability.

Figure 3 shows the test results of the analytical ability of the experimental group and the control group. In the experimental group, the analytical ability data of experimental group A is concentrated between 82 and 90, with an average of 86, and a large fluctuation; the data of experimental group B is between 83 and 89, with an average of 86.9, with a slightly smaller fluctuation but still maintaining a high level. In contrast, the analysis ability data of the control group A ranges from 70 to 75, with an average of 72.2, which fluctuates greatly but is generally low; the data of the control group B ranges from 71 to 75, but the average is 72.8, with slightly smaller fluctuations, indicating that its analysis ability is not only low but also less stable. In summary, the analytical ability of the experimental group is significantly higher than that of the control group (about 14 points higher on average), which shows the positive effect of the training strategy on improving analytical ability, while the control group performs poorly due to the lack of a training environment.

4.3. Result Analysis

By comparing the test scores of students in the experimental group and the control group, the following conclusions can be drawn:

(1) Strategy effectiveness: The critical thinking test scores of the students in the experimental group were significantly improved after the experiment, indicating that the proposed critical thinking training strategy has a significant effect in the primary school basic education stage. These strategies can help students improve their observation and analytical skills, thereby developing their critical thinking.

(2) Practical significance: Cultivating SCT in the primary school basic education stage will help them better cope with future learning and life challenges. At the same time, it will also help improve students' comprehensive quality and innovation ability, laying a solid foundation for their future development.

(3) Suggestions for improvement: Although the critical thinking test scores of the experimental group students improved significantly, there are still some shortcomings. Some students still find it

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difficult to conduct in-depth analysis and reasoning when faced with complex problems. Therefore, in future teaching, we can further optimize the critical thinking training strategy and strengthen the cultivation of students' thinking ability and problem-solving ability. At the same time, we can also design critical thinking training activities that are closer to students' lives based on their actual conditions and interests, so as to enhance students' interest in learning and their participation.

5. Conclusion

This paper proposes and verifies a set of strategies suitable for cultivating critical thinking among students in the primary school basic education stage, including project-based learning and a diversified evaluation system. The experimental results show that after the implementation of the strategy, students' scores in critical thinking tests significantly improved, and their learning attitudes and participation also improved significantly. This paper only evaluated the experimental period of one semester, and future research with a longer time span is needed to verify the long-term effects of the strategy. In addition, the limited sample size may affect the generalizability of the results. It is recommended that future research further expand the sample size, extend the experimental period, and explore more diversified teaching strategies and evaluation methods to more comprehensively promote the development of SCT; at the same time, strengthen home-school cooperation to jointly create a good thinking cultivation environment.

Transparency:

The author confirms that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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