

The Effectiveness of Basic Concepts of Social Studies Teaching Materials in Improving Critical Thinking Skills among Primary School Teacher Education Students

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Abstract Critical thinking is an important competence for prospective elementary school teachers because they need to analyze information, evaluate arguments, and formulate logical solutions to academic and social problems. This study aimed to examine the effectiveness of Basic Concepts of Social Studies teaching materials in improving the critical thinking skills of Primary School Teacher Education students. The study employed a quantitative approach with a quasi-experimental non-equivalent control group design. The participants were 60 first-semester students from two existing classes, consisting of 30 students in the experimental group and 30 students in the control group. Class II was assigned as the experimental group and used Basic Concepts of Social Studies teaching materials, while Class IJ served as the control group and received conventional learning. Data were collected using an essay-based critical thinking test administered before and after the intervention. The research instruments were reviewed by two experts and obtained an overall mean validation score of 3.75 on a four-point scale, categorized as very feasible. The results showed that the mean critical thinking score of the experimental group increased from 40.00 in the pretest to 84.03 in the posttest, with an N-gain of 0.730, categorized as high. The control group increased from 40.07 to 80.80, with an N-gain of 0.683, categorized as moderate. The independent samples t-test showed no significant difference in pretest scores between the two groups ($t(58) = -0.037$, $p = .971$), but showed a significant difference in posttest scores ($t(58) = 2.374$, $p = .021$). The N-gain analysis also showed a significant difference between the two groups ($t(58) = 2.230$, $p = .030$). These findings indicate that the use of Basic Concepts of Social Studies teaching materials resulted in greater improvement in students' critical thinking skills than conventional learning.

Keywords basic concepts of social studies; critical thinking; teaching materials; pre-service teachers; primary school teacher education

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I. Introduction

Critical thinking is one of the essential competencies that must be developed in higher education, particularly among Primary School Teacher Education students who are preparing to become elementary school teachers. Students at this level are expected not only to master academic content but also to analyze information systematically, evaluate the strength of arguments, identify meaningful problems, and formulate appropriate solutions grounded in reasoning. These abilities are particularly important because prospective PGSD teachers will later encounter a wide range of pedagogical and social problems that require logical, reflective, and evidence-based decisions in the classroom. However, previous studies have consistently indicated that the critical thinking skills of PGSD students still require substantial strengthening. Firmansyah and Rizal (2019) reported that PGSD students' critical thinking remained relatively low and that Social Studies learning had not fully provided opportunities to train and measure these competencies. Wiyoko (2019) similarly found that several critical thinking indicators particularly interpretation, evaluation, and inference remained relatively

weak among PGSD students. These findings collectively indicate that critical thinking development remains an important and unresolved issue in Indonesian teacher education.

The need to develop critical thinking becomes particularly relevant in Social Studies learning because Social Studies encompasses complex, interrelated content drawn from social, cultural, economic, historical, geographical, and civic domains that intersect with the everyday life of students. Consequently, PGSD students need more than the ability to memorize discrete concepts; they must be able to understand the relationships among concepts, examine social problems from multiple perspectives, evaluate the credibility and relevance of information sources, and formulate reasoned solutions to authentic issues. Witarsa and Muhammad (2023) emphasize that critical thinking is essential because it supports students in solving problems in both academic and real-life situations, and their study found that learning sequences involving problem identification, information gathering, structured presentation, and reflection could measurably improve students' critical thinking. These findings underscore that critical thinking development in Social Studies requires deliberately designed cognitive engagement rather than passive information transfer.

Previous research has also shown that active learning can strengthen critical thinking among prospective teachers. Verawati et al. (2021) found that reflective practices integrated into inquiry learning were effective in training the critical thinking skills of PGSD students. Rahmawati and Annita (2020) similarly reported that social inquiry learning could improve critical thinking among prospective elementary school teachers. These findings collectively indicate that PGSD students need learning experiences that encourage them to analyze problems rather than simply receive information. One instructional component that can support such learning experiences is teaching material. Teaching materials are not only used to deliver information but can also be deliberately designed to direct students to perform specific learning activities. When teaching materials contain contextual cases, analytical questions, problem-solving activities, and reflection, students are provided with greater opportunities to actively use the information they have learned. This issue is particularly important in the Basic Concepts of Social Studies course because the course provides PGSD students with a foundational understanding of Social Studies concepts and their application to real social situations.

The development of teaching materials for prospective teachers has received increasing scholarly attention. Ana et al. (2023), for example, developed teaching materials for thematic learning courses for PGSD students and examined their effectiveness in improving critical thinking, reporting positive outcomes. Nafisah et al. (2025) developed Basic Concepts of Social Studies teaching materials through SDGs-integrated case studies for prospective teachers, and their study showed that the teaching materials were valid and practical and produced an N-gain of 0.56, categorized as moderate. These studies provide important evidence regarding the potential of teaching materials to support critical thinking development. However, the majority of previous studies have focused primarily on the development and validation of teaching materials or on the implementation of particular learning models. Empirical evidence concerning the effectiveness of Basic Concepts of Social Studies teaching materials through a direct comparison between an experimental group and a control group remains limited. Therefore, further research is needed to determine whether the use of these teaching materials produces greater improvement in critical thinking than conventional learning.

The present study is a continuation of a research program conducted by the authors in 2025. The previous stage focused on the development and implementation of the Basic Concepts of Social Studies teaching materials, whereas the present study emphasizes rigorous empirical evidence of their effectiveness through a quasi-experimental comparison. The materials used in this study were designed to provide contextual learning experiences through case analysis, contextual exercises, and reflective discussions organized around core Social Studies concepts. These activities were expected to provide PGSD students with structured opportunities to analyze information, evaluate possible solutions, formulate arguments based on evidence, and reflect on their conclusions cognitive processes that are central to critical thinking. Based on these theoretical and empirical considerations, the present study aims to examine the effectiveness of Basic Concepts of Social Studies teaching materials in improving the critical thinking skills of Primary School Teacher Education students, particularly by comparing the improvement obtained by students who used the developed materials with the improvement obtained by students who received conventional learning.

II. Literature Review

A. Basic Concepts of Social Studies Teaching Materials

Teaching materials are an important part of the learning process because they organize content and provide students with directions for learning activities. In higher education, teaching materials need to be aligned with learning outcomes and student characteristics. In Social Studies, this is particularly important because the content is closely related to social phenomena and requires students to connect theoretical concepts with real situations. For Primary School Teacher Education students, Basic Concepts of Social Studies provides a

foundation for understanding various concepts that will later be taught in elementary schools. Therefore, teaching materials need to support not only conceptual understanding but also students' ability to examine social phenomena critically.

Research on teaching materials has increasingly emphasized the importance of integrating learning activities into instructional materials. Nasrul (2018), for example, developed integrated thematic teaching materials based on problem-based learning and emphasized the use of problems as part of the learning material. Ana et al. (2023) similarly developed teaching materials for prospective elementary teachers and examined their effectiveness in improving critical thinking. Nafisah et al. (2025) developed Basic Social Studies Concepts teaching materials using an SDGs-integrated case-study approach. Their findings showed that the materials achieved a validity score of 82.92%, a practicality score of 83.39%, and an N-gain of 0.56. This study is particularly relevant because it demonstrates that teaching materials in the same course area can be designed to support higher-order thinking among prospective teachers. In the present study, Basic Concepts of Social Studies teaching materials are positioned not simply as a source of course content. The materials provide opportunities for students to analyze cases, complete contextual exercises, discuss problems, and reflect on their understanding. These activities are intended to make the learning process more active and meaningful.

B. Critical Thinking Skills

Critical thinking refers to the ability to process information carefully, analyze relationships, evaluate evidence, formulate conclusions, and make decisions based on logical considerations. In teacher education, critical thinking is particularly important because teachers need to make decisions based on information and evidence rather than simply rely on assumptions. The importance of critical thinking among PGSD students has been demonstrated in previous research. Firmansyah and Rizal (2019) found that the critical thinking skills of PGSD students were still not optimal. Wiyoko (2019) also reported that interpretation, evaluation, and inference were among the indicators that needed further development. These findings indicate that critical thinking needs to be trained through learning activities that require students to use higher-order cognitive processes.

Critical thinking can be developed when students are given opportunities to examine problems and reflect on their reasoning. Verawati et al. (2021) showed that reflective practices integrated with inquiry learning could effectively train pre-service teachers' critical thinking. Witarsa and Muhammad (2023) also demonstrated that learning involving problem identification, information gathering, presentation, and reflection could improve critical thinking among university students. Thus, critical thinking development requires more than delivering information. Students need learning experiences that allow them to use information, examine evidence, construct arguments, and evaluate their own conclusions.

C. Relationship between Teaching Materials and Critical Thinking Skills

The relationship between teaching materials and critical thinking depends largely on how the materials are designed and used. Materials that primarily provide factual information may support conceptual understanding but offer limited opportunities for students to practice higher-order thinking. Conversely, materials that incorporate cases, problems, questions, and reflective activities can create opportunities for students to analyze information, evaluate alternatives, and formulate conclusions. Teaching materials can therefore function as a pedagogical instrument for embedding critical thinking activities into regular learning. Sumardi et al. (2025), for example, showed that teaching materials organized through Task, Explanation, and Evaluation activities could support critical thinking and cultural literacy. Such a structure allows students to engage with a task, understand the underlying explanation, and evaluate their learning.

This relationship is also supported by Ana et al. (2023), who found that teaching materials designed for prospective elementary school teachers could improve critical thinking. Irhasyurna et al. (2022) similarly found that teaching materials integrated with local wisdom significantly affected students' critical thinking skills. Although their research was conducted in science education, the findings indicate that teaching materials can support critical thinking when they provide meaningful contexts and appropriate cognitive activities. The relationship is particularly relevant to the Basic Concepts of Social Studies teaching materials examined in this study. The materials provide contextual cases, exercises, and reflective discussions rather than relying exclusively on exposition. Through these activities, students are encouraged to understand concepts, examine social problems, and formulate reasoned responses. The expected relationship can therefore be described as: Conceptually, the present study posits that contextual teaching materials facilitate active learning activities that require students to engage in the analysis and evaluation of information. Through repeated exposure to these cognitive activities, students develop reflective reasoning capabilities, which in turn contribute to improved critical thinking skills. This conceptual sequence positions teaching materials not merely as a conduit for information but as a pedagogical instrument that scaffolds higher-order thinking. This framework provides the

basis for examining whether students who use the Basic Concepts of Social Studies teaching materials demonstrate greater improvement in critical thinking than students who participate in conventional learning.

III. Methods

A. Research Design

This study employed a quantitative approach with a quasi-experimental non-equivalent control group design. The design was used to examine the effectiveness of Basic Concepts of Social Studies teaching materials in improving students' critical thinking skills. Two existing classes were involved in the study. Class 1I served as the experimental group and received learning using the Basic Concepts of Social Studies teaching materials, while Class 1J served as the control group and received conventional learning. Both groups completed a pretest before the intervention and a posttest after the intervention. The pretest was used to identify students' initial critical thinking skills, whereas the posttest was used to determine their critical thinking performance after the learning process. The comparison between the two groups was used to determine whether the use of the teaching materials resulted in greater improvement than conventional learning. The study was conducted during the first semester of the 2025/2026 academic year, beginning on August 26, 2025. These research design and implementation details are consistent with the manuscript previously prepared for this study.

B. Participants

The participants were first-semester students enrolled in the Primary School Teacher Education Program, Faculty of Teacher Training and Education, Universitas Mataram, who were taking the Basic Concepts of Social Studies course. The participants consisted of 60 students from two existing classes, with 30 students in each class. Class 1I was assigned as the experimental group, while Class 1J was assigned as the control group.

Table 1. Distribution of Research Participants

Group	Class	Number of Students	Treatment
Experimental	1I	30	Basic Concepts of Social Studies teaching materials Conventional learning
Control	1J	30	
Total		60	

C. Learning Intervention

The experimental group used the Basic Concepts of Social Studies teaching materials as the main learning resource. The materials had been developed previously as a learning resource for the course and were designed to address students' learning needs in understanding fundamental Social Studies concepts. The materials presented concepts through contextual explanations, social problem cases, analytical questions, exercises, and reflective activities. Students were encouraged to identify problems, interpret relevant information, compare possible explanations or solutions, provide reasons for their responses, and formulate conclusions. In contrast, the control group participated in conventional learning using the learning resources routinely used in the course. The main difference between the two groups was therefore the use of the developed teaching materials and the critical-thinking-oriented activities embedded in those materials. The focus of this study was not the development or validation of the teaching materials, but the empirical examination of their effectiveness in improving students' critical thinking skills.

D. Research Instrument

The primary research instrument was an essay-based critical thinking test administered before and after the intervention. The test was designed to assess students' critical thinking skills, particularly their ability to engage in analysis, evaluation, and inference. The instruments were reviewed by two experts. The validation process considered the suitability of the test with the research objectives and the critical thinking indicators. The validators also provided recommendations regarding contextual stimuli and higher-order questions. The overall validation score was 3.75 on a four-point scale and was categorized as very feasible. The detailed validation results are presented in Table 2.

E. Data Collection Procedure

Data collection was conducted in several stages. First, the researchers administered the pretest to students in both groups to determine their initial critical thinking skills. Second, the learning intervention was implemented. Class 1I used the Basic Concepts of Social Studies teaching materials, while Class 1J participated in conventional learning. After the intervention, both groups completed the posttest using the same critical

thinking assessment. The resulting pretest and posttest scores were used as the primary quantitative data for examining the effectiveness of the teaching materials.

F. Data Analysis

The quantitative data were analyzed using descriptive and inferential statistics. The mean and standard deviation were calculated for the pretest and posttest scores. The magnitude of improvement was examined using normalized gain (N-gain). The N-gain values were interpreted as low (<0.30), moderate ($0.30-0.70$), and high (>0.70). An independent-samples *t*-test was used to compare the experimental and control groups. The analysis included pretest, posttest, and N-gain scores. The significance level was set at $\alpha = 0.05$. A paired samples *t*-test was also used to examine changes between pretest and posttest scores within each group. Assumptions of normality and homogeneity were examined before inferential analysis. Because some variables did not fully meet the normality assumption, a Mann–Whitney U test was additionally considered as a non-parametric confirmation of the between-group findings.

IV. Results and Discussion

A. Research Results

1. Instrument Validation

The research instruments were reviewed by two experts before being used in the study. The validation results are presented in Table 2.

Table 2. Validation Results of Research Instruments

Instrument	Validator 1	Validator 2	Mean	Category
Critical thinking test	3.50	3.50	3.50	Very feasible
Observation sheet	3.75	3.75	3.75	Very feasible
Perception questionnaire	3.75	3.75	3.75	Very feasible
Critical thinking rubric	4.00	4.00	4.00	Very feasible
Overall mean	3.75	3.75	3.75	Very feasible

The overall mean validation score was 3.75, which was categorized as very feasible. The critical thinking test obtained a mean score of 3.50. The critical thinking rubric obtained the highest mean score of 4.00. The validators also provided recommendations concerning contextual stimuli and higher-order questions. These suggestions were considered important because the test was intended to measure critical thinking rather than students' ability to recall information. The validation results therefore indicate that the instruments were considered appropriate for use in the study. At the same time, the validation process provided an opportunity to improve the quality of the test before it was administered.

2. Pretest, Posttest, and N-gain

The pretest and posttest scores are presented in Table 3.

Table 3. Pretest, Posttest, and N-gain Scores

Group	N	Pretest Mean	Posttest Mean	Mean Gain	N-gain	Category
Experimental (1I)	30	40.00	84.03	44.03	0.730	High
Control (1J)	30	40.07	80.80	40.73	0.683	Moderate

The experimental and control groups had almost identical pretest means. The experimental group obtained 40.00, while the control group obtained 40.07. The difference was only 0.07 points, indicating that the two groups began the intervention at a relatively similar level. After the intervention, the experimental group obtained a mean posttest score of 84.03, while the control group obtained 80.80. The experimental group therefore showed a mean increase of 44.03 points, compared with 40.73 points in the control group. The N-gain results show a clearer difference in the category of improvement. The experimental group obtained an N-gain of 0.730, which falls into the high category, while the control group obtained 0.683, which falls into the moderate category.

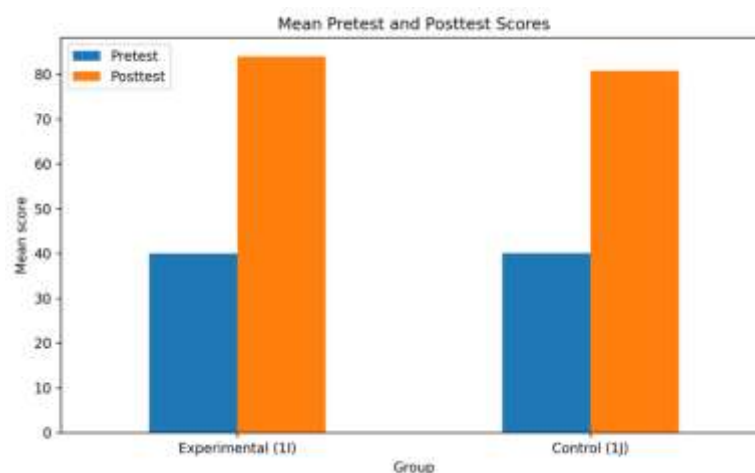


Figure 1 Comparison of Pretest and Posttest Mean Scores

Figure 1 shows that the two groups began from almost the same level. After the learning intervention, both groups showed improvement, but the experimental group achieved a higher posttest mean.

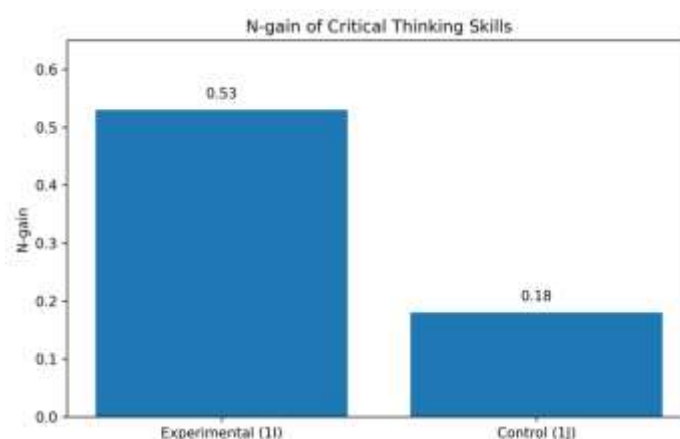


Figure 2. Comparison of N-gain between Groups

Figure 2 shows that the experimental group achieved a higher N-gain than the control group. The difference also corresponds to a difference in category, with the experimental group reaching the high category and the control group remaining in the moderate category.

3. Independent Samples *t*-test Results

The independent samples *t*-test was conducted to determine whether the differences between the experimental and control groups were statistically significant.

Table 4. Independent Samples *t*-test Results

Variable	Experimental M ± SD	Control M ± SD	<i>t</i>	df	Sig. (2-tailed)
Pretest	40.00 ± 7.03	40.07 ± 6.99	-0.037	58	.971
Posttest	84.03 ± 5.05	80.80 ± 5.49	2.374	58	.021
N-gain	0.730 ± 0.097	0.683 ± 0.062	2.230	58	.030

The analysis showed no significant difference in pretest scores between the experimental and control groups, $t(58) = -0.037, p = .971 > .05$. This finding indicates that the two groups had comparable initial critical thinking performance. In contrast, a significant difference was found in posttest scores, $t(58) = 2.374, p = .021 < .05$. The experimental group obtained a higher posttest mean than the control group. A significant difference was also found in N-gain scores, $t(58) = 2.230, p = .030 < .05$. Therefore, the improvement observed in the experimental group was not only higher descriptively but also statistically different from the improvement observed in the control group.

B. Discussion

The main finding of this study is that the use of Basic Concepts of Social Studies teaching materials resulted in greater improvement in students' critical thinking skills than conventional learning. The experimental and control groups began from almost identical conditions. The pretest mean was 40.00 in the experimental group and 40.07 in the control group, while the independent samples *t*-test showed no significant difference ($p = .971$). This initial similarity is important because it provides a reasonable basis for comparing the learning outcomes after the intervention. Following the intervention, the experimental group obtained a posttest mean of 84.03, while the control group obtained 80.80. The difference was statistically significant, with $t(58) = 2.374$ and $p = .021$. This finding indicates that students who learned using the Basic Concepts of Social Studies teaching materials achieved higher critical thinking scores than students who participated in conventional learning.

The N-gain results provide additional information regarding the magnitude of improvement. The experimental group achieved an N-gain of 0.730, categorized as high, while the control group achieved 0.683, categorized as moderate. The independent samples *t*-test also showed a significant difference in N-gain ($p = .030$). Thus, the findings do not only show that the experimental group obtained a higher final score but also indicate that the increase relative to students' initial scores was greater in the experimental group. The higher improvement in the experimental group can be related to the characteristics of the teaching materials. The materials were designed not only to present Social Studies concepts but also to provide activities that required students to use the concepts in different situations. Contextual cases, analytical questions, exercises, and reflective activities gave students opportunities to examine information and formulate responses.

This finding is consistent with Verawati et al. (2021), who found that reflective practices integrated into inquiry learning could strengthen critical thinking among pre-service teachers. The similarity lies in the opportunity provided to students to examine problems and reflect on their reasoning. Although the intervention in the present study was delivered through teaching materials rather than primarily through inquiry learning, both approaches emphasize active cognitive engagement. The findings are also related to Witarsa and Muhammad (2023), who showed that learning activities involving problem identification, information gathering, presentation, and reflection could improve critical thinking among university students. The present study shows a similar pattern through the use of contextual cases and exercises in the teaching materials. Students were encouraged to use information to understand social problems rather than merely memorize concepts.

The results are particularly relevant when compared with Nafisah et al. (2025), whose research focused on Basic Social Studies Concepts teaching materials for prospective teachers. Their teaching materials used SDGs-integrated case studies and obtained an N-gain of 0.56, categorized as moderate. The present study obtained a higher N-gain of 0.730, categorized as high. The two studies cannot be compared directly because their designs and learning contexts were not identical. However, both findings support the importance of contextualizing Social Studies content and providing learning activities that encourage students to engage with problems. The present findings are also consistent with Ana et al. (2023), who found that teaching materials designed for prospective elementary school teachers could improve critical thinking. The similarity lies in positioning teaching materials as an active learning resource rather than simply as a source of information. This distinction is important because the cognitive activity provided through the materials may influence how students process the content.

The role of contextual cases is particularly relevant in Social Studies. Social problems often involve several factors and may have more than one possible explanation or solution. When students are presented with a case, they need to identify the main problem, examine available information, consider possible alternatives, and formulate a conclusion. These activities provide opportunities for students to practice analysis and evaluation in a context related to the course content. Contextual exercises also help students connect theoretical concepts with situations that are closer to their experiences. Basic Concepts of Social Studies covers concepts from several social science disciplines. If learning is limited to definitions and explanations, students may understand the concepts but experience difficulties when applying them to actual social situations. The teaching materials used in the experimental group attempted to address this issue by connecting concepts with cases and exercises.

Reflective activities provide another explanation for the improvement observed in the experimental group. Through reflection, students have opportunities to reconsider their answers and explain the reasons behind their conclusions. This is in line with Verawati et al. (2021), who emphasized the role of reflection in strengthening critical thinking among prospective teachers. The findings also respond to the issue identified by Firmansyah and Rizal (2019), who found that critical thinking among PGSD students still needed to be strengthened. The present study provides one practical alternative through the use of teaching materials that integrate activities requiring analysis, evaluation, and reasoning. The results can also be related to Wiyoko (2019), who found that several critical thinking indicators among PGSD students, particularly interpretation, evaluation, and inference, needed further development. The activities contained in the teaching materials provide opportunities for students

to interpret information, evaluate possible responses, and formulate conclusions. In this sense, the teaching materials can support the development of critical thinking through repeated practice within the learning process.

Another important point is that the control group also showed improvement. Its mean score increased from 40.07 to 80.80, with an N-gain of 0.683. Therefore, conventional learning was also able to improve students' critical thinking. The effectiveness of the teaching materials should not be interpreted as meaning that conventional learning was ineffective. Rather, the results indicate that students in the experimental group experienced greater improvement under the learning condition using the developed teaching materials. The validation results also strengthen the methodological basis of the study. The overall instrument validation score was 3.75 and was categorized as very feasible. The validators' recommendations concerning contextual stimuli and higher-order questions were particularly relevant because the critical thinking test needed to assess students' reasoning rather than their ability to recall information.

The findings have implications for Primary School Teacher Education. Students in this program are future elementary school teachers, so their learning experiences at university can influence how they later design learning activities for elementary school students. Teaching materials that include contextual problems, analytical questions, and reflection can therefore support students' own critical thinking while also providing an example of how learning resources can be designed to encourage higher-order thinking.

For lecturers, the findings suggest that teaching materials should not be treated merely as collections of course content. They can also function as learning guides that direct students toward specific cognitive activities. In Basic Concepts of Social Studies, this can be implemented through social cases, contextual questions, analytical exercises, and reflection. This study nevertheless has several limitations. First, the participants were limited to 60 students from two existing classes in one Primary School Teacher Education Program. Second, the classes were not randomly assigned at the individual level. Third, the study focused primarily on quantitative evidence from the critical thinking test. Therefore, future research could involve a larger sample from several teacher education institutions and examine whether the findings remain consistent across different student characteristics and learning contexts.

V. Conclusion

This study shows that the use of Basic Concepts of Social Studies teaching materials can improve the critical thinking skills of Primary School Teacher Education students. The experimental and control groups had comparable initial critical thinking performance, as indicated by their pretest means and the non-significant difference between the groups. After the intervention, the experimental group obtained a mean posttest score of 84.03, while the control group obtained 80.80. The experimental group also achieved an N-gain of 0.730, categorized as high, whereas the control group obtained an N-gain of 0.683, categorized as moderate. The independent samples *t*-test showed a significant difference in posttest scores ($p = .021$) and N-gain scores ($p = .030$). These findings indicate that the use of Basic Concepts of Social Studies teaching materials resulted in greater improvement in critical thinking than conventional learning.

The findings suggest that contextual cases, analytical exercises, and reflective activities embedded in teaching materials can provide meaningful opportunities for students to practice critical thinking. Therefore, Basic Concepts of Social Studies teaching materials can be used as an alternative learning resource to support critical thinking development among Primary School Teacher Education students. Future research should involve larger samples and different institutional contexts and examine which components of the teaching materials contribute most strongly to critical thinking improvement.

Conflict of Interest

The authors declare no conflict of interest related to this study.

Author Contributions

B.Y.W. contributed to the conceptualization, research design, and overall coordination of the study. H.R.P. and V.R.H. contributed to the research implementation, data collection, and development of the VARK-based mathematics e-module. M.P.S. and A.A.F. contributed to data analysis and the interpretation of the findings. M.T.D. contributed to the preparation, review, and editing of the manuscript. All authors contributed to the revision of the manuscript and approved the final version for publication.

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