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Critical Thinking Skills Infused in Upper Primary Science Textbooks in Malaysia

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Abstract:
The purpose of this study is to determine the infusion of critical thinking skills (Attributing, Comparing and Contrast, Grouping and Classifying, Sequencing, Prioritizing, Analyzing, Detecting Bias, Evaluation, and Making Conclusions) in the Malaysian upper primary science textbooks (grade 4-6) that were implemented by the Ministry of Education in Malaysia. The researchers used the descriptive-analytical approach to analyze the content using the content analysis tool that includes critical thinking skill items and considered text, picture, and activities as analysis units. Units from 4-6 grades Malaysian science textbooks are randomly selected as the research sample. Two science teachers conducted the content analysis, a high level of reliability and validity of analysis verified using Cohen's kappa gets a value of 0.85. The findings revealed that the science textbook does not prioritize, evaluate, and detect bias thinking skills. The most frequent critical thinking skills are attributing, analyzing, grouping and classifying, and sequencing gradually. Most of the skills have been in the text, the picture, and finally, the activities. The results reveal that the current upper primary science textbooks in Malaysia are not including all the critical thinking skills equally as determined in the Conceptual Framework of Science Curriculum; therefore, the curriculum developers and teachers need to rethink about giving more attention to infusing thinking skills in the science content, and during the teaching and learning process. Most of the previous studies aimed at measuring students' thinking skills, but they neglected to ensure their availability in the textbook. This study emphasizes the importance of analyzing the textbook content to ensure the presence of thinking skills, which may be the main reason students do not have the necessary thinking skills.

Keywords: science textbooks, critical thinking skills, content analysis.

马来西亚高年级科学教科书中注入的批判性思维技能

摘要：
本研究的目的是确定马来西亚高小学科学教科书（4年级-

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6)由马来西亚教育部实施。研究人员使用描述性分析方法使用内容分析工具分析内容，该工具包括批判性思维技能项目和考虑的文本、图片和活动作为分析单元。随机选取4-6年级马来西亚科学教科书的单元作为研究样本。两名理科教师进行了内容分析，使用科恩的卡帕验证的分析的高水平信度和效度值为0. 85。调查结果显示，科学教科书没有优先考虑、评估和检测偏见思维技能。最常见的批判性思维技能是逐渐归因、分析、分组和分类以及排序。大部分技能都在文字、图片，最后是活动。结果显示，马来西亚目前的高小科学教科书并未包括科学课程概念框架中确定的所有批判性思维技能；因此，课程开发者和教师需要重新考虑在科学内容和教学过程中更多地关注注入思维技能。以前的研究大多旨在衡量学生的思维能力，但他们忽略了确保它们在教科书中的可用性。本研究强调分析教科书内容以确保思维技能存在的重要性，这可能是学生不具备必要的思维技能的主要原因。

关键词：科学教科书、批判性思维技能、内容分析。

1. Introduction

Science is one of the most important subjects that are taught in our schools. It is a subject that takes part in the growth of the minds of students. It gives answers to the questions rising in their minds, and it helps them adjust to their environment. In the modern world, educationalists highly emphasized the need to reshape and realign the educational policies and practices to equip their citizens with the necessary knowledge and skills to prepare them for the rapid flow of information and knowledge in science, technology they are using in their daily life. Therefore, the education sector needs to play a major role in equipping the future generation with essential skills to survive in this fast-paced progressing world. This sector bonds knowledge, potential, training, interest, and other quality to achieve the country's aspiration.

The Ministry of Education in Malaysia introduced the National Philosophy of Education (NPE) in 1988; it is an ongoing effort towards further developing Malaysian citizens who are knowledgeable, competent, responsible, capable of achieving a high level of personal well-being, possess high moral standards, and contribute to the betterment of the family, society, and the nation (Al-Hudawi et al., 2014). The school curriculum is the essential resource that teachers have traditionally relied on in their teaching; it includes all content, activities, experiments, investigations, questions, and materials teachers will need to teach a given academic subject. According to the Ministry of Education Malaysia (2002), primary education aims at ensuring the overall balanced and integrated development of a child's potential, which includes intellectual, spiritual, emotional, and physical aspects to produce balanced and harmonious individuals with high moral standards. This means that one of the main aims of primary schools in Malaysia is to enhance and improve students' intellectual capability where they should be able to think rationally, critically, and creatively.

The traditional need to equip pupils with the 3R skills (reading, writing, and arithmetic) is no longer adequate. Critical thinking is one of the four learning and innovation skills relevant to preparing pupils for 21st-century skills. Therefore, to educate students to compete globally, they must be proficient critical thinkers, communicators, collaborators, and creators. This gives researchers every reason to believe that critical thinking ought to be the heart and core of educational reform and support the believes that the development of critical thinking skills is an essential component of students' instruction because critical thinking involves the ability to observe, think about, and respond to information logically (Easterbrooks & Scheetz, 2004). In recent years, the application and construction of high-order thinking skills have been very highly valued in teaching and learning. Several influential psychologists and educationists have supported the importance of developing thinking skills in learning (Jarvis, 2006, p. 96). Critical thinking is evaluating conclusions by logically examining the problem, the evidence, and the solution (Aslan & Polat, 2008). More recently, the Partnership for 21st Century Skills has identified critical thinking as one of several learning and innovation skills necessary to prepare students for post-secondary education and the workforce (Lai, 2011).

2. Literature Review

The curriculum's contemporary theory emphasizes the learning experiences and the students' positive role in the learning process. In this research, the curriculum definition is "the plans made for guiding learning in schools, usually described in documents (textbooks, curriculum guides, course syllabus, lesson plans) of several levels of generality and the execution of those plans in and out the classroom. As experienced by learners, those experiences take place in a learning environment (classroom, laboratory, outdoors) which also influences what is learned" (Hassard, 2005). The 'curriculum' is what is written in the syllabus. It encompasses courses and subject designs, course development and approval of the content, teaching and assessment strategies, facilities, timetabling, and access to information. Importantly, the curriculum is affected by what is and is not included.

Yager (1993) outlines a contemporary set of curriculum goal clusters for science that are eventually adopted by the National Science Teaching Association (NSTA) to include Personal Needs, Societal Issues,

Academic Preparation, and Career Education/Awareness (Yager, 1993). Following the National Education Philosophy in Malaysia, the science curriculum should enhance students' personal development and contribute to their lives by developing competitive, dynamic, robust, and resilient citizens able to master scientific knowledge and technological competency. Good science teaching and learning for all children is the primary goal of current national reform efforts (Howes, 2002); it is important to teach science because of many reasons, among them the significance of science as part of human culture and its role in developing language, logic, and problem-solving skills in the classroom (National Research Council, 2007). Science education reformers currently characterize professional science as a specialized form of inquiry and a body of knowledge (Howes, 2002). It improves students' abilities to acquire the skills to use critical thinking and problem-solving skills independently (Putra & Suparman, 2021).

Critical thinking is part of higher-order thinking that is a major concern of education in the 21st century (Kriswantoro et al., 2021). Over the past decade, thinking skills have become a widely discussed issue in improving and developing students' cognitive ability, which is a major goal in education policy (Zulkpli et al., 2017). Williams (1993) presented three definitions of critical thinking by leading researchers:

1) Robert Ennis's classic definition: "Critical thinking is reasonable, reflective thinking that is focused on deciding what to believe or do";

2) Matthew Lipman's definition: "Critical thinking is skillful, responsible thinking that is conducive to good judgment because it is sensitive to context, relies on criteria, and is self-correcting";

3) In informal presentations, Richard Paul uses this definition: "Critical thinking is thinking about your thinking, while you are thinking, to make your thinking better".

Integrating critical thinking in the curriculum helps students practice their prior knowledge and change their prior knowledge evaluating their thinking (Aslan & Polat, 2008), emphasizing science process skills. The learning outcomes will have a positive impact on student understanding. Critical thinking in any area involves pursuing one's questions through self-directed search, interrogation of knowledge, a sense that knowledge is contestable, and presenting evidence to support one's arguments (Thompson, 2011; Purnomo et al., 2020).

According to Williams (1993), there are some prominent features of critical thinking:

1) Critical thinking is reflective;

2) Critical thinking involves standards;

3) Critical thinking is authentic;

4) Critical thinking involves being reasonable.

Each of these critical thinking and thinker features identifies the learner's role when thinking and prompts students to discover the nature of the scientific enterprise while learning science concepts. In essence, as students develop the skills to conduct scientific investigations, their knowledge of science concepts and processes will be enhanced (Lewis, 2012). Consequently, science education must help young students develop the critical thinking skills needed throughout their lives. Similarly, the science curriculum must give students opportunities to learn and practice the skill throughout science textbooks.

Generally, the infusion approach to teaching thinking is defined as integrating or combining a few skills during the teaching and learning process. In this approach, types of thinking skills are identified and taught together using the learning content (Zulkpli et al., 2017). To incorporate thinking skills in science education, thinking strategies and thoughtful learning should be emphasized throughout the teaching-learning process (Ministry of Education Malaysia, 2002). The results of TIMSS report 2011 shows that Malaysia's average score for the last ten years has seen a marked decline from a high of 510 (above the benchmark score of 500) to a low of 426 in 2011 (Martin et al., 2012). On the other hand, over the last decade, there has been a decline in the number of students taking up science in upper secondary schools. Such results and statistics caused great concern among many politicians and science educators over the availability of skilled human resources necessary to achieve the nation's vision (Ling, 1999).

Textbooks provide the central resource for students as the principal means for conveying information to students and enable teachers to animate the curricula and give life to the subjects taught in the classroom (Aslan & Polat, 2008). The recent call for infusing critical thinking skills within the science curriculum and the results of the UPSR (Ujian Penilaian Sekolah Rendah) show dissatisfaction and difficulty in problem-solving. While efforts have been made over time to support science teaching in the classroom, it is unclear how science textbooks have attended to the use of thinking skills in science education. Most literature available focuses more on students' achievement, and a few works of literature focus on teachers to enhance teaching thinking across the curriculum (Zulkpli et al., 2017). Therefore, and because of the absence of research about the infusion of thinking skills in science textbooks in Malaysia, this study will provide useful information by exploring the infusion of the critical thinking skills of students' editions of 4-6 grade science textbooks published by the Ministry of education in Malaysia. Thus, the research aimed to answer the following questions:

1) To what extent has the content of the science textbooks of upper primary school used critical thinking skills?;

2) To what extent is there a balance of critical thinking skills in the content of science textbooks of upper primary school?

3. Research Methods

This study aims to explore how critical thinking skills have been included in upper primary science textbooks. The content analysis method is preferred to identify critical thinking skills in upper primary science textbooks to address the research questions. Content analysis has been defined as a systematic, replicable technique for compressing many text words into fewer content categories based on explicit coding rules (Krippendorff, 1980). It is a qualitative research method frequently used in this type of study for analyzing textual information in a standardized way that allows evaluators to make inferences about that information (Lewis, 2012).

3.1. Population and Sampling

In this research, the researchers analyzed upper primary science textbooks through "content analysis". Upper primary science textbooks (Grades 4-6) approved by the Ministry of Education for upper primary schools constitute this research sample. Thus, the statistical sample includes all lesson and chapter contents of the upper primary science textbooks in Grades 4-6. The sample consists of 11 topics randomly selected from Grade 4-6 textbooks.

3.2. Reliability

Inter-rater reliability is used for this research; it is the extent to which two or more raters give the same opinion or agreement. Inter-rater reliability addresses the issue of consistency in the implementation of a rating system. Inter-rater reliability can be evaluated by using several different statistics, such as Cohen's kappa (κ), which reflects the level of agreement between raters or judges (Krippendorff, 2004). The Cohen's kappa results for this research are 0.85, which means 85% of similarities between the first and second analysis for the same topic.

3.3. Research Instruments

During the analysis, the instrument developed is a critical thinking skill codebook that defines what is perceived as a codable thinking skill in a science textbook. The critical thinking skills are aligned with the Science Curriculum Framework that guided the analysis of the textbooks. All keywords for each critical thinking skill were extracted from the Standards-Based Curriculum for Primary Schools.

3.4. Data Collection Process

In the analysis, researchers highlighted the units of analysis. The analysis units included complete paragraphs, activities, examples, figures with captions, tables with captions, charts with captions, and marginal comments.

The data analysis has been done in the next steps (Lewis, 2012):

1. Establishing coding categories: For this research, the critical thinking skills were taken from the Conceptual Framework of Science Curriculum (Table 1). The categories of analysis were determined in content analysis. The "sentence" (question or activities) has been chosen as the unit of analysis, and the frequency of occurrence of designated categories in each sentence (question or activities) has been determined. The topic of "critical thinking skills" is considered as analysis category "main category" in this study.

2. Reading and coding the data: Two science teachers analyzed a random sample of units. They read, interpreted, and coded instances of critical thinking skills in the Grade 4-6 revised upper primary science textbooks.

3. Determining frequency: After coding the critical thinking skills identified in each textbook, researchers tabulated the number of occurrences for each skill and calculated their percentages of critical thinking skills infused in the revised upper primary science textbook for Grades 4-6 using contingency.

Table 1. Categories, definitions, and codes

Categories	Definition	Codes
Attributing	Identifying characteristics, features, qualities, and elements	1
Comparing and Contrasting	Finding similarities and differences	2
Grouping and Classifying	Separating and grouping objects or phenomena	3
Sequencing	Arranging objects and information in order	4
Prioritizing	Arranging objects or information in order based on their importance and urgency	5
Analyzing	Processing information in detail by breaking it down into smaller parts	6
Detecting bias	Detecting views or opinions	7
Evaluating	Making consideration on the good and bad qualities.	8
Making conclusions	Making statements	9

4. Findings

4.1. The Infusion of Critical Thinking Skills

To determine the extent of critical thinking skills infused in revised upper primary science textbooks, Contingency tables (crosstabs tables) were used between the skills and the category (text, pictures, and

activities) to answer the above question. Table 2 shows the results of contingency tables between skills and the category for year Four.

Table 2 shows that Chi-Square is significant (Chi-Square = 6.6, df 6, P = .359), which means that there is no association between the skills and three categories of the content analysis for the Grade 4 textbook. From the results, "Attributing" is the most frequent with 75.9% of all skills, while "Grouping and Classifying" constitute 15.2%, "Comparing and Contrast" - 5.1%, and "Making Conclusion" - 3.8%. Based on the results, the most frequent critical thinking skill is "Attributing," especially throughout the text and pictures with around 30% and then within the "activities" with 12%.

Table 2. Contingency tables between the skills and Grade 4

	Category			
Skills	**Text**	**Pictures**	**Activities**	**Total**
Attributing	31.00%	32.90%	12.00%	75.90%
Comparing and Contrast	1.30%	1.90%	1.90%	5.10%
Grouping and Classifying	3.80%	6.30%	5.10%	15.20%
Making Conclusions	1.90%	1.30%	0.60%	3.80%
Total	38.00%	42.40%	19.60%	100.00%
Chi-Square = 6.6, df 6, P = .359				

Similarly, the researchers analyzed the content of the science textbook for Grade 5. Results of contingency tables between skills and the category are presented in Table 3.

Table 3. Contingency tables between the skills and Grade 5

	Category			
Skills	**Text**	**Pictures**	**Activities**	**Total**
Attributing	29.7%	26.2%	26.2%	82.0%
Comparing and Contrast	0.6%	2.3%	1.7%	4.7%
Sequencing	2.9%	2.9%	1.2%	7.0%
Analysing	0.6%	0.6%	0.0%	1.2%
Making Conclusions	2.3%	2.3%	0.6%	5.2%
Total	36.0%	34.3%	29.7%	100.0%
Chi-Square = 5.76, df 8, P = .674				

Table 3 shows that Chi-Square is not significant (Chi-Square = 5.76, df 8, P = .674); there is no association between the skills and three content analysis categories. From the results, the most frequent with 82% of all skills were "Attributing" thinking skills, while "Sequencing" has 7%, "Making Conclusions" - 5.2%, "Comparing and Contrasting" - 4.7%, and "Analyzing" - 1.2%. Based on the results, the most frequent critical thinking skills are "Attributing" skills disseminated within the "pictures", "text," and "activities".

Table 4 shows that Chi-Square is significant (Chi-Square = 66.4, df 12, P = .000); this means an association between the skills and the three categories of the content analysis. From the results, "analyzing" skills are half of all thinking skills within the science textbook of year six, "attributing" and "making conclusion" comes next with about 20% for each. Based on the results, the most frequent critical thinking skills are "analyzing"; most of these skills have been in the "text" and then within the "picture".

Table 4. Contingency tables between the skills and Grade 6

	Category			
Skills	**Text**	**Pictures**	**Activities**	**Total**
Attributing	4.7%	11.7%	2.3%	18.8%
Comparing and Contrast	2.3%	3.1%	0.0%	5.5%
Grouping and Classifying	0.0%	0.0%	1.6%	1.6%
Sequencing	0.0%	0.0%	0.8%	0.8%
Analyzing	29.7%	20.3%	0.0%	50.0%
Detecting Bias	1.6%	1.6%	0.0%	3.1%
Making Conclusions	6.3%	3.1%	10.9%	20.3%
Total	44.5%	39.8%	15.6%	100.0%
Chi-Square = 66.4, df 12, P = .000				

4.2. The Balance of Critical Thinking Skills in the Content

To determine to what extent there is a balance of critical thinking skills in the science textbooks of upper primary school, the researchers implemented contingency tables (crosstabs tables) between the skills and the category (text, pictures, and activities) to answer the above question.

Table 5 shows the contingency between skills and the category for the upper primary school science textbooks. From the results, "attributing" got the most frequent with 62% of all thinking skills, while "analyzing" got 14%, and "making conclusion" got 9%. Moreover, Grade 5 science textbook was the most frequent with 38% compared to the other grade textbooks, while Grade 4 science textbook had 34% and Grade 6 science textbook - 28%. Based on the results, the highest percentage of critical thinking skills infused in the revised upper primary science textbook is in Grade 5; those skills have been disseminated in the "text" and then within the "picture" and finally within the "activities". The second-highest percentage of critical thinking skills infused in revised upper primary science textbook is in year Four, with the most of these skills have been in the "pictures", the "text" and finally

within the "activities". The lowest percentage of critical thinking skills infused in revised upper primary science textbook is in Grade 6, with the most of these skills have been in the "text", "pictures", and finally within the "activities".

Table 5. Contingency tables for skills and grades

		Skills (*)										Total	
Year	**Category**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**By**	**Category**	**By year**
	Text	49	2	6	0	0	0	0	0	3	60	38%	
4	Pictures	52	3	10	0	0	0	0	0	2	67	42%	158
	Activities	19	3	8	0	0	0	0	0	1	31	20%	34%
	Text	51	1	0	5	0	1	0	0	4	62	36%	
5	Pictures	45	4	0	5	0	1	0	0	4	59	34%	172
	Activities	45	3	0	2	0	0	0	0	1	51	30%	38%
	Text	6	3	0	0	0	38	2	0	8	57	45%	
6	Pictures	15	4	0	0	0	26	2	0	4	51	40%	128
	Activities	3	0	2	1	0	0	0	0	14	20	16%	28%
Total	By skills	285	23	26	13	0	66	4	0	41	458		
		62%	5%	6%	3%	0%	14%	1%	0%	9%	100%		

(*) Attributing (1), Comparing and Contrast (2), Grouping and Classifying (3), Sequencing (4), Prioritizing (5), Analyzing (6), Detecting Bias (7), Evaluation (8), Making Conclusions (9)

5. Discussion and Conclusion

The main purpose of this research is to analyze the content of upper primary science textbooks (Grades 4-6), which were implemented by the Ministry of Education in Malaysia, in terms of the infusion of critical thinking skills. According to the science curriculum framework, one of the general aims of the science curriculum is to "develop the basic skills, such as scientific, constructive, critical, and creative thinking, expressing himself/herself, communicating, cooperating, problem solving, and initiating". The content analysis for the revised Grade 4 science textbook shows that the most frequent critical thinking skill is "attributing". Most of the skills have been in the pictures, then within the text, and finally within the activities. Similarly, for the revised Grade 5 science textbook, the most frequent critical thinking skill is "attributing." Mostly, this skill has been in "pictures", next within "text," and finally within the "activities". On the other hand, the most frequent critical thinking skill in the third revised Grade 6 science textbook is "analyzing". Most of these skills have been in the "text", then within the "picture," and finally within the "activities". In the Grade 6 science textbook, the quantity of "text" used to learn the critical thinking skill "analyzing" increases significantly compared to Grades 4 and 5 science textbooks. The skills in this level correspond to the basic thinking skills, such as attributing and analyzing, as reported in the other studies related to this subject. For instance, Bilgisi and Dalı (2014) analyzed the 6th- and 7th-grade science coursebooks and determined that basic SPS, such as classifying, predicting, communicating, and constructing hypotheses, are less present than others and that the profile of Science Process Skills in all activities is not systematic. Aslan and Polat (2008) mentioned that the overall investigation of the science coursebooks revealed that the Science Process Skills recommended in science curriculums are not reflected in the science coursebooks used in middle schools. Skills like variable determination and controlling-changing variables are either included at the lowest rates or not included in the science coursebooks.

From all the three science textbooks, the highest percentage of critical thinking skills infused in revised upper primary science textbook is in year Six, with the most of these skills have been in the "text" and then within the "picture" and finally within the "activities". The second highest percentage of critical thinking skills infused in revised year Five science textbook, with the most of these skills have been in the "text" with and then within the "picture" and finally within the "activities". The lowest percentage of critical thinking skills infused in revised upper primary science textbook is in year Four, with the most of these skills have been in the "pictures" and then within the "text" and finally within the "activities". The findings reveal that the difference can be attributed to the "year" variable in favor of the upper grades compared to the lower ones; such results are congruent with the study results by Aldossari et al. (2016). The researchers refer these results to the fact that most science curriculum is spiral, where key concepts are presented repeatedly but with deepening layers of complexity or in different applications. The results revealed that the current upper primary science textbooks in Malaysia do not equally include all critical thinking skills, as determined in the Conceptual Framework of Science Curriculum (2012). Aslan and Polat (2008) obtained similar results when they analyzed the Turkish science textbook; they found that the aims of the Turkish instruction program are not taken into consideration in the questions included at the beginning of the texts covered in the books.

The purpose of the current study was to determine the infusion of critical thinking skills (Attributing, Comparing and Contrast, Grouping and Classifying, Sequencing, Prioritizing, Analyzing, Detecting Bias, Evaluation, and Making Conclusions) in the Malaysian upper primary science textbooks (Grades 4-6). This

study has shown that "prioritizing", "evaluation," and "detecting bias" thinking skills are not included in the 4-6th grade science textbooks. The most frequent critical thinking skills in the revised 4-6th grade science textbooks are "attributing", "analyzing", "grouping and classifying," and "sequencing". The results show that the higher percentage of "pictures" for the "attributing" critical thinking skills infused in the revised 4th- and 6th-grade science textbooks gives incredible benefits for the children. This study indicates that the current upper primary science textbooks in Malaysia do not include all the critical thinking skills equally as determined in the Conceptual Framework of Science Curriculum. The study contributes to our understanding of the urgent need to include thinking skills in science curricula for the primary stage; it is illogical to demand acquiring students with skills that are not already present in the textbooks. Considerably more work will need to be done to determine the infusion of critical thinking skills in science textbooks of other levels. Greater efforts are needed to emphasize thinking skill elements and the crucial roles of teachers in enhancing students' higher-order thinking, which can encourage active learning among students.

6. Limitations and Further Study

This study focused on analyzing the content of 4-6th grade science textbooks as the revised KSSR was launched in 2017. Therefore, the results of this study will not be generalizable across 1-3rd grade primary science textbooks.

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Authors' Contributions

All the authors conducted this research by doing the literature review, designing the research, collecting and analyzing data, and reviewing the paper as one research team.

References

[1] ALDOSSARI, A.T., AL KHALDI, J.K., & ALTARAWNEH, M.H. (2016). Content Analysis of Science Books for Upper Primary Stage in Jordan and Intermediate Stage in Saudi Arabia from an Islamic Perspective: Analytical Comparative Study. *Journal of Education and Practice*, 7(30), 60–69. Retrieved from https://www.iiste.org/Journals/index.php/JEP/article/view/33620

[2] AL-HUDAWI, S., FONG, R.L.S., MOHAMMED MUSAH, A., & TAHIR, L.M. (2014). The Actualization of the Malaysian National Education Philosophy in Secondary Schools: Student and Teacher Perspectives. *International Education Studies*, 7(4), 57-68. https://doi.org/10.5539/ies.v7n4p57

[3] ASLAN, C., & POLAT, D. (2008). Content Analysis on Primary Education Turkish Course Books from the Point of Acquiring Critical Thinking Skills. In PAPANIKOS, G.T. (ed.) *Issues on Education and Research*, Vol. 1. Athens: Athens Institute for Education and Research, pp. 147-160.

[4] BILGISI, F., & DALI, A. (2014). Milli Eğitim Bakanlığı (MEB) İlköğretim 6. Sınıf Fen Bilgisi Ders Kitabının Bilimsel Süreç Becerileri Yönünden Değerlendirilmesi. *Milli Eğitim Bakanlığı (MEB) İlköğretim 6. Sınıf Fen Bilgisi Ders Kitabının Bilimsel Süreç Becerileri Yönünden Değerlendirilmesi*, 4(1), 7–17. https://doi.org/10.17051/io.15150

[5] EASTERBROOKS, S.R., & SCHEETZ, N.A. (2004). Applying Critical Thinking Skills to Character Education and Values Clarification With Students Who Are Deaf or Hard of Hearing. *American Annals of the Deaf*, 149(3), 255–263. https://doi.org/10.1353/aad.2004.0024

[6] HASSARD, J. (2005). *The Art of Teaching Science*. New York: Oxford University Press.

[7] HOWES, E.V. (2002). Learning to teach science for all in the elementary grades: What do preservice teachers bring? *Journal of Research in Science Teaching*, 39(9), 845–869. https://doi.org/10.1002/tea.10049

[8] JARVIS, P. (2006). *The Theory and Practice of Teaching*. 2nd ed. Routledge. https://doi.org/10.5860/choice.40-1061

[9] KRIPPENDORFF, K. (1980). *Content Analysis: An Introduction to Its Methodology*. Newbury Park, California: Sage.

[10] KRIPPENDORFF, K. (2004). *Content Analysis: An Introduction to Its Methodology*. 2nd ed. Thousand Oaks, California: Sage Publications.

[11] KRISWANTORO, KARTOWAGIRAN, B., & ROHAETI, E. (2021). A critical thinking assessment model integrated with science process skills on chemistry for senior high school. *European Journal of Educational Research*, 10(1), 285–298. https://doi.org/10.12973/EU-JER.10.1.285

[12] LAI, E.R. (2011). *Critical thinking: A literature review*. Pearson. Retrieved from http://images.pearsonassessments.com/images/tmrs/CriticalThinkingReviewFINAL.pdf

[13] LEWIS, R.A. (2012). *A Content Analysis of Inquiry in Third Grade Science Textbooks*. Provo: Brigham Young University. Retrieved from https://scholarsarchive.byu.edu/cgi/viewcontent.cgi?article=4170&context=etd

[14] LING, A.Y.J. (1999). *Primary Science Curriculum Implementation in Malaysia: Inquiry as Hope and Practice*. Palmerston North: Massey University.

[15] MARTIN, M.O., MULLIS, I.V.S., FOY, P., & STANCO, G.M. (2012). *TIMSS 2011 International Results in Science*. International Association for the Evaluation of Educational Achievement. Retrieved from https://www.iea.nl/publications/study-reports/international-reports-iea-studies/timss-2011-international-results-0

[16] MINISTRY OF EDUCATION MALAYSIA. (2002). *Integrated Curriculum for Secondary Schools*. Curriculum Development Centre.

[17] PURNOMO, A., WASINO, ASTUTI, T.M.P., & SUYAHMO. (2020). Strengthening Students' Critical Knowledge of Controversial Issues in Social Studies Classroom. *Journal of Southwest Jiaotong University*, 55(5). https://doi.org/10.35741/issn.0258-2724.55.5.22

[18] PUTRA, N.S., & SUPARMAN. (2021). Problem-Based Learning: Its Effect on Students' Critical Thinking Abilities in Mathematics and Sciences Learning: A Meta-Analysis. *Journal of Hunan University Natural Sciences*, 48(8), 163-171. Retrieved from http://jonuns.com/index.php/journal/article/view/679

[19] NATIONAL RESEARCH COUNCIL. (2007). *Taking Science to School: Learning and Teaching Science in Grades K-8*. Washington, District of Columbia: The National Academies Press. https://doi.org/10.17226/11625

[20] THOMPSON, C. (2011). Critical Thinking across the Curriculum: Process over Output. *International Journal of Humanities and Social Science*, 1(9), 1-7. Retrieved from https://www.ijhssnet.com/journal/index/263

[21] WILLIAMS, T.M. (1993). What is critical? *International Journal of Project Management*, 11(4), 197-200. https://doi.org/10.1016/0263-7863(93)90035-L

[22] YAGER, E.R. (1993). Science-Technology-Society As Reform. *School Science and Mathematics*, 93(3), 145-151. https://doi.org/10.1111/j.1949-8594.1993.tb12213.x

[23] ZULKPLI, Z., ABDULLAH, A.H., KOHAR, U.H.A., & IBRAHIM, N.H. (2017). A review research on infusion approach in teaching thinking: Advantages and impacts. *Man in India*, 97(12), 289–298. http://dx.doi.org/10.17977/um052v12i2p120-128

参考文:

[1] ALDOSSARI, A.T., AL KHALDI, J.K., & ALTARAWNEH, M.H. (2016)。从伊斯兰角度分析约旦高中和沙特阿拉伯中级科学书籍的内容：分析比较研究。教育与实践杂志，7(30)，60-69。取自 https://www.iiste.org/Journals/index.php/JEP/article/view/33620

[2] AL-HUDAWI, S.、FONG, R.L.S.、MOHAMMED MUSAH, A. 和 TAHIR, L.M.（2014）。马来西亚国民教育哲学在中学的实现：学生和教师的观点。国际教育研究，7(4)，57-68。 https://doi.org/10.5539/ies.v7n4p57

[3] ASLAN, C., & POLAT, D. (2008)。从获得批判性思维技能的角度分析初级教育土耳其语课程书籍的内容。在 PAPANIKOS，G.T. (编。) 教育和研究问题，卷。 1. 雅典：雅典教育与研究学院，第 147-160 页。

[4] BILGISI, F., & DALI, A. (2014)。国家教育部（MEB）小学六年级科学教材科学过程技能评价，4(1)，7-17。 https://doi.org/10.17051/io.15150

[5] EASTERBROOKS, S.R., & SCHEETZ, N.A. (2004)。将批判性思维技能应用到品格教育中，并为失聪或听力障碍的学生阐明价值观。美国聋人年鉴，149(3)，255-263。 https://doi.org/10.1353/aad.2004.0024

[6] HASSARD, J. (2005)。科学教学的艺术。纽约：牛津大学出版社。

[7] 豪斯，E.V. (2002)。学习为小学一年级的所有人教授科学：职前教师带来什么？科学教学研究杂志，39（9），845-869。 https://doi.org/10.1002/tea.10049

[8] 贾维斯，P.（2006）。教学理论与实践。第二版。劳特利奇。https://doi.org/10.5860/choice.40-1061

[9] KRIPPENDORFF, K. (1980)。内容分析：方法论简介。加利福尼亚州纽伯里公园：鼠尾草。

[10] KRIPPENDORFF, K. (2004)。内容分析：方法论简介。第二版。加利福尼亚州千橡市：Sage 出版社。

[11] KRISWANTORO, KARTOWAGIRAN, B., & ROHAETI, E. (2021)。一种结合高中化学科学过程技能的批判性思维评估模型。欧洲教育研究杂志，10(1)，285-298。 https://doi.org/10.12973/EU-JER.10.1.285

[12] LAI, E.R. (2011)。批判性思维：文献综述。皮尔逊。取自 http://images.pearsonassessments.com/images/tmrs/CriticalThinkingReviewFINAL.pdf

[13] 刘易斯，R.A. (2012)。三年级科学课本探究的内容分析。普罗沃：杨百翰大学。取自 https://scholarsarchive.byu.edu/cgi/viewcontent.cgi?article=4170&context=etd

[14] 凌，A.Y.J. (1999)。马来西亚初级科学课程实施：作为希望和实践的探究。北帕默斯顿：梅西大学。
[15] MARTIN, M.O., MULLIS, I.V.S., FOY, P., & STANCO, G.M. (2012)。蒂姆斯2011国际科学成果。国际教育成就评估协会。取自 https://www.iea.nl/publications/study-reports/international-reports-iea-studies/timss-2011-international-results-0
[16] 马来西亚教育部。(2002)。中学综合课程。课程发展中心。
[17] PURNOMO, A., WASINO, ASTUTI, T.M.P., & SUYAHMO。(2020)。加强学生对社会研究课堂有争议问题的批判性知识。西南交通大学学报，55(5)。https://doi.org/10.35741/issn.0258-2724.55.5.22
[18] 普特拉、N.S., 和 SUPARMAN。(2021)。基于问题的学习：它对学生在数学和科学学习中批判性思维能力的影响：元分析。湖南大学自然科学学报, 48(8), 163-171.取自 http://jonons.com/index.php/journal/article/view/679
[19] 国家研究委员会。(2007)。把科学带到学校：钾-8
年级的科学学习和教学。华盛顿哥伦比亚特区：美国国家科学院出版社。 https://doi.org/10.17226/11625
[20] 汤普森，C.（2011）。跨课程的批判性思维：过程胜于输出。国际人文与社会科学杂志，1(9)，1-7。取自 https://www.ijhssnet.com/journal/index/263
[21] 威廉姆斯，T.M. (1993)。什么是关键？国际项目管理杂志，11(4)，197-200。 https://doi.org/10.1016/0263-7863(93)90035-L
[22] YAGER, E.R. (1993)。作为改革的科学技术社会。学校科学与数学，93（3），145-151。 https://doi.org/10.1111/j.1949-8594.1993.tb12213.x
[23] ZULKPLI, Z.、ABDULLAH, A.H.、KOHAR, U.H.A. 和 IBRAHIM, N.H. (2017)。教学思维灌输法综述研究：优势与影响[J].印度人，97（12），289-298。 http://dx.doi.org/10.17977/um052v12i2p120-128