p-ISSN : 2708-2113 | e-ISSN : 2708-3608

DOI(Journal): 10.31703/gesr
DOI(Volume): 10.31703/gesr/.2024(IX)
DOI(Issue): 10.31703/gesr.2024(IX.I)

www.gesrjournal.com
Global Educational Studies Review
GESR
educating, humanity

GESR

GLOBAL EDUCATIONAL STUDIES REVIEW

HEC-RECOGNIZED CATEGORY-Y

VOL. IX, ISSUE I, WINTER (MARCH-2024)

HumanityPublications
sharing research
www.humapub.com
US | UK | Pakistan

Double-blind Peer-review Research Journal
www.gesrjournal.com
© Global Educational Studies Review

Humanity Publications (HumaPub)
www.humapub.com
Doi:https://dx.doi.org/10.31703

Article Title

Development of Critical Thinking Skills among Secondary School Science Students: An Analysis of Chemistry Textbook Grade IX (2020)

Global Education Studies Review

p-ISSN: 2708-2113 **e-ISSN:** 2708-3608

DOI(journal): 10.31703/glsr

Volume: IX (2024)

DOI (volume): 10.31703/gesr.2024(IX)

Issue: I (Winter-March 2024)

DOI(Issue): 10.31703/gesr.2024(IX-I)

Home Page
www.glsrjournal.com

Volume: IX (2024)
https://www.glsrjournal.com/Current-issues

Issue: I-Winter (March-2024)
https://www.glsrjournal.com/Current-issues/9/1/2024

Scope
https://www.glsrjournal.com/about-us/scope

Submission
https://humaglobe.com/index.php/glsr/submissions

Google Scholar

Visit Us

Abstract

This study focuses on a Chemistry textbook for grade IX to determine how effective it is at fostering critical thinking skills in students. The researchers did a qualitative content analysis using NVivo 12 software, and they picked the textbook with purposive sampling. It was found that the textbook does a good job of promoting critical thinking through different strategies. It encourages inquiry and questioning, relates abstract concepts to real-life applications, prompts students to compare and contrast ideas, promotes problem-solving, talks about the history behind scientific concepts, and addresses misconceptions. At the end of every topic are "Test Yourself" sections that ask thought-provoking questions meant to challenge students' analytical thinking. Relating chemical concepts to real-world situations fosters critical thinking by connecting abstract with concrete knowledge. Lastly, there are lots of examples and problems for students to work through which helps them apply what they know while developing problem-solving abilities too

Key Words:: Critical Thinking, Chemistry Textbook, Qualitative Content Analysis, NVIVO 12

Authors:

Muhammad Jamil: (Corresponding Author)
Lecturer, Department of Education Government College Women University Sialkot, Punjab, Pakistan. (Email: m.jamil@gcwus.edu.pk)

Wahid Mehmood: Ph.D Scholar, Department of Education, Northern University Nowshera, KP, Pakistan.

Wahid Mehmood: Assistant Professor, Department of Education, Mir Chakar Khan Rind University, Sibi, Baluchistan, Pakistan.

Pages: 13-20

DOI:10.31703/gesr.2024(IX-I).02

DOI link: https://dx.doi.org/10.31703/gesr.2024(IX-I).02

Article link: http://www.glsrjournal.com/article/A-b-c

Full-text Link: https://glsrjournal.com/fulltext/

Pdf link: https://www.glsrjournal.com/jadmin/Auther/31rvIolA2.pdf

This work is licensed under the Attribution-Noncommercial- No Derivatives 4.0 International.

Humanity Publications (HumaPub)
www.humapub.com
Doi:https://dx.doi.org/10.31703

Citing this Article

02		Development of Critical Thinking Skills among Secondary School Science Students: An Analysis of Chemistry Textbook Grade IX (2020)						
		Author	Muhammad Jamil Wahid Mehmood Wahid Mehmood		DOI	10.31703/gesr.2024(IX-I).02		
Pages		13-20	Year	2024	Volume	IX	Issue	I
Referencing & Citing Styles	APA	Jamil, M., Mehmood, W., & Mehmood, W. (2024). Development of Critical Thinking Skills among Secondary School Science Students: An Analysis of Chemistry Textbook Grade IX (2020). *Global Educational Studies Review*, *IX*(I), 13-20. https://doi.org/10.31703/gesr.2024(IX-I).02						
	CHICAGO	Jamil, Muhammad, Wahid Mehmood, and Wahid Mehmood. 2024. "Development of Critical Thinking Skills among Secondary School Science Students: An Analysis of Chemistry Textbook Grade IX (2020)." *Global Educational Studies Review* IX (I):13-20. doi: 10.31703/gesr.2024(IX-I).02.						
	HARVARD	JAMIL, M., MEHMOOD, W. & MEHMOOD, W. 2024. Development of Critical Thinking Skills among Secondary School Science Students: An Analysis of Chemistry Textbook Grade IX (2020). *Global Educational Studies Review,* IX**,** 13-20.						
	MHRA	Jamil, Muhammad, Wahid Mehmood, and Wahid Mehmood. 2024. 'Development of Critical Thinking Skills among Secondary School Science Students: An Analysis of Chemistry Textbook Grade IX (2020)', *Global Educational Studies Review*, IX: 13-20.						
	MLA	Jamil, Muhammad, Wahid Mehmood, and Wahid Mehmood. "Development of Critical Thinking Skills among Secondary School Science Students: An Analysis of Chemistry Textbook Grade Ix (2020)." *Global Educational Studies Review* IX.I (2024): 13-20. Print.						
	OXFORD	Jamil, Muhammad, Mehmood, Wahid, and Mehmood, Wahid (2024), 'Development of Critical Thinking Skills among Secondary School Science Students: An Analysis of Chemistry Textbook Grade IX (2020)', *Global Educational Studies Review,* IX (I), 13-20.						
	TURABIAN	Jamil, Muhammad, Wahid Mehmood, and Wahid Mehmood. "Development of Critical Thinking Skills among Secondary School Science Students: An Analysis of Chemistry Textbook Grade Ix (2020)." *Global Educational Studies Review* IX, no. I (2024): 13-20. https://dx.doi.org/10.31703/gesr.2024(IX-I).02.						

This work is licensed under the Attribution-Noncommercial- No Derivatives 4.0 International.

e-ISSN: 2708-3608 Volume: IX (2024) Issue: I-Winter (March-2024) p-ISSN: 2708-2113

Global Educational Studies Review
www.glsrjournal.com
DOI: http://dx.doi.org/10.31703/glsr

Pages: 13-20 URL: https://doi.org/10.31703/gesr.2024(IX-I).02 Doi: 10.31703/gesr.2024(IX-I).02

Authors:

Muhammad Jamil: (Corresponding Author)

Lecturer, Department of Education Government College Women University Sialkot, Punjab, Pakistan.

(Email:m.jamil@gcwus.edu.pk)

Wahid Mehmood: Ph.D Scholar, Department of Education, Northern University Nowshera, KP, Pakistan.

Wahid Mehmood: Assistant Professor, Department of Education, Mir Chakar Khan Rind University, Sibi, Baluchistan, Pakistan.

Contents

Title

Development of Critical Thinking Skills among Secondary School Science Students: An Analysis of Chemistry Textbook Grade IX (2020)

Abstract

This study focuses on a Chemistry textbook for grade IX to determine how effective it is at fostering critical thinking skills in students. The researchers did a qualitative content analysis using NVivo 12 software, and they picked the textbook with purposive sampling. It was found that the textbook does a good job of promoting critical thinking through different strategies. It encourages inquiry and questioning, relates abstract concepts to real-life applications, prompts students to compare and contrast ideas, promotes problem-solving, talks about the history behind scientific concepts, and addresses misconceptions. At the end of every topic are "Test Yourself" sections that ask thought-provoking questions meant to challenge students' analytical thinking. Relating chemical concepts to real-world situations fosters critical thinking by connecting abstract with concrete knowledge. And lastly, there are lots of examples and problems for students to work through which helps them apply what they know while developing problem-solving abilities too.

Keywords: Critical Thinking, Chemistry Textbook, Qualitative Content Analysis, Nvivo 12

Introduction

Critical thinking lets people analyze information accurately and make informed decisions (Dwyer et al., 2014). The ability to think critically allows them to effectively analyze, evaluate, and synthesize information. Nowhere is this more important than in science education where students need it for inquiry-based learning and data interpretation (Vieira et al., 2011). Textbooks play a massive part in shaping student understanding of subjects (Oates, 2014).

As well as influencing cognitive development too

This work is licensed under the Attribution-Noncommercial- No Derivatives 4.0 International.

(Chingos & Whitehurst, 2012). So, it makes sense to look at their impact on fostering critical thinking skills.

Chemistry also plays a huge part when it comes to developing these very same skills because it forces students to be observant when collecting data about properties or changes matter undergoes interpretation (Jamil et al., 2021). With all these cognitive processes being used together like analysis or interpretation — chemistry education has become something that focuses on developing critical thinking skills among students, so they can apply their knowledge to real-world situations and make smarter decisions moving forward (Danczak et al., 2017).

Textbooks are a staple in the learning process and with teachers and students as well — they are important for cognitive development (Khine, 2013; Oates, 2014). Poor quality content or textbooks overall is damaging to students' growth in critical thinking (Chingos & Whitehurst, 2012). Then again though a good one will do wonders.

In Pakistan, there have already been numerous studies done looking into this topic across many different areas of study. In one study Ali et al. (2017) concluded that general science textbooks for grades VI-VIII lacked higher-order thinking questions and activities. The remedy to this the study said, was to include more critical thinking-oriented content in the books to enhance students' cognitive skills. In the same way, different studies have been conducted in this perspective as an analysis of education policy and science teachers' practices for CT skills development (Jamil, 2021); an analysis of the Physics curriculum and Physics textbook for grade IX for the development of CT skills among students (Jamil et al., 2024a; 2024b); analysis of mathematics and Biology curriculum for CT skills (Jamil et al., 2024a; 2024b); single national curriculum social studies for critical thinking skills development (Jamil, et al., 2024); qualitative content analysis of Chemistry curriculum for the development of critical thinking incorporated in the curriculum (Jamil et al., 2024); qualitative content analysis of policy and curriculum documents for this phenomenon (Jamil et al., 2020); and critical thinking skills development of Pakistan studies, analysis of the document (Naseer et al., 2022).

On an international scale, various studies have looked at science textbooks to see how well they foster a strong mind when it comes to problem-solving (Hsu et al., 2024; Nguyen et al., 2021; Szabo et al., 2020). All these studies focus on critical thinking skills development in different contexts through different relevant pedagogical practices in science education. Johnson et al. (2020) investigated the concerns about national mathematics curriculum reforms. The qualitative study was conducted with the institutions of Ireland with twelve student teachers. Findings revealed that there were few information concerns by the students having different assumptions about the reforms. A final college-level introductory study by Gillette and Sanger (2014) has shown that most questions in popular chemistry textbooks only ask students to remember or understand. Though these skills are essential, the researchers suggest that publishers make room for higher-level thinking and problem-solving prompts too. In a study on science education in the United Kingdom, Osborne (2014) focused on how critical thinking skills could be developed in students. The author stressed that it's important for students to question claims and build arguments supported by scientific evidence through argumentation and evidence-based reasoning. They suggested adding tasks like these to science textbooks.

This study aims to analyze Pakistan's grade IX chemistry textbook. By analyzing the strategies employed by this book to foster critical thinking, we hope to provide insights for future generations of student chemists.

Objective of the Study

- To analyze the Chemistry textbook for Grade IX to identify the strategies employed by the textbook to promote critical thinking skills among secondary school students.
- To analyze the role of chemistry textbook Grade IX in fostering critical thinking skills among secondary school science students, and to offer recommendations for different stakeholders to effectively support the development of critical thinking abilities among students.

Research Methodology

The current study employed a qualitative content analysis approach to analyze the Chemistry textbook regarding the development of CT skills among secondary school science students. The current method is the most suitable one since it systematically interprets the large textual data to identify its themes, patterns, and meanings (Kyngäs, 2019). For textbook analysis, this approach is considered the most suitable in educational material like textbooks to get insights from the content and its learning outcomes (Mayring, 2014). The Chemistry textbook (downloaded from

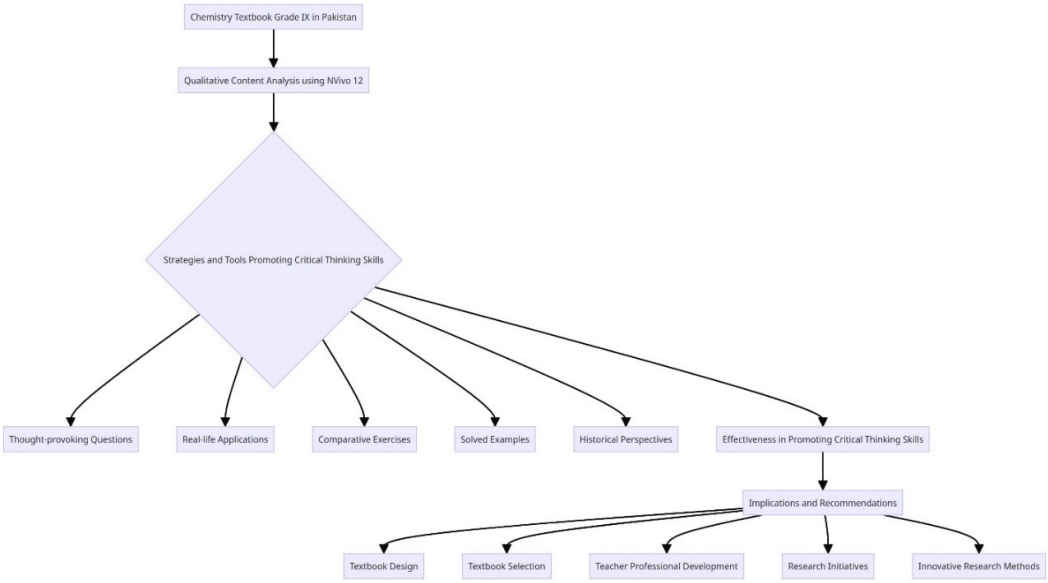
https://pctb.punjab.gov.pk/E-Books) for grade IX (2020) was selected through a purposive sampling technique. This technique was used based on specific criteria and characteristics (Etkina et al., 2006). NVivo software was used as a facilitator for qualitative content analysis (Bazeley & Jackson, 2007). Moreover, NVivo is used for data organizing, analysis, and textual data efficiently (Silver & Woolf, 2015).

Findings of the Study

The Chemistry textbook for 9th grade covers a wide range of topics that can help develop CT skills among students. The following diagram illustrates the findings of the study.

Diagram 1

Aspects related to the findings of the study



Further details with different aspects of the document that promote critical thinking, along with relevant references:

Encouraging questioning and inquiry:

The textbook includes "Test Yourself" sections at the end of each topic, which contain thought-provoking questions. These questions encourage students to think critically about the concepts they have learned and apply their knowledge to solve problems. For example, in the "Test Yourself 1.2" section on page 9, *"Can you identify mixture, element or compound out of the following?* Here the students are asked to identify mixtures, elements, and compounds from a given list, promoting analytical thinking.

Linking concepts to real-life applications:

The textbook relates chemical concepts to real-world situations, encouraging students to think about the practical implications of what they are learning. For instance, on page 23, the book mentions the composition of the human body in terms of elements, helping students understand the relevance of chemistry in their daily lives. By providing the real-world uses of sodium, magnesium, and calcium, the book enables students to apply their understanding to practical scenarios. An example is *"Magnesium is used in flashlight bulbs and in fireworks" (page 144).* Such examples foster critical thinking by connecting abstract concepts to concrete applications.

Comparing and contrasting ideas:

The textbook often presents comparative tables and asks students to differentiate between related concepts. For the analysis of similarities and differences, this approach develops critical thinking that is required by the students. For instance, in Table 1.4 on page 9, there is the comparison of compounds and mixtures, while students are asked to

differentiate atoms and irons on page 15. In the same way, in tables 8.2 and 8.3 properties and reactivities of alkali and alkaline earth metals are compared (pages 142 & 143). It encourages the students to analyze the similar and different aspects of the two groups. The book describes *"A comparison of chemical properties and reactivities of alkali metals and alkaline earth metals is given in table 8.3" (page 143).* Such types of exercises provide higher-order thinking skills with a conceptual deeper understanding of the subject matter.

Encouraging problem-solving:

There are several examples and practical problems used the encourage students to apply their knowledge to the solution of complex problems. For example, on pages 20-22, the book provides examples and practice questions related to mole calculations, challenging students to think critically and use their problem-solving skills. For example, "*i. How many atoms of sodium are present in 3 moles of sodium and what is the mass of it? ii. How many atoms are in 1 amu and 1 g of hydrogen (H)? iii. How many atoms are present in 16 g of O and 8g of S?" (page 22).*

Such exercises help develop logical reasoning and computational abilities.

Discussing the historical development of scientific concepts:

The textbook often includes information about the historical context in which scientific ideas were developed, promoting critical thinking by showing how scientific knowledge evolves. For example, on pages 31-33, the book discusses the atomic models proposed by Rutherford and Bohr, highlighting the progressive nature of scientific understanding. For example,

"Observations made by Rutherford were as follows:

Almost all the particles passed through the foil un-deflected. ii. Out of 20000 particles, only a few were deflected at fairly large angles and very few bounced back on hitting the gold foil" (page 31).

This approach encourages students to think critically about the development of scientific theories and the role of experimentation in advancing knowledge.

Addressing misconceptions and common errors:

The textbook occasionally addresses common misconceptions and errors, encouraging students to think critically about their understanding and the limitations of their knowledge. For example, on page 34, the book clarifies the difference between atomic mass and atomic number, helping students avoid confusion between these two concepts. By addressing such misconceptions, the textbook promotes critical self-reflection and encourages students to question their assumptions.

Discussion

The chemistry textbook for grade IX in Pakistan was analyzed to measure how effective it is at building critical thinking skills for students. The results of the software-facilitated, qualitative content analysis show that the textbook does use a mix of strategies and teaching tools that help build these skills. These findings align with what Osborne (2014) and Vieira et al. (2011) both say about science education's need for critical thinking skills. The analysis showed that the book contains questions designed to stir up thoughts in sections called "Test Yourself" which appear at the end of each topic. Questions like these make students apply their knowledge to real-life situations and solve problems analytically. In a study by Ibitoye (2021), it was found that in the subject of Biology, project-based learning with practical skills in secondary schools was found effective in improving students' practical skills and achievement in Biology. So, the authors of this study conclude that this particular chemistry textbook—which has already been shown to encourage higher-order thinking—does a good job of fostering critical thinking abilities in kids. Another study's authors agree: This one does do just that, according to this study's researchers. Another successful method used by the book was its inclusion of comparative tables as well as exercises where students had to explain differences between two similar concepts. Gillette and Sanger (2014) highlighted the importance of asking high-level questions like these when discussing chemistry topics when they looked into what makes helpful chem textbooks. By coaxing out similarities and differences from their brains, students are more inclined to develop a deeper understanding of their curriculum—a result consistent with what this present study found in grade IX Pakistani chem books. Dolan and Collins (2015) also have recommendations for improving science textbooks, so they better build critical thinking skills. They said textbooks should include more inquiry-based activities and real-world applications. In a study conducted by Ngozi and Hyacinth (2021), there was used cycle model based on 7-E learning with lecture method for the promotion of CT skills in Chemistry. These models were found effective for the promotion of CT skills. The provision of learning

opportunities to the students was suggested by the authors for the promotion of learning outcomes of the students in Chemistry.

Conclusion

The purpose of the current study was to analyze the Chemistry textbook for grade IX to explore the incorporation of critical thinking-specific aspects to promote CT skills among science students of secondary level. It was a qualitative study, and NVivo 12 was used to facilitate the data analysis for the document. After document analysis, it was found that different pedagogies have been used for the promotion of critical thinking capabilities. Moreover, the presence of real-life applications, questioning based on thinking, comparative exercises, examples with solutions, and historical perspectives of different phenomena are also highlighted. In science education, the textbook plays a role in the development of critical thinking. "Test Yourself" sections have been used for thought-provoking questions that encourage learners to apply their previous knowledge with problem-solving and analytical thinking. Also, the linkage of chemistry concepts with critical thinking skills development helps the students to understand Chemistry in daily life with conceptual understanding. Comparative exercises and tables foster a deeper understanding of the subject matter by engaging students in analyzing similarities and differences. Solved examples and practice problems provide opportunities for students to apply their knowledge and develop problem-solving skills. Furthermore, the discussion of the historical context of scientific ideas promotes critical thinking by encouraging students to consider the progressive nature of scientific understanding and the role of experimentation in advancing knowledge. The study's findings contribute to the existing literature by providing insights into the role of chemistry textbooks in fostering critical thinking skills in the Pakistani context. The analysis demonstrates that the chemistry textbook for grade IX in Pakistan effectively incorporates strategies and tools that promote higher-order thinking skills, which is crucial for the development of critical thinking abilities.

Recommendations

Following are the recommendations based on the study findings:

- Textbook authors and publishers should explicitly incorporate strategies and tools that promote critical thinking skills, such as thought-provoking questions, real-life applications, comparative exercises, solved examples, and historical perspectives, to support the development of critical thinking abilities among students.
- Educators should prioritize the selection of textbooks that effectively integrate elements that foster critical thinking skills, ensuring that the instructional materials align to promote higher-order thinking abilities.
- Professional development programs for teachers should emphasize the importance of critical thinking skills in science education and guide how to effectively utilize textbooks and other instructional materials to promote these skills in the classroom.
- Educational institutions and policymakers should encourage and support research initiatives that investigate the effectiveness of textbooks in promoting critical thinking skills across different educational contexts and disciplines, to inform the development and selection of high-quality instructional materials.
- Researchers in the field of education should consider employing innovative research methods, such as qualitative content analysis and NVivo 12 software, to systematically and rigorously analyze the critical thinking potential of textbooks and other instructional materials, contributing to the growing body of knowledge in this area.

References

Ali, I., Akhter, N., & Nawaz, M. (2017). Critical analysis of general science textbooks for inclusion of the nature of science used at the elementary level in Khyber Pakhtunkhwa. *Journal of Educational Research*, *20*(1), 113-131.

Google Scholar Worldcat Fulltext

Chingos, M. M., & Whitehurst, G. J. (2012). *Choosing blindly: Instructional materials, teacher effectiveness, and the common core* (Brookings Institution, Issue.

Google Scholar Worldcat Fulltext

Danczak, S., Thompson, C., & Overton, T. (2017). 'What does the term Critical Thinking mean to you?' A qualitative analysis of chemistry undergraduate, teaching staff and employers' views of critical thinking. *Chemistry Education. Research and Practice*, *18*(3), 420–434. https://doi.org/10.1039/c6rp00249h

Google Scholar Worldcat Fulltext

Dolan, E. L., & Collins, J. P. (2015). We must teach more effectively: here are four ways to get started. *Molecular Biology of the Cell*, *26*(12), 2151–2155. https://doi.org/10.1091/mbc.e13-11-0675

Google Scholar Worldcat Fulltext

Dwyer, C. P., Hogan, M., & Stewart, I. (2014). An integrated critical thinking framework for the 21st century. *Thinking Skills and Creativity (Print)*, *12*, 43–52. https://doi.org/10.1016/j.tsc.2013.12.004

Google Scholar Worldcat Fulltext

Etkina, E., Murthy, S., & Zou, X. (2006). Using introductory labs to engage students in experimental design. *American Journal of Physics*, *74*(11), 979–986. https://doi.org/10.1119/1.2238885

Google Scholar Worldcat Fulltext

Gillette, G., & Sanger, M. J. (2014). Analysing the distribution of questions in the gas law chapters of secondary and introductory college chemistry textbooks from the United States. *Chemistry Education. Research and Practice*, *15*(4), 787–799. https://doi.org/10.1039/c4rp00115j

Google Scholar Worldcat Fulltext

Hsu, J., Sung, R., Swarat, S., Gore, A. J., Kim, S., & Lo, S. M. (2024). Variations in student approaches to problem-solving in undergraduate Biology education. *CBE Life Sciences Education*, *23*(2). https://doi.org/10.1187/cbe.23-02-0033

Google Scholar Worldcat Fulltext

Ibitoye, T. M. (2021). *Project-based learning and self-regulatory strategies as determinants of secondary school student achievement, attitude and practical skills in Biology concepts in Ibadan, Nigeria*

Google Scholar Worldcat Fulltext

Bazeley, P., & Jackson, K. (2007). *Qualitative Data Analysis with NVivo*. http://ci.nii.ac.jp/ncid/BB28166066

Google Scholar Worldcat Fulltext

Jamil, M. (2021). *An analysis of education policy and science teachers' practices for developing critical thinking skills in secondary school students, [PhD dissertation,* University of Management and Technology, Lahore, Pakistan].

Google Scholar Worldcat Fulltext

Jamil, M., Aslam, M., & Ali, S. (2024). Single national curriculum (SNC) for social studies (2020): Document analysis for the development of critical thinking skills at the primary level. *Pakistan Journal of Law, Analysis and Wisdom*, *3*(2), 67-74.

Google Scholar Worldcat Fulltext

Jamil, M., Bokhari, T. B., & Ahmad, D. (2024). Evaluation of Critical Thinking Elements: A Qualitative Content Analysis of Physics Textbook Grade IX. *Qlantic Journal of Social Sciences*, *5*(1), 344-350.

Google Scholar Worldcat Fulltext

Jamil, M., Bokhari, T. B., & Iqbal, J. (2024). Incorporation of Critical Thinking Skills Development: A case of mathematics curriculum for grades I-XII. *Journal of Asian Development Studies*, *13*(1), 375–382. https://doi.org/10.62345/jads.2024.13.1.32

Google Scholar Worldcat Fulltext