Journal of Instructional Mathematics
E-ISSN 2722-2179

DOI: 10.37640/jim.v6i1.2344
Volume 6, Issue 1; 2025

Exploring the potential of Mathematics; Innovative Mobile Application for multiplication by 5, Sharpening Students' Critical Thinking and Mathematical Computational Skills

Khoerul Umam[1]*, Abdul Hakim Ma'ruf[2], Ervin Azhar[1], Hari Setiadi[3]
[1]Teacher Professional Education Study Program, Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia
[2]Matematics Education Study Program, Sekolah Tinggi Keguruan dan Ilmu Pendidikan Kusuma Negara, Indonesia
[3]Educational Research and Evaluation Study Program, Universitas Muhammadiyah Prof. DR. HAMKA, Indonesia
*khoerul.umam@uhamka.ac.id

Article Info

Received
April 11, 2025

Revised
June 20, 2025

Accepted
July 21, 2025

Keywords

Computational Thinking; Critical Thinking; Development; Mobile Application; Multiplication Rule.

Abstract

The integration of innovative digital tools offers a promising avenue to address traditional learning hurdles and enhance student engagement. This study aims to develop a mobile application to improve students' critical thinking and mathematical computational skills in the material of the multiplication rule of 5. The low level of both abilities and the limitations of innovative learning media. The use of the ADDIE development research method. The results of the study showed that the application was significantly successful in improving computational skills and critical thinking skills, which was empirically proven by increased test scores and active student involvement during the mathematics learning process. An important contribution in providing effective digital learning solutions for basic materials as a foundation in developing knowledge for students. Furthermore, this application serve as a scalable model for integrating technology to address fundamental learning gaps in mathematics across various educational settings. Its success suggests the potential for broader adoption of similar tools to foster essential cognitive skills from an early age.

How to Cite:
Umam, K., Ma'ruf, A. H., Azhar, E., & Setiadi, H. (2025). Exploring the potential of Mathematics; Innovative Mobile Application for multiplication by 5, Sharpening Students' Critical Thinking and Mathematical Computational Skills. *Journal of Instructional Mathematics*, *6*(1), 49-57.

INTRODUCTION

Computational thinking and critical thinking skills are fundamental skills that are increasingly emphasized in today's mathematics learning (Brandsæter & Berge, 2025; Susandi et al., 2019). Critical thinking allows students to analyze something

better, evaluate continuously, and synthesize information to solve complex problems (Dwijayani, 2017; Nurlaeli et al., 2018). In contrast to mathematical computational thinking, which complements this ability by training students to formulate a problem, break it down into smaller parts, and how students are able to develop algorithms and systematic solutions that can be implemented (Adler & Kim, 2018; Emara et al., 2021). In the context of mathematics learning, especially in fundamental materials such as multiplication rules, mastery of these two skills is an important foundation (Karim, 2021; Kuniasih et al., 2022). A deep understanding of multiplication rules not only facilitates the mastery of subsequent mathematical material, but also trains accuracy, speed, and efficiency in reasoning and calculating, which are important aspects of computational thinking (Adler & Kim, 2018; Richado et al., 2023; Shukla et al., 2020). Therefore, the integration of the development of critical thinking and mathematical computation from an early age through basic materials such as multiplication is a necessity.

Various studies have explored the use of technology to improve mathematics learning and thinking skills (Bringula et al., 2017; Mamolo, 2019; Salam et al., 2015). The effectiveness of interactive learning media based on Android applications in improving learning outcomes of arithmetic operations (Yusmanita et al., 2018). Research that highlights the importance of gamification in mathematics learning for student motivation and engagement (Salam et al., 2015). In the scope of computational thinking, problem-based learning supported by technology can facilitate its development in elementary school students (Richado et al., 2023). Meanwhile, the use of visual learning media can support the improvement of mathematical critical thinking skills (Wardhani & Oktiningrum, 2022). Although many efforts have been made in developing media and improving thinking skills separately, there is still minimal research that specifically integrates the development of mobile learning media for the material of the multiplication rule of 5 with a dual emphasis on improving mathematical critical and computational thinking skills simultaneously.

Based on the literature review, there is a significant gap in research (Ahmed et al., 2018; Bringula et al., 2017; Mensah et al., 2023). Although many mobile-based mathematics learning media and studies on improving critical and computational thinking skills have been carried out separately, there are not many studies that explicitly develop mobile learning media for the material of the multiplication rule of 5 that are specifically designed to simultaneously improve both critical and computational mathematical skills. Previous studies by Siswanto et al. (2019) and Umam et al. (2019) tend to focus on one aspect or use different materials. The novelty of this study lies in the development of a mobile application integrated with a systematic learning method, designed to facilitate an in-depth understanding of the multiplication rule of 5 while training students in critical thinking to analyze problems and computational thinking to compile steps for solving efficiently. This gap arises from the facts in the field, namely the low mathematical critical thinking ability of students in analyzing varied multiplication problems and not only focused on memorization, as well as students' limitations in applying multiplication concepts computationally to formulate systematic solution steps. In addition, the availability of innovative mathematics learning media that are relevant to students' digital learning styles is still limited, especially those specifically designed for the material of the multiplication rule of 5 with a focus on developing both abilities.

Therefore, this study aims to develop a mobile application for the multiplication rule of 5 that is effective in improving students' mathematical critical and computational thinking skills, and to analyze the effectiveness of this application in improving critical and computational thinking skills more specifically.

RESEARCH METHODS

This study uses the ADDIE approach which includes analysis, design, development, implementation and evaluation. ADDIE was chosen by the researcher because it is easy to present research stages that are clearer and more comprehensive. This will make it easier for researchers to describe the stages of research activities in more detail so that readers are able to understand the flow of the research process that has been carried out.

Data collection was carried out at schools using a large scale that participated as many as 40 students. The involvement of these students used purposive sampling where students who participated were selected with classes that had technology during the learning process. This is because the research process will involve interaction between students and the mobile phones they have as a means for the learning process.

The research instrument used in this study will measure the impact on students' critical thinking skills which include how students analyze a problem, synthesize problems, and evaluate mathematical problems. While computational skills will measure the extent to which students are able to formulate a solution to a problem, develop ways to solve problems to be simpler, and assess how students compile problem-solving algorithms.

Analysis of research data using descriptive data described based on the ADDIE development stages, namely analysis, design, development, implementation, and evaluation. The data analysis stage of conceptual understanding ability will be made into a score according to the rubric validated by Mathematics and Technology Education experts. In evaluating the impact of critical and computational thinking skills, an evaluation of the pre-test and post-test on learning is carried out.

RESULTS AND DISSCUSSION

The research results are presented in stages based on the development process framework, starting from the analysis phase through to evaluation.

Analysis Stage

At the analysis stage, the researcher conducted several activities including student characteristics, curriculum analysis, and in-depth analysis of the material on the multiplication rule of 5. Initial observations and interviews with mathematics teachers showed that students still face significant challenges in internalizing basic multiplication concepts, especially the multiplication rule of 5, which is often only seen as memorization without a deep understanding of the patterns and their application in various contexts. Furthermore, students' critical thinking skills in analyzing mathematical problems related to multiplication are relatively low, as are their computational abilities in formulating problem-solving steps systematically

and efficiently. This phenomenon is in line with the findings of Mamolo (2019) who emphasized the need for interactive learning media to improve understanding of basic concepts. On the other hand, students showed significant interest in the use of mobile devices in mathematics learning activities, becoming a potential that must be utilized. The potential of gamification and mobile applications in increasing learning motivation (Kholid et al., 2021; Wu, 2018). The curriculum analysis confirms that the material of the multiplication rules of 5 is a crucial foundation for more complex arithmetic operations, with an emphasis on conceptual understanding rather than mere memorization. The unique characteristics of the multiplication material of 5, which always produces numbers ending in 0 or 5, are a strategic gap to train computational thinking skills in identifying patterns and rules. Therefore, the results of this analysis clearly show the need for innovative mobile-based learning media that are specifically designed to overcome challenges in mastering the material while explicitly facilitating the development of critical thinking and mathematical computational skills.

Design Stage

This design stage focuses on the preparation of the conceptual framework of the application, user interface design and user experience, and the design of learning activities that support the research objectives. The application is designed with core features that include an interactive learning module for the rules of multiplication of 5 enriched with pattern visualization to facilitate understanding of the concept. In stimulating critical thinking, the application includes various practice questions that require students to analyze, such as story problems and error identification that are in line with findings on the importance of visualization and practice for critical thinking. In addition, computational-based challenges are also designed that encourage students to solve problems and find efficient multiplication strategies, reflecting the principles of computational thinking (Emara et al., 2021). The design of the user interface and user experience is a priority with the aim of creating a learning environment that is intuitive, visually appealing, easy to understand concepts and easy for students to navigate, using predetermined plate colors, and simple animations to maintain student engagement in the learning process (Mamolo, 2019).

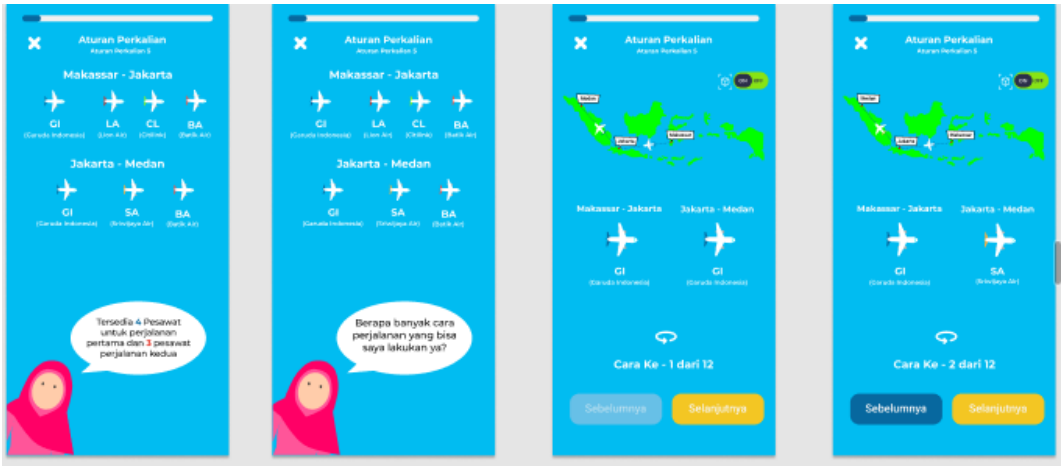

Figure 1. Design learning for study, the engagement to move the planes

The overall design of the learning activities is directed to promote higher-order thinking, such as the “Find the Pattern” activity that trains computational pattern recognition, and “Error Analysis” to hone critical thinking skills. Thus, this comprehensive design ensures that the application does not only function as a presenter of materials, but as a tool that systematically integrates elements that trigger, train, and develop critical thinking and mathematical computational skills.

Development Stage

In the development stage, the mobile application prototype is implemented based on the design that has been made involving writing code, content integration, and a series of internal tests. The application is developed using Android Studio, ensuring wide compatibility with the majority of students' mobile devices, in line with the trend of developing Android-based educational applications that have been proven effective. The content of the 5 multiplication rule material is presented in a rich multimedia format, including text, images, audio, and interactive animations, which are designed to enrich the learning experience and meet various student learning styles. The importance of multimedia in learning has been widely proven, such as in studies that show an increase in conceptual understanding through visualization.

Practice questions and challenges are carefully arranged based on the modified Bloom's taxonomy targeting not only conceptual mastery (Yasir & Alnoori, 2020), but also critical thinking skills, especially at the stages of analyzing and evaluating, and computational thinking which includes decomposition, pattern recognition, abstraction, and algorithms (Richado et al., 2023). Internal testing is carried out thoroughly by the development team to verify the functionality of each feature, identify and fix bugs, and ensure the responsiveness of the application (Astuti et al., 2023). The result of this development is a functional, stable application prototype that is ready for further testing. Choosing the right platform and creating pedagogically relevant content are key to the success of this stage, ensuring that the application is not only technically strong but also educationally effective.

Implementation Stage

The implementation stage will involve a gradual trial of the application to students who have been selected to participate in the study, in order to collect empirical data in a real learning environment. A limited trial is conducted on a small number of students to obtain initial feedback on ease of use, visual appeal, and clarity of instructions related to the application. All input collected from this initial trial is very useful for making some minor improvements before going to a larger scale, ensuring an optimal user experience. Next, the application is implemented in a field trial on a larger group of students, usually one class, in a realistic learning scenario. In seeing the impact, it can be seen in the cycle 1 and cycle 2 tables, which are depicted in the pre-test and post-test in Figure 2.

During this stage, data were collected comprehensively through direct observation, feedback questionnaires, and pre-test and post-test instruments. The use of pre-tests and post-tests has become a standard method in development research in measuring improvements in cognitive abilities, including critical and computational thinking, as a result of learning media interventions (Ariyanto et al., 2019; Rahmadhani & Wahyuni, 2020).

Observations provide qualitative information about how students interact with the application and demonstrate critical and computational thinking behaviors, while questionnaires capture students' perceptions of their learning experiences (Emara et al., 2021; Višňovská & Cortina, 2025). Thus, this systematic field trial serves as an important empirical validation, providing comprehensive data on the effectiveness of the application in a real learning environment.

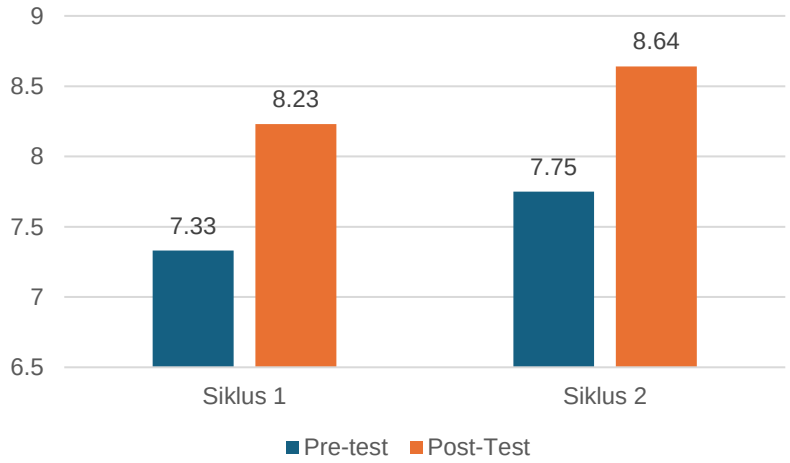

Figure 2. Cycle 1 and 2 assessments depicted in the post-test and pre-test

Evaluation Stage

The evaluation stage is the culmination of the entire development process, which focuses on a comprehensive assessment of the effectiveness, efficiency, and attractiveness of the application based on the data that has been collected. The effectiveness in improving mathematical critical thinking skills is clearly shown by a significant increase in students' pre-test and post-test scores (Rahmawati et al., 2023). The quantitative analysis is supported by qualitative findings from students' answers that show improvements in their ability to analyze problems, synthesize important information, and evaluate solutions related to the multiplication rule of 5. These results are consistent with the literature showing that interactive media can facilitate the development of critical thinking (Avsec & Kocijancic, 2014; Nurlaeli et al., 2018).

Similarly, the effectiveness in improving mathematical computational skills is proven through the improvement of students' performance in aspects such as problem decomposition (solving complex multiplication problems by 5), pattern recognition (identifying unique patterns of multiplication by 5), abstraction (generalizing patterns into rules), and algorithm development (arranging efficient steps to calculate). This improvement is reflected in their speed and accuracy in solving computational challenges in the application, which is in line with the idea that technology-based learning can encourage computational skills. In terms of user appeal and engagement, the questionnaire showed that students were highly motivated and enthusiastic about using the application with an attractive design, gamification elements, and interactive feedback being key factors driving high engagement.

Finally, the feasibility and practicality aspects were also met; reports from mathematics teachers confirmed that the application was easy to integrate into teaching and learning activities, effectively visualized concepts, and provided a variety of teaching methods that increased the effectiveness of overall mathematics learning (Mamolo, 2019; Rahmadhani & Wahyuni, 2020). Overall, the evaluation results consistently show that the developed mobile application has succeeded in achieving its objectives, not only improving the mastery of the material on the rules of multiplication of 5 but also significantly developing students' critical thinking and mathematical computational skills, strengthening the argument for the adoption of technology-based learning media in mathematics education.

CONCLUSION

This development research has successfully achieved its goal in developing a mobile application for the material of the multiplication rule of 5 that is effective in improving students' critical thinking and mathematical computational skills. Key findings indicate that applications designed with interactive features, varied exercises, and computational challenges have been proven to significantly improve students' critical thinking skills in analyzing multiplication problems and improve students' mathematical computational skills in formulating more efficient and effective problem-solving strategies. This effectiveness is supported by an increase in scores on the evaluation instrument and a high level of student engagement during the use of the application. In general, this mobile-based learning media not only strengthens the mastery of the concept of multiplication of 5, but also succeeds in developing highly relevant 21st century cognitive skills.

Future research can also explore the effectiveness of this application in different learning contexts, such as distance learning or mathematics learning that integrates with artificial intelligence for more personalized adaptation of mathematics learning. In addition, further research can focus on developing modules to measure more specific aspects of mathematical computational thinking, such as algorithm optimization skills, which have not been fully covered in current measurements.

REFERENCES

Adler, R. F., & Kim, H. (2018). Enhancing future K-8 teachers' computational thinking skills through modeling and simulations. *Education and Information Technologies*, *23*(4), 1501–1514. https://doi.org/10.1007/s10639-017-9675-1

Ahmed, A., Zahid, A., Wajid, H., Muhammad, H. R., & Vighio, S. (2018). An analysis of the influence of a mobile learning application on the learning outcomes of higher education students. *Universal Access in the Information Society*, *17*(2), 325–334. https://doi.org/10.1007/s10209-017-0551-y

Ariyanto, L., Aditya, D., & Dwijayanti, I. (2019). Pengembangan Android Apps Berbasis Discovery Learning Untuk Meningkatkan Pemahaman Konsep Matematis Siswa Kelas VII. *Edumatika: Jurnal Riset Pendidikan Matematika*, *2*(1), 40-51. https://doi.org/10.32939/ejrpm.v2i1.355

Astuti, N. L. S., Istiyono, E., & Widihastuti, W. (2023). Incorporating School Culture in Character Education Evaluation: The Development, Validity and Reliability Testing of the "CHILDREN" Character Assessment. *AL-ISHLAH:*

Jurnal Pendidikan, *15*(2), 2052–2061. https://doi.org/10.35445/alishlah.v15i2.2523

Avsec, S., & Kocijancic, S. (2014). Effectiveness of Inquiry-Based Learning: How do Middle School Students Learn to Maximise the Efficacy of a Water Turbine? *International Journal of Engineering Education*, *30*(6), 1436–1449.

Brandsæter, A., & Berge, R. L. (2025). Promoting mathematical competence development through programming activities. *Educational Studies in Mathematics*, 225–247. https://doi.org/10.1007/s10649-024-10380-y

Bringula, R., De Leon, J. S., Rayala, K. J., Pascual, B. A., & Sendino, K. (2017). Effects of different types of feedback of a mobile-assisted learning application and motivation towards mathematics learning on students' mathematics performance. *International Journal of Web Information Systems*, *13*(3), 241–259. https://doi.org/10.1108/IJWIS-03-2017-0017

Dwijayani, N. M. (2017). Pengembangan Media Pembelajaran ICARE. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *8*(2), 126–132. https://doi.org/10.15294/kreano.v8i2.10014

Emara, M., Hutchins, N. M., Grover, S., Snyder, C., & Biswas, G. (2021). Examining student regulation of collaborative, computational, problem-solving processes in openended learning environments. *Journal of Learning Analytics*, *8*(1), 49–74. https://doi.org/10.18608/JLA.2021.7230

Karim, A. (2021). Stochastic Block Model Reveals Maps of In Applied Mathematics Studies Using VOS Viewer Stochastic Block Model Reveals Maps of in Applied Mathematics Studies Using VOS Viewer. *International Journal of Progressive Mathematics Education*, *1*(2), 127–142. https://doi.org/10.22236/ijopme.v1i2.6917

Kholid, M. N., Imawati, A., Swastika, A., Maharani, S., & Pradana, L. N. (2021). How are Students' Conceptual Understanding for Solving Mathematical Problem?. *Journal of Physics: Conference Series*, *1776*(1), 012018. https://doi.org/10.1088/1742-6596/1776/1/012018

Kuniasih, E., Ammnet, A., & Domingo, M. J. (2022). Profil Kemampuan Geometri Menurut Teori Van Hiele Pada Materi Transformasi Geometri. *International Journal of Progressive Mathematics Education*, *2*(2), 100-119. https://doi.org/10.22236/ijopme.v2i2.8876

Mamolo, L. A. (2019). Development of digital interactive math comics (DIMaC) for senior high school students in general mathematics. *Cogent Education*, *6*(1), 1689639. https://doi.org/10.1080/2331186X.2019.1689639

Mensah, R. O., Quansah, C., Oteng, B., & Nii Akai Nettey, J. (2023). Assessing the effect of information and communication technology usage on high school student's academic performance in a developing country. *Cogent Education*, *10*(1), 2188809. https://doi.org/10.1080/2331186X.2023.2188809

Nurlaeli, N., Noornia, A., & Wiraningsih, E. D. (2018). Pengaruh Model Pembelajaran Problem Based Learning Terhadap Kemampuan Berpikir Kritis Matematis Siswa Ditinjau Dari Adversity Quotient. *FIBONACCI: Jurnal Pendidikan Matematika dan Matematika*, *4*(2), 145-154. https://doi.org/10.24853/fbc.4.2.145-154

Rahmadhani, E., & Wahyuni, S. (2020). Integrasi Pembelajaran Matematika Berbasis ICARE dan Islam Pada Materi Pecahan. *JNPM (Jurnal Nasional Pendidikan Matematika)*, *4*(1), 110–124.

https://doi.org/10.33603/jnpm.v4i1.2874

Rahmawati, N. U., Nugroho, P. B., Dinata, K. B., & Truong, A. T. T. (2023). Pengembangan Video Pembelajaran Berbasis Pemecahan Masalah Berbantuan Adobe Captivate Materi Matriks di Sekolah Kejuruan (SMK) 3 Kota Bumi. *International Journal of Progressive Mathematics Education*, *3*(1), 51–70. https://doi.org/10.22236/ijopme.v1i3.7689

Richado, R., Dwiningrum, S. I. A., & Wijaya, A. (2023). Computational Thinking Skill for Mathematics and Attitudes Based on Gender: Comparative and Relationship Analysis. *Pegem Egitim ve Ogretim Dergisi*, *13*(2), 345–353. https://doi.org/10.47750/pegegog.13.02.38

Salam, A., Hossain, A., & Rahman, S. (2015). The Effect of using Teams Games Tournaments (TGT) Cooperative Technique for Learning Mathematics in secondary schools of Bangladesh. *Journal of Research in Mathematics Education*, *4*(3), 271–287. https://doi.org/10.17583/redimat.2015.1519

Shukla, T., Dosaya, D., Nirban, V. S., & Vavilala, M. P. (2020). Factors extraction of effective teaching-learning in online and conventional classrooms. *International Journal of Information and Education Technology*, *10*(6), 422–427. https://doi.org/10.18178/ijiet.2020.10.6.1401

Siswanto, R. D., Hilda, A. M., & Azhar, E. (2019). Development combinatorics realistic mathematics education application based on the android mobile. *International Journal of Innovation, Creativity and Change*, *5*(6), 123–140.

Susandi, A. D., Sa'dijah, C., As'ari, A. R., & Susiswo. (2019). What error happened to inferences of senior high school students using mathematical critical thinking ability?. *International Journal of Scientific and Technology Research*, *8*(9), 507–511.

Umam, K., Nusantara, T., Parta, I. N., Hidayanto, E., & Mulyono, H. (2019). An Application of Flipped Classroom in Mathematics Teacher Education Programme. *International Journal of Interactive Mobile Technologies (IJIM)*, *13*(03), 68-80. https://doi.org/10.3991/ijim.v13i03.10207

Višňovská, J., & Cortina, J. L. (2025). Curriculum and mathematical coherence: exploring the tensions in teaching and learning number. *ZDM - Mathematics Education*, 1-13. https://doi.org/10.1007/s11858-025-01706-y

Wardhani, D. A. P., & Oktiningrum, W. (2022). Meningkatkan Kemampuan Berpikir Kritis Mahasiswa Melalui Pengembangan Soal Matematika Dengan Konteks Covid-19. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *11*(1), 69-79. https://doi.org/10.24127/ajpm.v11i1.4377

Wu, Y. L. (2018). Gamification design: A comparison of four m-learning courses. *Innovations in Education and Teaching International*, *55*(4), 470–478. https://doi.org/10.1080/14703297.2016.1250662

Yasir, A. H., & Alnoori, B. S. M. (2020). Teacher Perceptions of Critical Thinking Among Students and its Influence on Higher Education. *International Journal of Research in Science and Technology*, *10*(4), 7–19. https://doi.org/10.37648/ijrst.v10i04.002

Yusmanita, S., Ikhsan, M., & Zubainur, C. M. (2018). Penerapan Pendekatan Matematika Realistik untuk Meningkatkan Kemampuan Operasi Hitung Perkalian. *Jurnal Elemen*, *4*(1), 93-104. https://doi.org/10.29408/jel.v4i1.469