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Mobile Mathematics Development: Sample Space and Probability for Critical Thinking and Problem Solving

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Abstract. *Students' critical thinking and mathematical problem-solving skills are important elements in learning mathematics; however, facts in the field still provide notes on the average learning outcomes in the material of sample spaces, and simple event probabilities are still low. This study aims to develop a mobile-based mathematics learning application to improve students' critical thinking and mathematical problem-solving skills. This study uses the ADDIE development design (analysis, design, development, implementation, evaluation) and quasi-experimental methods with a pre-test-post-test design in the experimental and control groups. The study subjects were 11th-grade public and private high school students, with a total of 145 students participating. The instruments include critical thinking and mathematical problem-solving tests based on established indicators. Quantitative analysis uses a paired t-test. The results showed a significant increase in the average score of students in the experimental group with critical thinking skills (experiment 88.77, control 72.65) and mathematical problem solving (experiment 86.55, control 76.54) after using the application. The development of mobile learning applications on the material of sample spaces and simple events can effectively improve the critical thinking and mathematical problem-solving skills of high school students.*

Keywords: *Critical Thinking Skills, Problem Solving Skills, Mobile, Mathematics Learning*

INTRODUCTION

Critical thinking skills have become the focus of research on mathematics learning in recent years (Pramoda Wardhani & Oktiningrum, 2022; K Umam, 2018). Critical thinking skills include the ability to solve problems, as well as the ability to analyze, evaluate, and construct logical arguments and consider alternative solutions in solving problems. In education, mathematical critical thinking involves students' ability to understand and apply mathematical concepts in depth and relevance, and can integrate mathematical concepts with real life (Ndiung et al., 2021; Purwanto, 2020). This ability not only plays a very important role in students' academic progress, but also helps students to face various increasingly complex life challenges and integration (Kusaeri & Aditomo, 2019; Shukla et al., 2020; Veloo & Chairhany, 2013).

Many current studies discuss critical mathematical thinking skills, the main goal of learning mathematics (Janah et al., 2019; Shukla et al., 2020). One of the materials that can support students' critical thinking skills is the material on sample spaces and simple event probabilities. The material on sample spaces and simple event probabilities requires students to analyze data more systematically, understand various relationships between various data in random situations, and make the right decisions based on mathematical probability and logic (Irsal et al., 2017; Susanti & Hartono, 2019; Warwick, 2007). Therefore, learning sample spaces and simple event probabilities is about memorizing concepts and developing students' ability to think critically and rationally in solving problems based on probability, reasoning, and logic. Students learn the importance of this material on sample spaces and simple event probabilities because it hones students' ability to adapt to solving various problems (Bintoro et al., 2021; Nakhanu & Musasia, 2015). The material students study on sample space and simple event probability is very much needed in life, although it does not directly impact. Concepts such as sample space, simple event probability, and probability calculations are often abstract and cannot directly relate to students' daily lives. In bringing mathematical concepts closer to real life, students need to be helped so that they can understand the material better, interestingly, and relevant to students' needs.

Several previous studies have shown that learning mathematics using technology has a very positive impact on mathematics learning outcomes and interest in learning mathematics (Halimah et al., 2020; Moorhouse et al., 2019; Khoerul Umam et al., 2024; Van Vaerenewyck et al., 2017). Research shows that learning mathematics using technology has a long-term positive impact on students. Students become more motivated in learning mathematics because they are given a very positive impression of the mathematics learning experience (Hemmi et al., 2021; Tran & O'Connor, 2024; Webb et al., 2013). Other studies show that mobile-based mathematics learning can improve students' creative thinking skills, especially in solving mathematical problems.

However, although many studies have shown positive results, the development of mobile-based mathematics learning applications on the material of sample spaces and simple event probabilities that play a role in improving students' critical thinking skills is still very limited. Therefore, this study aims to develop a mobile-based mathematics learning support tool that teachers and students will use in learning sample space and simple event probability material. This application is expected to positively impact students' psychology in the long term (Ariyanto et al., 2019; Chen, 2019). This application also improves students' critical thinking skills, as shown in the behavior of students who are willing to play an active role in learning, dare to express their opinions, and can explain sample space and simple event probability material more comprehensively.

The main purpose of developing this application is to improve students' critical thinking skills and mathematical problem-solving abilities. It helps students understand sample space and simple event probability material more easily and stimulates them to think critically in solving mathematical problems. Thus, this application can present an alternative mathematics learning support tool that is effective for use in the classroom but can also be accessed by students outside of school hours.

RESEARCH METHOD

This study uses the ADDIE development design to achieve maximum development of mathematics learning. At the analysis stage, student needs, teacher needs, critical thinking skills needs, and technology needs to improve students' mathematical critical thinking skills are carried out. After that, the design stage involves visualizing the results of the analysis that has been done by creating a flow display in the figma program so that development will be easier in developing its application. The selection of figma has the aim of being able to be simulated with the research team and teachers so that it is easy to discuss if there is a discrepancy between the concept and implementation (Alim et al., 2016; Ariyanto et al., 2019; Iftitah, 2023). In the development stage, it is done by changing the figma results into a programming form to make the results more realistic. Before implementation, product validation involves expert validation in mathematics education and technology, which examines the product techniques' suitability, clarity, development potential, and feasibility. Researchers then use this expert feedback to revise before the product is tested on a wider scale to identify practical problems (Nugrahani & Apriani, 2021; Samo et al., 2017). In the implementation stage, researchers and teachers collaboratively implement the developed product in a predetermined classroom setting. During this process, the focus is to closely observe student interactions with the product and collect direct feedback from students and teachers regarding the user experience and potential obstacles that may arise. In the final stage, an evaluation is carried out to measure the effectiveness of learning using the technology developed. This process analyzes how technology implementation impacts students' critical mathematical thinking skills. Quantitative data through test instruments and feedback will be collected and analyzed to gain a comprehensive understanding of the influence of technology on students' cognitive abilities.

This study was conducted in the odd semester from April to May 2024 at 2 high schools, namely public and private high schools. The selection of schools was based on the same AKM value, so the characteristics of the school tend to have a population with the same mathematical ability. Each school will have one control class, so there are 4 classes, 2 experimental classes with 71 students, and 2 control classes with 74 students. Based on gender, out of 145 students, 75 are male, and 70 are female. The assessment instruments used in evaluating this study are two instruments, namely the application evaluation instrument and the instrument for measuring students' critical thinking skills and mathematical problem-solving abilities. In measuring the extent of students' understanding of the concept of sample space theory and simple event probabilities, 6 mathematical problems were created, which were distributed based on indicators of critical thinking and problem-solving abilities (Abdiyani et al., 2019; Janah et al., 2019; K Umam, 2018). Teachers and mathematics practitioners then validate the problems created. The problems are open-ended; students must think and analyze before solving the problem. Several experts mention five indicators of students' mathematical critical thinking skills: interpretation, analysis, evaluation, inference, and explanation (Abdiyani et al., 2019; Janah et al., 2019). Meanwhile, students' mathematical problem-solving abilities indicate understanding the problem, planning to solve the problem, solving the problem, and looking back at the problem (Risani & Nuriyatin, 2021; Wahyu Hidayat, 2018).

The research data analysis uses descriptions based on the ADDIE development stages: analysis, design, development, and evaluation. The stages of data analysis of students' critical thinking skills will be scored according to the rubric that mathematics and technology education experts have validated. Experts provide a score assessment between 1 and 5 for each aspect. The average assessment of each aspect must get a minimum score of 4. In this study, three assessment criteria were determined, including not feasible (average score $\leq$4.0), feasible 4.0 <average score $\leq$4.5), and very feasible (average score> 4.5) (Mamolo, 2019; Rahmadhani & Wahyuni, 2020). The impact of technology implementation on students' critical thinking and mathematical problem-solving skills was evaluated through a t-test after the prerequisites for normality and homogeneity were met. The paired t-test analyzed the differences in pre-test and post-test scores of the experimental group.

RESULTS AND DISCUSSION

Analysis

Analysis of learning mathematics material, sample space, and probability of simple events obtained from teachers and students. The challenge in teaching material sample space and probability of simple events is that students often find it difficult to understand abstract concepts in sample space and probability of simple events, such as sample space and sample space and probability of simple events. This is due to the nature of the material, which requires a high understanding of logic and critical thinking skills. This material, which tends to be difficult, is often presented in text or formulas that are sometimes difficult for students to understand (Blum & Borromeo, 2009; Choppin et al., 2022; Nyroos et al., 2015). The teacher noted that students often confuse the difference between sample space and event, while a student said, "The formulas look scary and hard to remember".

The analysis shows a need for Interaction in the mathematics learning process, equipped with sample space material and simple event probabilities, and quizzes to provide a strong understanding for all students. The analysis results show that quizzes on understanding the concept of sample space and simple event probabilities that can be done repeatedly can increase students' understanding of the material, so this proposal needs to be considered carefully so that it is recorded in the analysis results. In supporting the results of this analysis, the researcher made a design for the learning process of sample space

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and simple event probabilities that need to be validated by mathematics education experts and mathematics teachers.

Design

After conducting an in-depth analysis, the research will be designed in Figma based on the results. The design begins by considering the data analysis of student needs, learning objectives, technical aspects required, and various inputs from teachers, practitioners, and students. In designing this mobile application, we carried out two stages: the interpretation stage of the analysis results and the design of the mobile learning application.

The interpretation of the analysis results begins by creating a concept that suits the needs of students. Analysis emphasizes students' problem-solving and critical mathematical thinking abilities that need attention. The team interprets this by creating a simulation image.

In developing Figma, researchers adjust several aspects, the first of which is the learning activities that will be carried out, the colors that will be given to the application, student activities, buttons on the screen, and the back button. The most challenging aspect of the Figma development process lies in adapting the mathematics learning scenario based on the conducted data analysis, which necessitates extensive discussions and considerable time investment.. To see further, how this application is designed in Figma can be seen as follows.

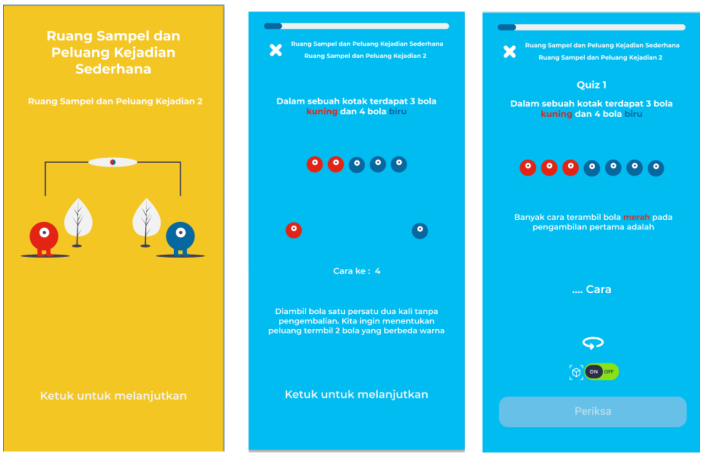

Figure 1. Application of sample space and probability of simple events

Development

The development of this application began based on a mock-up that had been created on the figma page. Development began by coding the front-end of the Figma data. In developing this application, researchers collaborated with technology experts who could facilitate the realization of the design concept that had been developed. Before the development stage of this application began, we considered various inputs from several mathematics education experts and technology education experts. The assessment from technology education experts can be seen in Table 1.

Table 1: Educational Technology Expert Results

No	Category	Average	Criteria
1	Device Engineering	4.53	Very Receivable
2	Visual Display	4.28	Receivable
3	Students' Interaction with the Application	4.76	Very Receivable

When looking at the data, it can be explained that the very positive response from technology education experts is related to the developed application. In device engineering, it obtained a value of 4.53, which is included in the very feasible criteria. This indicates that the structure, functionality, and reliability of the application software students use are considered very feasible. The data in Table 1 shows that the level of expert confidence in the application that has been developed has a strong technical and Interaction foundation and is very feasible to be used in the mathematics learning process in the classroom that supports students' problem-solving abilities and critical mathematical thinking abilities. Furthermore, in obtaining more comprehensive assessment results, the same opinion was expressed by mathematics education experts, as seen in Table 2.

Table 2: Mathematics Expert Validation Results

No	**Category**	**Average**	**Kriteria**
1	Learning Design	4.30	Receivable
2	Device Engineering	4.66	Very Receivable
3	Visual Display	4.22	Receivable
4	Students' Interaction with the Application	4.75	Very Receivable

Table 2 data illustrates the level of expert confidence in the developed product, where the interaction assessment gets a fairly significant value of 4.75, indicating it is very feasible. This expert assessment reinforces that Interaction in the mathematics learning process is important. With fairly active student interaction, students' ability to analyze a problem increases, and students' ability to compile a series of problem-solving becomes better (Ariyanto et al., 2019; Iftitah, 2023; Pramoda Wardhani & Oktiningrum, 2022). Active activities in this learning process support the creation of increased problem-solving abilities and students' critical mathematical thinking abilities. Mathematics education experts provide input on concepts that need to be strengthened. This is different from technology education experts who suggest that the technology faced must prioritize aspects of ease of Interaction so that the application is in demand by students and teachers.

Impelementaion

This shows the influence this mathematics learning process has on students' critical mathematical thinking skills, as seen in Table 3.

Table 3: Results of the t-test of students' visualization ability scores

class	Amount of Students	Average	Sig.	notes
Experiment	73	88.77	0.002	Sig. < 0,05
Control	72	72.65		

The results show that all the sig data and a significant difference in students' critical mathematical thinking skills using mobile-based learning. Most students exceed 5 indicators of students' critical mathematical thinking skills: interpretation, analysis, evaluation, inference, and explanation. Using mobile-based learning, students' critical mathematical thinking skills increased in all experimental classes. This learning succeeded in encouraging more active and effective student interaction. Mathematics learning outcomes also increased from the average value of students in problem-solving skills, as seen in Table 4.

Table 4. Results of the t-score test of student ability

Class	Number of Students	Average	Sig.	Notes
Experiment	73	86,55	0.003	Sig. < 0,05
Control	72	76,54		

The data shows a significant difference because it can be interpreted as a difference where students in the experimental class who use mobile learning simultaneously also show increased problem-solving abilities. Students who can easily mathematize problems. The teacher's response in this mathematics learning is positive, where student interaction with other students increases significantly, encouraging students to think critically. With a significant level of Interaction, students' ability to interpret a problem becomes more rational. Students' rationalization of the problem is based on analytical skills that have increased significantly, assisted by how students model a problem solution through four stages of problem-solving abilities. Combining problem-solving abilities and mathematical critical thinking abilities in this mathematics learning greatly helps teachers create more effective and efficient mathematics learning.

Evaluation

In evaluating the implementation of this learning activity, it contributes to improving students' critical mathematical thinking skills and mathematical problem-solving skills. The evaluation results show that using this learning media can significantly improve students' critical thinking skills, where students become more active in the learning process and are more critical of the mathematical materials explained. Students can argue logically by providing facts about the problems faced. Students can also provide problem-solving skills that are clearer and more orderly, so that students who listen to the explanation can understand it well. From the teacher's experience, the teacher feels that all the students involved greatly feel the ease of use of this application. Teachers know the great benefits of using this application, so they are very happy to use it. The impression teachers give to this application is impressive because teachers are very helped and students also feel a positive impact. Several studies on applications also reinforce this. Using applications in mathematics learning greatly helps many technical and conceptual matters, where teachers explain the material more easily and students receive more easily understood lessons.

CONCLUSION

The development of the application of sample space material and simple event probabilities brings mathematical concepts closer to students' daily lives. Assessments from several experts show that the developed application can empirically improve students' critical thinking skills, with the majority of experts giving decent and very decent assessments in several aspects of the assessment. The results of the study in quantitative data on mathematics learning outcomes also showed a significant increase in the average score of critical thinking skills (experiment 88.77, control 72.65) and mathematical problem solving (experiment 86.55, control 76.54) of students in the experimental group after using the application. This is indicated by students who become more interested in learning mathematics because of direct Interaction between students and teachers. The impact of the development of this application is that students can argue better on mathematical problems. Students can also consider more logical and systematic problem solutions. The positive impacts that arise are due to a better and quality mathematics learning process supported by mobile-based technology.

This study has various shortcomings that were not met when carried out, including the involvement of students in larger numbers. This limitation is because the researcher's ability to reach a wider research area requires much cooperation and money. Therefore, future research can cover this by increasing the number of schools and subjects participating in this study. This study also has not reached students who do not have mobile phones, because in this study, researchers require students to have mobile phones to make it easy to learn mathematics. Future research needs to consider how this research is conducted on subjects who do not have mobile phones because most students in the regions cannot access communication tools with limited signals and other supporting technologies. By knowing the shortcomings of research that does not use mobile phones, this application can be redeveloped to meet the various needs of mathematics teachers in the future.

REFERENCES

Abdiyani, S. S., Khabibah, S., & Rahmawati, N. D. (2019). Profil Kemampuan Pemecahan Masalah Matematika Siswa SMP Negeri 1 Jogoroto Berdasarkan Langkah-langkah Polya Ditinjau dari Adversity Quotient. *Al-Khwarizmi: Jurnal Pendidikan Matematika Dan Ilmu Pengetahuan Alam*, *7*(2), 123–134. https://doi.org/10.24256/jpmipa.v7i2.774

Alim, E. S., Umam, K., & Wijirahayu, S. (2016). The Implementation of Blended Learning Instruction by Utilizing the WeChat Application. *ICCE 2016 - 24th International*

Conference on Computers in Education: Think Global Act Local - Workshop Proceedings.

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. https://doi.org/10.32939/ejrpm.v2i1.355

Bintoro, H. S., Walid, & Mulyono. (2021). The Spatial Thinking Process of the Field-Independent Students based on Action-Process-Object-Schema Theory. *European Journal of Educational Research*, *10*(4), 1807–1823.

Blum, W., & Borromeo, R. (2009). Mathematical Modelling: Can It Be Taught And Learnt? *Journal of Mathematical Modelling and Application*, *1*(1), 45–58.

Chen, Y. C. (2019). Effect of Mobile Augmented Reality on Learning Performance, Motivation, and Math Anxiety in a Math Course. *Journal of Educational Computing Research*, *57*(7), 1695–1722. https://doi.org/10.1177/0735633119854036

Choppin, J., Roth McDuffie, A., Drake, C., & Davis, J. (2022). The role of instructional materials in the relationship between the official curriculum and the enacted curriculum. *Mathematical Thinking and Learning*, *24*(2), 123–148. https://doi.org/10.1080/10986065.2020.1855376

Halimah, L., Arifin, R. R. M., Yuliariatiningsih, M. S., Abdillah, F., & Sutini, A. (2020). Storytelling through "Wayang Golek" puppet show: Practical ways in incorporating character education in early childhood. *Cogent Education*, *7*(1). https://doi.org/10.1080/2331186X.2020.1794495

Hemmi, K., Bråting, K., & Lepik, M. (2021). Curricular approaches to algebra in Estonia, Finland, and Sweden–a comparative study. *Mathematical Thinking and Learning*, *23*(1), 49–71. https://doi.org/10.1080/10986065.2020.1740857

Iftitah, L. S. (2023). Designing Effective Instructional Media in Early Childhood Education: A Comparative Review of the ADDIE and Dick and Carey Instructional Design Models. *Advances in Educational Technology*, *2*(1), 49–70.

Irsal, I. L., Jupri, A., & Prabawanto, S. (2017). Junior High School Students' Understanding and Problem-Solving Skills on the Topics of Lines and Angles. *Journal of Physics: Conference Series*, *895*(1), 4–11. https://doi.org/10.1088/1742-6596/895/1/012073

Janah, S. R., Suyitno, H., & Rosyida, I. (2019). Pentingnya Literasi Matematika dan Berpikir Kritis Matematis dalam Menghadapi Abad ke-21. *PRISMA, Prosiding Seminar Nasional Matematika*, *2*, 905–910.

Kusaeri, & Aditomo, A. (2019). Pedagogical beliefs about Critical Thinking among Indonesian mathematics pre-service teachers. *International Journal of Instruction*, *12*(1), 573–590. https://doi.org/10.29333/iji.2019.12137a

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

Moorhouse, N., tom Dieck, M. C., & Jung, T. (2019). An experiential view of children learning in museums with Augmented Reality. *Museum Management and Curatorship*, *34*(4), 402–418. https://doi.org/10.1080/09647775.2019.1578991

Nakhanu, S. B., & Musasia, A. Ma. (2015). Problem-based learning technique and its effect on acquiring linear programming skills by secondary school students in Kenya. *Journal of Education and Practice*, *6*(20), 68–75.

Ndiung, S., Sariyasa, Jehadus, E., & Apsari, R. A. (2021). The effect of Treffinger's creative learning model using RME principles on creative thinking skills and mathematics learning outcomes. *International Journal of Instruction*, *14*(2), 873–888. https://doi.org/10.29333/iji.2021.14249a

Nugrahani, P., & Apriani, M. S. (2021). Pengembangan Modul Matematika Materi Hubungan Antar Sudut Pada Dua Garis Sejajar. *Jurnal Pendidikan Matematika Undiksha*, *12*(1), 17–31. https://doi.org/10.23887/jjpm.v12i1.33216

Nyroos, M., Jonsson, B., Korhonen, J., & Eklöf, H. (2015). Children's mathematical achievement and how it relates to working memory, test anxiety, and self-regulation: A person-centred approach. *Education Inquiry*, *6*(1). https://doi.org/10.3402/edui.v6.26026

Pramoda Wardhani, D. A., & 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. https://doi.org/10.24127/ajpm.v11i1.4377

Purwanto, S. E. (2020). The Effect of Realistic Mathematics Education Approach on Mathematical Problem-Solving Ability. *Edumatika : Jurnal Riset Pendidikan Matematika*, *3*(2), 94. https://doi.org/10.32939/ejrpm.v3i2.595

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

Risani, R. T., & Nuriyatin, S. (2021). Profil Pemecahan Masalah Matematika Siswa Ditinjau. *Jurnal Penelitian Pembelajaran Matematika*, *14*(2), 13–20.

Samo, D. D., Darhim, D., & Kartasasmita, B. (2017). Developing Contextual Mathematical Thinking Learning Model to Enhance Higher-Order Thinking Ability for Middle School Students. *International Education Studies*, *10*(12), 17. https://doi.org/10.5539/ies.v10n12p17

Shukla, T., Dosaya, D., Nirban, V. S., & Vavilala, M. P. (2020). Factor 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

Susanti, E., & Hartono. (2019). Mathematical critical thinking and creative thinking skills: How does their relationship influence mathematical achievement? *ACM International Conference Proceeding Series*, 63–66. https://doi.org/10.1145/3348400.3348408

Tran, D., & O'Connor, B. R. (2024). Teacher curriculum competence: How teachers act in curriculum making. *Journal of Curriculum Studies*, *56*(1), 1–16. https://doi.org/10.1080/00220272.2023.2271541

Umam, K. (2018). Peningkatan Kemampuan Berpikir Kritis Matematis Siswa Melalui Pembelajaran Reciprocal Teaching. *Jurnal Pendidikan Matematika Indonesia*, *3(2)*. https://doi.org/10.33603/ev6i2.2216

Umam, Khoerul, Fatayan, A., Nuriadin, I., & Azhar, E. (2024). Apakah Augmented Reality Dapat Menstimulus Pemahaman Konsep Dan Visualisisasi Geometri Siswa? *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *13*(2), 720–729.

Van Vaerenewyck, L. M., Shinas, V. H., & Steckel, B. (2017). Sarah's Story: One Teacher's Enactment of TPACK+ in a History Classroom. *Literacy Research and Instruction*, *56*(2), 158–175. https://doi.org/10.1080/19388071.2016.1269267

Veloo, A., & Chairhany, S. (2013). Fostering Students' Attitudes and Achievement in Probability Using Teams-Games-Tournaments. *Procedia - Social and Behavioral Sciences*, *93*, 59–64.

https://doi.org/10.1016/j.sbspro.2013.09.152

Wahyu Hidayat, R. S. (2018). Kemampuan Pemecahan Masalah Matematis dan Adversity Quotient Siswa SMP Melalui Pembelajaran Open Ended. *Jurnal JNPM (Jurnal Nasional Pendidikan Matematika)*, *2*(1), 109. https://doi.org/10.1016/S0962-8479(96)90008-8

Warwick, J. (2007). Some Reflections on the Teaching of Mathematical Modeling. *Mathematics Educator*, *17*(1), 32–41. https://doi.org/10.1080/00220485.1975.10845421

Webb, N. M., Franke, M. L., Ing, M., Wong, J., Fernandez, C. H., Shin, N., & Turrou, A. C. (2013). Engaging with others' mathematical ideas: Interrelationships among student participation, teachers' instructional practices, and learning. *International Journal of Educational Research*, *63*, 79–93. https://doi.org/10.1016/j.ijer.2013.02.001