Al-Jabar: Jurnal Pendidikan Matematika
Volume 14, Number 2, 2023, Pages 501 – 513
http://ejournal.radenintan.ac.id/index.php/al-jabar/index

Improving mathematical communication and critical thinking in middle school students: Study of anchored instruction learning assisted by edpuzzle

Annisa Nurina Vidyastuti[1], Baiduri[1*], Siti Inganah[1], Emmanuel Hagenimana[2]
[1] Universitas Muhammadiyah Malang, Indonesia.
[2] Institut d'enseignement superieur de Ruhengeri, France.
✉ baiduri@umm.ac.id

Article Information
Submitted April 07, 2023
Revised December 17, 2023
Accepted December 19, 2023

Keywords
Critical thinking ability; Mathematical communication ability; Anchored instruction learning; Edpuzzle.

Abstract
Background: Mathematics is often perceived as a daunting and monotonous subject by students due to its repetitive teaching methods. This leads to a lack of student interest in learning mathematics.
Aim: This research aims to analyze students' mathematical communication and critical thinking abilities in anchored instruction assisted by Edpuzzle.
Method: This descriptive quantitative study involved 24 junior high school students. Data gathering tools included student observation forms, worksheets, and evaluations of critical thinking skills.
Result: The study produced several findings. First, there was a significant improvement in students' critical thinking abilities, evident from their confidence in asking questions, responding to inquiries, and engaging with peers' opinions during the learning process. Second, students' mathematical communication abilities, both written and oral, also improved in each session. Third, regarding critical thinking abilities, students were categorized into three groups: high (5 students), medium (16 students), and low (3 students). Fourth, in terms of written mathematical communication in problem-solving, 5 students showed very high ability, 13 students had high ability, and 6 students had low ability.
Conclusion: The implementation of Anchored Instruction assisted by Edpuzzle proved effective in enhancing students' communication skills and improving their critical thinking abilities.

INTRODUCTION

21st-century skills are considered capable of meeting the demands of the 2013 curriculum implemented at various educational levels (Meryansumayeka et al., 2021). The competencies required of students in the 21st century include creativity and innovation, critical thinking and problem solving, communication, and collaboration (Nurjanah, 2019). In mathematics education, it is acknowledged that there are five mathematical abilities students need to possess, namely reasoning ability, communication ability, representation ability, connection ability, and problem-solving ability (Kabeakan et al., 2018; NCTM, 2000)

A number of abilities are not adequately acquired by a significant portion of students. Insights from unstructured observations and interviews reveal several issues: students visibly struggle with mathematical challenges, showing difficulty in addressing problems set by teachers and a tendency towards passivity in initiating questions and discussions. Interviews with a variety of students and educators highlight that: a) students struggle with critiquing and correcting peers' work and arguments, b) there is a lack of comprehension regarding the questions posed, c) students infrequently provide feedback due to insufficient understanding of

How to cite: Vidyastuti, A. N., Baiduri, Inganah, S., & Hagenimana, E. (2023). Improving mathematical communication and critical thinking in middle school students: Study of anchored instruction learning assisted by edpuzzle. *Al-Jabar: Pendidikan Matematika*, *14*(2), 501-513.
E-ISSN: 2540-7562
Published by: Mathematics Education Department, UIN Raden Intan Lampung

mathematical concepts, d) while some students manage to complete mathematical tasks, they fail to grasp the intrinsic meaning of the problems, e) several students are unable to synthesize conclusions from learned concepts, f) there is a noticeable lack of interest and enthusiasm among students during lessons. These findings point to a deficiency in students' mathematical communication and critical thinking abilities.

The abilities of critical thinking and mathematical communication are two closely connected student skills that have a profound impact on their academic performance (Sachdeva & Eggen, 2021). Ningtyas (2021) and Rachmawati et al. (2021) suggest that the enhancement of mathematical communication can be fostered through promoting collaboration and respect for differing viewpoints, with students engaging in small group learning activities. Teachers play a crucial role in establishing these educational groups within the classroom, enabling peer interactions that allow for the uninhibited expression of concepts and perspectives. Consequently, the significance of communication abilities in mathematical education is emphasized, as they enable students to structure and consolidate their thought processes and delve into various mathematical concepts.

Teachers need to be adept in classroom management to improve students' critical thinking and mathematical communication capabilities. This includes the strategic choice of suitable educational models and resources. According to Hartanto & Reye (2019), an essential part of educational planning is the teacher's skill in foreseeing student requirements and selecting appropriate content or methodologies that support learning goals. The Anchored Instruction model, as described by Liu et al. (2020), is designed to actively involve students in communication and support the application of their critical thinking skills throughout their educational journey. The Anchored Instruction (*AI*) learning model was introduced by The Cognition and Technology Group at Vanderbilt (CTGV) and is related to constructivism theory. Anchored Instruction collects all the information needed to solve a problem, making learning easier with limited time and resources.

Prayitno & Alphareno (2021) describe teachers as facilitators, enabling student-led learning at any time and place. The learning approach incorporates contextual problems that students commonly encounter in daily life. These challenges serve to connect the learners' curiosity with their ability to analyze and take initiative on the taught subjects. The approach involves extracting information from the given problems, synthesizing, and interpreting learnings from various sources (Oliver, 1999). This AI learning model's unique aspect is its incorporation of multimedia in problem-solving, providing a more tangible and relatable experience for the students.

Media plays a vital role in enhancing the learning experience, particularly with the anchored instruction model. Edpuzzle stands out as a convenient and accessible educational tool. This platform, identified as a video conferencing software by Beard & Aghassibakes (2021), is advantageous in the educational realm as it enables educators to freely share video content. Teachers have the capability to enrich these videos with additional audio, notes, and quizzes. As highlighted by Abou-Afach et al (2018), Edpuzzle is instrumental in allowing students to engage with video content prior to actual learning sessions, thereby streamlining the educational process and fostering self-directed learning skills. Integrating Edpuzzle with problem-based learning, as noted by Emiliya Hidayat & Dzulfiqar Praseno (2021), is a key goal. This approach enables students to independently review materials and tackle quizzes on

Edpuzzle, complementing the problem-based learning strategies applied by teachers during in-person sessions

According to Saputra (2012), learning with Anchored Instruction can strengthen students' mathematical communication skills, as this learning model requires students to build their own knowledge based on their thinking patterns. This model encourages students to interact and discuss to solve the presented mathematical problems, and the knowledge gained is then communicated to other students. Through such ideas, students develop high mathematical communication skills

A substantial body of research, including works by Sasindua et al (2020a), Prayitno & Alphareno (2021b), and Prado & Gravoso (2011) has explored the anchored instruction model. These studies collectively demonstrate that classrooms utilizing this model tend to surpass traditional classrooms in various aspects. Prado & Gravoso (2011) observed that such classrooms became more vibrant and interactive, promoting realistic situational learning, self-motivation, collaborative engagement, and environmental awareness. In contrast, Edy Saputra's (2017) research indicated no significant enhancement in mathematical communication skills across students of varying initial skill levels within the Anchored Instruction framework. Future research directions, as advised by Ariyanto (2011), include the development of student-friendly educational tools that are problem-based and applicable to daily life scenarios

Studies on the educational tool Edpuzzle include those by Sundi et al., (2020), Sirri & Lestari (2020), and Alsalamah (2022), especially during the pandemic's online learning phase. Alsalamah's study in 2022 uniquely integrated a flipped classroom model infused with ethnomathematics and supplemented by Edpuzzle, which yielded superior results in mathematical reasoning compared to traditional problem-based learning methods. Considering the prior focus on online implementation of Edpuzzle, there's a research opportunity to investigate its application in face-to-face, offline educational settings

Exploration into the use of Edpuzzle in conjunction with the anchored instruction model, particularly in developing critical thinking and mathematical communication, remains uncharted. Investigated the impact of anchored instruction on students' mathematical communication, but this was limited to problem-solving contexts, not in the broader learning process. Similarly, Prayitno & Alphareno's (2021) study on enhancing critical thinking through anchored instruction also focused primarily on problem-solving. It's crucial to recognize that evaluating students' critical thinking and mathematical communication should extend beyond problem-solving capacities to encompass the entire learning experience.

Therefore, based on previous research, analyzing the mathematical communication and critical thinking abilities of junior high school students using the anchored instruction model assisted by Edpuzzle in senior high school students is worth further investigation. While extensive research has been conducted in these areas, the focus has predominantly been on problem-solving. The need to evaluate and scrutinize the actual learning process to meet predefined indicators is equally important. The usage of Edpuzzle, previously studied in the context of the pandemic's one-directional online learning environment, limited interactive communication. This limitation impeded the full development of students' verbal mathematical communication abilities. This study introduces a novel approach by analyzing these skills using the anchored instruction model supported by Edpuzzle, emphasizing learning indicators and problem-solving in an offline context. This aims to describe the mathematical communication and critical thinking skills of junior high students in learning and problem-solving settings with anchored instruction aided by Edpuzzle.

METHODS

Research Approach and Design

This study employs a quantitative research methodology with a descriptive framework, aiming to articulate the students' abilities in critical thinking and mathematical communication within the educational context and in problem-solving scenarios. The research is organized into three primary phases: 1) Preparation: The researcher engages in school observations to pinpoint prevalent learning challenges. Conversations with mathematics educators and students are also conducted to gain further insight into recurrent learning difficulties. Solutions are then formulated to tackle these identified issues. 2) Execution: The researcher develops educational tools and assessment instruments specifically for topics on angles and lines. The teaching process follows the strategically planned lesson plans, incorporating these validated tools. The study was conducted from the 2nd to the 20th of February 2023, encompassing five teaching sessions focused on lines and angles. The following details the subject matter addressed in each meeting.

Table 1. Details of Material at Each Session

Session 1	• Explanation of the concepts of line, line segment, and ray • Explanation of a point's position in relation to a line
Session 2	• Explanation of the positions between two lines (intersecting, overlapping, and parallel) • Explanation of types of angles • Explanation of the relationship between two angles (adjacent, perpendicular, supplementary, vertically opposite).
Session 3	• Detailed explanation and analysis of angles formed when two parallel lines are cut by a transversal • Investigating the angles produced by the intersection of two non-parallel lines with a transversal • Analyzing the characteristics of angles resulting from two parallel lines intersected by a transversal (corresponding, alternate interior, alternate exterior, consecutive interior, consecutive exterior, supplementary).
Session 4	• Solving mathematical problems related to the relationships between angles formed by two parallel lines intersected by two non-parallel transversals (corresponding angles, alternate interior angles, alternate exterior angles, consecutive interior angles, consecutive exterior angles, supplementary angles) • Solving mathematical problems related to the relationships between angles formed by two parallel lines intersected by two parallel transversals (corresponding angles, alternate interior angles, alternate exterior angles, consecutive interior angles, consecutive exterior angles, supplementary angles).
Session 5	• Tackling mathematical problems focusing on the angle relationships from two parallel lines intersect

Instrument

This study employs two primary research instruments: 1) Instrument Validation: This process is designed to evaluate the appropriateness of the proposed instruments, which have been vetted by both an academic lecturer and a school teacher. The validation process utilizes a Likert scale ranging from 1 to 4 for assessment. Validators complete the validation forms to collect data confirming the instruments' validity, ensuring they are suitable for experimental application. The set of research tools includes Lesson Plans (RPP), observation sheets, Evaluation Test Items, and Student Worksheets (LKS). The validators have deemed these instruments valid based on the results of the validation process

Data Analysis

This research utilizes data focusing on students' critical thinking capabilities during the learning process and in solving problems, as well as their mathematical communication proficiency in these same contexts. The types of data collected are as follows: a) Data on critical thinking during the educational process, acquired from observation sheets validated by experts and Student Worksheets (LKS), b) Data on critical thinking in the context of problem-solving, sourced from students' performance on tests, c) Data reflecting oral and written mathematical communication skills during the learning process, obtained via observation sheets and LKS, d) Data on written mathematical communication skills in problem-solving scenarios, also derived from students' test responses.

RESULTS AND DISCUSSION

Result

This study's results will articulate the students' proficiency in critical thinking and oral mathematical communication throughout the educational process, along with their written mathematical competence and critical thinking skills in solving problems. The assessment of the students' mathematical skills during the learning phases is based on observations recorded by an observer throughout these sessions. In contrast, their problem-solving abilities are gauged from the outcomes of evaluation tests conducted at the conclusion of the learning period.

Critical Thinking Skills in Learning

The evaluation of students' critical thinking during educational sessions stems from the observer's assessments using established observation criteria and insights gained from field discussions. The observed critical thinking abilities of students span from the first to the fourth session. The observer's initial assessment categorizes the students' critical thinking in the first session as underdeveloped. The researcher's teaching approach was noted as adequate, yet areas like enhancing student motivation to participate in Edpuzzle-based problem-solving need refinement. Moreover, the researcher is encouraged to gain a more profound understanding of the Anchored Instruction model for classroom implementation.

The observer's initial assessment categorizes the students' critical thinking in the first session as underdeveloped. The researcher's teaching approach was noted as adequate, yet areas like enhancing student motivation to participate in Edpuzzle-based problem-solving need refinement. Moreover, the researcher is encouraged to gain a more profound understanding of the Anchored Instruction model for classroom implementation. The observer's subsequent analyses in the AI-supported Edpuzzle environment rated the sessions as showing moderate critical engagement. The observer identified areas for the researcher's improvement in future sessions, such as preparing backup resources to prevent students from needing to leave the classroom. Also, there is a recommendation for the researcher to more thoroughly exploit the Edpuzzle platform's capabilities.

Observations conducted by the observer revealed that by the third session, students had achieved a critical level of thinking in the AI and Edpuzzle-supported learning environment. The observer acknowledged enhancements in the researcher's classroom management, yet highlighted the need for more effective organization of students and a more measured approach to leading them to conclusions. The researcher is advised to give more profound affirmations to foster deeper critical engagement among students. Furthermore, a more comprehensive application of the Edpuzzle platform is recommended. The observer's review of the fourth session noted a significant improvement, placing it within a critically engaging category. The researcher's management was seen as improved over prior sessions, though the observer suggested improvements, particularly in establishing clear guidelines for student participation to prevent competition due to insufficient writing space. Deeper affirmations from the researcher could further enhance students' critical expression of their thoughts. From the initial to the fourth meeting, an upward trend in students' critical thinking skills was observed.

Written and Oral Mathematical Communication Skills in Learning

The observational study focusing on students' written and oral mathematical communication skills throughout the learning process, particularly from the first to the fourth sessions, revealed distinct insights. In the initial session, under the first indicator which evaluates the ability to express mathematical ideas both orally and in writing, including their demonstration and visual representation, students significantly struggled to articulate their ideas, remaining mostly silent, likely due to acclimating to a new environment. The second indicator assessed their use of mathematical terms and notations applicable to real-world scenarios. Here, while students were able to share their thoughts orally, they occasionally inaccurately used terms or notations, notably when representing line segments and rays. The third indicator, focusing on the ability to comprehend and critically evaluate mathematical ideas in both oral and written forms, showed a mixed response. Some students effectively communicated their ideas orally, but others found it challenging to verbally explain their written concepts. Overall, the proficiency of students in mathematical communication during these sessions was found to be insufficient, indicating a need for further development and support in this area.

In the second session's assessment, the observer noted various aspects of the students' mathematical communication skills, both written and oral. The first indicator, which examines the ability to express mathematical ideas in both spoken and written forms and to visually represent them, showed that students were beginning to respond more actively to the teacher's guidance. Several students successfully articulated their ideas and opinions, though some inaccuracies remained. The second indicator evaluated the students' application of mathematical terms and notations in real-life contexts. Improvements were evident, as some students correctly symbolized line segments and rays, addressing the previous session's errors. However, a notable issue was the occasional failure to include the angle symbol "∠" in their written work. The third indicator assessed the students' comprehension and evaluation of mathematical ideas. While some could effectively communicate their ideas orally, others struggled with verbally explaining their written concepts. An interesting observation was the higher frequency of oral contributions from female students compared to male students, indicating greater active participation among them. Despite these individual variances, the overall mathematical capability of the students in the learning process was rated as moderate, reflecting a scope for continued growth and development in their mathematical communication skills. This analysis points to a dynamic learning environment where students are gradually improving in their ability to understand, articulate, and visually demonstrate mathematical concepts, though the rate and manner of this progression vary among individuals.

Observations in the third session’s by the observer regarding students' written and oral mathematical communication abilities revealed insights across various indicators. In Indicator I, concerning the ability to express mathematical ideas, some students successfully solved the given problems, yet they struggled to explain the reasoning behind their written answers, being able to express their solutions in written form only. For Indicator II, which assesses the use of mathematical terms and notations relevant to real-life contexts, a few students still forgot to include angle symbols in their written work. Additionally, there were students who couldn't justify their reasoning about specific angle types, such as ‘consecutive interior’ or ‘alternate exterior’ angles. In Indicator III, focusing on the ability to understand and evaluate mathematical ideas in both written and oral forms, students showed progress. They were able to critically evaluate their peers' work, pointing out inaccuracies, and presenting their ideas and corrections both orally and on the board. Overall, the students' mathematical abilities in the learning process were classified as high, indicating a substantial understanding and application of mathematical concepts and communication

In the fourth session's observations on the students' written and oral mathematical communication skills, significant progress was noted across several indicators. Under Indicator I, which evaluates the ability to express mathematical ideas, students demonstrated increased comfort in articulating their ideas both verbally and in writing within their groups. Indicator II assesses the use of mathematical terms and notation in real-world applications. By this session, students had become adept in accurately using notations for large angles, reflex angles, and consistently applying degrees, among others. For Indicator III, focused on understanding and evaluating mathematical ideas in both written and oral formats, there was a notable increase in student activity. Students actively engaged in expressing agreement or dissent regarding their peers' presentations, leading to dynamic discussions that enriched the learning process. This level of engagement and critical evaluation indicates that the students' overall mathematical abilities in the learning process have reached an exceptionally high level, reflecting a deep understanding and effective communication of mathematical concepts.

Discussion

Written and Oral Mathematical Communication Ability

The students' mathematical communication skills were observed to improve in each meeting. Initially, under the first indicator, students primarily listened to the researcher's words, but their engagement evolved over time. They moved from minimal responses to becoming actively involved in the learning process by articulating their thoughts and feedback. This indicates their understanding of the material, as they could describe their work both orally and in writing. However, the observer noted differences in communication styles between male and female students during the learning process. Female students were more likely to express their opinions, often with greater accuracy and detail in discussing what they learned and observed, as suggested by Dalimunthe et al. (2022). Their contributions were also considered to be of higher quality. In contrast, in written mathematical communication, students tended to be verbose in detailing problem-solving steps, with male students being more direct and to the point, often without much detail, as described by Putri & Rochmad (2021). This observation aligns with Faradina et al.'s (2016) findings, suggesting that males generally have lower verbal abilities compared to their spatial skills.

In the second indicator, focusing on the use of terms and notation, students often lacked precision in applying the correct terms and notation relevant to the problems at hand. For instance, there were instances where students incorrectly wrote line segments and rays. Similarly, when denoting angle sizes, they sometimes omitted the angle notation '∠', leading to ambiguous or altered meanings in their statements. However, despite inaccuracies in their written work, some students demonstrated a greater ability to explain concepts orally rather than in writing. This aligns with Wijaya et al., (2016) assertion that students' mathematical communication skills are not solely reflected in their writing ability. Instead, students can convey ideas through speaking, explaining, listening attentively, asking questions, responding, and collaborating effectively.

The third indicator pertains to students' ability to understand, interpret, and evaluate ideas by utilizing mathematical notations and terms, and by connecting existing structures. Students can connect what they know with their discoveries, eventually forming decisions to solve problems. There are two types of decision-making in problem-solving: written and oral. Kurniawan et al. (2017) argue that oral mathematical communication can be a tool to gauge understanding in clarifying written content. For laypeople participating in reading the material, verbal explanations are essential to convey accurate understanding. Therefore, it is crucial for students to have balanced skills in both written and oral mathematical communication. The objective is to enable the audience to actively participate in reflecting on the learning outcomes that have been achieved (Maya & Setiawan, 2018).

Students with strong writing skills can articulate their thoughts independently, without waiting for a verbal exchange. This aligns with Putri & Rochmad's (2021) view that writing is a key aspect of mathematical ability, which can be performed anywhere and anytime in a conscious state. It represents a higher-level thinking process captured in writing when an idea emerges and needs to be documented. Similarly, Aurelyasari & Nur (2023) suggest that solving problems requires high-level thinking, where sudden ideas should be promptly written down. However, male students tend to be more imaginative, and sometimes their thoughts are unstructured, leading to problem-solving based on immediate understanding, as noted by Hendriana & Kadarisma (2019). Male students often approach problem-solving in a non-sequential and concise manner. As Purnamasari & Afriansyah (2021) found, male students are more likely to solve non-contextual, logical problems correctly without following a step-by-step process. They tend to observe and immediately apply logic to derive answers.

Critical Thinking Ability

Students' critical thinking abilities in both learning and problem-solving have shown improvement in each session. This enhancement in critical thinking skills is attributed to the implementation of Anchored Instruction (AI) assisted by Edpuzzle. In this learning approach, students are presented with contextual problems through multimedia presentations. This method has enabled students to develop a more dynamic learning process and improved thinking skills, supported by diverse media and teaching methods (Dadri et al., 2019). Previously, at SMPN 8 Malang, particularly in class VII-H, teaching was conducted conventionally, centered around the teacher, where tasks and exercises were provided in each session. This approach lacked interaction between students and between students and teachers, resulting in a passive learning environment that hindered the development of problem-solving skills, whether contextual or otherwise, as discussed by Astiantari et al. (2022), Faiziyah & Priyambodho (2022), and Zetriuslita et al. (2016).

Critical thinking skills are deemed essential for developing an individual's mindset, whether in decision-making, problem-solving, or collaboration, and are particularly crucial for students' intellectual development (Dadri et al., 2019; Florentina & Leonard, 2017; Rohani et al., 2022). Critical thinking is considered a foundational ability encompassing questioning, writing, reading, and expressing opinions. Therefore, learning settings using Anchored Instruction assisted by Edpuzzle are appreciated for not being monotonous, making learning enjoyable and fostering students' thinking skills. By adopting Anchored Instruction in teaching lines and angles, and introducing contextual problems students often encounter, the approach encourages deeper exploration of critical thinking and problem-solving skills. The AI learning model prompts students to delve into material more profoundly because these contextual problems require connecting various concepts to solve a problem (Zetriuslita et al., 2016). The AI model actively involves students in the learning process. Problem-based learning models were chosen because they engage students directly and actively in their learning journey. This approach aligns with Suparno's view (Prayitno & Alphareno, 2021) that learning is an active process of constructing knowledge based on observation, vision, and hearing.

At the beginning of the lesson, the teacher presents a problem, prompting students to observe and analyze its elements to discover underlying concepts. Subsequently, students and their groups are encouraged to discuss and expand upon their findings, which will later be presented. At the lesson's end, students and the teacher collectively evaluate the session and formulate conclusions. This approach aligns with Silverajah & Govindaraj's (2018) definition of thinking as a process of drawing conclusions, emphasizing that students should also be capable of deriving conclusions from the problems presented in the Edpuzzle videos.

CONCLUSIONS

The research findings suggest that the use of Anchored Instruction supplemented with edpuzzle can enhance students' critical thinking skills in each session. This improvement is evident from their confidence in asking questions, responding to inquiries, and engaging with their peers' opinions throughout the learning process. Students' mathematical communication skills, both in writing and orally, have also shown growth in each meeting. In terms of critical thinking abilities, students are categorized into three levels: high, medium, and low. The distribution of students in these categories includes 5 students at the high level, 16 students at the medium level, and 3 students at the low level. Regarding written mathematical communication skills in problem-solving, it was observed that 5 students demonstrated exceptionally high abilities, 13 students showed high abilities, and 6 students exhibited low abilities.

The research results show that the implementation of Anchored Instruction assisted by edpuzzle can effectively enhance students' critical thinking and mathematical communication abilities. This provides insights for educators to integrate innovative and technology-based learning methods into the mathematics curriculum. This study focused on the topics of lines and angles. Future research could explore the effectiveness of Anchored Instruction with edpuzzle in other mathematical subjects, to determine if similar outcomes can be achieved in different content contexts.

REFERENCES

Abou-Afach, S., Kiwan, E., & Semaan, C. (2018). How to enhance awareness on bullying for Special Needs Students using "Edpuzzle" a web 2.0 tool. *International Journal of Educational Research Review*, *3*(1), 1–7. https://doi.org/10.24331/ijere.372260

Aini, N. R., Syafril, S., Netriwati, N., Pahrudin, A., Rahayu, T., & Puspasari, V. (2019). Problem-based learning for critical thinking skills in mathematics. *Journal of Physics: Conference Series*, *1155*(1). https://doi.org/10.1088/1742-6596/1155/1/012026

Alsalamah, N. A. (2022). Kemampuan penalaran matematis dalam pembelajaran flipped classroom bernuansa etnomatematika berbantuan edpuzzle. *ANARGYA: Jurnal Ilmiah Pendidikan Matematika*, *5*(1). https://doi.org/10.24176/anargya.v5i1.7578

Amaliah. (2020). Implementation of edpuzzle to improve students' analytical thinking skill in narrative texT. *Prosodi*, *14*(1). https://doi.org/10.21107/prosodi.v14i1.7192

Ariyanto, L. (2011). Pengembangan perangkat pembelajaran matematika model berjangkar (Anchored Instruction) materi luas kubus dan balok kelas VIII. *Aksioma: Jurnal Matematika Dan Pendidikan Matematika UPGRIS Semarang*, *2*(2).

Astiantari, I., Pambudi, D. S., Oktavianingtyas, E., Trapsilasiwi, D., & Murtikusuma, R. P. (2022). Kemampuan berpikir kritis siswa smp dalam menyelesaikan masalah matematika ditinjau dari adversity quotient (AQ). *AKSIOMA : Jurnal Program Studi Pendidikan Matematika*, *11*(2), 1270–1281. https://doi.org/10.24127/ajpm.v11i2.5073

Aurelyasari, S., & Nur, I. R. D. (2023). Analisis kemampuan komunikasi matematis siswa SMP pada materi aljabar. *Radian Journal: Research and Review in Mathematics Education*, *1*(3), 127–134. https://doi.org/10.35706/rjrrme.v1i3.7153

Beard, L., & Aghassibakes, N. (2021). Edpuzzle. *Journal of the Medical Library Association*, *109*(1), 159–161. https://doi.org/10.5195/jmla.2021.1202

Bransford, J. D., Sherwood, R. D., Hasselbring, T. S., Kinzer, C. K., & Williams, S. M. (1990). Anchored instruction: Why we need it and how technology. In *Cognition, Education, and Multimedia* (1st Editio, p. 28).

Cahyati, I., Kuntadi, D., & Mulhayatiah, D. (2019). Penerapan model pembelajaran anchored instruction untuk meningkatkan kemampuan pemecahan masalah peserta didik pada materi kalor. *Journal of Teaching and Learning Physics*, *1*(1), 19–23. https://doi.org/10.15575/jotalp.v1i1.3434

Crews, T. R., Biswas, G., Goldman, S., & Bransford, J. (1997). Anchored interactive learning environments. *International Journal of Artificial Intelligence in Education (IJAIED)*, *8*, 142-178.

Dadri, P. C. W., Dantes, N., & Gunamantha, I. M. (2019). Pengaruh model pembelajaran kooperatif tipe NHT terhadap kemampuan berpikir kritis dan hasil belajar matematika siswa kelas V SD Gugus III Mengwi. *PENDASI: Jurnal Pendidikan Dasar Indonesia*, *3*(2), 84–93.

Dalimunthe, S. A. S., Mulyono, M., & Syahputra, E. (2022). Pengembangan model pembelajaran interaktif berbasis think pair share untuk meningkatkan kemampuan komunikasi matematis siswa. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *6*(1), 735–747. https://doi.org/10.31004/cendekia.v6i1.1229

Duron, R., Limbach, B., & Waugh, W. (2006). Critical thinking framework for any discipline. *International Journal of Teaching and Learning in Higher Education*, *17*(2), 160–166.

Emiliya, H. L., & Dzulfiqar Praseno, M. (2021). Improving students' writing participation and achievement in an edpuzzle-assisted flipped classroom. *Education of English as Foreign*

Language, *4*(1), 1–8. https://doi.org/10.21776/ub.educafl.2021.004.01.01

Facione, A. . (1994). Holistic critical thinking scoring rubric. *California Academia Press*, *19*, 2007.

Fadila, N., & Hasbi, M. (2019). Kemampuan Pemecahan Masalah Matematis Siswa melalui Model Pembelajaran Anchored Instruction di SMPN 1 Darul Imarah Aceh Besar. *Jurnal Ilmiah Mahasiswa Pendidikan Matematika*, *4*(3), 21-35.

Faiziyah, N., & Priyambodho, B. legawo. (2022). Analisis kemampuan berpikir kritis dalam menyelesaikan soal hots ditinjau dari metakognisi siswa. *AKSIOMA : Jurnal Program Studi Pendidikan Matematika*, *11*(4), 2823–2835. https://doi.org/10.24127/ajpm.v11i4.5918

Faradina, A. T. E., Sunardi, & Trapsilasiwi, D. (2016). Analisis kemampuan komunikasi matematis siswa dalam memahami masalah segiempat. *Kadikma : Bachelor Of Mathematics Education Universitas Jember*, *7*(1), 46–56.

Florentina, N., & Leonard, L. (2017). Pengaruh model pembelajaran kooperatif terhadap kemampuan berpikir kreatif matematis siswa. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *7*(2), 96–106. https://doi.org/10.30998/formatif.v7i2.1877

Hartanto, B., & Reye, J. (2019). Anchored instruction ITS: A novel approach to make learning programming interesting and effective. *IOP Conference Series: Materials Science and Engineering*, *703*(1). https://doi.org/10.1088/1757-899X/703/1/012048

Hendriana, H., & Kadarisma, G. (2019). Self-efficacy dan kemampuan komunikasi matematis siswa SMP. *JNPM (Jurnal Nasional Pendidikan Matematika)*, *3*(1), 153. https://doi.org/10.33603/jnpm.v3i1.2033

John E. McPeck. (1981). *Critical thinking and education*. St. Martin's Press.

John W. Santrock. (2011). *Psikologi pendidikan* (2nd ed.). Kencana Prenada Media Group.

Kabeakan, I. M., Bambang S, R. ., & Suhartati. (2018). Kemampuan komunikasi matematis siswa pada materi segiempat di kelas VIII SMP Muhammadiyah Subulussalam Tahun Ajaran 2017/2018. *Jurnal Ilmiah Mahasiswa Pendidikan Matematika*, *3*(2), 97–103. https://doi.org/10.31004/cendekia.v2i1.36

Kurniawan, D., Yusmin, E., & Hamdani. (2017). Deskripsi kemampuan komunikasi matematis siswa dalam menyelesaikan soal cerita kontekstual. *Jurnal Pendidikan dan Pembelajaran*, *6*(2), 1–11.

Liu, M., Xie, T., & Ding, J. (2020). Applying anchored instruction in crowdsourcing platforms to promote career competence of digital media students. *Journal of Physics: Conference Series*, *1646*(1). https://doi.org/10.1088/1742-6596/1646/1/012011

Mahadewi, N. K. N., Ardana, I. M., & Mertasari, N. M. S. (2020). Kemampuan komunikasi matematis melalui model reciprocal teaching berbantuan media interaktif. *JNPM (Jurnal Nasional Pendidikan Matematika)*, *4*(2), 338. https://doi.org/10.33603/jnpm.v4i2.3606

Mardhiyanti, D., Ilma, R., & Kesumawati, N. (2013). Pengembangan soal matematika model pisa untuk mengukur kemampuan komunikasi matematis siswa Sekolah Dasar. *Jurnal Pendidikan Matematika*, *5*(1). https://doi.org/10.22342/jpm.5.1.334.

Maya, R., & Setiawan, W. (2018). Analisis kemampuan komunikasi matematis siswa smp pada materi statistika. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, *1*(6), 1095-1104.

Meryansumayeka, M., Zulkardi, Z., Putri, R. I. I., & Hiltrimartin, C. (2021). Students' strategies in solving PISA mathematical problems reviewed from problem-solving strategies. *Jurnal Pendidikan Matematika*, *15*(1), 37–48. https://doi.org/10.22342/jpm.15.1.10405.37-48

NCTM. (2000). *Principles and standards for school mathematics*. Virginia: United States of America.

Ningtyas, E. Z. (2021). Mathematics communication junior high school students in solving open-ended question based on reflective-impulsive cognitive style. *EduTeach : Jurnal Edukasi Dan Teknologi Pembelajaran*, *2*(1), 21-37. https://doi.org/10.37859/eduteach.v2i1.2410

Nurjanah, S. A. (2019). Analisis kompetensi abad-21 dalam bidang komunikasi. *Gunahumas : Jurnal Kehumasan*, *2*, 388–402. https://doi.org/10.17509/ghm.v2i2.23027

Oliver, K. (1999). Anchored instruction. *The SAGE Encyclopedia of Educational Technology*. https://doi.org/10.4135/9781483346397.n20

Prayitno, S. H., & Alphareno, O. J. (2021). Efektivitas model pembelajaran anchored instruction dalam pembelajaran matematika terhadap kemampuan berpikir kritis siswa. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *5*(2), 1842–1853. https://doi.org/10.31004/cendekia.v5i2.565

Purnamasari, A., & Afriansyah, E. A. (2021). Kemampuan komunikasi matematis siswa SMP pada topik penyajian data di pondok pesantren. *Plusminus: Jurnal Pendidikan Matematika*, *1*(2), 207–222. https://doi.org/10.31980/plusminus.v1i2.1257

Putri, D. K., & Rochmad. (2021). Kemampuan komunikasi matematis siswa SMP muhammadiyah pangkalan bun ditinjau dari kemandirian belajar pada pembelajaran model knisley. *PRISMA, Prosiding Seminar Nasional Matematika*, *4*, 134–138.

Rachmawati, L. N., Cholily, Y. M., & Zukhrufurrohmah, Z. (2021). Mathematics communication mistakes in solving HOTS problems. *Infinity Journal*, *10*(1), 69. https://doi.org/10.22460/infinity.v10i1.p69-80

Rohani, Ahmad, M., Lubis, I. S., & Nasution, D. P. (2022). Kemampuan berpikir kritis matematika siswa melalui model pembelajaran kooperatif tipe think pair share. *AKSIOMA : Jurnal Program Studi Pendidikan Matematika*, *11*(1), 504–518. https://doi.org/10.24127/ajpm.v11i1.4408

Ruggiero, V. R. (1998). *The art of thinking: A guide to critical and creative thought* (5th ed.).

Sachdeva, S., & Eggen, P.-O. (2021). Learners' critical thinking about learning mathematics. *International Electronic Journal of Mathematics Education*, *16*(3), 123-134. https://doi.org/10.29333/iejme/11003

Saputra. (2012). Pengaruh penggunaan model pembelajaran anchored intruction terhadap peningkatan kemampuan komunikasi matematis dan self concept siswa. *Disertasi Upi Bandung*.

Saputra, E., Ulya, K., Wahyuni, S., Rahmadhani, E., & Hakim, H. (2020). Media application in anchored instruction to support mathematics teachers' pedagogical content knowledge. *Journal of Physics: Conference Series*, *1460*(1), 10783. https://doi.org/10.1088/1742-6596/1460/1/012042

Sasindua, R., Rampe, M., & Karundeng, M. (2020). Pengaruh model pembelajaran anchored instruction terhadap hasil belajar siswa. *oxygenius Journal Of Chemistry Education*, *2*(1), 23. https://doi.org/10.37033/ojce.v2i1.141

Scriven, M., & Paul, R. (2011). Defining critical thinking. *Inquiry: Critical Thinking Across the Disciplines*, *26*(1), 38–46. https://doi.org/10.5840/inquiryctnews20112616

Setyowati, A., & Subali, B. (2011). Implementasi pendekatan konflik kognitif dalam pembelajaran fisika untuk menumbuhkan kemampuan berpikir kritis siswa SMP kelas VIII. *Jurnal Pendidikan Fisika Indonesia*, *7*(2), 89–96.

Shorten, A., & Smith, J. (2017). Mixed methods research: Expanding the evidence base. *Evidence-Based Nursing*, *20*(3), 74–75. https://doi.org/10.1136/eb-2017-102699

Silverajah, V. S. G., & Govindaraj, A. (2018). The use of Edpuzzle to support low-achiever's development of self-regulated learning and their learning of chemistry. *ACM International Conference Proceeding Series*, *October 2018*, 259–263. https://doi.org/10.1145/3290511.3290582

Sirri, E. L., & Lestari, P. (2020). Implementasi edpuzzle berbantuan whatsapp group sebagai alternatif pembelajaran daring pada era pandemi. *Jurnal Pendidikan Matematika*, *5*(2), 67–72.

Sugianto, R., Cholily, Y. M., Darmayanti, R., Rahmah, K., Hasanah, N., & Malang, U. M. (2022). Development of rainbow mathematics card in TGT learning for increasing mathematics communication ability**.** *K r e a n o*. *13*(2), 221–233. https://doi.org/10.15294/kreano.v13i2.38068

Sundi, V. H., Astari, T., Rosiyanti, H., & Ramadhani, A. (2020). Efektivitas penggunaan edpuzzle dalam meningkatkan motivasi belajar pada masa pandemi covid-19. *Seminar Nasional Pengabdian Masyarakat LPPM UMJ*, 1–10.

Wahyuni, V. (2022). Pengaruh model pembelajaran talking chip terhadap kemampuan komunikasi matematis. *LENTERNAL: Learning and Teaching Journal*, *3*(1), 1–9. https://doi.org/10.32923/lenternal.v3i1.2228

Webster, M.-I. (1995). *Webster's new encyclopedic dictionary* (BD&L (Firm) (ed.)). Black Dog & Leventhal Publishers.

Wijaya, H. P. I., Sujadi, I., & Riyadi, R. (2016). Kemampuan komunikasi matematis siswa sesuai dengan gender dalam pemecahan masalah pada materi balok dan kubus (studi kasus pada siswa SMP kelas VIII SMP Islam Al-Azhar 29 Semarang). *Jurnal Pembelajaran Matematika*, *4*(9), 1-28.

Zaditania, A. P., & Ruli, R. M. (2022). Kemampuan komunikasi matematis siswa SMP dalam menyelesaikan soal himpunan. *Jurnal Educatio FKIP UNMA*, *8*(1), 328–336. https://doi.org/10.31949/educatio.v8i1.1997

Zetriuslita, Ariawan, R., & Nufus, H. (2016). Analisis kemampuan berpikir kritis matematis mahasiswa dalam menyelesaikan soal uraian kalkulus integral berdasarkan level kemampuan mahasiswa. *Infinity Journal Ilmiah Program Studi Matematika STKIP Siliwangi Bandung*, *5*(1), 56-78. https://doi.org/10.22460/infinity.v5i1.p56-66

Zulhelmi, Adlim, & Mahidin. (2017). Pengaruh media pembelajaran interaktif terhadap peningkatan keterampilan berpikir kritis siswa. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, *5*(1), 72–80.