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# Improving students' mathematical critical thinking ability using learning start with a questions

**Asri Ode Samura ***
Institut Agama Islam Negeri Ternate, Ternate, Maluku Utara, Indonesia, 97727

**Corresponding Author*: asriodesamura@iain-ternate.ac.id

**Abstract.** This study compares Learning Start with a Question (LSQ) with traditional learning to investigate how to improve mathematical critical thinking skills. Quantitative research methods are used in a quasi-experimental way. The sample of this study was 83 junior high school students in Ternate City, Indonesia. An essay test was used, with questions based on mathematical critical thinking skills. Inferential statistics and an independent sample t-test were used to analyze the data. Based on the study's results, with the application of LSQ learning, most students can solve problems in critical mathematical thinking correctly, assisted by steps and indicators of completeness of mathematical critical thinking skills. Students who use LSQ learning have a higher average test score than traditional learning students. The results of the t-test calculation show that students who learn to use LSQ learning have differences in increasing mathematical critical thinking skills with students who follow traditional learning.

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## INTRODUCTION

Mathematics is a subject that can change the way students think, from the irrational to the rational (Rijal et al., 2021; Ibrahim et al., 2021). A well-formed way of thinking will create logical reasoning and thinking. Learning mathematics requires the ability to reason and think. Rifqi et al. (2021) stated that students who learn mathematics well would have good critical thinking skills. In addition, Sari and Caswita (2020) also stated that the benefits of critical thinking would stick for life, supports students in setting learning abilities and further empowers them to think actively. Mathematical critical thinking skills are higher-order thinking abilities that can be honed through the study of mathematics (Hobri et al., 2021).

In teaching mathematics, teachers are expected to develop students' critical thinking skills (Blömeke et al., 2020). According to Indonesian legislation, one of the fundamental abilities of teachers is to strengthen students' skills and actualize them in dealing with diverse situations, as outlined in the Minister of National Education's Regulation. This competency directs teachers to provide various learning activities that encourage students to develop and actualize their abilities in critical thinking (Shin & Shim, 2021). This ability is inseparable from the teacher's efforts so that students are expected to have critical thinking skills to support the mathematics learning process (Jusoh et al., 2019; Sukestiyarno et al., 2021).

Someone with the ability to think critically will ponder and work more fully. Students must think critically, test, question, relate, and assess all parts of the circumstance or topic that prompts them in order to learn mathematics (Sachdeva & Eggen, 2021). The critical thinking ability of students is beneficial in learning mathematics. Likewise, mathematics learning can train students in critical thinking processes. Critical thinking skills can help someone sort out relevant information on math problems or outside mathematics. Therefore, learning mathematics must be maximized in order to improve critical thinking skills (Susanti & Retnowati, 2018; Cipta et al., 2019).

Most of us encounter in class that learning mathematics cannot improve students' ability in higher-order thinking, one of which is thinking critically mathematically. Furthermore, the teacher is unable to connect mathematics to real-life situations (less applicability, less grounded, less realistic, or less contextual) (Wulandari et al., 2020). This could be due to a scarcity of qualified teachers who can help pupils improve their critical thinking skills during the learning process. To avoid all of this, it would be better if the teacher was given a briefing in the form of training on the introduction of learning models. Presumably, steps like this can help teachers improve higher-order thinking skills in students (As'ari et al., 2017).

The efforts that students must make to acquire higher-order thinking skills must arise from within the students themselves. Students are motivated to learn to show high interest, enthusiasm, and perseverance, without dependence on the teacher (Setyawati et al., 2020). Likewise, with learning mathematics, students who are motivated to learn mathematics significantly affect the improvement of their mathematics learning achievement (Susilo, 2022). According to motivation theory, students who are positively motivated towards their achievements are classified as intrinsic motivation. This means that students who have intrinsic motivation (motivation that comes from within) will be more involved in learning than students who have extrinsic motivation (motivation that arises because of the desire to get rewards or prizes). Intrinsic motivation that students have will have an impact on the success of students themselves (Suherman et al., 2021; Nur'azizah et al., 2021).

LSQ learning is student-centered learning that begins with questions. LSQ learning is a type of active learning in asking questions; Students are asked to learn the material to be studied by reading first. This learning can be used to increase learning activities and create active student learning conditions. With LSQ learning, students can ask questions about ideas before the teacher's explanation. Learning something new will be more effective if students actively ask questions rather than just accepting what the teacher teaches. One way for students to learn actively is to make them ask questions about the subject matter before there is an explanation from the teacher (Nuraina & Mursalin, 2018).

Learning with LSQ involves six drivers or motives. The six drivers are meaningfulness, confidence, relevance, enjoyment, social relationships, and targets. The essence of this strategy is meaningfulness or meaningful Learning. Mathematical subjects are understood and interpreted, conceptually, procedurally, and rationally for students. Students are more driven to finish the session because they are shown the significance of mathematics (Huincahue et al., 2021; Samura et al., 2020).

According to Nuraina and Mursalin's (2018) study, students who learn to use LSQ learning with modules have more vital mathematical communication skills than students who learn to use traditional learning. Similarly, Ibrahim et al. (2021) discovered that students with an advocate approach to mathematics learning who were given open-ended questions performed better than students who were given traditional learning.

This study examines the improvement of mathematical critical thinking skills using LSQ learning. Taking into account the descriptions stated above, the problems in this study can be formulated: Can LSQ learning improve mathematical critical thinking skills?

Based on the explanation above, the researcher thinks a comprehensive study is needed about students' mathematical critical thinking skills by applying the LSQ. For this reason, the researcher raised research entitled "Improving Students' Mathematical Critical Thinking Ability using Learning Star with a Questions" to obtain a comprehensive study.

## METHOD

This study uses a quantitative approach. The purpose of using a quantitative approach is to enable researchers to measure the effect of a treatment. The research was designed by experimental pretest-posttest control group design, by applying Learning starts with a question in mathematics learning. The pretest-posttest control group design extends the one-group pretest-posttest design in two ways: a second group is added, called the comparison or control group, and subjects were randomly assigned to each group (Diaz-Kope et al., 2019), as shown in Figure 1.

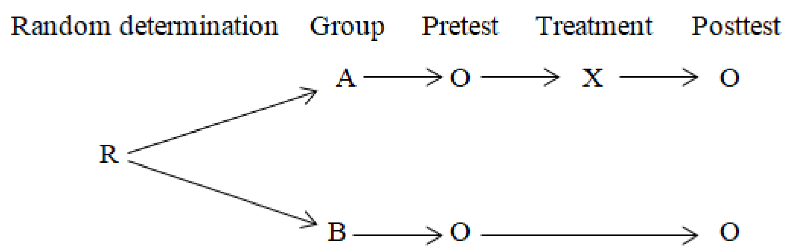


**Figure 1.** Design of pretest-posttest control group

Research subjects were not taken randomly but were then placed in the experimental class and the control class. Research subjects were given a pretest; they were given LSQ learning for the experimental class and traditional learning for the control class. Posttest is given after LSQ learning and traditional learning. The purpose of giving pretest and posttest is to see whether LSQ learning can affect the improvement of mathematical critical thinking skills.

*Sample*

The research sample was taken at State Junior High School 6 Ternate City, Indonesia. The research was carried out in the 2020/2021 academic year. Class VIII was used as the research sample with a total of 83 people, grouped into two classes; 42 people for the Experiment class and 41 people for the control class.

*Instruments*

The questions were set in the form of critical thinking skills, and the essay test was applied. The instrument's objective is to assess pupils' mathematical critical thinking abilities. The content of linear equation was included in the mathematical critical thinking ability test in this study. There were five questions in the form of a description with a processing time of 2 x 40 minutes. When the entire learning process had been completed, the test was given (Pitkäniemi, 2020).

*Procedure*

Formulating research problems, next steps; compose learning instruments and tools. Several mathematics subject teachers were selected to validate learning instruments and devices. Following the validation results, a modest trial with a large number of students was undertaken to establish the instrument's degree of language readability and whether it could be used for data collecting. Following validation and a small trial, more improvements and analyses were carried out in order to produce better learning instruments and tools.

At this stage, the researcher took one of the schools to be used as a research location. The first stage is to make a research letter to the related parties. After the letter was obtained from the relevant person, observations were made of the research location and coordination with subject teachers regarding the placement of the experimental and control groups. Learning and data collection began when the experimental and control groups were assigned. Figure 2 illustrates the research process.

Students in the experimental class were taught using LSQ, and students in the control class were taught using traditional learning. Data were obtained from the pretest and posttest results in both classes. The data is analyzed, and the results of the data analysis are discussed in the findings and discussion section (Stoecker & Avila, 2021).

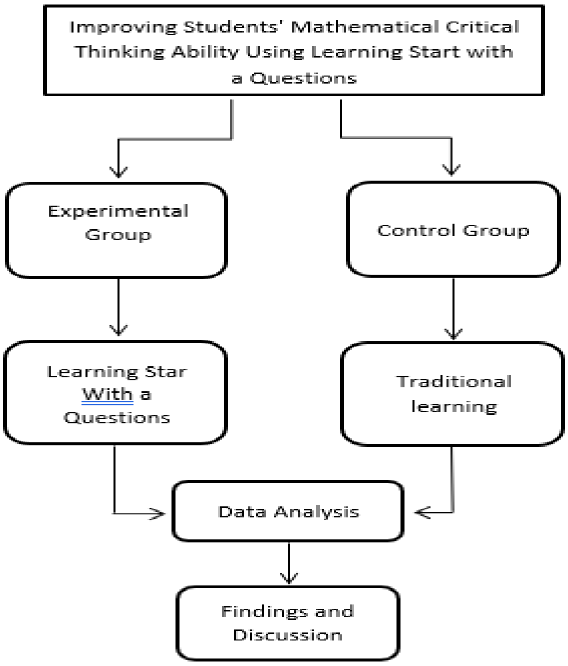


**Figure 2.** Research flow

*Data analysis*

The following are the steps in data processing. Data were analyzed using independent sample t-test. Prior to the t-test, the normality and similarity of the data were first tested, the purpose of which was to see the normality and homogeneity of variance (Albers, 2017).

- The increase in students' mathematical critical thinking skills was calculated using the normalized gain formula. The difference between the pretest and posttest scores was compared with the ideal maximum and pretest scores to obtain a normalized gain value:

$$Normalized\ gain\ (g) = \frac{\text{posttest score} - \text{pretest score}}{\text{ideal maximum score} - \text{pretest score}}$$

Table 1 shows the criteria for the gain index.

**Table 1.** Criteria for normalized gain scores

| Gain Score Normalized (g) | Interpretation |
|---|---|
| $g \geq 0{,}70$ | High |
| $0{,}30 \leq g < 0{,}70$ | Medium |
| $g < 0{,}30$ | Low |

- Descriptive statistics were calculated, including the average value of pretest, posttest, and normalized gain.

## RESULTS AND DISCUSSION

At the end of the next lesson, a final test is carried out, called the posttest. The purpose of the posttest is to find out about improving students' critical thinking skills by comparing them to the pretest. In the following, some descriptions or examples of the results of student work on the mathematical critical thinking ability test are given. Two questions and the students' answers were taken as samples of analysis on research findings, which were representative of several students. The evaluation results showed that the number of students who answered questions about critical thinking skills correctly was above average after being given the LSQ treatment. So, it can be said that the application of LSQ learning can help students improve their critical thinking skills. Here are some examples of student work on mathematical reasoning on the subject of straight-line equations:

Consider the line segment AB in Figure 3, and determine the equation of the line!

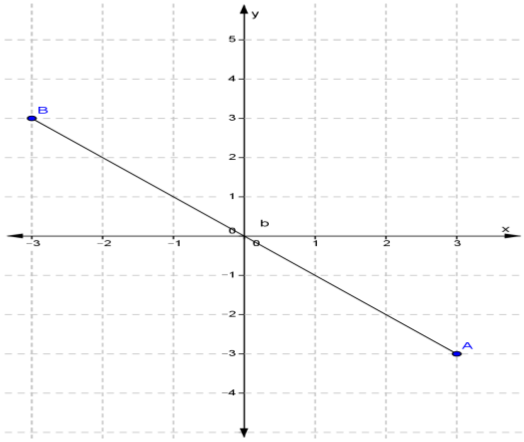


**Figure 3.** Graph of coordinates between lines A and B

The answers to the questions above can be shown in Figure 4 as follows:

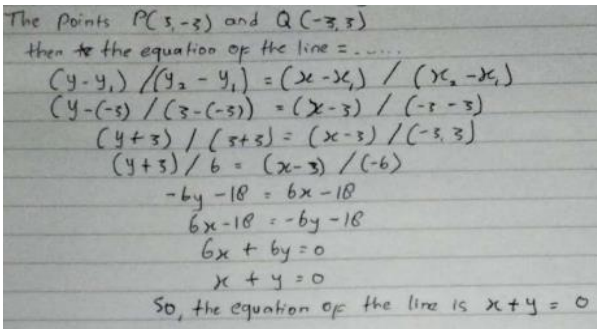
The Points P(3,-3) and Q(-3,3)
then the equation of the line = .....
(y-y₁) /(y₂ - y₁) = (x-x₁) / (x₂ -x₁)
(y-(-3)) / (3-(-3)) = (x-3) / (-3 - 3)
(y+3) / (3+3) = (x-3) /(-3, 3)
(y+3) / 6 = (x-3) /(-6)
-6y -18 = 6x - 18
6x-18 = -6y - 18
6x + 6y = 0
x + y = 0
So, the equation of the line is x+y = 0

**Figure 4.** Students can determine the equation of a line by paying attention to the line segment

Based on the results of student work from the problems above, it can be illustrated that students have understood the indicators of completion of mathematical thinking skills in determining the equation of a straight line by paying attention to the graph that has been determined. Students can solve problems correctly, based on structured completion steps, by paying attention to signs of critical thinking ability in mathematics.

Determine the straight-line equation that goes through the point R (3,2) and has a gradient of 4!

Figure 5 depicts the answers to the above-mentioned questions:

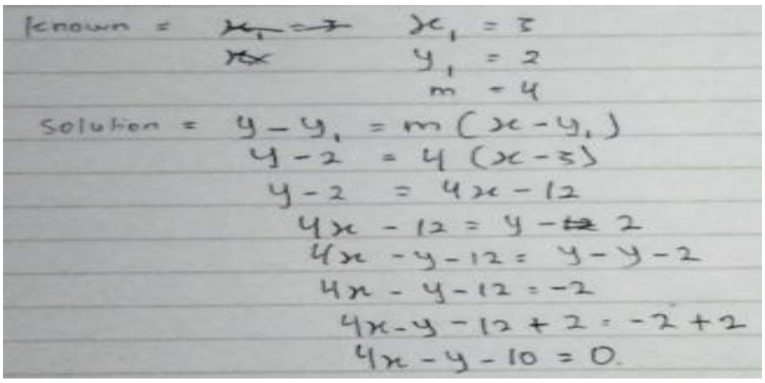
Known = x₁ = 3
y₁ = 2
m = 4
Solution = y - y₁ = m (x - y₁)
y - 2 = 4 (x - 3)
y - 2 = 4x - 12
4x - 12 = y - 2
4x - y - 12 = y - y - 2
4x - y - 12 = -2
4x-y - 12 + 2 = -2 + 2
4x - y - 10 = 0.

**Figure 5.** Students can work out the equation for a straight line with a 4 percent gradient. Using the letter R (3,2)

By paying attention to the students' answers to the questions in this section, it can be seen that students master the indicators of completion of mathematical critical thinking skills. The solution is to determine the line equation with known gradients and points; students can solve it using the steps in critical mathematical thinking.

Critical Mathematical Thinking Ability

The pretest and posttest results can be used to see whether students' mathematical critical thinking skills have increased. Based on the pretest and posttest data, the N-Gain test can be said to increase critical thinking skills. With the content of straight-line equations, five questions are aimed at assessing mathematical critical thinking skills in the form of descriptions. The description of N-Gain experimental data and N-Gain control data for learning-based mathematical reasoning abilities is presented in Table 2 to get a complete picture of data on increasing mathematical critical thinking skills.

**Table 2.** Description of the N-Gain Data for Reasoning Ability Mathematics based on Learning

| Statistics | N_Gain Experiment | N Gain Control |
|---|---|---|
| Maximum | 0,18 | 0,2 |
| Minimum | 0,04 | 0,04 |
| Mean | 0,1052 | 0,0973 |
| Std. Deviation | 0,03776 | 0,03668 |

Table 2 demonstrates that students who received LSQ learning improved their mathematical critical thinking skills by an average of 0.1052 (N-Gain). Similarly, students in traditional classes improved their mathematical critical thinking skills by an average of 0.0973 (N-Gain). Each learning group's data distribution on improving mathematical critical thinking skills is nearly identical. This suggests that students in both study groups have improved their ability to reason mathematically.

*Average LSQ Improvements vs. Conventional Learning Improvements*

Table 2 shows that students who take LSQ learning have a higher average value for improving their mathematical critical thinking skills than students who take traditional learning. As demonstrated in Figure 6 below, the average increase in mathematical critical thinking skills based on learning groups;

*Normality test*

The goal of the normality test is to determine if a sample of the population is normally distributed (Yasin et al., 2020). The range of research data is between $20 \leq n \leq 1000$, the test was carried out using the Kolmogorov-Smirnov test. The importance of the two lessons, namely learning With LSQ and Conventional on N-Gain, is more than, as shown in Table 3 below, as assessed by the Kolmogorov-Smirnov test using the SPSS output.

**Table 3.** Kolmogorov-Smirnov normality tests

| Class | | Statistics | df | Sig. |
|---|---|---|---|---|
| NGain Score | Experiment | 0,093 | 42 | .200 |
| | Control | 0,084 | 41 | .200 |

The significance value of the two lessons, namely learning With LSQ and Conventional on N-Gain, is greater than, as shown in Table 3 below, as assessed by the Kolmogorov-Smirnov test using the SPSS output.

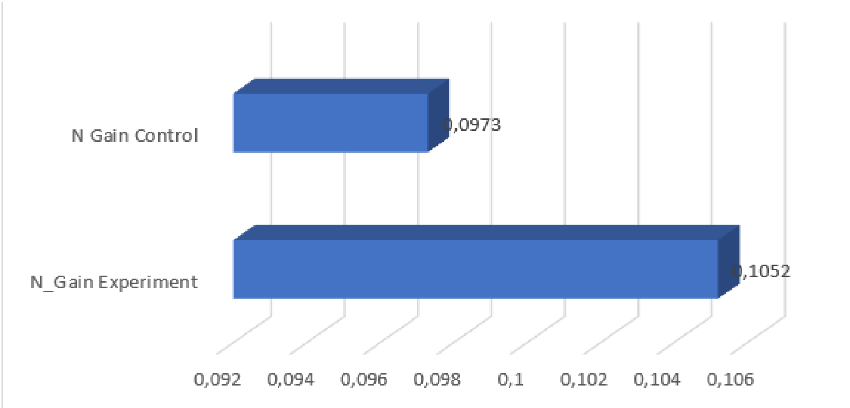


**Figure 6.** Comparison of the Average Improvement of Thinking Ability Mathematical Critical by Learning Group

*Test for homogeneity*

The homogeneity test was used to determine whether the data from traditional LSQ learning had the same variance. The homogeneity test decision-making tool refers to the significant results of the Test of Homogeneity of Variances. For students that received LSQ and Conventional Learning, the significance value (Sig.) of the learning outcome variables was greater than alpha (based on the significance of the Test of Homogeneity of Variances results). Table 4 shows what was brought.

**Table 4.** Test for homogeneity of variances

| NGain Score | | | |
|---|---|---|---|
| **Levene Statistics** | **df1** | **df2** | **Sig.** |
| 0,013 | 1 | 81 | 0,911 |

According to the homogeneity test decision-making principles, the variation of mathematics learning outcomes of students who receive LSQ learning with traditional learning is the same or homogeneous. An independent sample t-test was used to assess the outcomes of the Equal variance's assumption.

*T-Test with Independent Samples*

The difference in mathematics critical thinking skills between pupils who received LSQ and those who received traditional Learning was tested using a T-test (Nur et al., 2020). The results of the independent sample t-test are shown in Table 5

**Table 5.** Independent samples t-test for equality of means

| **Statistics** | **Ngain_Score LSQ and Conventional** | |
|---|---|---|
| | **Equal variances assumed** | **Equal variances not assumed** |
| t | 0,928 | 0,928 |
| df | 81 | 80,953 |
| Sig. (2-tailed) | 0,356 | 0,356 |
| Mean Difference | 0,00744 | 0,00744 |
| Std. Error Difference | 0,00801 | 0,00801 |

The value of Sig. (2-tailed) More than = 0.05, while tcount = 0.928, is explained in Table 5. For df = 81, the value of ttable = 1.664 is obtained. Pay attention to the value of Sig. (2-tailed) which is more than the level of significance (α), and the result of the calculation of tcount, which is less than ttable. As a result, there is no difference in the average development in mathematical critical thinking skills between students who study with the LSQ model and those who study with the conventional model.

Students look enthusiastic and active in the learning process with LSQ. Students communicate with each other by asking questions, and students in other groups quickly respond to questions submitted. For every question submitted, all students analyze to find a set of solutions using critical thinking skills.

During the LSQ learning, the students in the experimental class looked very active. Each group discussed with each other the problems asked. During the lesson, each group was allowed to ask questions. Questions revolve around the subject being studied. From these questions, it becomes a problem to be discussed together. In learning activities, the teacher acts as a facilitator, not fully involved in explaining the material or problems that arise through the questions submitted by students. It can be seen that LSQ learning is beneficial for students (Munadliroh & Anggraini, 2022). Every problem solving is always solved together in groups.

LSQ learning can solve various challenging problems. Problems that are challenging in nature can build aspects of mathematical critical thinking skills, namely self-confidence in solving problems. When students can solve problems and provide solutions, students self-confidence will grow. The more accustomed to using mathematical critical thinking skills, it will be able to form a confident attitude toward solving problems in mathematics. In line with the philosophy of constructivism, Veyis (2020) says constructivism assumes that students must construct their knowledge. Such habits allow students to be able to develop the potential of their critical and creative thinking skills.

LSQ learning can explore student activities by increasing problem-solving ideas well (Parmithi & Wahidin, 2016). The activity of reflecting on the suitability or correctness of the answer also encourages students to interpret the solution appropriately. As stated by Polya, this activity is the stage in the ability to think critically and mathematically. They explain how learning with LSQ can improve mathematical critical thinking skills (Salahuddin & Ramdani, 2021). The results of the study explain that learning with LSQ has a significant effect on increasing mathematical critical thinking skills.

According to the posttest results, students who study with LSQ learning are able to answer or complete the questions. The number of questions is five; most students can complete or work on problems or questions ideally based on mathematical critical thinking rules. Students can master the steps and indicators in solving mathematical critical thinking questions, the results of student work attest to this.

N-Gain data can be used to assess mathematical critical thinking abilities. The N-Gain calculation evaluates the development of mathematical critical thinking skills in LSQ learning. Students who attend LSQ courses have an average difference in gaining mathematical critical thinking skills compared to students who complete traditional learning, according to the N-Gain data on mathematical critical thinking skills, as shown in Table 2. The distribution of data possessed by students in the two lessons is same. As a result of the two lessons, mathematics critical thinking skills have improved.

Table 2 also compares mathematical critical thinking skills from the two learnings, LSQ and Conventional Learning. The average value that LSQ learning is higher than conventional Learning, as shown in Figure 3 above. The findings of the t-test calculations in Table 5 show that students who study using the LSQ model have no difference in increasing mathematical critical thinking skills compared to students who study conventionally.

## CONCLUSIONS

Based on the findings and discussions, it can be concluded that students who learn using LSQ can improve their ability to think critically mathematically. The average difference between LSQ learning and traditional learning is insignificant. The results of this research have limitations; that is, the subject of the research is only high school students, and the findings in this study still need to be re-examined in order to be generalized to the lower or higher school level. This research study focuses only on the ability to think critically mathematically, so the study of other students' mathematical abilities needs to be followed up. As advice to practitioners of further education and research, the application of LSQ can be used as one of the alternative changes in the implementation of mathematics learning in schools.

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## REFERENCES

Albers, M. J. (2017). Quantitative data analysis-in the graduate curriculum. *Journal of Technical Writing and Communication*, *47*(2), 215–233. https://doi.org/10.1177/0047281617692067

As'ari, A. R., Mahmudi, A., & Nuerlaelah, E. (2017). Our prospective mathematic teachers are not. *Journal on Mathematics Education*, *8*(2), 145–156. http://dx.doi.org/10.22342/jme.8.2.3961.145-156

Blömeke, S., Kaiser, G., König, J., & Jentsch, A. (2020). Profiles of mathematics teachers' competence and their relation to instructional quality. *ZDM - Mathematics Education*, *52*(2), 329–342. https://doi.org/10.1007/s11858-020-01128-y

Çelik, H. C., & Özdemir, F. (2020). Mathematical thinking as a predictor of critical thinking dispositions of pre-service mathematics teachers. International Journal of Progressive Education, 16(4), 81–98. https://doi.org/10.29329/ijpe.2020.268.6

Cipta, D. A. S., Avianty, D., & Kurniawati, A. (2019). Profil berpikir kritis siswa asperger pada pembelajaran bangun datar dengan metode montessori. *Jurnal Didaktik Matematika*, *6*(2), 149–160. https://doi.org/10.24815/jdm.v6i2.14175

Diaz-Kope, L. M., Miller-Stevens, K., & Henley, T. J. (2019). An examination of dissertation research: The relationship between gender, methodological approach, and research design. *Journal of Public Affairs Education*, *25*(1), 93–114. https://doi.org/10.1080/15236803.2018.1463792

Hobri, H., Arifin, S., Murtikusuma, R. P., Oktavianingtyas, E., & Setya Putri, I. W. (2021). Students' critical thinking process in solving jumping task according to gregorc's thinking style. *Jurnal Didaktik Matematika*, *8*(1), 15–31. https://doi.org/10.24815/jdm.v8i1.19776

Huincahue, J., Borromeo-Ferri, R., Reyes-Santander, P., & Garrido-Véliz, V. (2021). Mathematical thinking styles—the advantage of analytic thinkers when learning mathematics. *Education Sciences*, *11*(6), 289. https://doi.org/10.3390/educsci11060289

Ibrahim, I., Sujadi, I., Maarif, S., & Widodo, S. A. (2021). Increasing mathematical critical thinking skills using advocacy learning with mathematical problem solving. *Jurnal Didaktik Matematika*, *8*(1), 1–14. https://doi.org/10.24815/jdm.v8i1.19200

Jusoh, A., Salleh, M., Embong, R., & Mamat, M. (2019). The influence of mathematical teacher competency on creative teaching practice. *International Journal of Academic Research in Progressive Education and Development*, *7*(4), 397–409. https://doi.org/10.6007/ijarped/v7-i4/5333

Munadliroh, N. H., & Anggraini, K. C. S. (2022). Pengaruh strategi learning start with a question terhadap hasil belajar di MI Tarbiyatul Banat. *Fikroh: Jurnal Pemikiran dan Pendidikan Islam*, *15*(1), 63-72. https://doi.org/10.37812/fikroh.v15i1.384

Nur, A. S., Waluya, S. B., Rochmad, R., & Wardono, W. (2020). Contextual learning with ethnomathematics in enhancing the problem solving based on thinking levels. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, *5*(3), 331–344. https://doi.org/10.23917/jramathedu.v5i3.11679

Nur'azizah, R., Utami, B., & Hastuti, B. (2021). The relationship between critical thinking skills and students learning motivation with students' learning achievement about buffer solution in eleventh grade science program. *Journal of Physics: Conference Series*, *1842*(1), 012038. https://doi.org/10.1088/1742-6596/1842/1/012038

Nuraina, N., & Mursalin, M. (2018). Improving students' mathematical communication skills through learning start learning models with a question on pythagoras. *Malikussaleh Journal of Mathematics Learning (MJML)*, *1*(2), 44-47. https://doi.org/10.29103/mjml.v1i2.2231

Parmithi, N. N., & Wahidin, A. (2016). Implementation of the strategy learning start with a question (LSQ) to enhance the activity and learning achievement of grade X AP2 SMK Triatma Jaya Badung academic year 2013-2014. *Emasains : Jurnal Edukasi Matematika dan Sains*, *5*(1), 13-18. https://doi.org/10.59672/emasains.v5i1.14

Pitkäniemi, H. (2020). Tracking learning and teaching chains and their variations in the development of mixed-methods methodology. *Educational Process: International Journal*, *9*(1), 58–73. https://doi.org/10.22521/edupij.2020.91.4

Rifqi, A., Rochmad, R., & Suyitno, H. (2021). Critical thinking skills reviewed from logical-mathematical and musical intelligence on process oriented guided inquiry learning. *Unnes Journal of Mathematics Education Research*, *10*(2), 175–183.

Rijal, M., Mastuti, A. G., Safitri, D., Bachtiar, S., & Samputri, S. (2021). Differences in learners' critical thinking by ability level in conventional, NHT, PBL, and integrated NHT-PBL classrooms. *International Journal of Evaluation and Research in Education*, *10*(4), 1133–1139. https://doi.org/10.11591/IJERE.V10I4.21408

Sachdeva, S., & Eggen, P.-O. (2021). Learners' critical thinking about learning mathematics. *International Electronic Journal of Mathematics Education*, *16*(3), em0644. https://doi.org/10.29333/iejme/11003

Salahuddin, M. & Ramdani, N. (2021). Kemampuan berpikir kritis siswa dalam memecahkan masalah matematika berdasarkan tahapan polya. *Tarbiyah wa Ta'lim: Jurnal Penelitian Pendidikan dan Pembelajaran*, *8*(1) 37-48. https://doi.org/10.21093/twt.v8i1.3127

Samura, A. O., Juandi, D., & Darhim. (2020). Improving mathematical critical thinking skills through problem-based learning. *Journal of Physics: Conference Series*, *1521*(3), 032102. https://doi.org/10.1088/1742-6596/1521/3/032102

Sari, D. R., & Caswita. (2020). The analysis of mathematical critical thinking skills of students in junior high school. *Proceedings of the International Conference on Progressive Education (ICOPE 2019)*, *422*, 123–126. https://doi.org/10.2991/assehr.k.200323.103

Setyawati, D. U., Febrilia, B. R. A., & Nissa, I. C. (2020). Profil kemampuan berpikir kritis mahasiswa dalam menyelesaikan soal pemecahan masalah matematika ditinjau dari jenis kelamin. *Jurnal Didaktik Matematika*, *7*(1), 90–104. https://doi.org/10.24815/jdm.v7i1.15709

Shin, D., & Shim, J. (2021). Students' perceived mathematics teacher competence: Longitudinal associations with learning outcomes and choice of college major. *Education Sciences*, *11*(1), 1–14. https://doi.org/10.3390/educsci11010018

Stoecker, R., & Avila, E. (2021). From mixed methods to strategic research design. *International Journal of Social Research Methodology*, *24*(6), 627–640. https://doi.org/10.1080/13645579.2020.1799639

Suherman, S., Zaman, A. M., & Farida, F. (2021). Fostering of mathematical critical thinking ability using ARCS model and students' motivation. *JTAM (Jurnal Teori Dan Aplikasi Matematika)*, *5*(1), 134. https://doi.org/10.31764/jtam.v5i1.3798

Sukestiyarno, Y., Mashitoh, N. L. D., & Wardono, W. (2021). Analysis of students' mathematical creative thinking ability in module-assisted online learning in terms of self-efficacy. *Jurnal Didaktik Matematika*, *8*(1), 106–118. https://doi.org/10.24815/jdm.v8i1.19898

Susanti, E., & Retnowati, E. (2018). Exploring mathematical critical thinking skills of Yogyakarta junior secondary school students. *Southeast Asian Mathematics Education Journal*, *8*(1), 29–38. https://doi.org/10.46517/seamej.v8i1.61

Susilo, B. E. (2022). Students' mathematical critical thinking ability in problem-based learning viewed based on learning style. *Jurnal Elemen*, *8*(1), 187–200. https://doi.org/10.29408/jel.v8i1.4536

Veyis, F. (2020). Investigation of the self-efficacy beliefs of Turkish language and literature teachers in practicing constructivist approach in terms of various variables. *International Education Studies*, *13*(7), 47-56. https://doi.org/10.5539/ies.v13n7p47

Wulandari, S., Hajidin, H., & Duskri, M. (2020). Pengembangan soal higher order thinking skills (HOTS) pada materi aljabar di sekolah menengah pertama. *Jurnal Didaktik Matematika*, *7*(2), 200–220. https://doi.org/10.24815/jdm.v7i2.17774

Yasin, M., Fakhri, J., Siswadi, Faelasofi, R., Safi'i, A., Supriadi, N., Syazali, M., & Wekke, I. S. (2020). The effect of SSCS learning model on reflective thinking skills and problem solving ability. *European Journal of Educational Research*, *9*(2), 743–752. https://doi.org/10.12973/eu-jer.9.2.743