Analysis of Students' Mathematical Thinking Ability in Terms of Self Efficacy

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Abstract

Mathematical thinking ability must be owned by students to solve various problems. Students are considered capable of fulfilling the indicators of mathematical thinking ability properly if they are balanced with good self-efficacy abilities. This research method is qualitative which aims to find new indicators and describe mathematical thinking ability in terms of self-efficacy and provide recommendations for teachers. The research subjects were six students from the first year of senior high school using purposive sampling. Indicators of mathematical thinking ability, include 1) Reasoning: identifying concepts and problems; 2) Generalizing: demonstrating mathematical ideas in writing and using mathematical language to express ideas correctly; 3) Critical Thinking: using representations to create mathematical models; 4) Problem Solving: planning problem solving strategies, implementing and checking results. 5) Communicating: revealing the results of problem solving. The results: 1) low self-efficacy's students were only able to master reasoning; 2) moderate self-efficacy's students are able to master reasoning, generalizing, and critical thinking; 3) high self-efficacy's students are able to master all indicators. Recommendations for teachers are by giving opportunity to low self-efficacy's students to speak in public, give appreciation for their efforts and reprimand if it doesn't lower their confidence when they make mistakes.

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1. Introduction

Currently, the problems faced by mathematics teachers in one of the senior high school in Kudus, Central Java, Indonesia, namely MAN 1 Kudus are the low average student learning outcomes after taking mathematics lessons due to the decreased enthusiasm for student learning and lack of focus in learning because the changing learning system during the pandemic COVID-19. Many students have to take part in remedial activities to improve their previous grades. Therefore, there is a need for a study to analyze what problems students experience in mathematical thinking ability so that solutions can be found. So, this research be expected can solve the problem completely and deeply. Then recommendations be given to teachers related to learning that must be carried out at MAN 1 Kudus so that students' mathematical thinking abilities are optimal.

Mathematical thinking is one of the main goals in teaching and learning activities at schools. PISA in Primasatya (2016) stated that the mathematical thinking ability of students and students using their mathematical thinking ability in solving a problem is an important goal in learning at school because students' mathematical thinking ability can support their lives in the future. According to Kahar (2017) mathematics has certain characteristics and requires more ability to understand a theorem or definition. Students must be persistent and earnest in learning mathematics and tend to take a relatively long time to understand the lesson.

According to The National Council of Teachers of Mathematics (NCTM) in Amalia (2013) there are five abilities based mathematics which is standard, that is Problem Solving, Reasoning and Proof, Communication, Connection, and Representation. Whereas according to opinion The Partnership for 21st Century Skills the 4Cs present in Erdoğan (2019) stated that students at 21st century generation need ability which required for chase technology which the more growing. That ability included Communication, Collaboration, Creativity, Critical Thinking, and Problem Solving. Another opinion according to Mason's theory in Tohir et al. (2020) and Stacey's theory in Primasatya (2016) state that process which must traversed student in mathematical thinking, that is Specializing, Generalizing, Conjecturing, and Convincing. Opinion about mathematical thinking ability also put forward by Rahman in Permanasari et al. (2013) that mathematical thinking ability include: 1) *Pemahaman Konsep*; 2) *Berprosedur*; 3) *Komunikasi*; 4) *Penalaran*; and 5) *Pemecahan Masalah*. Research results by Mubarak in Long & Jiar (2014), he shared mathematical thinking ability became six aspect, that is Generalization, Induction, Deduction, Use of Symbol, Logical Thinking and Mathematical Proof. Table 1 below is the competence of mathematical thinking skills according to previous findings.

Table 1. Mathematical thinking competence according to previous findings

Founder	Mathematical thinking competence				
NCTM	Problem Solving	Reasoning and Proof	Communicating	Connect	Representation
4C	Communicating	Collaboration	Creativity	Critical Thinking	Problem Solving
Mason, Stacey	Specializing	Generalizing	Conjecturing	Convincing	
Rahman	Pemahaman Konsep	Berprosedur	Komunikasi	Penalaran	Pemecahan Masalah
Mubarak	Generalization	Induction, Deduction	Use of Symbols	Logical Thinking	Mathematical Proof

Problem Solving competence according to NCTM in Purnamasari & Setiawan (2019) there are four indicators, 1) students can identify problem correctly, mention what is known and asked in the problem; 2) students can plan solution, state and write models or the formula used to solve the problem; 3) students can complete problems according to plan, perform arithmetic operations correctly; 4) students can evaluate, draw a conclusion from answer which obtained and check return calculation which obtained. Based on Pujiastuti et al. (2020) set up of six steps of the processes to resolve the mathematical problem solving, namely: reading and understanding; analyzing and planning; organizing strategy; solving the problem; confirmation of the process; and confirmation of the answer.

Reasoning and Proof competence according to NCTM in Ramdani (2012) there are four indicators, 1) students can recognize and apply deductive and inductive reasoning into the problem; 2) students can apply reasoning process with special attention on proportions and graphs certain; 3) students can evaluate conjectures and arguments by logical; 4) students can assess absorption and reasoning power as part of mathematics.

Communication competence according to NCTM in Lutfiananisak & Sholihah (2018) there are four indicators, 1) students can organize and consolidate their mathematical thinking ability through communication; 2) student can communicate their mathematical thinking ability coherently and clearly to their friends, teacher and others; 3) students can analyze other people's mathematical thinking ability strategies; 4) students can use mathematics language to express mathematics ideas correctly.

Connection competence according to NCTM in Lestari et al. (2018) there are four indicators, 1) student can recognize representation which equivalent of the same concept; 2) students can recognize procedural relationships between representation which equivalent; 3) student can use and evaluate connection some mathematics topic; 4) student can use and assess connections between mathematics and other disciplines.

Representation competence according to NCTM in Syafri (2017) there are three indicators, 1) students can create and use representation for organize, take notes, and communicate their mathematical ideas; 2) students can choose, use and translate between representation to solve problems; 3) students can use representation for make model and interpret phenomenon mathematical, physical, and social.

Opinion of The Partnership for 21st Century Skills the 4Cs present to be consideration for perfect stages mathematical thinking ability competence. Communication competence in Sagala & Simajuntak (2019) there are two indicators, that is student can present information and disclose argument to public. Collaboration competence in Zubaidah (2018) there are also two indicators, that is student can compromise or discuss with their friends and show respect to someone older especially teachers and parents. Creativity

competence according to Greenstein in Zubaidah (2018) there are three indicators of creative and innovative thinking skills, that is students have high curiosity, flexibility in issue ideas, questions and answers based on the angle look which different and authentic, secrete expression, way, or ideas which unique and no thought of others for complete the problem. Then, Critical Thinking and Problem Solving competence in Utami et al. (2017) there are six indicators, that is student can test the truth of statement, distinguish relevant and irrelevant information, identify the causes and consequences, think critically about what is read, understand the material, and make solution. According to Marlina in Sholikha & Fitrayati (2021) Critical Thinking ability interpreted as high level thinking ability where not only just memorize but also use theory which has studied for customized with every problems.

The theory of Stacey and Mason becomes consideration for perfecting the stages of competence in the students mathematical thinking ability. In the Specializing competence, there are two indicators, that is student can identify problem which given to them, then students develop strategies by trying various strategies which possible conducted where student feel more effective while use that method to solve the problem. On the Generalizing competence, there are two indicators, that is student can reflect on the ideas, then expand predetermined ideas as of information for solving these problems. In Conjecturing competence, there is only one indicator, students can analyze cases that are similar to the given problem by making analogies with the types of problems that have occurred before. Then, the Convincing competence, there are three indicators, that is students look for reasons how to get the results with the method of forming a pattern from the results obtained are true and make the negation.

Rahman's opinion also becomes consideration for perfecting stages of student's mathematical thinking ability competence. On the *Pemahaman Konsep* competence, there are three indicators, that is students can define the given concept, identify the concept and provide examples or not examples of the concepts that they have understood. On the *Berprosedur* competence, there is only one indicator, students can recognize process or calculation procedure, not only process which the correct way, but also recognize the incorrect way. On the *Komunikasi* competence, there are two indicators, students can capable state or interpret mathematics idea and demonstrate it in spoken and written. On the *Penalaran* competence, there is only one indicator, student can capable give simple inductive and deductive reason. Then, the *Pemecahan Masalah* competence, there are three indicators, that is students can understand overall the problem, choose the most effective solution strategy by themself and complete problem use the chosen strategy.

Based on the analysis of the mathematical thinking ability competence that has been found previously, the formulation of the new mathematical thinking ability competence that students must pass are 1) Reasoning: identifying concepts and problems; 2) Generalizing: demonstrating mathematical ideas in writing and using mathematical language to express ideas correctly; 3) Critical Thinking: using representations to create mathematical models; 4) Problem Solving: planning problem solving strategies, implementing strategies and checking results. 5) Communicating: revealing the results of problem solving.

In Reasoning competence, students can identify material's concepts that has been presented. Students also identify problems to confirm students really understand the concept. In Generalization competence, students can demonstrate mathematical ideas in writing and use mathematical language to express these ideas correctly. In Critical Thinking competence, students can use reflected ideas to create mathematical models. In Problem Solving competence, students planning problem solving strategies based on ideas that have been verified. Then students implementing problem solving strategies by using the correct counting procedures to get the final result. Then check the results carefully so that there are no errors in the calculation. In Communication competence, students can express their opinions in the form of problem solving results. If there is something that is not appropriate from the results of problem solving, students can discuss each others.

Based on the opinion of Saragih & Napitupulu (2015), mathematics provides logical, critical, systematic, precise, developing creativity, hard-working habits, independent, impartial, disciplined, has a high social attitude, a sense of beauty with mathematical regularity, develops objective and minded openness needed to face an ever-changing future and increase self-confidence or commonly called self-efficacy.

Self-efficacy must be optimized because self-efficacy supports the students' potential (Bandura, 2012). Self-efficacy is a role variable in predicting students' achievement, especially in mathematics. Students need self efficacy on mathematical thinking skills because it affects students' behavior in learning or mindsets to improve mathematical thinking skills and how they consider mathematics. Self-efficacy affects

individual, how they think, feel, motivate themselves, and act (Herman, Fahinu, & Makkulau, 2016). According to Fitri (2017) self-efficacy has four principles, that is 1) self-efficacy can improve performance; 2) self-efficacy can increase or decrease when witnessing the success or failure of others on certain tasks; 3) self-efficacy can appear when given a suggestion to be able to do a task and disappear when it fails; 4) self-efficacy is related to emotional. According to Bandura in Subaidi (2016) the dimensions that are used as guidelines in measuring a person's self-efficacy are magnitude, strength, and generality. Table 2 below is more detailed self efficacy indicators (Hendriana, et al. 2018)

Table 2. Self efficacy indicators

Dimension	Indicator
Magnitude	Great interest in lessons
	Optimistic about doing the job
	Develop ability and achievement
	Make a plan to complete the task
	Confident to solve the problem
	Study according to schedule
	Seeing difficult tasks as challenges
	Selective in achieving goals
Strength	Effort can increase performance
	Commitment in completing tasks
	Knowing the advantages
	Persistence in completing tasks
	Aim positive in many ways
	Have good motivation
Generality	Take things well
	Experience as a path to success
	Likes to find new situations
	Overcome all situations effectively
	Try a new challenge

The mathematical thinking ability in this study has five competencies that students must pass sequentially. Researchers developed new thinking indicators based on expert opinion from the competence of mathematical thinking ability in terms of self efficacy achieved by students systematically starting from the simplest abilities with low self-efficacy to the most complex abilities with high self-efficacy. So, this research be expected can solve the problem completely and deeply. Then recommendations be given to teachers related to learning that must be carried out at MAN 1 Kudus so that students' mathematical thinking abilities are optimal. Therefore, the aims of this study is find new indicators and describe mathematical thinking ability in terms of self-efficacy and provide recommendations for teachers.

2. Methods

This type of research is qualitative. According to Sukestiyarno (2021) stated that qualitative research is used to examine natural objects, the key instrument of this research is the researcher with triangulation collection techniques including interviews, observation, and documentation. Research data are analyzed to interpret or understand uniqueness, construct a phenomenon, and find new hypotheses. The definition of qualitative research according to Shidiq & Choiri (2019) is research with findings that can not be obtained using statistical procedures or using quantitative methods.

The study was conducted in class X MIPA 3 as a trial class with 35 students and X MIPA 4 as an experimental class with 33 students at MAN 1 Kudus which was held from February 14, 2022 to March 7, 2022. The research subjects were taken by six students using purposive sampling technique. Each two students with low self efficacy, two students with moderate self efficacy, and two students with high self efficacy.

The research preparation stage includes making proposals, field observations, compiling research instruments, conducting instrument trials and expert validation. The results of the analysis of the self efficacy questionnaire test, there are 7 statements out of 30 invalid statements so they are not used and replaced. The results of calculations using SPSS obtained an alpha reliability coefficient of 0.903. This

means that the reliability coefficient is high. The results of the trial analysis about mathematical thinking ability are valid and the reliability is equal 0.842 to which means it is reliable.

The research implementation stage includes distributing self efficacy questionnaires, conducting interviews to confirm the level of self-efficacy for six students to be selected as research subjects, giving questions about mathematical thinking ability to research subjects and interviews to confirm the results of the research subjects' work and documentation for triangulation.

The data processing stage includes collecting data from observations of student self efficacy, collecting data from tests of mathematical thinking ability in terms of self efficacy and interview results, processing and analyzing data from tests of mathematical thinking ability and interview results. The stage of drawing research conclusions by concluding research results based on the formulation of the problem from the data obtained and the suitability of the conclusions with the research objectives and providing recommendations. Data collection techniques must be implementation correctly because instruments that have been tested for validity and reliability are not necessarily valid and reliable if the instruments are not used properly in data collection (sugiyono, 2018). Data collection techniques used to obtain research data include observation, questionnaires, tests, and interviews. Research instruments include a self efficacy questionnaire, a matter of mathematical thinking ability, and interview guidelines.

3. Results & Discussions

3.1. Result of self efficacy questionnaires

Self efficacy (SE) questionnaires were given to 33 students of class X MIPA 4 which were used to classify students into the criteria of low self efficacy, moderate self efficacy, and high self efficacy.

Based on the results of the self efficacy questionnaire, the lowest score was 52 and the highest score was 252. The results of the classification of the self efficacy questionnaire are presented in table 3 as follows.

Table 3. Results of Classification of Self Efficacy Criteria

Interval	Self efficacy criteria	Multiple subjects	Percentage
$x < 120$	Self Efficacy (SER)	6	18.18%
$120 \leq x < 210$	Self Efficacy (SES)	20	60.60%
$210 \leq x$	Self Efficacy (SET)	7	21.21%

3.2. Result mathematical thinking ability test

Based on the results of the questionnaire given to students in class X MIPA 4, it shows that there are six students SER, 20 students SES, and seven students SET. These results indicate that class X MIPA 4 is dominated by SES with a percentage of 60.60%.

In each criterion, two SER students, two SES students, and two SET students were taken so that there were six students as research subjects. The determination of the six research subjects is shown in table 4 as follows.

Table 4. Research Subjects Based on Self Efficacy Criteria

Student code	SE score	KBM score	Name	SE criteria
P-06	114	10	S-1	Low
P-02	116	40	S-2	Low
P-14	164	65	S-3	Moderate
P-20	185	85	S-4	Moderate
P-18	212	95	S-5	High
P-30	252	100	S-6	High

The achievement of indicators of mathematical thinking ability by research subjects is presented in Table 5 below.

Table 5. Achievement of mathematical thinking ability indicators by research subjects

Subject	Mathematical thinking ability indicator				
	1	**2**	**3**	**4**	**5**
S-1	–	–	–	–	–
S-2	√	–	–	–	–
S-3	√	√	–	–	–
S-4	√	√	√	–	–
S-5	√	√	√	√	–
S-6	√	√	√	√	√

Based on the data analysis that has been done, further discussion of the results of the analysis of mathematical thinking skills in terms of students' self-efficacy is discussed.

3.3. Analysis of mathematical thinking ability in terms of self efficacy.
Analysis of mathematical thinking ability in terms self efficacy S-1 is low. In indicator 1, S-1 is unable to identify the concepts used in the questions and is unable to identify what problems are presented in the questions. S-1 only writes what is known in the problem and works on the problem with an integral formula. This proves that S-1 has not understood the concept. During the interview, S-1 stated that he could work on questions whose problems were clearly presented, but it was difficult if the problems were presented in the form of 'daily story' questions. S-1 is not able to fulfill indicator 1 so that S-1 has difficulty fulfilling the next indicator.

Analysis of mathematical thinking skills in terms of self efficacy S-2 is low. In indicator 1, S-2 is able to explain that problem solving in questions uses the concept of function composition. S-2 is also able to identify what problems must be solved in the problem. But S-2 is not able to find mathematical ideas that used for solving the problem. This proves that S-2 is able to fulfill indicator 1. But S-2 is not able to fulfill indicator 2. Because not able to demonstrate mathematical ideas, so S-2 is not able to compile a mathematical model that used for problem solving. During the interview, S-2 seemed confused in explaining what was done on the answer sheet. So it can be concluded that S-2 is only able to fulfill indicator 1 and cannot fulfill other indicators.

Analysis of mathematical thinking skills in terms of self efficacy S-3 is moderate. In indicator 1, S-3 is able to explain the concept of composition function well and is able to identify existing problems. S-3 is also able to find ideas into mathematical language well. Based on the ideas obtained, S-3 is able to make mathematical models. However, S-3 was not able to formulate a problem-solving strategy. During the interview, S-3 admitted that she was wrong in carrying out problem-solving strategies so that the wrong results were obtained. S-3 also acknowledged the lack of time in solving problems. It can be concluded that S-3 is able to fulfill indicator 2 but is not able to fulfill indicator 3 and subsequent indicators.

Analysis of mathematical thinking skills in terms of self efficacy S-4 is moderate. In indicator 1, S-4 is able to identify the concept of function composition and explain what problems are contained in the questions well. S-4 is able to express the ideas obtained for problem solving and is able to use representations to create mathematical models that are used as the basis for making problem solving strategies. However, S-4 was wrong in writing down the information in the questions and did not re-check the answers obtained so that S-4 failed to fulfill indicator 4. So it can be concluded that S-4 was only able to fulfill up to indicator 3 only.

Analysis of mathematical thinking skills in terms of self efficacy S-5 is high. In indicator 1, S-5 is able to identify the concepts used in the problem to explain his knowledge of the concept of function composition and is able to identify problems that must be solved. S-5 is able to demonstrate the idea and explain how to get the idea. S-5 is able to make mathematical models for the basis of planning problem solving strategies and doing problem solving well and admits to re-examining the results of problem solving that have been found. S-5 is also able to explain the process used to get the results of solving these problems in front of the class. This is a confirmation that the S-5 has a high level of confidence. This is in accordance with the results of the self efficacy questionnaire which shows that he belongs to the category of high self efficacy. Although S-5 is able to express the results of problem solving orally well, S-5 makes mistakes in writing the final results using unwanted units in the questions. This causes the S-5 to be unable to fulfill indicator 5.

Analysis of mathematical thinking skills in terms of self efficacy S-6 is high. S-6 is able to meet all indicators of mathematical problem solving well. In indicator 1, S-6 correctly identifies the concept and identifies the problem correctly. S-6 is able to demonstrate ideas that she used in problem solving and can express these ideas. So that a mathematical model can be generated. S-6 also develops problem-solving strategies and performs problem-solving strategies correctly. Because the strategy used is right, S-6 has plenty of time to re-examine the solutions that have been found. S-6 is also able to present the results of her work in front of her friends orally and is able to write the problem-solving process in writing correctly. It can be concluded that S-6 is able to fulfill all indicators of mathematical thinking ability.

Based on the explanation above, it can be seen that S-1 and S-2 have low self-efficacy and low mathematical thinking skills. S-1 and S-2 difficulties in identifying concepts and identifying problems in the questions. They also have difficulty in demonstrating mathematical ideas in writing and using mathematical language to express the ideas they get correctly. Because they do not find ideas for problem solving, so they have difficulty making mathematical models that are used as the basis for problem solving. So, planning strategy for solving the problems, doing strategies also can't be passed well, even they lack time so they don't have enough time to re-examine the results of problem solving that have been found. Because they have low self-efficacy, they are nervous about revealing results solving problems verbally and tend to be silent when the teacher asks questions or when discussing with other students.

Then it can be seen that S-3 and S-4 have moderate self efficacy and moderate mathematical thinking skills. S-3 and S-4 can identify concepts and identify the problems contained in the questions well. They can also demonstrate mathematical ideas in writing and use mathematical language to express ideas correctly. But S-3 has a little difficulty in using representations to make mathematical models, while S-4 can make mathematical models well in each item. S-3 and S-4 have flaws in planning strategy solving problems, implement strategies and check result. They can plan strategies and execute those strategies, but fail at some points. They are also able to reveal the results solving problems quite well in writing although there are still errors because they do not re-check the answers, but are less able to express the results of problem solving well when in front of the class and explain to their friends.

In contrast to S-5 and S-6, it can be seen that they have high self-efficacy and high mathematical thinking ability. S-5 and S-6 are able to meet all indicators of problem-solving ability very well on the questions. S-5 and S-6 are able to identify concepts and identify problems, demonstrate and express ideas for solving these problems, represent these ideas in the form of mathematical models, are able to plan strategy solving problems, carry out strategies and check the results obtained and able reveal results solving problems in spoken and written. Although S-5 has a few errors in writing the final result that has not been converted to the units requested in the problem, S-5 is able to present the answers that have been found well in front of the class. While S-6 has a perfect score in solving all the problems in the problem and has a very high level of self efficacy.

3.4. Recommendation

Based on the results of the discussion above, it is recommended things that must be considered by the teacher, namely by giving special treatment to students who have low self efficacy. Teachers can provide opportunities for students to speak more often in front of others such as small discussions in class or presenting their work in front of the class, giving appreciation for their efforts and reprimands if it does not reduce their confidence when they make a mistake. According to Indrawati (2014) self efficacy has a big influence on improving performance, so self efficacy assessment is needed to a group, not only given to the group but to individuals who are in the group. Counseling guidance teacher can also help improve students' self efficacy by providing group guidance. The results of the study Putra et al. (2013) showed that the provision of group guidance was effective in increasing students' self efficacy . This is in line with Prayitno's opinion in Putra et al. (2013) that students get the opportunity to have an opinion about the surrounding environment, have an objective understanding, can learn to be positive in groups, arrange activity programs, and carry out activities that produce results.

In this study, students with low self efficacy already had difficulties in fulfilling indicator 1, namely identifying concepts and identifying problems on difficult questions but were able to fulfill indicator 1 on easy questions. Recommendations that can be given to these problems are to teach the concept of functions associated with daily activities. This is in line with the Jarmita (2015) opinion, the teacher provides a variety of diverse activities in learning mathematics, so the emphasis is not on memorizing. The teacher starts learning from concrete to abstract, generalizing to real situations so that they can build the foundation for a good level of conceptual understanding.

Indicator 2 of mathematical thinking ability that can't be fulfill by students with low self efficacy are demonstrating mathematical ideas in writing and using mathematical language to express ideas correctly.

Recommendations that can be given to these problems are teachers can provide problems to students and how to solve problems. According to Choridah (2013) teachers can form small groups and are required to be able to demonstrate something they have learned in the form of a product or a performance result in the hope that students are more confident in exploring mathematical ideas.

Students with low self efficacy are not able to fulfill indicator 3, namely using representations to create mathematics model. Recommendations that can be given to these problems are teachers can teach students to solve a problem using the right formulas. According to Purnama et al. (2019) in representing problem solving ideas related to students' understanding of the concept. Representations can be used to assess the extent to which students understand a concept so that when students do not understand a certain concept, students not be successful in presenting mathematics model to solve problems.

Indicator 4 mathematical thinking ability is planning strategy solving problems, carry out strategies and check the results have also not been achieved by students with low self efficacy. Recommendations that can be given to these problems are teachers can use the Problem Based Learning model. According to the research results of Allevato and Onuchic in Simamoraa et al. (2017) stated that learning mathematics through problem solving activities can increase knowledge about mathematical concepts and the mathematical material be more meaningful and effective when studied. The results of the study Hendriana et al. (2018) concluded that students were more active in Problem Based Learning model, more creative, confident, able to communicate and work together in solving the problems. So that problem solving skills have a high influence in increasing self-confidence. According to Supandi (2019) teachers can provide open-ended questions to students so that they are accustomed to working on open-ended questions to support their creativity.

Students with low self efficacy also have not been able to fulfill indicator 5, which is expressing results solving problem. Recommendations that can be given to these problems are to give students the opportunity to express the results of solving problems they find verbally in order to increase their self efficacy. This is in line with the results of research Hendriana et al. (2017) that self efficacy affects students' communication skills. According to Rahmi et al. (2017) self efficacy affects mathematical communication skills because the higher a person's level of confidence, the higher his mathematical communication skills.

4. Conclusion

Based on the analysis of the mathematical thinking ability competence that has been found previously, the formulation of the new mathematical thinking ability competence that students must pass are 1) Reasoning: identifying concepts and problems; 2) Generalizing: demonstrating mathematical ideas in writing and using mathematical language to express ideas correctly; 3) Critical Thinking: using representations to create mathematical models; 4) Problem Solving: planning problem solving strategies, implementing strategies and checking results. 5) Communicating: revealing the results of problem solving.

Description of students' mathematical thinking abilities based on new indicators that have been found in terms of self-efficacy, the results: 1) low self-efficacy's students were only able to master reasoning; 2) moderate self-efficacy's students are able to master reasoning, generalizing, and critical thinking; 3) high self-efficacy's students are able to master all indicators namely Reasoning, Generalizing, Critical Thinking, Problem Solving, and Communicating.

Then, recommendations are given to the teacher by giving opportunity to students with low self-efficacy speak in public, give appreciation for their efforts and reprimand if it does not lower their confidence when they make mistakes.

References

Amalia, R. (2013). *Penerapan Model Pembelajaran Pembuktian untuk Meningkatkan Kemampuan Berpikir Matematis Tingkat Tinggi Siswa SMA*. (Doctoral dissertation, Universitas Pendidikan Indonesia).

Bandura, A. (2012). On the functional properties of perceived self-efficacy revisited. *Journal of Management*, *38*(1), 9–44. https://doi.org/10.1177/0149206311410606

Choridah, D. T. (2013). Peran Pembelajaran Berbasis Masalah Untuk Meningkatkan Kemampuan Komunikasi Dan Berpikir Kreatif Serta Disposisi Matematis Siswa SMA. *Infinity Journal*, *2*(2), 194. https://doi.org/10.22460/infinity.v2i2.35

Erdoğan, V. (2019). Integrating 4C Skills of 21st Century into 4 Language Skills in EFL Classes.

International Journal of Education and Research, *7*(11), 113–124. Retrieved from www.ijern.com

Fitri, I. (2017). Peningkatan Self Efficacy Terhadap Matematika Dengan Menggunakan Modul Matematika Kelas VIII SMP Negeri 2 Bangkinang. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *1*(2), 25–34. https://doi.org/10.31004/cendekia.v1i2.17

Hendriana, H., Rohaeti, E. E., & Hidayat, W. (2017). Metaphorical thinking learning and junior high school teachers' mathematical questioning ability. *Journal on Mathematics Education*, *8*(1), 55–64. https://doi.org/10.22342/jme.8.1.3614.55-64

Hendriana, H., Johanto, T., & Sumarmo, U. (2018). The role of problem-based learning to improve students' mathematical problem-solving ability and self confidence. *Journal on Mathematics Education*, *9*(2), 291–300. https://doi.org/10.22342/jme.9.2.5394.291-300

Hendriana, H., Rohaeti, E. E., & Sumarmo, U. (2018). *Hard skills dan soft skills matematik siswa* (second; nurul falah atif, Red). bandung: PT refika aditama.

Herman, Fahinu, & Makkulau. (2016). Pengaruh Model Pembelajaran Van Hiele dan Pembelajaran Scientific terhadap Kemampuan Penalaran Geometris Berdasarkan Self-Efficacy Siswa Sekolah Menengah Pertama. *Jurnal Pembelajaran Berpikir Matematika*, *1*(1), 41–50.

Indrawati, Yeti. (2014). Pengaruh Self Esteem, Self Efficacy Dan Kepuasan Kerja Terhadap Kinerja Karyawan (Studi Kasus Perawat RS Siloam Manado). *Jurnal riset bisnis dan managemen*, *2*(4), 12–24.

Jarmita, N. (2015). Kesulitan Pemahaman Konsep Matematis Siswa Dalam Pembelajaran Matematika Di Kelas Awal Sekolah Dasar. *PIONIR: Jurnal Pendidikan*, *4*(2), 1–16. Retrieved from https://jurnal.ar-raniry.ac.id/index.php/Pionir/article/view/176/157

Kahar, M. S. (2017). Analisis Kemampuan Berpikir Matematis Siswa SMA kota Sorong terhadap Butir Soal dengan Graded Response Model. *Tadris: Jurnal Keguruan dan Ilmu Tarbiyah*, *2*(1), 11. https://doi.org/10.24042/tadris.v2i1.1389

Lestari, R. S., Rohaeti, E. E., & Purwasih, R. (2018). Profil kemampuan koneksi matematis siswa smp. *Jurnal Ilmiah Pendidikan Matematika*, *3*(1), 51–58.

Long, C. Y., & Jiar, Y. K. (2014). Mathematical Thinking and Physics Achievement of Secondary School Students. *Sains Humanika*, *2*(4), 231–237. https://doi.org/10.11113/sh.v2n4.492

Lutfiananisak, & Sholihah, U. (2018). Kemampuan Komunikasi Matematis Siswa dalam Menyelesaikan Soal Materi Komposisi Fungsi Ditinjau dari Kemampuan Matematika. *Jurnal Tadris Matematika*, *1*(1), 1–8. https://doi.org/10.21274/jtm.2018.1.1.1-8

Permanasari, V., Sugiarto, B., & Kurniawati, I. (2013). Efektivitas Pendekatan Pembelajaran Open-Ended terhadap Kemampuan Berpikir Matematis Siswa pada Materi Trigonometri Ditinjau dari Kreativitas Belajar Matematika Siswa. *Jurnal Pendidikan Matematika SoLuSi (Tersohor Luas dan Berisi), 1*(1), 31–38.

Primasatya, N. (2016). Analisis Kemampuan Berpikir Matematis Calon Guru Sekolah Dasar Dalam Menyelesaikan Masalah Matematika. *JPM : Jurnal Pendidikan Matematika*, *2*(1), 50–57. https://doi.org/10.33474/jpm.v2i1.206

Pujiastuti, E., Suyitno, H., Waluya, B., & Mulyono. (2020). *Analysis and Tracing of the Problem Solving Process by Students in Advanced Calculus at UNNES*. *443*(Iset 2019), 83–86. https://doi.org/10.2991/assehr.k.200620.016

Purnama, R. N., Kusmaryono, I., & Basir, M. A. (2019). *Analisis Kemampuan Representasi Matematis Siswa Kelas VIII SMP Al Fattah Semarang Rizki*. *3*(1), 23–36.

Purnamasari, I., & Setiawan, W. (2019). Analisis Kemampuan Pemecahan Masalah Matematis Siswa SMP pada Materi SPLDV Ditinjau dari Kemampuan Awal Matematika. *Journal of Medives : Journal of Mathematics Education IKIP Veteran Semarang*, *3*(2), 207. https://doi.org/10.31331/medivesveteran.v3i2.771

Putra, S. A., Daharnis, D., & Syahniar, S. (2013). Efektivitas Layanan Bimbingan Kelompok dalam Meningkatkan Self Efficacy Siswa. *Konselor*, *2*(2), 1–6. https://doi.org/10.24036/02013221399-0-00

Rahmi, S., Nadia, R., Hasibah, B., & Hidayat, W. (2017). the Relation Between Self-Efficacy Toward Math With the Math Communication Competence. *Infinity Journal*, *6*(2), 177. https://doi.org/10.22460/infinity.v6i2.p177-182

Ramdani, Y. (2012). PENGEMBANGAN INSTRUMEN DAN BAHAN AJAR UNTUK

MENINGKATKAN KEMAMPUAN KOMUNIKASI, PENALARAN, DAN KONEKSI MATEMATIS DALAM KONSEP INTEGRAL. *Jurnal Penelitian Pendidikan*, *13*(1), 44–52.

Sagala, Y. D. A., & Simanjuntak, M. P. (2019). Implementation of Project-Based Learning (PjBL) in Collaboration Skills and Communication Skills of Students. *Annual International Seminar on Transformative Education and Educational Leadership (AISTEEL)*, *384*(4), 608–612. https://doi.org/10.2991/aisteel-19.2019.138

Saragih, S., & Napitupulu, E. (2015). Developing student-centered learning model to improve high order mathematical thinking ability. *International Education Studies*, *8*(6), 104–112. https://doi.org/10.5539/ies.v8n6p104

Shidiq, U., & Choiri, M. (2019). *Metode Penelitian Kualitatif di Bidang Pendidikan*. Retrieved from http://repository.iainponorogo.ac.id/484/1/METODE PENELITIAN KUALITATIF DI BIDANG PENDIDIKAN.pdf

Sholikha, S. N., & Fitrayati, D. (2021). Integrasi Keterampilan 4C dalam Buku Teks Ekonomi SMA/MA. *Edukatif: Jurnal Ilmu Pendidikan*, *3*(5), 2402–2418. Retrieved from https://www.edukatif.org/index.php/edukatif/article/view/823

Simamoraa, R. E., Sidabutar, D. R., & Surya, E. (2017). Improving Learning Activity and Students' Problem Solving Skill Through Problem Based Learning (PBL) in Junior High School. *IJSBAR:international journal of sciences:basic and applied research*, *33*(2), 321–331. Retrieved from http://search.proquest.com/docview/1773215035?accountid=8330

Subaidi, A. (2016). Self-Efficacy Siswa Dalam Pemecahan Masalah Matematika. *Sigma*, *1*(2), 64–68. Retrieved from doi: http://dx.doi.org/10.0324/sigma.v1i2.68

Sugiyono. (2018). *Metode penelitian kuantitatif, kualitatif, dan kombinasi (mix methods)* (Sutopo, Red). Bandung: Alfa Beta.

Sukestiyarno, Y. L. (2021). *Metode penelitian pendidikan* (3rd ed). semarang.

Supandi, S., Suyitno, H., Sukestiyarno, Y. L., & Dwijanto, D. (2019). Adaptation and creativity in mathematics learning. *Journal of Physics: Conference Series*, *1321*(2). https://doi.org/10.1088/1742-6596/1321/2/022132

Syafri, F. S. (2017). KEMAMPUAN REPRESENTASI MATEMATIS DAN KEMAMPUAN PEMBUKTIAN MATEMATIKA. *Jurnal Edumath*, *3*(1), 49–55.

Tohir, M., Maswar, M., Moh, A., Saiful, S., & Rizki Pradita, D. A. (2020). Prospective teachers' expectations of students' mathematical thinking processes in solving problems. *European Journal of Educational Research*, *9*(4), 1735–1748. https://doi.org/10.12973/EU-JER.9.4.1735

Utami, B., Saputro, S., Ashadi, A., Masykuri, M., & Widoretno, S. (2017). Critical thinking skills profile of high school students in learning chemistry. *International Journal of Science and Applied Science: Conference Series*, *1*(2), 124. https://doi.org/10.20961/ijsascs.v1i2.5134

Zubaidah, S. (2018). Mengenal 4C: Learning and Innovation Skills Untuk Menghadapi Era Revolusi Industri 4.0. *2nd Science Education National Conference*, 1–7.