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Design of *an Inquiry-Based Mathematical Literacy* Learning Model to Encourage Critical Thinking

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ABSTRACT

Critical thinking skills are part of higher-order thinking skills that need to be developed. Many strategi have been given by researchers in the field of mathematics. Newton and Tonelli (2020) provide inquiry-based mathematics lessons (inquiry) to overcome the problems of learners who struggle in the face of students' understanding in the field of mathematics. The learning and inquiry process itself has been widely developed to improve critical thinking skills. The purpose of this development research is to develop an inquiry-based mathematical literacy learning model to encourage critical thinking. From the results of the needs analysis and conceptual design, an inquiry-based mathematical literacy (IBML) learning model design was obtained that pays attention to the IBL model and the type of inquiry will be tested on the design made.

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INTRODUCTION

Current learning is oriented towards the characteristics of 21st century learning, namely *High Order Thinking Skills* (HOTS). HOTS is a learner's thinking pattern by relying on the ability to analyze, create, and evaluate all aspects and problems. In improving these abilities, it is inseparable from 4 (four) skills including critical thinking, communication, collaboration and creativity. The four skills include the process of developing learners' curiosity and the process of building learners' knowledge (Sasson, judah, & Malkinson, 2018). These high-level thinking skills need to be developed because they have become a demand for needs in the modern era. Critical thinking skills are one part of higher order thinking skills that need to be developed. Critical thinking skills can be developed in learning activities through the application of learning models that are able to encourage students' critical thinking skills optimally. A lot of research related to the development of learning models encourages critical thinking skills. These skills can be developed by applying *collaborative learning* models that are able to encourage active participation, understanding construction, problem solving, and critical thinking skills of

students (Wulandari & Anita, 2019), and critical thinking skills can also be trained through cooperative-based *learning problem solving* (Hotimah & Harun, 2019).

Each individual's critical thinking skills differ from one another. Individuals who have not been able to think critically are obstacles encountered when the learning is not optimal. Filsaime (2008) reveals 6 (six) things that cause person inability to think critically, namely: 1). The difficulty of eliminating the fear of making mistakes; 2). Prediction of failure; 3) lack of self-confidence; 4). Difficulties in thinking; 5). Intrinsic motivation that is nothing more than the abundance of extrinsic motivation; 6). Low tolerance to ambiguity. On the other hand, Ormrod (2003) gives some advice to teachers to encourage the development of critical thinking of learners: 1). Teach a little topic but with a deep understanding, 2). Encourage learners to ask questions or challenge some of the learners' ideas to be driven by their intellectual skepticism, 3). Give examples of how to give critical thinking for example by presenting scientific reports, 4). Learners are given the opportunity to learn to think critically by identifying, conducting evaluations, using evidence and logic and so on, 5). The teacher gives questions that lead to critical thinking, 6). Teachers ask learners to debate controversial issues with views and arguments, 7). Teachers help learners understand that critical thinking involves mental effort, 8) teachers instill critical thinking skills in the context of authentic activities. Therefore, to understand these things, strategies are needed to encourage critical thinking.

Several strategies have been developed by critical thinking experts to integrate and develop critical thinking into the classroom. Abrami, et al (2014) classify into four categories. First, individual studies, including strategies by which learners must work alone on the proposed activities. Secondly, dialogue, characterized by an emphasis on discussion. Third, authentic or anchored instruction, refers to the selection of authentic problems or situations of interest to the learner. Fourth, mentoring, refers to strategies that bring together subject matter experts with beginners. Ashman and Conway (1997) state that approaches such as *scaffolded* instruction, reciprocal teaching, cooperative learning, peer tutoring and cognitive apprenticeship as well as shallow and traditional teaching approaches The strategies outlined above focus on the activeness and participation of students in the learning process. Such a learning model is known as a student-centered learning model (Hamalik, 2001). One of the learning models known in the 2013 curriculum is the inquiry learning model. The inquiry learning model can be expressed as a set of learning activities that focus on the process of critical thinking and study to collect and find for themselves a disputed problem (Sanjaya, 2009). According to Coffman (2009) in the inquiry learning model, students are involved in a direct way of thinking, giving questions, exploring and experimenting so that students can obtain solutions or ideas that are logical and scientific.

The inquiry learning model itself has undergone many changes. This is done to adjust the field of study and the concepts taught. Such as, Serafin, et al (2014) the use of inquiry-based instruction in the context of constructivism shows its effectiveness in primary and secondary education as well as in students with special needs including the gifted. Suduc, et al (2015) stated that the existence of modules through the *Inquiry-based science education* (IBSE) learning model can arouse student motivation, the application of student inquiry skills, and the construction of meaningfulness and gain scientific knowledge. In the field of mathematics, Newton and Tonelli (2020) provide inquiry-based mathematics lessons (inquiry) to overcome the problems of students who struggle in the face of the learning process.

The word "inquiry" is a popular term used to describe the pedagogical approach that reformers of science education aspire to. In the mathematics education reform community, terms such as constructivist, discovery, hands-on, problem-based, experiential, reform-orientation (as opposed to traditional), and authentic, have been used to describe an ideal approach to the teaching and learning of mathematics (Savery & Duffy, 1995; Jaworski, 2002; Smith, Desimone, and Ueno, 2005; Pauli, Reusser, & Grob, 2007). According to Pedaste, et al (2015), 5 (five) inquiry phases consist of 1) orientation, namely the process of determining curiosity, 2) conceptualization, namely the process of stating hypotheses or research questions, 3) investigation, namely the process of planning experiments or exploration, collecting and analyzing data, 4) conclusions, namely the process of drawing a conclusion based on data, and 5) discussion, namely the process of presenting findings and communicating with each other and actively participating in reflective activities. Despite the

terminology, the pedagogical emphasis by reformers in the mathematics and science education community has a general belief that learners learn very well when they are actively involved in the learning process rather than when taught by educators who is knowledgeable. This pedagogical belief, championed by Piaget (1964) and Vygotsky (1978), is rooted in constructivist learning theory.

While mathematical literacy has been propagated by policymakers and educational authorities, the term is not well defined in the scientific literature. Terms such as numeracy and quantitative literacy have been used, less is more synonymous with mathematical literacy, without a defining definition of what the term entails (Geiger, Goos, & Forgasz, 2015). Mathematical literacy is the capacity of an individual to score a thesis, work on and decompose mathematics into various environments. Mathematical literacy in it contains mathematical reasoning and utilizes mathematical concepts, rules, facts and tools to describe, explain and foresee phenomena. This helps a person in knowing the role that mathematics plays in the world and also in making appropriate/appropriate judgments and decisions needed by constructive, active and reflective citizens. (OECD, 2017).Some authors see the development of critical dispositions as the main aspects of mathematical literacy. In the model developed by Goos, Geiger and Dole (2014) the critical orientation is seen as an all-encompassing element. D'Ambrosio (2003) uses the term matheracy along with literacy and technoracy as essential to "providing, in a critical, communication, analytical, and technological instrumental way necessary for life in the twenty-first century". Based on the description above, the researchers developed inquiry-based mathematical literacy to encourage critical thinking. So that the purpose of this study is to produce an inquiry-based learning model design based on mathematical literacy.

METHODS

This research adapts the *Four-D* development model. Model suggested by Thiagarajan, et al (1974) consists of 4 stages of development, namely *define, design, develop, and disseminate.* The development product of this research is *an inquiry-based mathematical literacy (IBML)* learning model to encourage critical thinking. Figure 1 is a flow chart of the stages of development carried out.

1. Instrument

A research instrument is a set of tools used in research to obtain data. The instruments used in this development research are observation sheets, questionnaires and interview guidelines. The instrument is used to observe, collect information, and confirm all activities carried out in the school and is used at the define and design stage.

2. Analysis Data

The data that has been collected at each meeting is analyzed with descriptive analysis to provide an overview of the Needs Analysis and conceptual design for the development of diktats. The analysis is carried out as follows:

- Analysis at the Need Assessment and Conceptual Design stages
- Expert Questionnaire Analysis and Student Response

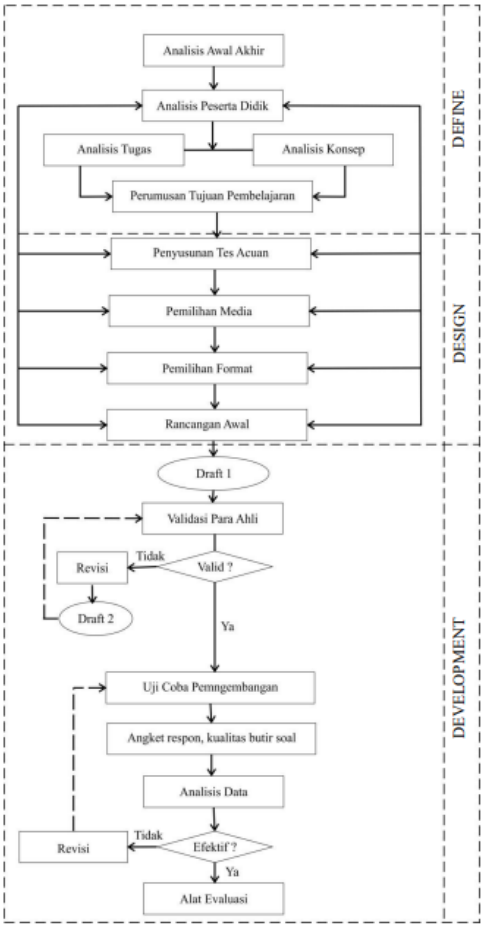

Figure 1. Research diagram

FINDINGS AND DISCUSSION

1. Findings

The first stage in the development of *an inquiry-based mathematical literacy* learning model is needs analysis. This needs analysis is carried out in 7 steps, namely:

Information Collection

Based on the flow chart above, information collection was carried out in this study. The information collected includes information about the learning programs at SD Muhammadiyah Manyar, information about mathematical literacy, information about students, information about the development of inquiry learning. The information obtained is described below:

Information on the learning program at SD Muhammadiyah Manyar

the school has a vision of "Becoming an Islamic and creative school that excels in piety, intelligence, and independence" has a learning program that emphasizes the ability to think high, one of which is the ability to think critically, this is stated in the ICP sub-curriculum. The existing ICP curriculum uses the Cambridge Assessment International Examination / CAIE which is implemented in 3 fields of study, namely mathematics, science, and English as second language. Based on the results of interviews with teachers in the field of study, this ICP curriculum greatly affects the thinking ability of students. This ICP class is also specially selected so not all classes have. The school wants to develop a learning model design that can be used in all classes, so that it can encourage the development of the higher-level thinking skills of its students.

Information about mathematical literacy,

mathematical literacy has been disseminated by policymakers and educational authorities, this term is not well defined in the scientific literature. Terms such as numeracy and quantitative literacy have been used, more or less synonymous with mathematical literacy, without a defining definition of what the term entails (Geiger, Goos, & Forgasz, 2015). Niss and Jablonka (2014) point out that researchers from non-English speaking countries may have objections to the use of the term based on the fact that it is not easy to translate and has no counterparts in many languages, including German and Scandinavian. For the PISA assessment, the OECD created a working definition that has been slightly altered over the years. Mathematical literacy is the capacity of an individual to synthesize, work on and decompose mathematics into various environments. Mathematical literacy in it contains mathematical reasoning and utilizes mathematical concepts, rules, facts and tools to describe, explain and foresee phenomena. This helps a person in knowing the role that mathematics plays in the world and also in making appropriate/appropriate judgments and decisions needed by constructive, active and reflective citizens. (OECD, 2017).

In the school, SD Muhammadiyah Manyar has been introduced to mathematical literacy starting from grade 4 and will continue to be improved in the upper grades. Mathematical literacy is raised as a design to develop critical thinking skills. This is in line with the opinion of D'Ambrosio (2003) using the term matheracy along with literacy and technoracy as essential to "providing, in a critical, communication, analytical, and technological instrument necessary for life in the twenty-first century". Matheracy is not about calculations or measurements, but about thinking and philosophy, about the ability to obtain, suggesting hypotheses and drawing conclusions from the data. Literacy, according to D'Ambrosio, is the ability to process information, such as the use of spoken and written language, characters and movements, codes and numbers.

Information about students,

students who are subjected to the development of *inquiry-based mathematical literacy* learning models is grade 4 totaling 78 students. The variables seen in learning are the characteristics of learners in terms of cognitive styles. Witkin et al. (1977) have shown that the cognitive style continuum *of field dependence/field independence* affects the preferences of, and responses to, various types of learning/teaching methods. While field *dependence* individuals have a preference for learning in groups and interacting with each other frequently as well as with teachers, *field independence* learners can respond better to a more independent and more individualized approach. The results of the GEFT test performed obtained data such as the following graph:

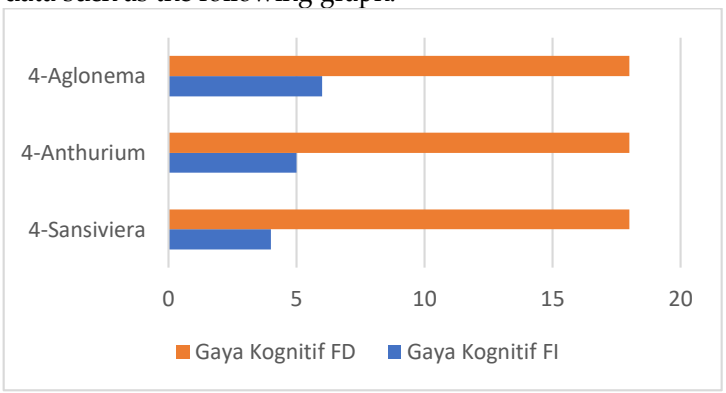

Figure 2. GEFT test result graph

The results describe a preference for studying in groups and interacting with each other frequently. this will be used as one of the factors for developing *an inqury-based mathematical literacy* learning model.

Information about the development of inquiry,

The use of inquiry learning was developed as a way to make mathematics more relevant to students, preparing them for an uncertain front in which the ability to ask questions, to reason, explore, explain

and develop creative and critical minds is seen as important. The following is presented a summary table of research for the development of inquiry learning models.

No	Title and author	Result
1	*Inquriy-based learning in maths and science classes*. (2013) Maaß, K., & Reitz-Koncebovski,	There are 6 stages, namely *Ask questions,* formulating conjectures (*Hypothesis formulas),* planning investigations / experiments (*Plan the investigation / experiment),* connecting experiments and evaluation results (*Conduct experiment and evaluate results),* Data interpretation (*interpret the data / generate knowledge),* (Discussion / presentation / reflection) *discussion / presentation / reflection.*
2	*Inquiry Based Science Learning in Primary Education*, (2015) Suduc, Bizoia , Gorghiu.	*Inquiry based science education* (IBSE) can generate student motivation, the application of learner inquiry skills, and the construction of meaningfulness and gain scientific knowledge.
3	*Phases of inquiry-based learning: Definitions and the inquiry cycle.* (2015) Pedaste, M., Mäeots, M., Siiman, L. A., De Jong, T., Van Riesen, S. A., Kamp, E. T., Tsourlidaki, E.	There are 5 stages of inquiry, namely *Orientation, Conceptualization, Investigation, Conclusion, Discussion*
4	*Building undergraduate STEM majors' capacity for delivering inquiry-based mathematics and science lessons: An exploratory evaluation study* (2020) Newton, Tonelly	The 5 stages of inquiry by Pedaste are combined with Duschel's theory. So that it becomes *An Orientation/Question, Conceptualization/Design, Investigation/Data, Conclusion/Conclusion, Discussion/Communication*

Identify Gaps

Kaufman's theory is used in the development of *inquiry-based mathematical literacy* learning models. This theory is known as the Organizational Elements Model (OEM) which consists of 5 related elements, namely *input*, *process*, *product*, *output*, and *outcome*.

- Inputs; conditions exist at this time, such as about building, time, finances, teachers, students, problems, goals, curriculum materials. The conditions available today have been very good, problems in learning can be solved with the collaboration of teachers. However, one goal to be achieved is to be able to develop learning that encourages higher-order thinking skills in all available classes.
- *Process*; that is, the implementation of direct education. The process consists of education that goes according to competence, individual learning, *staffing* patterns, planning, methods, and curriculum used. The school curriculum has already been formed and has been running very well. One of the advantages is the existence of the ICP curriculum.
- *Product*; namely the completion of education, knowledge, skills, and attitudes that arise, as well as graduation achievements.
- *Output*; consists of a graduation diploma, prerequisite skills, obtained licenses.
- *Outcomes*; that is, the final result that can be obtained.

Performance Analytics

The following are given the results of performance analysis consisting of identifying teachers, supporting facilities and completeness, various school / institutional policies, and social and psychological climate.

Table 2. Performance analysis

Identifying Teachers	• Teachers with S1 and S2 diplomas

	• Graduates according to the field of study and elementary school level. Especially for the field of mathematics studies have a diploma of S1 and S2 mathematics education • There is a teacher age balance between the senior and the junior
Identify supporting facilities and completeness	• Have enough classrooms • Has a science laboratory • Has a computer laboratory
Identifying school/institutional policies	• The curriculum used is K-13 and also integrates the prototype curriculum • More emphasis on Student centered Learning • Applying Lesson Study as a means of Brainstorming between lecturers in planning learning.

Identify barriers

Identification of Barriers and sources is carried out by examining time, materials, facilities, grouping compositions, personal and Organizations as well as philosophy. One of the obstacles that exist in the learning process is to encourage students to be able to think critically.

Learner Identification

Identification of Learners is carried out by interviewing the teacher and a cognitive style test is carried out. From the interviews conducted, it shows that the readiness of students at the elementary school level is qualified because all have passed the level in early childhood education. In addition, cognitive style tests are given to obtain maps and student preferences, so that they can be used in developing *inquiry-based mathematical literacy* learning models.

Purpose Identification

The following are given the results of identifying the objectives of research and development of inquiry-based *mathematical literacy* learning models. The data was obtained from the *Forum Group Discussion* (FGD). The objectives obtained are:

- How to build learner curiosity: develop and test researchable questions.
- How to build capabilities: designing and implementing investigations
- How to build assessment skills: assess students' initial knowledge, design assessment instruments, collect data, analyze and interpret.

Formulating the Problem

Jung, Pino, and Emory (1979) developed a format for formulating a problem. This format is known as *Research Utilizing Problem Solving* (GMS). There are 4 (four) main questions that must be answered in the GMS technique, the first, the one who is targeted, is it one self, the teaching group, or other groups, or the community?, secondly, who and what are the factors that cause the problem, is it caused by organizational factors? Weak support tools and materials?, third, what kind of problem is encountered, is it because of the lack of purpose about the goal? Is it caused by weak capability? Lack of adequate sources? Or lack of communication?, fourth, what are the development goals carried out, what is the differentiator when the goal is successfully achieved? What targets that should be achieved?

In the research and development of an inquiry-based mathematical literacy learning model, the subject of the study was grade 4 students at SD Muhammadiyah Manyar who obtained early learning of mathematical literacy. The problem faced is to design an inquiry-based mathematical literacy learning model design to encourage mathematical critical thinking of students at the elementary school level. Therefore, the purpose of this development is to develop an appropriate inquiry learning design to encourage mathematical critical thinking.

2. Discussion

Design Stage

Inquiry itself can have different goals in the educational process, Rezba, Auldridge and Rhea (1999) divide inquiry into several types (according to Banchi, Bell, 2008):

1. Confirmation questions: questions and approaches are given to student, the result is already known. The sole purpose of the investigation is to verify the results with the practice itself;
2. Structured questions: questions and approaches are notified to students by the teacher, the result is already known. The students form an explanation of the phenomenon given on its basis;
3. Focused questions: the teacher asks research questions, the students create a methodological approach and are aware of it;
4. Open-ended questions: the students ask questions themselves, they think about the approach, they conduct research and form the result.

The application of the instruction process can be divided on the activities of students and the activities of the teacher. Therefore, there is the term IBL (Inquiry-Based Learning) where this activity is related to student activities, and IBT (Inquiry-Based Teaching) where this activity is related to teacher activities. In this development, it will use Inquiry-Based Learning (IBL) which aims to carry out student activities so that they can have critical thinking skills. Stage instruction-based inquiry can be defined:

1. Activating the curiosity of students and increasing their interest in scientific issues,
2. Shifting students' curiosity towards educational projects: to challenge students to formulate the essence of a given problem using their own words,
3. to come from the definition of the problem to the investigation-based project planning; part of it is also the definition of the steps that lead to the realization of the project,
4. Realization of planned project activities,
5. Confrontation of results with reality; comparison of results and concrete conclusions with expected results; individual or collective validation of the results,
6. Processing the conclusions that emphasize the knowledge that has been obtained, and, subsequently, relate such conclusions to other scientific problems,
7. Connect science with ethics, technology, decision making and choosing the right solution.

The learning model is a broad and comprehensive teaching approach, having a coherent theoretical foundation or rationale of thinking about what will be achieved in a learning, teaching behavior, and learning environment needed to achieve learning goals (Arends, 2012). The design of the learning model developed refers to previous studies. In this study, using a lens from the development of inquiry-based learning by Maaß, K., & Reitz-Koncebovski, K. (Eds.) (2013). There are 6 stages, namely *Ask questions,* formulating conjectures (*Hypothesis formulas),* planning investigations / experiments (*Plan the investigation / experiment),* connecting experiments and evaluation results (*Conduct experiment and evaluate results),* Data interpretation (*interpret the data / generate knowledge),* (Discussion / presentation / reflection) *discussion / presentation / reflection.* The following is given the design of the Inquiry-based Mathematical Literacy Learning model

Table 2. Design An inquiry-based mathematical literacy learning model.

inquiry based learning phase by Maaß, K., & Reitz-Koncebovski, K. (Eds.) (2013)	**Inquiry-based Instruction Stage**	**Inquiry based Mathematical Literacy**
Ask question	An activation of students' curiosity and increased interest in scientific issues	*Ask questions:* Activate students' curiosity and increase their interest in scientific problems by providing open-ended questions: - the students ask their own questions, they think about the approach, they do the research and form the formulation of

		conjectures/hypotheses on mathematical literacy problems.
Formula hypothesis	Shifting students' curiosity towards educational projects: to challenge students to formulate the essence of a given problem using their own words,	*Hypothesis formula:* to challenge students to formulate the essence of a given mathematical literacy problem using their own words by being givena focused question: - the teacher asks research questions, the students create a methodological approach and realize it
Plan the investigation / experiment	Starting from the definition of the problem to the investigation-based project planning; part of it is also the definition of the steps that lead to the realization of the project	plan *the investigation/experiment:* From the definition of the problem to the planning of the investigation-based activity; part of it is also the definition of the steps that lead to the realization of mathematical literacy activities by being given focused questions.
Conduct experiment and evaluate result	Realization of planned project activities. Confrontation of results with reality; comparison of results and concrete conclusions with expected results; individual or collective validation of the results	*Conduct experiment and evaluate result:*the realization of planned mathematical literacy activities and confronted the results with reality.
interpret the data/ generate knowledge	Processing conclusions that emphasize the knowledge that has been obtained, and, subsequently, relate such conclusions to other scientific problems	*interpret the data/ generate knowledge:* comparing concrete results and conclusions with expected outcomes/hypotheses;
discussion/ presentation/ reflection.	Connect science with ethics, technology, decision making and choosing the right solution	*discussion/ presentation/ reflection.:* students perform collective validation of the results of mathematical literacy problems; Processing of conclusions that emphasize the knowledge that has been obtained, and, subsequently, relate such conclusions to other scientific problems.

CONCLUSION

The learning model developed is based on the inquiry based learning (IBL) learning model that has been developed by Maaß, K., & Reitz-Koncebovski, K. (Eds.) (2013). To show the focus on mathematical literacy, development was carried out on the IBL model instruction by paying attention to the types of inquiry that had been divided by Banchi, Bell, (2008). So, a design was obtained for the Inquiry-Based Mathematical Literacy (IBML) learning model to encourage critical thinking.

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In this section, We would like to thank the principal of SD Muhammadiyah Manyar for supporting this development activity. In addition, it is the participation of learners that has led us to the design of an inquiry-based mathematical literacy (IBML) learning model to encourage critical thinking.

CONFLICTS OF INTEREST

In this study, no conflict of interest has been found because the next stage will be carried out, namely trials in large quantities for testing the design of the development of inquiry-based mathematical literacy learning models.

REFERENCES

Abrami, P. C., Bernard, R. M., Borokhovski, E., Waddington, D. I., Wade, C. A., & Persson, T. (2014). Strategies for Teaching Students to Think Critically: A Meta-Analysis. Review of Educational Research, 1–40. https://doi.org/10.3102/0034654314551063

Arends, R. I. (2012). *Learning to teach*. New York: Mc. Graw-Hill.

Coffman, T. (2009). Engaging Students through Inquiry-Oriented Learning and Technology. Lanham, MD: Rowman & Littlefield Education.

D'Ambrosio, U. (2003). Stakes in mathematics education for the societies of today and tomorrow, Monographie de L?Enseignement Mathematique (39), 301–316

Filsaime, D. (2008). Menguak Rahasia Berpikir Kritis dan Kreatif. Jakarta: Preatasi Pustaka

Goos, Merrilyn & Geiger, Vince & Bennison, Anne & Roberts, J.. (2015). Numeracy teaching across the curriculum in Queensland: Resources for teachers. Final report.

Geiger, Vince & Forgasz, Helen & Goos, Merrilyn. (2015). A critical orientation to numeracy across the curriculum. ZDM. 47. 611-624. 10.1007/s11858-014-0648-1.

Hotimah, Nurul, & Nasrudin, Harun, 2019. Melatih Keterampilan Berpikir Kritis Peserta Didik Melalui Penerapan Model Pembelajaran Kooperatif Tipe Stad Berbasis Problem Solving Pada Materi Asam Basa Kelas XI SMA. Unesa Journal of Chemical Education Vol. 8, No. 1, pp. 53-58.

Jablonka, Eva & Niss, Mogens. (2014). Mathematical literacy.

Jaworski, B. (2002). Investigating mathematics teaching: A constructivist enquiry. Routledge.

Maaß, K., & Reitz-Koncebovski, K. (Eds.) (2013). Inquriy-based learning in maths and science classes. Freiburg, Germany: Pädagogische Hochschule Freiburg.

Newton, Tonelli Jr.(2020). Building undergraduate STEM majors' capacity for delivering inquiry-based mathematics and science lessons: An exploratory evaluation study. Studies in Educational Evaluation 64 100833

Ormrod, J. E. (2003). Educational Psychology: Developing Learners (4th ed.). New Jersey: Merrill Prentice Hall.

Pauli, C., Reusser, K., & Grob, U. (2007). Teaching for understanding and/or self-regulated learning? A video-based analysis of reform-oriented mathematics instruction in Switzerland. International Journal of Educational Research, 46(5), 294–305.

Pedaste, M., Mäeots, M., Siiman, L. A., De Jong, T., Van Riesen, S. A., Kamp, E. T., ... Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. Educational Research Review, 14, 47–61.

Piaget, J. (*1964*). Cognitive Development in Children Development and Learning. Journal of Research in Science Teaching, 2, 176-186

Sasson, I., Yehuda, I., & Malkinson, N. (2018). Fostering the Skills of Critical Thinking and Question-posing in a Project-based Learning Environment (Versi elektronik).Thinking Skills and Creativity, 29, 203-212.

Savery, J. R., & Duffy, T. M. (1995). Problem based learning: An instructional model and its constructivist framework. Educational technology, 35(5), 31–38.

Serafin, Dostal & Havelka (2015). Inquiry-Based Instruction in The Context of Constructivism. Procedia - Social and Behavioral Sciences 186. 592 – 599.

Smith, T. M., Desimone, L. M., & Ueno, K. (2005). "Highly qualified" to do what? The relationship between NCLB teacher quality mandates and the use of reform-oriented instruction in middle school mathematics. Educational Evaluation and Policy Analysis, 27(1), 75–109

Suduc, Bizoia , &Gorghiu (2015). Inquiry Based Science Learning in Primary Education. Procedia - Social and Behavioral Sciences 205. 474 – 479

Witkin, H.A, Oltman, P.K Raskin, E. 1971. Manual Embedded Figures Test, Children Embedded Figures Test, Group Embedded Figures Test. Consulting Psychology Press, Inc. California

Witkin, H.A, Moore, C.A, Goodnough D.R, dan Cox, P.W. 1977. Field Dependent and Field Inependent Cognitive Style and Their Educational Implication. Reviewof Educational Researh Winter. Vol 47. No.1

Wulandari, Riska & Anita, 2019. Model Pembelajaran Collaborative Learning untuk mendorong Keterampilan Berpikir Kritis Peserta Didik di Abad 21, Researchgate. Https://Www.Researchgate.Net/Publication/34570122