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Inquiry based learning: a student centered learning to develop mathematical habits of mind

A D Handayani[1,2]*, T Herman[3], S Fatimah[3], I Setyowidodo[2] and Y Katminingsih[2]

[1]Program Studi Pendidikan Matematika, Sekolah Pasca Sarjana, Universitas Pendidikan Indonesia, Bandung, Indonesia
[2]Program Studi Pendidikan Matematika, Universitas Nusantara PGRI Kediri, Kediri, Indonesia
[3]Departemen Pendidikan Matematika, Universitas Pendidikan Indonesia, Bandung, Indonesia

*Corresponding author's e-mail : apriliadwi@unpkediri.ac.id

Abstract. Inquiry based learning is learning that based on understanding constructivist mathematics learning. Learning based on constructivism is the Student centered learning. In constructivism, students are trained and guided to be able to construct their own knowledge on the basis of the initial knowledge that they have before. This paper explained that inquiry based learning can be used to developing student's Mathematical habits of mind. There are sixteen criteria Mathematical Habits of mind, among which are diligent, able to manage time well, have metacognition ability, meticulous, etc. This research method is qualitative descriptive. The result of this research is that the instruments that have been developed to measure mathematical habits of mind are validated by the expert. The conclusion is the instrument of mathematical habits of mind are valid and it can be used to measure student's mathematical habits of mind.

1. Introduction

The habit is a process in behaving and acting are done repeatedly until settled and automatically done. The process of changing the act or treatment into an automatic habit is not easy, among others: 1) Knowing. To make the slogan "do not throw garbage in the river" as a habit, every citizen must know first that disposing of the garbage is forbidden, 2) Accepting. After knowing the prohibition of throwing garbage in the river, there needs to be a process of receiving within the citizens. This can be done by giving motivation or benefit from the process to each person, 3) Doing. Receiving and understanding the benefits of "not littering the river" is not enough if there is no real implementation, 4) The existence of repetition. The real implementation needs to be done repeatedly to become a routine thing, 5) Habit. At this stage, the action will be automatically done in the face of similar situations.

Habit of mind is seen as a way of thinking, that when used normally, it can lead to the success on algebraic learning. The development of three algebraic habits of mind, namely: (a) performing mathematical processes; (b) rules to represent functions involving pattern recognition and generalization; and (c) abstracts of calculations involving thinking about structural calculations

without being tied to a specific number, such as acknowledment of equality about 5% of 7000 and 7% of 5000 [1].

Common thinking habits include recognizing patterns, experimenting, formulating, trying, creating, visualizing, and guessing [2]. Mathematical habits of mind, or mathematical approaches, among others, include small talk of small thinking (eg, learning concepts with related examples), small talk big think (eg, generalization, abstraction), thinking in terms of function, using multiple points of view and experimenting.

Habits of mind have two important characteristics: the characteristics of "thinking" and "accustomed" characteristics. In addition, habits of mind are associated with reflection of classroom practice. Mathematicians, educators, and other experts have tried to describe mathematical thinking, often using terms such as the mathematical habits of mind, mathematical processes, or mathematical practice. Students who only learn mathematical facts, definitions, rules, and procedures can solve math problems relatively easily [3]. But many of the same students later found that they could not use what they knew when they faced a real problem or situation. On the one hand, students who lack preparation and cannot apply what they have learned, while on the other hand, teachers continue to adhere to the old notion of mathematics that consists mainly of knowledge and skills [3].

Many overlapping descriptions of mathematical thinking habits. Mathematical habits of mind are closely related to the ability or observation to explain one's thinking about mathematical problems. Mathematical habits of mind involve dimensions of reasoning and reasoning itself [3]. Some descriptions of Mathematical habits of mind are constructed from the common intellectual habits of the mind, such as perseverance, persistence, listening and communication skills, or metacognitive skills such as reflection and analysis. Specifically, Mathematical habits of mind are related to mathematics, such as considering several ways to represent mathematical ideas, magnifying and narrowing aspects of a particular problem and the problem as a whole, the ability to connect ideas inside and outside mathematics, making conjectures and generalizations, understanding mathematical structures, remembering mathematical relationships, justifying and explaining mathematical solutions. Mathematical habits of mind are determined by the level of thought and age; students can develop and demonstrate the mathematical habit of mind in an appropriate way from their early experience with mathematics, the ability will increase year by year, and when students graduate from high school they have learned to develop a range of mental abilities, including habitual thinking.

Habits of mind is characteristic of what smart people do when they are faced with problems, and solutions are not immediately obvious. Habit of mind is a collection of sixteen problem-solving skills, skills related to everyday life, needed effectively for social life and supports reasoning, sensitivity, perseverance, creativity and expertise [4]. The understanding and application of the sixteen habits of thinking serves to give individuals the skills to work through real-life situations that equip people to respond to the use of conscious awareness (intent), thought, and strategy to achieve positive results.

Inquiry Based Learning is a learning model that encourages students to organize their own activities while studying mathematical statements. In mathematics inquiry, students take responsibility for directing the lesson with the teacher guiding the student's mathematical activities in the classroom.

The involvement of students in math inquiry begins with asking questions, making conjectures, planning and monitoring their math activities, exploring ideas in collaboration with friends, identifying when they will need new knowledge, asking teachers about the mathematics lessons they are learning, explaining the reason for answers and proving the results of their answers. While teacher activity in mathematics inquiry is utilizing student's' curiosity, connecting concepts and procedures, motivating students, building open inquiry, combining different forms of reasoning, developing initiative, independence and student leadership. Guided inquiry learning method leads to active participation of students in the learning process [5]. This learning method improves student's ability to analyze, synthesize, evaluate and relate the concepts contained in the learning with various disciplines and everyday life, thus causing the material to be studied more relevant for the students.

Inquiry is a term used both in education and in everyday life to explain how to get knowledge or information by asking questions [6]. Mathematical inquiry presents a clear similarity with scientific

inquiry. Like a scientific inquiry, mathematical inquiry begins with questions or problems, and the answers are got through observation and exploration; conducting experiments; make connections; and recognize appropriate mathematical techniques when needed.

In the Primas Report, inquiry is described as a deliberate process ranging from diagnosing problems, critiquing, experimenting, and differentiating alternatives, planning investigations, researching conjectures, seeking information, building models, arguing with colleagues, and forming coherent arguments. Use of Inquiry Based Learning is good for math and science education.

In the inquiry study, the educator acts as a provocateur, in the sense that the teacher (educator) is tasked to motivate the students in developing the initiative, independence and leadership as well as to arouse student's curiosity. The initial curiosity of students to conduct an inquiry is one of the major challenges of Inquiry-based learning. In this process, educators play an important role. Teachers contribute and broaden ideas, how to give question and how to investigate about student's ideas or theories. Teachers should find creative ways to introduce students to ideas and subject matter that interesting for them and offer potential inquiry or provide opportunities for students to engage in a sustainable inquiry. As individuals and small groups of students take different approaches to specific, through giving questions in the classroom, the teacher develops a classroom culture in which ideas emerge from each student. By hearing the opinion from their friend, students have a better understanding of their own ideas and approaches to questions and problems [7].

Inquiry Based Learning provides opportunities for children to build knowledge, abilities, and habits of mind that lead to a deeper understanding of their world and human experience [8]. The inquiry process focuses on developing interesting questions, formulated by teachers and children, motivating and guiding questions to topics and issues related to the content and outcomes of the curriculum.

Inquiry Learning is more than a simple learning method. Inquiry learning is a philosophical approach to learning and teaching, based on research and constructivist methods, involving children in investigations that lead to disciplined and trans-disciplinary understanding. Inquiry learning builds on the curiosity and wonder that is inherent in their children, their backgrounds, interests, and experiences. The process provides an opportunity for children to become active participants in collaborative search for meaning and understanding. The children involved in the inquiry can perform the following activities: 1) building deep knowledge and understanding, not just passively in receiving knowledge, 2) engaging directly in the process of discovering new knowledge, 3) finding conflicting ideas that transform knowledge and prior experience becomes a deep understanding, 4) transferring new knowledge and skills with new circumstances, 5) responsible for continuous learning and mastery of curriculum content and skills.

Inquiry learning motivates children to investigate topics in meaningful contexts. The process of inquiry is not in rigid, but flexible and recursive steps. Teachers as experienced reviewers will move back and forth through the cycle process as new questions arise and children become more comfortable with the process.

Questions of good questions are formulated within a broad scope and have many possibilities. They encourage children to explore, gather information, plan, analyze, interpret, synthesize, solve problems, take risks, make allegations, summarize, document, reflect learning, and develop new questions for further investigation [8].

As educators, teachers are faced with challenges and sensitivity in engaging students in learning so that they develop the skills and knowledge they need for everyday life [7]. One of the goals of teaching with inquiry is that students know and be able to transmit knowledge into other situations. This method consists of 4 stages: 1) the teacher stimulates the student with questions, problems, games and puzzles, 2) In response to the stimulus he receives, the student determines the procedure of seeking and gathering the information or data it needs to solve the question, and problems, 3) Students appreciate the knowledge they gain with the new inquiry, and 4) Students analyze the methods of inquiry and procedures that are found to be used as general methods that can be applied to other

situations. Inquiry learning is one of learning which is based on understanding constructivist mathematics learning.

2. Methods

This research is a descriptive qualitative research. at the beginning of the study conducted a study to learn more about the basic theory and the relationship between inquiry based learning and the relation to support the development of mathematical habits of mind. After an instrument was developed to measure the mathematical habits of mind. After compiling 39 items from sixteen indicators of mathematical habits of mind, then validation of the instrument is performed by the experts. The results are further described in order to be clearer.

3. Results and Discussion

Criteria mathematical habits of mind, namely [5]:

3.1. Diligent

Do the task to completion, and stay focused.

3.2. Manage impulsively

Take time to consider choices, think before talking or acting, stay calm when stressed or challenged, wise and caring with others, then proceed with caution.

3.3. Listening with understanding and empathy

Paying attention and not ignoring the thoughts, feelings and ideas of others, trying to put yourself in the shoes of others; Tell others what they are saying; Resist the mind to remain in a state of respect for others' point of view and feelings.

3.4. Flexible Thinking

Be able to change perspective, consider input from others, generate alternatives, weigh the options.

3.5. Thinking about Thinking (Metacognition)

Bringing out your own thoughts, feelings, intentions and actions; Knowing what I do and say affects others, Willing to consider the impact of choice on myself and others.

3.6. Trying with great effort

Checking errors, measuring at least twice, wanting precision and expertise.

3.7. Questioning and disguising problems

Asking yourself, "How do I know?"; Develop interrogation stance; consider what information is needed, choose a strategy to get information; consider the constraints needed to solve the problem.

3.8. Applying past knowledge to a new situation

Using what is learned, remembering previous knowledge and experience; Apply knowledge beyond the circumstances in which he or she studies.

3.9. Think and communicate clearly and precisely

Try to be clear when speaking and writing; strive for accuracy while speaking and writing, avoiding generalizations, distortions, minimization and deletion of speech, and writing.

3.10. Explores all sensitivities

Does not stop to observe what is being seen, listen to what is heard, pay attention to what smells, feel what is eaten, feel what is touched.

3.11. Creating, imagining, innovating
Thinking about how something can be done differently from the rules; proposing new ideas, striving for originality, considering new suggestions made by others.

3.12. Respond curiously
Intrigued by the beauty of the world, the forces of nature and the vastness of the universe, notice what is amazing and touching the heart, open to small and big surprises in the lives and lives of others.

3.13. Taking Responsibilities
Willing to try something new and different; consider doing something new, do not be afraid to make mistakes or short-term risks.

3.14. Finding humour
Willing to laugh right; looking for something strange, ironic and unexpected in life, laughing at yourself when you can.

3.15. Interdependent Thinking
Willing to work with others and accept their inputs and perspectives, Comply with work group decisions even if not agree, willing to learn from others in reciprocal situations.

3.16. Open minded to continue learning
Open to learn from new experiences, proud and low enough to admit when not knowing, receiving new information in all subjects.

From sixteen indicators of mathematical habits of mind were developed into 39 statement items. After the instrument of the scale of attitude of mathematical habits of mind is composed of 39 questions further validation is done to measure the validity of the instrument. Expert validation is performed by an expert in mathematics education. The results show that the instruments that have been compiled are valid, but still require some revisions. Expert advice for revisions is presented in Table 1.

Table 1. Revision of mathematical habits of mind questionnaire from validator.

Revision from Validator	Follow up revision
Instructions for filling questionnaire need to be clarified	instructions for filling questionnaire is clarified by using the effective and complete sentences
avoid using ambiguous statement phrases	The statement is arrange into clearer statement
avoid the use of five options because respondents often to choose neutral option	The questionnaire is arrange to four option to avoid the neutral answer by respondence

4. Conclusion

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