THE RELATIONS OF FORMAL THINKING ABILITY AND INQUIRY APPROACH IN SCIENCE LEARNING

Lina Arifah Fitriyah, S.Pd., M.Pd.
Program Studi Pendidikan IPA, FIP, Universitas Hasyim Asy’ari Jombang

Abstract

The science learning includes on learning process and product. Improving the quality of science learning that emphasizes the learning process can be done by giving the scientific work experience to students. Thinking skills of learners to be one of life skills that are needed to address the increasingly complex problems of life in the information age. Teachers are expected to plan and implement accommodate learning thinking skills. Formal thinking skills is the ability of learners to receive intellectual stimulations in the process of science learning concepts microscopic properties. Formal thinking skills give a small role in the ability inkuri someone. The suitable approach to improve the ability of intellectual inquiry is inquiry approach. Using a inquiry approach in laboratory-based, students have many opportunities to obtain data directly, interpret data, create hypotheses, test these hypotheses and discuss them to draw a conclusion. In guided inquiry learning approach, students are also more stimulated to find their own concepts in science. The students who have already begun to enter the formal level of thinking has been able to develop their own skills to find something that can be used to solve the problems faced.

Keywords: formal thinking skills, inquiry approach

INTRODUCTION

In this time, continue to evolve so as to bring considerable influence on the side of life, including in the field of education. In addition science and technology also requires qualified human resources who have the competencies required by the state holder. To improve the quality of Indonesian human resources, the Ministry of Education and Culture through Permentnikbud No. 54 Year 2013 on Competency Standards for Primary and Secondary Education as follows:

Competency for graduates from senior high school / MA / vocational high school / MAK / special senior high school / Package C of Equality Test has the attitude, knowledge, and skills. Attitude dimensions qualification ability have behaviors that reflect the attitude of the faithful, noble, knowledgeable, confident, and responsible to interact effectively with the social and natural environment as well as the place itself as a reflection of the nation in the association world. Dimensions of knowledge qualification ability have factual knowledge, conceptual, procedural, and metacognitive in science, technology, art, and culture with insight into humanity, national, state, and civilization-
Lina Arifah F: The Relation of Formal Thinking Ability and Inquiry Approach In Science Learning

Dimensions of skill qualification ability have thinking ability, effective and creative acts in the realm of the abstract and concrete as learned in the development of independent schools.)

Based on Competency Standards for Primary and Secondary Education showed that the students thinking skills need to be designed and implemented in a planned manner through learning. Students thinking skills will develop well if developed intentionally. To develop the potential of learners think learning should be implemented that can train students to develop the capacity to think.

Science deals with the natural way of finding out about a systematic manner, so that science is not only a mastery of knowledge in the form of a collection of facts, concepts, or principles, but also a process of discovery. Learning science is expected to be a vehicle for students to learn about themselves and the environment, as well as prospects for further development in applying them in everyday life. The learning process emphasizes providing direct experience to develop competence in order to explore and understand about scientific nature. Science education and inquiry directed to do so can help learners to gain a deeper understanding of the nature around.

Learners can indicated successful in learning from (1) understanding of the concept, (2) characteristics of learners, and (3) the learning process. Learning science in outline consists of a concept that is both macroscopic and microscopic. Macroscopic concepts is generally quite easy to understand compared to the concepts that are microscopic and can be seen or felt its presence with the five senses. Microscopic concept can not be formed directly from the observations because the state is actually very small and can not be observed with the five senses that required the ability to imagine.

To understand the concepts of science thinking skills, students needed formal thinking because science has a abstract concepts (microscopic). If there are students who have not reached the level of formal thinking skills then he will have difficulty in understanding abstract concepts that are also likely to have a false understanding of the concept in question.

Considering each student has a unique / special characteristics and there was never any two students have exactly the same life experiences, almost certain that learners have with one another learning speed, learning, and so different. Because of the diversity of the characteristics of learners, so teachers need classifying or grouping characteristics to facilitate learners in performing their duties with a more strategic level. Thus characteristics of students can also be said to be influential in the success of learning.

According to Piaget [1] level of intellectual development consists of four levels, namely sensorimotor, preoperational, concrete and formal. As we explained before that to understand concepts in science learning can be well understood by learners who have reached formal thinking skills. Based on research [2] that to study the natural sciences, especially the level of senior high school / MA / SMA LB / Package C of Equality Test required level
thinking skills formal abstractness because the higher the natural sciences.

Formal thinking abilities according to Piaget's theory of intellectual development in general has been owned by the students who have aged 11 years and over. But apparently not all of the students who have aged 11 years and over have the ability to think of formal [3], [2] research results (1983) reported that the proportion of learners class VI, VII, VIII, IX, and X show the formal thinking ability is still very small in the range from 12 to 15%. Pavelich and Abraham (1979) in his study reported that only 14% of students who have reached the level of formal operations level, 78% at the intermediate level (transition) and the remainder was still at the concrete operational level. Good, Kromhout, and Mellon (1979) concluded that the intellectual development of high school students and students who have reached the level of formal thinking ranged from 25 to 75%.

The process of inquiry aimed to cultivate the ability to think, work and behave scientifically and communication as one of the important aspects of life skills. In any inquiry process students learn and how they should be trained to think that the ability to think learners will increase because they are always faced with the information and analysis they need to conclude. According to Renner [4] one of the learning approaches that engage learners in finding that the concept of learning used by inquiry approach. In the process of inquiry learning approach, the ability of inquiry students will continue to be honed so that learners become easier to understand the concept.

[4] Also argues that freshmen do not yet have enough stock to do a practicum (lab activities) in finding the basic concepts in free inquiry and still need guidance from teachers that suggest learning by using guided inquiry approach. Therefore the inquiry approach, students are guided to discover concepts through the provision of problems, demonstrations or experiments, questions or instructions implementing directives trial.

And then, to improve the quality of graduates / students, learning science should accommodate those aspects that can train students to think / develop the capacity to think. Due to the characteristics of the scientific concepts required formal thinking skills and inquiry approach.

**FORMAL THINKING SKILLS**

The term human development according [5] refers to how people grow, adapt and change throughout the course of their lives, through physical development, personality, socio-emotional, cognitive and language. Each student has achieved a certain development prior experience learning in school. The development of learners’ learning is influenced by the diverse cultures of the family and the [1] Says that each individual experience levels of intellectual development. Each level gives an overview of the development of the cognitive content of a typical structure in accordance with the difference between the levels. The intended levels are as follows:

1. **Sensorimotor stage (at the time of birth until the age of 2 years).** The earliest stage is called sensorimotor because during this stage, babies and young children to explore their world using the senses and motor skills they have.

2. **Preoperational stage (ages 2 to 7 years).** If the baby can learn and understand the world only by manipulating physical objects,
preschool children have a greater ability to think about everything and can use symbols to represent objects in mind. During the preoperational stage, the language and concepts children develop with incredible speed. Preoperational child has egocentric, that children have difficulty to accept the opinions of others.

3. **Concrete Operational Stage (ages 7 to 11 years)**. This stage is the beginning of a child to think logically, this means that the child has the logical operations that can be applied to concrete problems.

4. **Formal Operational Stage (ages 11 years and over)**. This stage the child can use concrete operations to establish operations are more complex and have been able to think abstractly, which in turn can make deductions or conclusions are logical. Indicators of formal thinking skills is the ability to think abstractly, the ability to use logic and hypothetico-deductive thinking.

To measure the intellectual development of children can use Burney’s test. Burney’s test consists of 24 items about which is based on the tasks developed by Inhelder and Piaget.

The reasons for using standard test instruments according [2] is as follows:
1. Used a relatively short time is 30-60 minutes.
2. Implementation does not require special skills.
3. Indices of reliability and validity of the test is quite high at 0.852 and 0.853. Ardhana trial results in Abdurrahman (1999) obtain reliability and validity index of 0.6 and 0.56.
4. Test material were divided into 4 groups: (a) the reflection angle the ball, (b) the balance in the scales, (c) the surface of the water in the vessel-related, and (d) projection of shadows on the screen.

In order to determine whether students have achieved the ability to think formally or not can be known from the scores obtained by students in the Burney’s test. When learners have achieved a score between 17-24 so that learners can be categorized has reached formal thinking skills while learners who have not achieved a score of 17 means that the student has not reached a formal thinking skills.

**INQUIRY APPROACH**

Learning science is expected to be a vehicle for students to learn about themselves and the environment, as well as prospects for further development in applying them in everyday life. The learning process emphasizes providing direct experience to develop competence in order to explore and understand the universe around scientifically. One of the learning that takes into account such things is learning by using inquiry approach.

**Definition Inquiry Approach**

Inquiry is derived from English, intransitive verb to inquire which is to investigate. According to the dictionary is defined as a search for truth, information, knowledge, or research. The verb was later developed into a noun whose meaning is the same as the inquiry investigation, namely the investigation. Thus the inquiry can be defined as the process of asking questions and finding out the answer to a scientific question. Scientific questions are questions that can lead to an investigation into the activities of object questions. In other words, inquiry is a process for obtaining and get information by observation or
experiment to find an answer to a question or solve a problem or formulation problems by using critical and logical thinking skills.

There are several opinions about the approach of inquiry include: [6] stated that the inquiry as a learning situation for students preparing to conduct their own experiments; within the meaning of want to see what would happen, wanted to do something, want to use the symbol symbols and seek answers to questions raised themselves, connect with one another discovery, comparing what was found by other people are found. [6] Also explained that the inquiry as a process of defining and investigating problems, formulating problems, designing and conducting experiments, collecting and analyzing data, to draw conclusions. According to [7] suggested that the inquiry leads to the ability of learners and teachers are required to design and conduct a scientific investigation. Based on the above it can be concluded that the inquiry approach is a series of lessons that involve all students' abilities to locate, investigate, and found the concept of the experiment / study literature, question directives and guidelines in a systematic experimentation, critical, logical, analytical, so that they can formulate their own findings with confidence.

**The strengths and weaknesses of inquiry approach**

Based on the research that has been done suggests that some education experts, the implementation of inquiry models provide several advantages, which are as follows:

a. Found that application of the model of inquiry in science learning can improve thinking ability and scientific work of a high level learners [8].

b. States that some of the advantages of the process of inquiry include: first, the students will understand the concepts better. Second, assist learners in using memory and transfer in learning situations are new. Third, encourage students to think and work on his own initiative. Fourth, encourage students to think intuitively and formulate their own hypothesis. Fifth, provide intrinsic satisfaction and a more stimulating learning situations [9].

c. The process of learning to student centered. The role of the teacher is more emphasized as mediator, facilitator and process development motifator inquiry learners.

d. Establish and develop a self-concept and individual skills. Models of inquiry gives learners the freedom to determine his own way in getting the concept. The existence of a sense of security and flexibility in the learning process, can encourage learners to develop other talents, such as planning, organizing, social communication, creativity and academic.

e. Preclude learners from rote learning methods.

f. Provide sufficient time for students to assimilate and accommodate information.

g. Inquiry approach is supported by four main characteristics of learners, namely (1) instinctively inquisitive learners, (2) in the conversation learners always want to talk and communicate ideas; (3) in building (construction) learners always want to make something, (4) students always express art. From the perspective of the learner, the learning model is the end of the class paradigm of learning through listening and giving them the opportunity to
achieve the goals real and authentic. For teachers, inquiry-based in education is an end of speaking paradigm to teach and transform their role into a colleague and mentor for student participants.

In addition to having many advantages, inquiry learning model is also not free of the weaknesses, among others:

a. Inquiry learning model requires considerable time and adequate means of support.

b. Demands the ability of teachers, particularly in terms of the ability to set conditions for learning that can motivate learners for do the inquiry approach itself. These capabilities are likely not shared by most teachers.

c. Ability of learners which may affect the outcome of a variety of inquiry in the learning process.

Types of Inquiry Approach

For many years has conducted research on the openness scale inquiry as a method of learning science. [10] divides the scale into three levels of inquiry learning. The division is based on the level of student involvement in the research process, the level of involvement of teachers in guiding learners, background science students on the objects of research and other work-related methods. The first level of inquiry, problem solving and process have been raised by teachers, learners then work to find answers to the problem under the intensive guidance of the teacher. The second level of inquiry, learners significantly inkuirinya planning process based on the problem given by the teacher. Teachers emphasize the temporary nature of the (tentative) conclusion that makes an activity more like problem solving as in real life, where decisions can always be improved. While on the third level of inquiry, all phases of inquiry determined by openly learners, ranging from identifying problems, planning inquiry process until the decided conclusion [11].

categorizes as a first-level inquiry guided inquiry. While the second and third level inquiry into the category of open inquiry.

Inquiry approach can be implemented with two forms of free inquiry and guided inquiry. In free inquiry learning, select issues, planning experiments, analyzing data, and infer learner. The guided inquiry learning, select the problem and plan experiments done by teachers, while analyzing the data and concluded the data carried by learners.

Stages of Inquiry Approach

Inquiry approach based laboratory has phases that, namely the identification of the problem, hypothesis, experimentation, evaluation of hypotheses, and making inferences. As for the stages of inquiry approach can be described as follows:

a. Problem formulation phase: in this phase, the ability to be achieved by learners is the ability to understand a phenomenon that occurs, so as to determine the priority of the problem and take advantage of his knowledge to analyze problems that can be solved.

b. Hypothesized phase; learners are expected to determine the causal relationship of the problem to be solved. Through this analysis of causation in the end the students are expected to determine a variety of problem-solving possibilities.

c. Experimental phase: in this phase the students were asked to perform testing of hypotheses through experiments made. Expected ability is kecakapanpeserta students to
gather and select relevant data, and maps and present it in different views so it is easy to understand.

d. **Evaluation hypothesis phase**: in this phase the students were asked to evaluate whether their proposed hypothesis is accepted or rejected. The ability expected in this stage is to interpret the data in order to see the proficiency to do with the problem being studied. When found some irregularities in data collection and will have an impact on making the final conclusion as a result of the evaluation of the hypothesis, then the students were asked to read the literature (text book) and evaluate the processes that have been run previously in class discussion.

e. **Make decisions phase**: learners at this stage to make a decision in the form of conclusions based on hypotheses and use the conclusion to build a concept / theory.

THE RELATIONS OF FORMAL THINKING ABILITY AND INQUIRY APPROACH

Basically, every students are not same with others and the ability of each child to master and understand is also different. According [12] that the learner is a unique individual, it’s meaning there are not two people are exactly same, every student has a different with each others. The individual differences are influence in learning styles and learning outcomes. Hence, individual differences need to be considered by the teacher in the learning effort that takes into account the learner's intellectual development. By knowing the intellectual development of students, it can be chosen the right way of learning, which is a strategy / approach for effective learning.

The suitable approach to improve the intellectual abilities of learners is inquiry approach. Inquiry approach to further hone / attention to teamwork. Through the inquiry approach that integrated with laboratory activities, students have many opportunities to obtain data directly, interpret data, create hypotheses, test these hypotheses and discuss them to draw a conclusion.

This is consistent with the results of research conducted by [13] where the intellectual development of students who learned with guided inquiry way higher than the intellectual development of students who are taught the verification approach.

The intellectual ability can be measured by tests of formal thinking. Based on calculations, the ability to think formally give a small role in the ability inkuri someone. There are several versions of the formal tests of thinking skills that can be used to measure the level of intellectual development based on Piaget's theory of intellectual development. Test instruments that can be used for mapping and identification of early to know the level of intellectual development of students.is Piaget's Formal Instrument Objective (POFI) developed by Burney, so the test is named Burney’s test.

The students who have the intellectual ability (the ability to think concretely, the transition from concrete to formal and formal thinking abilities) will be able to improve their learning outcomes. [14] states that there are significant differences in learning outcomes of students who have the ability to think concretely and transition. Thus the result is in line with the theory that the level of intellectual development is one of the characteristics that will affect the
achievement of student learning outcomes [15].

The students who are at the level of concrete thinking skills and the transition take time in order to achieve formal thinking skills. [16] States that students who have not had formal thinking skills (just reached the stage of concrete operations and the transition from concrete to formal) will have difficulty understanding abstract science learning.

In the learning process, learners should receive intensive intellectual stimulations. The intellectual stimulation in the learning process and teachers to fully use the approach to the characteristics or individual differences that encourage the development of thinking skills formal learners.

Learners who have already begun to enter the formal level of thinking has been able to develop their own skills to find something that can be used to solve the problems faced. Based on research Fitriyah (2010) the ability of higher order thinking abilities of students who have the ability to think concretely and significantly different transitions. To reach the capability level a high level need to pay attention to ability to think formal students with way using approach and pay attention differences internal factors students. [14] expressed anyway that the approach inquiry learning in addition to can accommodate learners is based on modality learn also can develop the ability thinking learners namely capability high level and thinking ability formal. According to [12] the main purpose approach of inkuri namely develop the ability intellectual, critical thinking, and ability in solving problem scientifically.

By knowing the intellectual development of students before the learning begins and conducted inquiry approach in teaching and learning, it can lead students to be more motivated to satisfy curiosity utilizing learners in thinking and trying to find information from a variety of credible sources and using data from various sources can be used as capital for troubleshooting.

With using the ability to think and abilities of inquiry, the result of learning through inquiry approach learners are able and capable of reasoning and understanding of conservation in a problem.

According [17] ability to understand the issues related to conservation appears in individuals who are at the beginning level of formal thinking. Inhelder and Piaget give examples of problems that can be used to determine a person's ability to understand the problem as below.

There are two pieces of clay with the same shape, size and mass. Shaped clay balls shown in subjects who tested that the clay mass is equal to how to put the balls on the scales. Then one of the clay balls and flattened tested subjects were asked to answer the question, "How does the mass of the two balls of clay after one flaked?", And give the reasons for the answers given. Subjects were tested successfully expressed the task if she answers that the mass of the second ball of clay is the same, and give the exact reason of the answers given. The success of the subjects in answering the question on the grounds that the right to show that he has been able to understand the problems of conservation.

[1] Also suggests an example of reasoning problems requiring proportional reasoning ability do to solve it. Provided a balance that both arms of the same length and homogeneous, and some weights with
different masses that can be hung on both arms scales. Subjects were tested were asked to find the law that controls the equilibrium on scales through experiments using equipment that has been provided.

Criteria for success in these tasks is the ability to determine the law that controls the balance on the scales, which is the product of the mass of the load by the distance to the fulcrum on one arm is equal to the product of the mass of the load by the distance to the fulcrum on the other arm. When subjects were tested successfully find the legal means the subject can do proportional reasoning.

REFERENCES


