Apply model of teaching levels of inquiry for identifying experimental skills on solar system matter in the middle school

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Abstract. Apply model of teaching Levels of Inquiry in middle school level can identify experiment skills use the similarity from every stage in Levels of Inquiry process according to ten aspect of experimental skills that is adopted from Brotosiswojo and Richard J. Rezba. There are observation, making prediction, knowing variable, formulating hypotheses, operating variable, designing experimental procedure, collecting data, analyzing data, and making conclusion. This research is applied in the one of the middle school in Lembang, West Java with solar system as the matter. The research design used one group pretest-posttest design to 30 seventh-grade students. The learning process used semi-experimental phenomena because solar system matter in the middle school does not deliver much mathematic analyze. Collecting data from three meetings with different sub matter (time zone, moon phase, and solar eclipse). Supported instrument is student worksheet assessed using Lati criteria (very poor, poor, fair, good, and excellent). Identifying experiment skills can use its model and it can enhance from first to third meeting with the result is poor, fair, and good.

1. Introduction

Nowadays, we almost always meet with the quotes “Experience is the best teacher”. As many researchers since 1960 that said science process learning is important to give meaningful experience for students’ knowledge, skills, ability, or another [1-2]. Learning in the class isn’t focused on what they have to know, but make student to know the concept. The way you teach have to coherence with the indicator. The curriculum discloses that science learning is appropriate by engaging students through real experience, through inquiry [3], and through a scientific approach [4].

Scientific process skills can practice students’ experimental skills, such as 1) knowing variables, 2) operationalizing variables, 3) formulating hypotheses, 4) designing experiments, and 5) testing hypotheses [5-6]. The experimental skills is an integration of knowledge and skills to build an important process in a scientific investigation. Some of the difficulties is found in students in experimenting, among others: no familiar variables, not used to make predictions, and conclusions are not based on data [7]. The results of his research also showed that have not achieved the ability or high-level process skills such as design research activities (29%), interpret and report data (43%). Based on these data indicates that students experimental skills are still minimum and the learning process has not been able to practice students, especially in science materials. One of the reason there is no standard in physics practice exam that became the school reference. The results of the analysis
that the experimental guidelines are only 20% of schools that appropriate to the standards of physical practice processes [8].

The government expects lessons in the classroom rather than just deliver concept and ends with a school final examination. But it is also necessary to pay attention to the ability of students' science processes. The method used in the form of scientific learning that allows students to find first (discovery learning).

Problems that occur in junior high school students are generally they do not understand the material too deep and students are not confident when delivering the results of their thinking due to fear to be wrong. This problem is minimized as much as possible by delivering more interactive material and using approaches that elicit students' critical thinking. Inquiry is one of the most effective learning approaches to improve students' science process skills [9]. Experimenting using inquiry approaches can help students to understand concepts by practicing them directly and creating simple experiments made by the students themselves.

Scientific learning is in line with the pattern of the Model of teaching: Levels of Inquiry developed by Wenning since 2005 to construct the mindset and understanding of students especially in science subjects. Model of Levels of Inquiry is a continuous stage, the higher stages then the teacher's role is reduced because of the influence on student activity. When the teacher tries to teach the process of inquiry, it should increase through a series that goes hand in hand to a higher level of pedagogical practice, each level having a complex set of complex inquiry processes. Each level of inquiry itself has its own orientation, especially in the stage of concept mastery of students as in the Discovery learning stage, students are led to build concepts and knowledge from experience, then in the Interactive demonstration stage that helps students to reach conclusions through proof, followed by other levels [9].

2. Methods
The research design used is Quasi Experiment with one group pretest-posttest design, the respondents used cluster random sampling which was chosen only one class in one of the junior high school in Lembang with the number of respondents is 30 students. The analysis look at the development of students in one class during the three meetings for the material of the Solar System that is for sub time zone matter, moon phase, and solar eclipse. Each student meeting is given a different designed experiment and learning using the Levels of Inquiry model, then to see the identification of 10 aspects of students' experimental abilities.

The instrument used to measure the implementation of the model of Levels of Inquiry is a worksheet filled by observer and students’ experimental skills is measured by students worksheet created with each level applied (Discovery learning, Interactive demonstration, Inquiry lesson, and Inquiry laboratory) followed by 10 aspects of experimental skills. Assessment conducted using a score scale of 0-100, then the score is converted into Lati criteria (very poor, poor, fair, good, and excellent). Results of students experimental skills during 3 meetings (3 concept) are compared each other and we can obtain the data in every experimental skill.

3. Results and Discussion
Based on the assessment from implementation of Levels of Inquiry model. It said that the teacher still dominates than the students in the learning process. The comparison between teacher and students implementation is 82% and 75%. The implementation by teacher almost in each meeting is good enough, therefore the implementation by the students get progress in each meeting (concept) just as follows,
Table 1. Comparison of Levels of Inquiry Implementation in Each Concept

| Levels of Inquiry       | Experimental Skills | Time Zone | Moon Phase | Solar Eclipse |
|------------------------|---------------------|-----------|------------|---------------|
|                        |                     | Tch. (%)  | Stud. (%)  | Tch. (%)      | Stud. (%) |
| Discovery Learning     | OB                  | 80        | 70         | 90            | 85         | 90        | 90 |
|                        | PR                  | 80        | 72.5       | 87.5          | 85         | 90        | 85 |
| Interactive Demonstration | KV              | 85        | 60         | 90            | 75         | 95        | 90 |
|                        | HIP                 | 65        | 35         | 80            | 70         | 90        | 80 |
| Inquiry Lesson         | OV                  | 85        | 80         | 87.5          | 82.5       | 90        | 90 |
|                        | PRO                 | 47.5      | 35         | 82.5          | 70         | 87.5      | 80 |
| Inquiry Laboratory     | EX                  | 80        | 70         | 85            | 80         | 85        | 85 |
|                        | PD                  | 80        | 70         | 80            | 80         | 85        | 85 |
|                        | ANL                 | 75        | 65         | 80            | 75         | 82.5      | 80 |
|                        | CON                 | 70        | 60         | 80            | 77.5       | 85        | 80 |
|                        | Average             | 75        | 62         | 84            | 78         | 88        | 85 |
|                        | Whole Average       | 82        | 75         |                |            |           |    |

Note: Tch.: Teacher; Stud.: Students; OB: Observing; PR: Prediction; KV: Knowing Variable; HIP: Formulating Hypothesis; OV: Operating Variable; PROC: Designing Experiment Procedure; EX: Executing Experiment; PD: Processing Data; ANL: Analyzing Data; CON: Conclusion

Especially in the first meeting the implementation of Levels of Inquiry by the students is not going well because they haven’t known about new model of science and it is really affected to the activity in the class. The teacher must control them and finally the domination of the teacher is higher than the students. Actually, make the students understand first to make the learning process is able to continue. In the Interactive demonstration and Inquiry lesson need much time to inform about knowing variable, such as dependent variable, independent variable, and control variable. But there is increasing implementation of Levels of Inquiry in the next meeting (moon phase and solar eclipse matter). Another reason why the model of Levels of Inquiry cannot be good enough because we need more time to do this model in every science learning [14], and also depend on the quality of the teacher to prepare the class well [15].

According to Hierarchy Inquiry Process above, higher level that is used in the class then student engagement will be higher too. But based on data that are obtained, the score of implementation in higher level (inquiry laboratory) is lower than the student engagement in discovery learning. This is caused by the concept built in the discovery learning level is not sufficient for the next level, or other reason in discovery learning that is not compatible with the last goal. Recommendation for the next research, teacher also has to prepare well the investigation questions for connecting to the next level in each Level of Inquiry process and reach the goal.

Here are the data from experimental skills worksheet which describe the identification of students’ experimental skills in every meeting.
Table 2. Lati Criteria of Students Experimental Skills for Each Content.

| No | Experimental Skills | Time Zone | Moon Phase | Solar Eclipse |
|----|----------------------|-----------|------------|--------------|
| 1  | OB                   | 70        | 70         | 89           |
|    |                      | Fair      | Fair       | Excellent    |
| 2  | PR                   | 89        | 86         | 94           |
|    |                      | Very good | Fair       | Excellent    |
| 3  | KV                   | 55        | 67         | 92           |
|    |                      | Poor      | Very good  | Excellent    |
| 4  | HIP                  | 48        | 56         | 60           |
|    |                      | Poor      | Fair       | Excellent    |
| 5  | OV                   | 51        | 91         | 90           |
|    |                      | Poor      | Excellent  | Excellent    |
| 6  | PROC                 | 45        | 70         | 70           |
|    |                      | Very poor | Fair       | Fair         |
| 7  | EX                   | 43        | 71         | 91           |
|    |                      | Very poor | Good       | Excellent    |
| 8  | PD                   | 43        | 69         | 78           |
|    |                      | Very poor | Fair       | Good         |
| 9  | ANL                  | 41        | 48         | 79           |
|    |                      | Very poor | Very poor  | Good         |
| 10 | CON                  | 53        | 61         | 59           |
|    |                      | Poor      | Fair       | Poor         |
|    |                      | 54        | 69         | 80           |
|    | Average              | Poor      | Fair       | Good         |

Based on the data in each aspect there are increasing score in students own worksheets, these data could be analyzed horizontally and vertically. Which is mean to analyze in each meeting we could see horizontally and as whole average we obtained 54 (poor) to 69 (fair) and 80 (good) for the last meeting in Solar eclipse sub materia. Whereas to analyze vertically we could see that these ten aspects are related each other. The observing aspect is the lowest level of experimental skills, followed by making prediction that higher level than observing, knowing variable is higher level than making prediction, and so on. Then the important thing is knowledge in each lower level is used for the higher level. So when the students get higher score in higher level, it is a kind of error which obtained from teacher, instruments, nor the students themselves.

Theoretically the aspects from observing to concluding experiment is related aspects. When the students can predict something, the students also could observe for the phenomena as good as the concept build. Thus, the concluding skill based on student experiments indicates the student already has a high level of experimental skills followed by good processing data and analyzing data skills. Actually we acquire the data not as good as that. There are much error we found when we were doing the meetings, because unpredictable responses from the students followed by another reason that can’t be controlled.

Based on research above, there are a few data that had good score in the high level but still poor in low level. Some reasons could tell us why the data said that. When the real inquiry process deliver to the students, it means the process from beginning to the final must be related from each level to the next level. The process consist of how the teacher make the investigation questions to build the concept based on the experiment that they will do. Discovery learning matter must be appropriate with interactive demonstration that will be delivered. It is not separated level each other [9]. If the students get low score in observing skills but high score in predicting skill, there is possibility that concept in predicting skill inappropriate with observing skill concept that they had got.

These identifications of experimental skills can be used for looking for learning process in class. It will help teacher to guide what teacher should do suitable with the purpose they need when the students would be tough by using inquiry skills model. The results also could be used for pre-research in sustainable abstract matter just like solar system concept. This research can be accomplished for the standard assessments in experimental skills profile.
4. Conclusion
Apply model of Levels of Inquiry could identify students experimental skills in solar system concept for Junior High School. The results of identifying students’ experimental skill in three different meeting (time zone, moon phase, solar eclipse) are poor, fair, and good.

5. References
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