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Improving Students' Higher-order Thinking Ability by Exploring KWHL Diagram

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Abstract: ***The idea of this teaching innovation through classroom action research is aimed to exploring how the implementation of Open Inquiry-KWHL Chart learning model can improve students' high-order thinking skills. This is evidenced by the posttest result of high-order thinking skills, adapted from the international standard test of Cambridge Curriculum, and from the inquiry's observation sheet. Improvement of learning outcomes is seen in the mastery learning of students. If the initial study the mastery learning reached only 22.86%, then the first cycle increased to 54.29%, then in the second cycle mastery learning reached 77.14%. Activities and scientific attitudes of students in cycle II increased, in the first cycle of inquiry aspects have not observed optimally, but very developed in cycle II. This is considered by the Open Inquiry learning model are able to challenge students to reasoning more with their "personal experiment", with KWHL Chart as a classroom management framework. The enthusiasm of students to engage in groups can also scaffolding their thinking process in investigations.***

Keywords: Open Inquiry, KWHL Chart, Higher Order Thinking Skills, Students 'Inquiry Attitude.

1. Introduction

Learning science is an interdisciplinary field that focuses on developing effective learning methodologies and solutions. How does all this relate to educational arrangements in real practice? Look at what the students are doing. Take a peek at the material they use. Science makes it possible to ask questions about each aspect, then answer those questions by empowering students [7].

But as a reflective study, there are still weaknesses in Indonesian students' scientific abilities revealed in the results of PISA release [4]. The results show students' scientific literacy not as expected. PISA measure Higher Order Thinking Skills (Hot's), for this reason, it is important to immediately improve science learning process so that students' thinking skills can improve.

The low level of thinking ability can be seen from the results of formative assessments. So far, assessment in SMP Negeri 1 Subang have been adopted and adapted from international standard test of Cambridge curriculum with high cognitive levels. However, the test has not been satisfactorily answered by students. Following are the results of formative tests in Table 1.

Table 1: Higher Order Thinking Skills Test Result

Topic	*Average*
Pressure	54.46
Human Respiration	57.74
Excretion System	55.91

Data in Table 1 shows the results of students Higher Order Thinking Skills ability in formative test. The average score is low. Even though, the character of students are generally fast learners equipped with adequate facilities. However, with low assessment results, it can be analyzed that the problem is likely to lie in the strategy of learning science which is not supporting the development of high-level thinking skills.
Based on the results of observations there are several findings regarding the problem of learning science in class including:

- Science learning activities are necessary carried out by practical methods using worksheets sourced from national curriculum Student Handbook through Discovery Learning model.
- Work in groups that are considered less effective.
- Opportunities are lacking for students to explore knowledge and build their own concepts.
- Science learning is less challenging so it does not motivate students to develop their thinking skills.

From this description it can be concluded in science learning process has not been handled optimally. Learning is less attractive and challenging so that it does not provide opportunities for students to develop their abilities, including high order thinking skills.

Colburn [2] argues the right strategy for teaching science is the same as in real scientific investigations. Educational paradigm regarding science learning is carried out using a scientific approach that involves students in inquiry-based investigations. Students are directed to develop the ability to think, reason and work scientifically through inquiry learning through learning experiences [12]. The application of inquiry learning has been investigated capable of increasing students'high order skills [3].

Banchi & Bell [1] states that there are four levels of inquiry approaches in science learning: 1) confirmation inquiry, 2) structured inquiry, 3) guided inquiry, and 4) open inquiry.

Open inquiry or full inquiry is a learner-centered learning model that starts with student questions, followed by students (or groups of students) designing and conducting investigations or experiments and communicating results [2]. With sufficient experience at the level of previous inquiry, students are expected to be able to successfully carry out the highest inquiry (open inquiry).

This means that open inquiry learning model is one of the solutions to improve students' high order thinking skills, because the strategy appropriate for students to conducting investigations, including being able to record and analyze data, and draw conclusions from the evidence they have gathered [2], [6].

Open inquiry learning model closely reflects the actual work of scientists. Beginning with students ask questions in guiding their own investigations is the key to opening investigations [6]. It turns out that what is always a teacher's problem is the confusion at the beginning of this open inquiry [2]. A good place to start is to get rid of each table of data that was previously constructed, where students find out their own investigative activities [2]. Therefore, researchers argue KWHL Chart can be the best solution.

KWHL (Know-Want to Know-how to learn-what I Learn) Chart, which was developed by Ogle [9]. This table is the right step to start the open inquiry model, as well as signs that really help create conducive learning. With KWHL students are invited to ask questions about what they want to know [9], [11].

Based on the background described, the students' high order thinking skills need to be developed through science learning process. Then the researcher designed a strategy of Open Inquiry-KWHL Chart, implementing it in the topic of Vibration, Waves and Sounds (grade 8^{th}), with the aim of improving students' high order thinking skills.

2. Method

How do teachers prepare and manage open inquiry classes? Inquiry-based learning often creates new and complex classroom situations. For this, researchers argue KWHL Chart could be the answer.

KWHL is very suitable for open inquiry learning, because through KWHL students do research and try to find out what they want to know. This is very supportive for improving the ability of students' inquiry by practicing to arrange questions on the basis of certain criteria [11]. Therefore, the researcher designed an Open Inquiry KWHL Chart as shown in the following Figure 1.

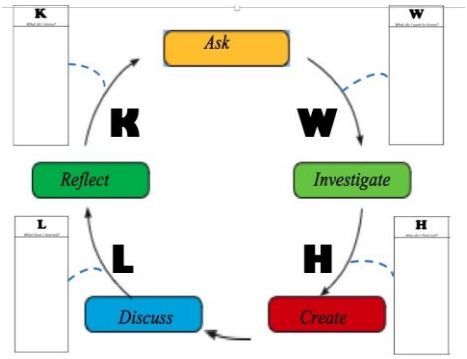

Figure 1: Open Inquiri KWHL Chart

The stages of Open Inquiry-KWHL Chart learning model are described as follows:

Stage I: Identification and determination of the scope of the problem, initiated with table K (what do I Know).
Stage II: Plan and Predict Results, confirmed by W table (what I want to know).
Stage III: Investigation for Data Collection, in the framework of table H (How do I find Out), guided by worksheet 'The Way Scientists Work'.
Stage IV: Data Interpretation and Developing Conclusions, in the framework of table H (How do I find Out), guided by worksheet 'How Scientists Work'.
Stage V: Perform Reflections, focused on the L table (what have I Learned).

The research method is classroom action research, the design uses two cycles, where each cycle consists of three meetings [5].

Specific actions given to the subjects of the study were science learning using Open Inquiry-KWHL Chart learning model. To find out how successful the treatment is, the subject is given an assessment of high order thinking skills, then the results of the assessment are compared with tests on the previous topic.

3. Result

3.1 Learning Process

Data assessment of inquiry attitude that researchers conducted in the initial study learning process; cycle I, and cycle II, gradually improved. We can see this in Table 2 below.

Table 2: Students' Inquiry Attitude

Inquiry Attitude	*Cycle I*			*Cycle II*		
	High	*Medium*	*Low*	*High*	*Medium*	*Low*
Showing curiousity	√			√		
Formulating problem		√		√		
Stating hipothesis		√		√		
Designing experiment	√			√		
Analizing experiment		√			√	
Drawing conclussion		√		√		
Participating in inquiry class	√			√		

From the table, scientific attitude of students in the second cycle increases, which initially in the first cycle aspects of inquiry have not looked optimally, but increased in cycle II. This is because in the first cycle students are still adapting to changing learning patterns, in the second cycle students' readiness in learning is classified as better [10].

In the KWHL Open Inquiry model, students have the opportunity to work like scientists. Involving students in inquiry allows students to engage in high mental processes (reasoning) and make decisions [1], [2], [3], [6].

Throughout the inquiry process, teachers and students are encouraged to think critically, openly, and curiousity. Students become more aware that they are responsible for their own findings. The inquiry process has the potential to develop skills for lifelong learning, for example,

independence, thinking skills, confidence, decision making, cooperative learning [1].

3.2 Learning Outcomes

In accordance with its characteristics, the science learning process carried out in scientific inquiry can foster the ability to think, work and be scientific and communicate it as an important aspect of life skills [12].

Through the implementation of the Open Inquiry-KWHL Chart learning model, it presents a full inquiry learning process, in which students carry out a whole set of scientific methods independently. Inquiry-based learning at this level requires scientific reasoning and high cognitive domains of students [6].

Students' High Order Thinking Skills (HOT's) are improve trough learning process can be seen in Graph 1.

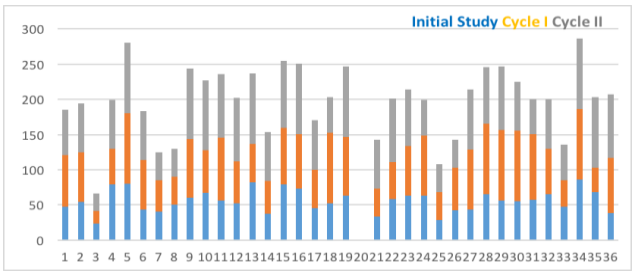

Figure 2: Students' Higher Order Thinking Score

The ilustration shows comparison students' HOT's score between the initial study, cycle I, and cycle II. The data shows that student learning outcomes have increased. Classical mastery learning in the initial study, cycle I, and cycle II experienced an increase of 22.86%, 54.29% and 77.14%.

Improvement of learning outcomes in the second cycle was triggered by the experience of teachers and the readiness of students in the implementation of the Open Inquiry-KWHL Chart model, both in practical sessions and the management of more advanced group presentations [8]. So that learning process becomes more meaningful, involves the activeness and creativity of students, as well as overall teacher guidance to students [10].

4. Conclusion

The implementation of Open Inquiry-KWHL Chart learning model can improve students' high-order thinking skills. This is evidenced by the posttest results, as well as students' inquiry attitude worksheets.

The activities and scientific attitudes of students in the second cycle increased, which initially in the first cycle aspects of inquiry did not appear optimally, but very developed in the second cycle. This is because in the first cycle students are still adapting to changing learning patterns from Discovery to Open Inquiry [10]. Students are also more involved in the thinking process in group experiments. In accordance with Vigotsky's view [8] which states that interaction with peers as an effective way to develop skills and strategies.

The implementation of Open Inquiry-KWHL Chart learning model is able to challenge students to reasoning [2], [3], [6].

5. Recommendations

The researcher provides several recommendations for teachers who will apply the results of this study or follow up with further research including:

1) Open Inquiry model is very flexible; it is possible for lesson plan will change according to the students' experimental interests. Therefore, a back-up plan for the possibilities that occur must be carefully considered.
2) The key to the success of Open Inquiry is the availability of experimenting. It doesn't have to be a lab tool specifically. Creative touch from teacher who brings a lot of potential "trinkets" to the experimental material will build the creativity of the students.
3) KWHL Chart can be effective in monitoring the progress of the learning process, proven to conquer the "wildness" of Open Inquiry. Instruct students to work on all steps of the scientific method in stages, and require teacher approval. This table is very well used in any method, not just for Open Inquiry.
4) Give time to review a lot of literature before students present their experimental results. Extensive insight into the experiments they conducted made the pace of discussion more dynamic. Students who have the opportunity to explore will feel expert to increase their confidence.
5) Do KWHL Chart in groups from the start. Scaffolding carried out by peers can help improve students' thinking skills.

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