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STUDENT'S SCIENCE MISCONCEPTIONS CONCERNING THE STATE CHANGES OF WATER AND THEIR REMEDIATION USING THREE DIFFERENT LEARNING MODELS IN ELEMENTARY SCHOOL

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ABSTRAK

Secara umum, kesalahpahaman yang dialami oleh mahasiswa dapat menyebabkan kesulitan dalam penelitian, sementara anak-anak memiliki kesadaran mereka sendiri. Tingkat kesalahpahaman yang dialami oleh siswa juga tidak sama, dalam kasus ini sesuatu mengalami kesalahpahaman pengalaman tingkat tinggi, menengah, dan rendah. Untuk alasan itu, siswa memerlukan model pembelajaran yang tepat untuk masing-masing tingkat kesalahpahaman yang dialami untuk membuat studi menjadi bermakna. Dalam makalah ini, peneliti mengeksplorasi informasi tentang; (1) tingkat kesalahpahaman ilmu siswa tentang perubahan wujud dari air, dan (2) model pembelajaran yang paling efektif untuk mengatasi kesalahpahaman siswa mengenai perubahan wujud air. Model pembelajaran tiga dalam penelitian ini adalah: siklus belajar, penyelidikan dipandu, dan model konsep pemetaan. Metode yang diterapkan dalam penelitian ini adalah wawancara klinis dan *pretest-posttest.* Informasi yang dikumpulkan dianalisis secara kuantitatif dengan percobaan uji ANOVA dan keuntungan rata-rata normal dihitung untuk setiap kelompok percobaan.

ABSTRACT

In general, misconceptions experienced by student could cause difficulties in study, meanwhile children have their own sense. Level of misconceptions experienced by student also unequal, in this case something experiences high level misconceptions, medium, and low. For that reason, student requires correct learning model for each level of misconception experienced to make the study become meaningful. In this paper, the researcher explored information about; (1) the level of science misconceptions of the student concerning the state changes of water, and (2) the most effective learning model to remedy student's misconceptions concerning the state changes of water. The three learning models in this research are: learning cycle, guided inquiry, and concept mapping model. The method applied in this research is the clinical interview and pretest-posttest. The information collected was analyzed in experiment quantitative manner by anova test and average normalized gains were calculated for each experiment group.

Keywords: science misconceptions; learning cycle; guided inquiry; concept mapping

INTRODUCTION

A major theme of science education research throughout the past three decades has been students' misconceptions of scientific phenomena. The terms 'alternative conceptions' and 'alternative frameworks' have been coined to describe misconceptions or views of science that are at odds with concepts currently accepted by the community of scientists (Boo 2006; 2007).

Studies in students' alternative conceptions in science have a long history, being traceable back to Piaget's early work on children's views of natural phenomena (Piaget 1930). There is now a substantial body of literature documenting the various types of alternative conceptions or preconceptions held by students in various conceptual areas (Carmichael *et al*. 1991; Pfund & Duit 1998).

That children and students hold various alternative conceptions concerning water and its state changes have been reported in a various studies such as Johnson (1998a, b); Bar & Travis (1991); Osborne & Cosgrove (1983). Those students also hold various misconceptions concerning physical science concepts have been reported by Operation Physics American Institute of Physics in 2009.

Science is an important subject at all levels of education. However, numerous studies have shown that many students, and even teachers, possess an inadequate understanding of science and its nature and getting misconceptions in science. This situation might be harmful, particularly if this condition happen continuously.

Misconceptions at emerging student continually can bother the forming of scientific conception. Heedless study of misconception causes difficulty of learning and finally would have estuary at the low achievement of their learning. Traditional opinion assuming that movable knowledge fully from teacher mind to student mind need

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to be shifted towards constructivism opinion assuming that knowledge built in student self (Howe 1996).

Based on the initial interview of the researcher to some elementary teachers in Semarang city indicate that students often getting misconceptions in science. Student's apparent misconceptions in the area of the state changes of water that identified by the teachers are discussed and will be remediated using constructivism teaching and learning models. The researcher focus to use three different learning models, they are: learning cycle, guided inquiry, and concept mapping.

The learning cycle is an established planning method in science education and consistent with contemporary theories about how individuals learn. It is easy to learn and useful in creating opportunities to learn science. In the learning cycle, students first engage in hands-on activities to familiarize them with the concepts and relationships before being introduced to new terms,reading text material, graphing or otherwise analyzing their observational data. Next, concepts are developed based on experiences acquired from exploratory activities. It appears that students are more receptive to understanding a concept if they have first engaged directly in a concrete experience which has raised a question in their minds. It is this need for further understanding that urges them to enter in to re-evaluating old or building new concepts. The third part of the learning cycle features an application activity where the concept is used in a slightly different setting than was originally developed, thus giving them a chance to more fully understand the concept in terms of a wider frame of reference.

Guided inquiry teaching takes children to new levels of awareness and involvement in science. As a student-centred activity, guided inquiry gives children ownership of the learning process and inspires them to become more independent learners. As students engage in critical thinking and problem solving, questioning, probing and discovering answers, they gain a more meaningful and longer lasting understanding of scientific processes. By questioning and designing systems for gaining knowledge, students become more resourceful, developing self-reliance and a greater under-standing of the life long learning process.

Concept mapping are graphical tools for organizing and representing knowledge. Concepts mapping are primarily a *discovery learning* process, where the individual discerns patterns or regularities in events or objects and recognizes these as the same regularities labelled by teacher with words or symbols. A new concept and propositional learning is mediated heavily by language, and takes place primarily by a *reception learning* process where new meanings are obtained by asking questions and getting clarification of relationships between old concepts and propositions and new concepts and propositions. This acquisition is mediated in a very important way when concrete experiences or props are available, hence the importance of “hands on” activity for science learning with young children.

Misconceptions experienced by student in general haves a character of resistant in study, while on the other side children has different formal common sense. Level of misconceptions experienced by student also unequal, in this case something experiences high level misconceptions, medium, and low. For that reason, student requires correct learning model for each level misconception experienced by that study to become meaningful.

METHOD

The population of this study is the students of elementary school grade 5. In this research the researcher take students of elementary school grades 5 as the sample. The elementary school located on Semarang city the capitol of Central Java Indonesia. This school was as main elementary school in the cluster school of this city. Technique sampling that the researcher used is cluster sampling.

The researcher used experimental research designs to controlled testing of causal processes. The general procedure is one or more independent variables are manipulated to determine their effect on a dependent variable (Box et al. 2005).

The researcher applies factorial design in this research. The total population of participants is randomly divided into two samples; the control sample, and the experimental sample. Only the experimental sample is exposed to the manipulated variable. The researcher compares the pre-test results with the post test results for both samples. Any divergence between the two samples is assumed to be a result of the experiment. This is similar to a classical design, except additional samples are used. Each group is exposed to a different experimental manipulation.

In this research three independent variables are manipulated to determine their effect on a dependent variable. Additional samples which have homogeneity are used in this research. Each group is exposed to a different experimental manipulation. Therefore, the researcher applies factorial design in this research.

The method applied in this research an interview and pre-test and post-test. The information collected was analyzed in experiment quantitative manner by anova test and to assess the effectiveness of the instructional treatment for each of the three experimental groups, average normalized gains were calculated for each group.

RESULTS AND DISCUSSION

The first step to identify the level of science misconception of the student is a test. The researcher analyzes the pre-test result to determine levels of the student science misconception before remediation.

All of the students are getting science misconception concerning state change of water in the different levels, 47 students in high level, 65 student in medium level, and only 2 students in low level.

The student misconceptions in science have been examined by many researchers. Among the sources of misconception suggested are the following, some of which overlap: from everyday experience and observation (Strauss 1981; Viennot 1979), from the use of perceptual thinking, which is related to the previous source, and is seen in a number of studies where students' explanations of scientific phenomena are dominated by what is immediately perceptible (Driver

1985; BouJaoude 1991), from diagrams or statements in textbooks (Blosser 1987; Cho *et al*. 1985), and from teachers and student teachers (Osborne & Cosgrove 1983; Bar & Travis 1991).

The researcher continues explore student misconception condition with clinical interview. Based on the interview results the researcher concludes that the causal factors of the student's science misconception are:

Everyday experience and observation factor often misconceptions are passed on by one person to the next. In other cases, students may be presented with two correct concepts, but combine or confuse them. Sometimes students make what to them seems like a logical conclusion, but is simply drawn from too little evidence or lack of experience. For example: student confusion between the everyday use of terms freezing and boiling and the scientific use of these terms. In everyday language, the word *observation* generally means something that we've seen with our own eyes. In science, the term is used more broadly. Scientific observations can be made directly with our own senses or may be made indirectly through the use of tools like thermometers, pH test kits, Geiger counters, etc. The quantities can be measure, but actually can't *observe* all of the process because the physical constraints or limitation. For example: The processes of freezing, melting and boiling involve a change in temperature substantively is a molecular process.

Often student work very hard to process information and arrive at their ideas. It takes just as much work to deconstruct those ideas and let go of the incorrect ones. For example: the narrow range of understanding in any given situation, for example, not recognizing that evaporation of water and melting of ice take place simultaneously at 0°C.

The students are getting high level science misconception because of combined factor above. Everyday experience and observation factor from their everyday life have actively constructed their science misconception. Student science misconception level is caused by family background. Based on the interview data, the researcher note that family with high education background or have professional employment better in their science communication to their children. That is happen to student with medium and low level of science misconception.

All of the students are getting decreased levels in science misconception concerning state change of water after remediation. They are 16 students in medium level, and 98 students in low level, and no student in high level. The researcher continue analysis the data using anova test to determine the most effective learning model to remedy student's misconceptions.

Based on the data analysis of mean rank value the most effective learning model to remedy elementary student's misconceptions concerning the state changes of water is learning cycle 75.57, and then followed by guided inquiry 55.97, and concept mapping 40.96.

The normalized gain calculation also clarifies that learning cycle model most able to develop student comprehension in science concerning the state changes of water, followed by guided inquiry and concept mapping.

The result of the research is in line with the previous work performed by other researchers (Sungur *et al*. 2001; Seyhan & Morgil 2007). Seyhan & Morgil (2007) compared two classes taught by traditional methods with two classes taught using the learning cycle 5E instructional model method. The study indicated that the experimental groups had much greater understanding of the information covered especially on questions that required interpretation. The subject of developing 5E activities orienting in Science Unit and evaluating its effectiveness determined that student teaching materials developed according to the learning cycle 5E instructional model increased achievements and attitudes of the experimental group more significantly than compared to the control group. The subject of the effect of materials developed based on integrative learning theory in Science Unit of the experimental class determined that it was effective for promoting learning concepts and the removal of science misconception through teaching based on a constructivist approach.

Based on the evidence obtained through the activities carried out in scope of the research, positive changes from the experimental group of students receiving the learning cycle 5E instructional model activities based on the constructivist approach have an effect of increasing success when learning about the state changes of water. It was observed that newly learned concepts were constructed in the mind correctly by removing concept errors existing in their pre-information.

Although guided inquiry Learning is not a new approach in classroom instruction, it can always be applied in science learning. This learning model promotes discovery learning by allowing the learners to examine the questions or problems. Also, with the guidance from the worksheet and the teacher, the learners should be able to develop the concept or rule, and then apply it to a new situation.

Douglas and Chiu (2009) also found that the implementation of guided inquiry improved performance of the student over learning activity. Based on the interviews conducted suggests that students recognize the benefits of working in groups, such as establishing critical thinking, learning cooperative skills, and retaining the content knowledge. However, the use of guided inquiry in this setting had minimal benefit due to the expectations of the students and the dynamics of group work. Some students felt uncomfortable with not being told the answers to the worksheet questions and suggested that the instructor offer the answers to all the questions, so they know they are getting them correct. Even though the teacher provided an active learning environment, students still expected to be fed knowledge by their teacher. The other reason may result from the dynamics of the group work. Some interviewees reflected that their peers did not talk much during the teamwork time. Thus, the quality of discussion was influenced by the characteristics of some of the team members. To make guided inquiry work effectively, this research suggests that it is important forstudents to develop confidence in their own abilities and to be aware that they cannot rely strictly on the teacher to learn.

The results of this research provided further evidence to support the findings in the related literature indicating that concept mapping is still an effective tool to reveal misconceptions and to teach scientific concepts concerning state change of water. The increments in means between pre and post tests of the experimental group although small were nevertheless significant. In addition, concept mapping can provide alternatives to traditional methods to remedial misconceptions. These results confirm the findings of previous research in that a text- based conceptual change approach can facilitate learning of scientific concepts (Alparslan *et al*. 2003; Tekkaya 2003; Kinchin *et al*. 2000; Türkmen, *et al*. 2005; Ozkan *et al*. 2004; Sungur *et al*. 2001; Ling & Boo 2007).

Although it was found that concept mapping produced a more positive effect on student learning, two

points are worthy of further consideration. First, the flexibility of map construction of concept mapping requires further investigation. The flexibility of map construction is a major principle in concept mapping (Heeren & Kommers 1992). A flexible method for students to construct maps may benefit a greater number of students with different learning styles or skills. Anyway, more experiments involving students' characteristics and learning duration are needed to verify if a trade-off exists between the map construction complexity and learning efficiency.

Secondly, the disadvantage of using concept mapping in science teaching work seems to be their complexity. The maps can be difficult for students unfamiliar with the format to read and the linkages may be harder to see as the maps get more and more complex. Because of this complexity, it is most often necessary teacher's guidance in conjunction with the maps. Additionally, the complexity at times makes it difficult for the students to determine what concepts are of critical importance and what concepts are of secondary importance.

All of the learning models, learning cycle, guided inquiry, and concept mapping are as constructivist and hands-on teaching methods. The results of this research found that constructivist and hands-on teaching methods effective to remedy student's science misconception and increase student comprehension. These results confirm the findings of previous research in the the effectiveness of constructivist and hands-on teaching methods to increase student comprehension (Guthrie *et al*. 2004; Kim 2005; Doğru and Kalender 2007).

The researcher found that the most effective learning model to remedy elementary student's misconceptions concerning the state changes of water is learning cycle, and then followed by guided inquiry, and concept mapping. The analysis of each learning model implementation result was discussed before. Nevertheless, the result has different with related previous research performed by other researcher. Hasnunidah (2007) found that the three different learning models (learning cycle, guided inquiry, and concept mapping) haves the same effectiveness to remedy student's misconception in grade 8 student. The researcher gives reasons that different sample and condition influence to the result. Finally, the important is that both results are significant to remedy student's science misconception.

The learning cycle model successful in the implementation as a strategy to remedy science misconception, because: recognize preconceptions that exist, probe for student's misconceptions through demonstrations and questions, ask students to clarify their conceptions. This learning model also accommodates to provide contradictions to students' misconceptions through questions, implications, demonstrations, encourage discussion, urging students to apply physical concepts in their reasoning. Foster the replacement of the misconception with new concepts through (i) questions, (ii) thought experiments, (iii) hypothetical situations with and without the underlying physical law, (iv) experiments or demonstrations designed to test hypotheses. Re-evaluate students' understanding by posing conceptual questions

CONCLUSION

All of the students are getting science misconception concerning state changes of water in the different levels. The causal factor of science misconceptions concerning the state changes of water are language factor, experience factor, observation factor, and thinking skill factor.

Based on the data analysis of mean rank value the most effective learning model to remedy elementary student's misconceptions concerning the state changes of water is learning cycle 75.57, and then followed by guided inquiry 55.97, and concept mapping 40.96.

The normalized gain calculation also clarifies that learning cycle model most able to develop student comprehension in science concerning the state changes of water, followed by guided inquiry and concept mapping.

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