



Conceptual Changes of Fifth Graders towards Water Properties Concept in Mixed Materials through The Implementation of Predict-Observe-Explain Strategy Assisted by Science Kits

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Abstract. The observation resulted that most elementary school students have misconceptions regarding the concept of water properties. A strategy which can be used to change the conception of elementary school students toward scientific conception is Predict-Observe-Explain (POE). This study aims to describe the level of conceptual change of fifth graders related to the concept of the water properties as an effect of applying the POE strategy-assisted science kit in learning. The method used was pre-experiment with one group pretest-posttest design on 38 fifth graders of an elementary school in Cileunyi District, Bandung Regency, West Java. The conceptions of fifth graders through POE strategy about concept of water properties identified by diagnostic test in the four-tier test (FTT) format. The results showed that the percentage of conceptual change of students consists of 1) early scientific conception (KISA) about 2.63%; 2) Static (S) around 23.68%; 3) Reconstruction (R) about 28.95%; 4) Construction (K) around 23.68%; and 5) Disorientation (D) around 21.06%. It can be concluded that the implementation of the POE strategy-assisted science kit in science learning materials for fifth graders has moderate effectiveness in facilitating the construction and the reconstruction level of elementary students' conceptions related to the concept of water properties.

Keywords: POE, science KIT, Level of Conceptual Change, water properties

INTRODUCTION ~ Science is one of the subjects at the elementary school that aims to make students possess the knowledge, ideas and concepts obtained from the involvement of experience through a series of scientific processes. Science not only contains facts, concepts and theories but also includes processes and attitudes. Therefore, learning science is not only about learning facts, concepts and theories but also learning processes and attitudes. Process skill is students' skill for the process of learning attitudes means instilling scientific attitudes, such as curiosity, honesty, working hard, never giving up and being open. Collete and Chiappetta (1994) in Adi and Widodo (2018) states that Science is essentially 1) A collection of knowledge (a body of

knowledge); 2) A way of thinking; and 3) Away of investigating about the universe.

The statement about the nature of Natural Sciences was also constructed by Adi and Widodo (2018), both concluded that the nature of science has several aspects, they are:

(a) Empirical based; scientific knowledge is based on the data or evidence obtained from observations with the five senses and/or experiments;

(b) Tentative; scientific knowledge is not something that is absolutely truthful and without error, but can be changed (refined) with new observational evidence and with reinterpretation of existing observations;



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(c) Theories and law; the law describes the relationships, observations, perceptions of natural phenomena which are usually accompanied by mathematical formulas while the theory is an explanation for natural phenomena and the mechanism of relationships between natural phenomena.

(d) Sociocultural embeddedness; science is the result of human effort until the process of getting it can be influenced by the society and culture where it is practiced then the value system and culture will influence and how science is carried out, interpreted and accepted;

(e) Creativity; scientific knowledge created from human imagination, creativity and logical reasoning so that it will continue to develop, the creation of scientific knowledge is based on creative planning, observation and conclusions;

(f) Scientific method; there is no definite and universally valid scientific method, scientists are free to use any method as long as it can be accounted for; and

(g) Subjective; personal subjectivity is unavoidable in science, factors such as personal values, beliefs, self-agendas and previous experiences will influence what and how a scientist does his work.

In addition to learning the nature of science, the learning process of science should also be able to help change students. These changes can be in the form of increasingly complete or true concepts. Sumirat (2017) argues that the

application of science learning in elementary schools is inseparable from how teachers can provide opportunities for students to facilitate and develop concepts from direct learning experiences, arouse curiosity, process to observe with their senses, train and apply scientific attitudes well .

Certainly the science concepts that students have will experience modifications or changes caused by experiences both daily experiences and learning experiences that accompany these students. Changing students' conceptions in learning the concepts of science in elementary schools is a challenge for teachers with their efforts to prevent misconceptions and increase understanding and mastery of true science concepts (Sumirat, 2017b). Therefore, the change in conception becomes very important to be an inseparable part of natural science learning because students have a certain amount of knowledge about natural objects and phenomena that are studied in science lessons.

Ignoring the lack of continuous understanding of concepts without checking it will cause students to experience misconceptions. According to Paul Suparno in Muna (2017), misconceptions are difficulties to correct, especially if they can help solve certain problems. Based on this, we need a learning process that can make students understand the concepts of science well.



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One learning strategy that involves the role of students actively while still raising the characteristics of science is that students are able to develop knowledge they have with scientific evidence is to use POE (Predict-Observe-Explain) learning strategies.

The application of POE strategies in learning has been widely studied. Several studies on the application of POE strategies include

1. Jia-Chi Liang (2011): POE helps children to understand abstract physical phenomena better, such as air.
2. Ayhan Cinici & Yavuz Demir (2013): POE can produce changes in students' conceptions of diffusion and osmosis.
3. Syawaludin and Rintayani (2016): the application of POE learning assisted by science kits in elementary school can improve the science process skills of fifth grade students of SDN Belik Surakarta in the academic year 2015/2016.
4. Hsiao, et al. (2017): POE inquiry learning strategies can help students to rectify their own understanding and reduce scientific misconceptions.
5. Fanny Sumirat (2017a): POE strategies are effective in facilitating changes in the conception of elementary students on energy material consisting of heat energy and sound energy.
6. Amri Amal and Syarifuddin Kune (2018): Learning using POE strategies can increase students' chances of observing,

measuring, communicating, predicting, experimenting and concluding and supporting correctly obtained conceptual understanding.

7. Marc Eckhardt, Detlef Urhahne and Ute Harms (2018): POE strategies combined with computer simulations can increase intuitive knowledge and conceptual understanding of the relationships between organisms in ecosystems.

8. Astuti, Sulianto, & Purnamasari (2017) told that there are differences in the ability of science to the students' comprehending the concept of learning used POE and learning model using conventional method.

The above studies also show a positive effect on learning outcomes through the implementation of the POE strategy. According to Wah Liew (2004) in Amal and Kune (2018), the benefits of POE learning strategies are 1) POE Learning Strategies can be used to explore initial ideas possessed by students; 2) Generate discussions between both students and teachers; 3) Provide motivation to students to investigate concepts that are not yet understood; 4) Generate students' curiosity about a problem.

Students find a lot of experience through science lessons, for example those related to water, light, magnetism, electricity and so on. The experience can be in the form of direct observation or even direct experience that the learning process can take place more easily and the learning



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outcomes are not easily forgotten. The topic of water has not been much researched even though water is very much close to the daily life of students. One topic in science learning for fifth grade students is to learn about the results of observing the properties of water, which is the material of single substances and mixtures and their constituent components in everyday life. Understanding the properties of water associated with homogeneous and heterogeneous mixed experimental reactions is material that has the potential for misconceptions because the particle matter of material classification is included in abstract material. This can be an opportunity for misconceptions. In addition, this material is the basic material for acceptance of chemical concepts that will be studied next, which is learned at the junior high school or university level.

Some of the properties of water that are relevant to material substances and mixtures in science learning at fifth grade are the nature of water can dissolve various substances, water can be purified and soapsuds can clean fatty or oily impurities. Previous research that showed the misconception of fifth grade students about water can dissolve various substances was done by Wahyuningsih (2016); students' misconceptions occur in understanding the changes that occur in cement mixed with water. Students consider cement mixed with water to dissolve like the drink powder that students often make. Spontaneously students

equate that cement mixed with water will result the same as drink powder mixed with water. But with the equal problem the researcher gave different results to 38 students in the subject of this study, students did not experience misconceptions. Similarly, observations of students' understanding of concepts about water can be purified. However, the nature of soapsuds can clean fatty or oily impurities, some students still experience misconceptions, especially in the formation of two layers when water is added to oil. There are still arguments that because they are both liquid so that they can mix, the oil layer is above the water because water is heavier than oil and assumes that when soapsuds is added to the oil water mixture it can mix because it is not the result of soap particles that have two different parts, one part will bind water and the other part binds oil or fat.

The activity of understanding and applying changes in the conceptions of elementary school students regarding the nature of water can be picked up through experiments using a science kit with the implementation of POE learning strategies. This is in line with Liang (2011) which states that POE is able to facilitate the strengthening of learning from students' point of view (Liang, 2011). Therefore, experiments to understand the nature of water can be carried out using POE learning strategies. Result of research from Kibirige, Osodo&Tlala (2014) is science educators, curriculum developers, and textbook writers should work together to



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include elements of POE in the curriculum as a model for conceptual change in teaching science in schools.

This research was conducted with the aim of describing the level of students' conceptual change as the implementation of learning with the POE strategy assisted by science kit related to the concept of water properties in the material of the mixture.

METHOD

The research method used in this study was a pre-experiment with one group pretest-posttest design that was applied to 38 fifth grade students in one elementary school in Cileunyi District, Bandung Regency, West Java. The research instrument used to identify the conceptions of elementary school students before and after the implementation of the POE strategy was in the form of a conception test related to the concept of water properties in a four-tier test (FTT) format. The instrument was given to students who were randomly selected before and after students learned the concept and conducted an experiment about one of the properties of water, soapsuds which can clean oily or fatty impurities through the POE strategy assisted with science kit.

The research stages were carried out as follows

(1) Study on the syllabus of elementary school science subjects then get some misconceptions that occur on various science materials are obtained;

(2) Limiting students' misconceptions with material substances and heterogeneous mixtures of liquid substances that are related to the nature of water so that one of the selected water properties is determined that soapsuds can clean oily or fatty impurities;

(3) Designing instruments in the form of four-tier tests (pretest and posttest) that can diagnose students' misconceptions;

(4) Validation by experts, instruments validation by lecturers of Sciences Practicum Study at UPI Postgraduate School in Bandung;

(5) Before the learning process was conducted, students were first given pretest questions (initial tests) related to the material and the experiments that will be conducted.

(6) The learning process was carried out through the POE model accompanied by a practicum or experiment that supports a comprehensive explanation of the concept by using a science kit. The science kit used is the Water and Air Properties Kit.

(7) After receiving the learning and engaging themselves in practical activities, students were given a post-test (final test) to find out how their conceptions had change.

(8) Analyzing the results of instruments given to students after the learning process. This analysis was done by entering the results of each student's response in

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the categories that had been made before. The analysis was made based on a general understanding of the results of the four tier tests given before and after the learning process continued by looking at each level of representation of changes in students' conceptions. After that, checking the changes that occurred and included in the advanced category, permanent or decline in understanding the concept.

The following is an example of a four-tier test question instrument on substances and heterogeneous mixtures of liquid substances that are associated with one of the properties of water namely soapsuds

can clean fatty impurities or oil.

2. Dilakukan suatu percobaan dengan langkah-langkah sebagai berikut: siapkan tiga buah tabung reaksi yang bersih dan kering (A, B, dan C). Ke dalam tabung A dimasukkan air suling/ *aquadest*, ke dalam tabung B masukkan air ledeng dan ke dalam tabung C masukkan air kapur masing-masing sebanyak 2 mL. Setiap tabung reaksi, di dalamnya teteskan 1 tetes sabun cair kemudian dikocok.

Pertanyaan *Predict*:

2.1 Apa yang akan terjadi saat 2 mL air suling atau aquadest (tabung reaksi A) yang telah ditambahkan 1 tetes sabun cair dikocok?

- Air suling dan air sabun bercampur serta timbul lapisan busa
- Lapisan air suling atau aquadest berada di bawah lapisan air sabun
- Tidak ada perubahan
-

2.2 Apakah kamu yakin dengan jawaban tersebut?

- Yakin
- Tidak yakin

2.3 Alasan berdasarkan pilihan jawaban pada 2.1 adalah

- Partikel sabun memiliki dua bagian yang berbeda sifatnya, bagian yang larut dalam air dan sukar larut sehingga menjadi bercampur dan timbul lapisan busa
- Air sabun massa jenisnya lebih besar dari air suling atau aquadest
- Keduanya sama-sama berwujud cair
-

2.4 Apakah kamu yakin dengan jawaban tersebut?

- Yakin
- Tidak yakin

The Analysis of Student Conception Based on Four-Tier Test Results Data

The conception categories of students based on data from the conception test results with the four-tier test format (Gurel et al., 2015) are shown in Table 1.

Table 1 Students' Conception Category Based on Four-Tier Test Results Data

Tier 1	Tier 2	Tier 3	Tier 4	Categories
True	Sure	True	Sure	Scientific conception
True	Sure	True	Doubt	No conception
True	Doubt	True	Sure	No conception
True	Doubt	True	Doubt	No conception
True	Sure	False	Sure	Misconception
True	Sure	False	Doubt	No conception
True	Doubt	False	Sure	No conception



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<i>Tier 1</i>	<i>Tier 2</i>	<i>Tier 3</i>	<i>Tier 4</i>	Categories
True	Doubt	False	Doubt	No conception
False	Sure	True	Sure	Misconception
False	Sure	True	Doubt	No conception
False	Doubt	True	Sure	No conception
False	Doubt	True	Doubt	No conception
False	Sure	False	Sure	No conception
False	Sure	False	Doubt	No conception
False	Doubt	False	Sure	No conception
False	Doubt	False	Doubt	No conception

The Analysis of Conceptual Change Levels as a Result of the Implementation of the POE Strategy Assisted by Science Kits.

There are various possibilities of the conceptions of the fifth-gradestudents revealed in the initial test, namely having a scientific conception (*KI*), not having a conception (*TMK*) and in a state of misconception (*MK*). The conditions of this conception can change to other types of conceptions after participating in the learning process through the POE model

assisted by the science kits (water and air). The type of conception changed from the initial state (pretest) to the final state (posttest) is known as the level of conceptual change (Hermita et al., 2017). There are various levels of conception change that can occur in students, which are having a scientific conception from the beginning (*KISA*), construction (*K*), reconstruction (*R*), static (*S*) and disorientation (*D*), can be viewed in Table 2 adapted from Hamid et al. (2017) and Hermita et al. (2017) in the following.

Table 2. Guidelines for Determining the Level of Conception Change

No	Level Perubahan Konsepsi	Respon Awal* (Pretes)	Respon Akhir* (Postes)
1	Konsepsi Ilmiah sejak Awal (KISA)	KI	KI
2	Statis (S)	M	M
3	Rekonstruksi (R)	M	KI
4	Konstruksi (K)	M	TMK
5	Disorientasi (D)	TMK	KI
		KI	M
		KI	TMK
		TMK	M

*Notes: TMK for not having any conceptions, M for misconceptions and KI for scientific conceptions.

The effectiveness of the POE model in facilitating the understanding of elementary school student concepts to reach the conception construction and reconstruction level is determined by counting the number of students who reach the construction and reconstruction level as the effects of POE activities. Table 3 shows the classification of the effectiveness of the POE model in

achieving the level of construction and reconstruction of students' conceptions adapted from Hermita, et al, (2017).

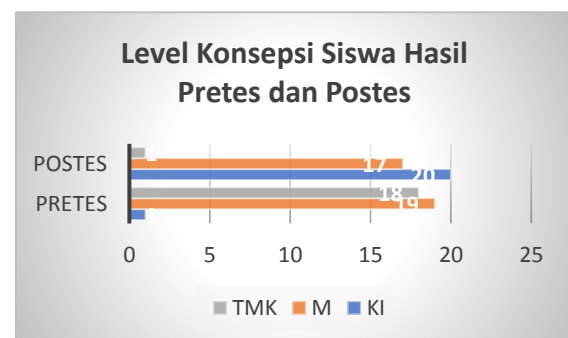
Table 2 Classification of the Effectiveness of the POE model in facilitating understanding of elementary school student concepts to reach the level of conceptual construction and reconstruction

The quantity of students (R) who reached the level of conceptual construction and reconstruction as the effects of learning activities with the POE strategy (%)	Classification of effectiveness
$75 < R < 100$	High
$50 < R < 75$	Moderate
$R < 50$	Low

RESULTS AND DISCUSSION

The results of identifying the level of change in the conception of the fifth graders on the heterogeneous mixture of liquid substances that are associated with the nature of the soapsuds can clean grease or oil impurities through the POE

strategy assisted by science kit.



Based on the chart above, it can be seen that the results of the pretest of 38 students



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as research subjects showing mixed responses. From this response, it is found that there was a student who gave an answer according to scientific conception, 17 students answered misconceptions, and 20 students did not have a concept at all. This shows that more students do not have concepts according to the material before learning. However, after learning with the POE model and given the posttest obtained conceptual changes in students, 20 students gave answers according to scientific conceptions, 17 students had misconceptions and one student did not have any conception. In general, the overall results showed that the implementation of the POE learning model can facilitate changes in the conception of fifth grade students on heterogeneous mixtures of liquid substances that are associated with the subconcept water properties of soapsuds to clean fatty impurities or oil. Similar to changes in theory in science, changes in conception in students can occur due to various complex factors. Posner et al. (1982) in Hermita et al. (2017) states that there are four essential conditions for changing the conception [2], they are: 1) Dissatisfaction with the current conception, 2) The new

conception introduced must be clear (intelligible), 3) The new conception introduced must be plausible and 4) New conceptions introduced must be fruitful.

The change of students' conceptions from pretest to posttest of 38 students can be seen in table 3 below.

The changes in students' understanding in table 3 indicate a mismatch with the concepts they just received so that this must be responded carefully by the teacher, because it can be the basis for determining the success of students' conception changes. According to Duit, Treagust & Widodo (2008), conditions that indicate conflicting information received by students is called cognitive conflict, which may not be effective in facilitating changes in conception if it does not stand on the view of constructivism. One set of interpretations of conceptual change is closely related to the growth of an awareness of the diversity and tenacity of students' views of natural phenomena (Peter W. Hewson Madison, 1992)

Based on the results in table 3, it can be understood that the profile of the level of change in students' conceptions as presented in Table 4 in the Level of students' conceptual Change.

Table 3. Classification of Students' Conceptual Changes Levels
Results of Pretest and Posttest

KLASIFIKASI	POSTTEST		
PRETEST	TMK (No Conception)	M (Misconception)	KI (Scientific Conception)



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TMK (No Conception)	Student number 2 (Static)	Student number 4, 6, 8, 17, 20, 21, 23, 26 (Disorientation)	Student number 5, 11, 16, 19, 24, 31, 32, 34, 36 (Construction)
M (Misconception)	Student number 35 (Reconstruction)	Student number 7, 9, 12, 13, 15, 22, 29, 30 (Static)	Student number 3, 10, 14, 18, 25, 27, 28, 33, 37, 38 (Reconstruction))
KI (Scientific Conception)	0	0	Student number 1 (Early scientific conception)

Table 4. Profile Levels of Students' Conceptual Change

Levels of Conceptual Change	Student	Total	%
Early scientific conception (KISA)	1	1	2,63
Static (S)	2, 7, 9, 12, 13, 15, 22, 29, 30	9	23,68
Reconstruction (R)	3, 10, 14, 18, 25, 27, 28, 33, 35, 37, 38	11	28,95
Construction (K)	5, 11, 16, 19, 24, 31, 32, 34, 36	9	23,68
Disorientation (D)	4, 6, 8, 17, 20, 21, 23, 26	8	21,06

The table above shows the percentage of the number of fifth grade students at each level of conception changes that occur. Of all research subjects after learning with the POE model assisted by science kits, 2.63% were at the level of scientific conception from the start (KISA), 23.68% are at the static level (S), 28.95% are at Reconstruction, 23.68% are at the Construction level and 21.06% are at the Disorientation level (D). This shows that the application of the POE strategy assisted by science kits has moderate effectiveness in reaching the level of construction and reconstruction (23.68% + 28.95% = 52.63%) in heterogeneous liquid mixture material which is associated with the water nature

of the soapsuds can clean fatty impurities or oil.

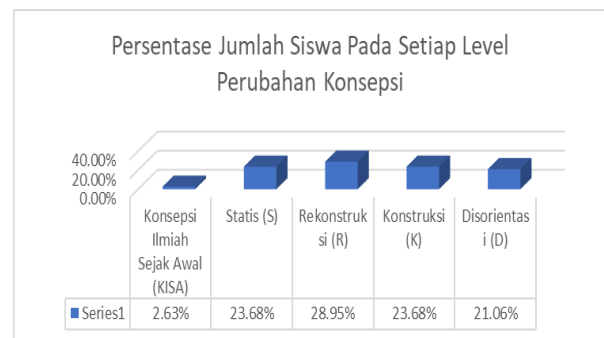


Figure 1. Diagram Number of students at each Level of conception change

The picture above shows that the POE strategy is effective in facilitating students' understanding of reaching the level of change in the conception of construction and reconstruction of fifth grade students. The change in conception after learning



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by using the POE model which is better than the previous method learning shows a good learning progress for students during the learning process with the Predict-Observe-Explain strategy. Students who initially had a scientific conception did not turn into a misconception or did not have a conception but remained consistent at the level of scientific conception so that the implementation of the POE strategy in learning can help students strengthen the scientific conception they already have. Pimthong (2015) indicate that it is important for science teachers to be concerned with affective and social factors when developing learning strategies to facilitate conceptual change.

CONCLUSION

The implementation of the POE strategy assisted by science kits focused on properties of water in the heterogeneous mixture of liquid substances associated with the soapsuds can clean fatty impurities or oil resulting in five levels of students' conceptual change is 2.63% at the level of scientific conception from the start (KISA), 23, 68% are at the static level (S), 28.95% are at Reconstruction, 23.68% are at the Construction level and 21.06% are at the disorientation level (D). This study shows that the application of a POE strategy assisted by science kits in learning of science materials for fifth grade students has moderate effectiveness in facilitating the level of construction and reconstruction of elementary school

students' conceptions related to the concept of water properties.

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