# THE STUDENTS' CONCEPTUAL CHANGE USING POE STRATEGY ASSISTED BY AIR PROPERTIES-EXPERIMENTAL KIT

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**Abstract**: Most elementary school students have misconceptions on the concept of air properties. It can lead to other misconceptions in other science topics or concepts. Therefore, it is very important to create a learning strategy in order to promote students' conception change, one of them by using POE strategy assisted by air properties-experimental kit. The research aims to get a description about the students' conceptions change after using POE strategy assisted by air properties-experimental kit. This study used descriptive method involving 18 elementary school students (mean 10 – 11 years old). The description of students' conceptual change is obtained by looking at the students' answers in the prediction stage in the beginning of POE learning and the posttest results (directly after instruction) using six-tier diagnostic tests. Results showed that the great majority of the students' conceptions about air properties change from misconception to scientific conception after learning. Findings are discussed in terms of cognitive engagement and students' interest. Based on the findings, it was suggested to apply the POE strategy assisted by air properties-experimental kit in elementary school. Because, this strategy was helpful for students to understand science concepts and improves their interest for learning science.

**Keywords**: conceptual change, POE, air properties-experimental kit, cognitive engagement, student' interest

# 1. Introduction

The properties of air are one of the core topics in science subjects in elementary schools. Understanding this concept correctly is an important prerequisite to be able to study well other scientific topics at a higher level or natural phenomena that occur in life. But in fact, most students have difficulty understanding the concepts of air properties, even misconceptions occur even though this topic has been given in the previous class. Many students believe that air pressure has a direction and changes the shape of a system only at the top and bottom (She, 2002). In addition, it seems they also believe that high air pressure occurs when temperatures are high, while low air pressure occurs when temperatures are low (Akbaş and Gençtürk, 2011). One of the causes of this is that they have difficulty understanding and constructing their thoughts in abstract science concepts (Şahin and Çepni, 2011; She, 2002). Because of the fact, the teacher only gives traditional learning instructions in teaching these concepts which make limited observations and experiences in everyday life. These misconceptions will constantly interact with other science concepts and can lead to other conceptions of other science topics or concepts (Akbaş and Gençtürk, 2011). This raises the question of how to improve students' conceptions in the domain of air properties. What are the possible learning strategies to encourage changes in students' conceptions of air property?

Generally, several studies to encourage conceptual change have been carried out, for example using conceptual change texts, Dual Situated Learning, analogies, and others (Güler, 2008; Şahin and Çepni, 2011; She, 2002). However, using these methods frequently can also lead to failure in results and students may feel bored using these methods (Huddel et al., 2000). According to Chamber and Andre (1997), although using these methods effectively supports changes in students' conceptions, hand-on activities that involve students directly gaining experience will provide better benefits for them. The process of changing conceptions of students requires the construction of active knowledge by students based on their initial knowledge to gain new knowledge (Barke et al., 2010; Driver, 1988; Sahin et al., 2009). In line with this opinion, other experts argue that inquiry learning using authentic tasks is the best way for conceptual change (She, 2002; Pintrisch, 1992; and Posner et al., 1982). Therefore, we develop alternative learning as an effort to encourage students' conceptual change, namely through the POE (Predict-Observe-Explain) strategy which is assisted by an air properties-experimental kit.

POE (Predict-Observe-Explain) is a learning strategy based on a constructivism approach in which new knowledge is built based on prior student knowledge (Barke et al., 2010; Joyce, 2006). Some findings indicate that POE significantly increases students' interest and desire to take part in science learning (Hong et al., 2014), increases student understanding (Berek et al., 2016), and improves student achievement and attitudes toward science (Gernale et al., 2015). Whereas, the use of air properties-experimental kit as authentic investigation tools in POE facilitates students to build understanding of their content (Dickerson et al., 2014; Dickerson et al., 2006, Jones et al., 2012; Rubino et al., 1994 ; Young and Lee, 2005). Hilario (2015) argues that the POE associated with experiment or observation can investigate students' understanding of concepts. This is one way to create cognitive conflict in students (Posner, 1982) and is a central condition for changing student conceptions (Limon, 2001). In addition, Hong et al. (2014) stated that visual and vocal observations can strengthen students' understanding of natural phenomena. Thus, it is expected that the POE strategy assisted by an air properties-experimental kit used in this study can promote students' conceptual change in air properties concept.

Specifically, this research will attempt to answer the following questions:

*How is the description of students' conceptual changes using POE strategies assisted by air properties-experimental kit?*

# 1. Related Work

**What is conceptual change?**

Basically from an early age, humans have had ideas (preconceptions) (Chi et al., 1994; Wisudawati and Sulistyowati, 2015) that naturally build personal theories or simple and intuitive conceptual models to explain their world (Jonassen et al., 2005). Through experience and reflection, they reorganize and add complexity to their conceptual theories or models. It is this process of building and reorganizing a conceptual model called conceptual change (Jonassen at.al. 2005). Conceptual change can also be interpreted as a cognitive process for adapting and restructuring an unstructured conception conceptual that exist in humans (Duit and Treagust , 2008; Vosniadou, 1994). From these notions, it can be concluded that basically the change in conception involves a cognitive process for restructuring the concepts that students have had before to be a new conception. In addition, this conceptual change involves the Peaget cognitive process of assimilation and accommodation (Duit et al., 2008; Posner, et al., 1982).

The first condition that must be met in the conceptual change model is student dissatisfaction (cognitive conflict), which is needed in the accommodation stage to obtain new concepts (Limon, 2001; Posner et al., 1982). Cognitive conflicts can be created, among others, by confronting problems, demonstrations, and laboratory activities (Posner et al., 1982). When competing conceptions do not produce dissatisfaction, new conceptions can be assimilated together for a long time (Duit et al, 2008). They argued that students' dissatisfaction with the old conception and the presence of an intelligible, plausible and fruitful substitution conceptions would encourage the process of accommodation of new conceptions. An intelligible conception means that the conception makes sense, is not contradictory and its meaning can be understood by students. A plausible conception if students understand the meaning of the conception and can be trusted. While the conception is fruitful if it can help students solve other problems or suggest new research directions. So that students can understand a concept, the main thing is that the concept must make sense. Meanwhile, a useful conception must be understandable and reasonable. These four conditions, namely dissatisfaction with existing conceptions, intelligibility, reliability and fruitfulness are the conditions for conceptual change (Duit et al, 2008; Posner et al., 1982).

When students are dealing with new concepts, it is not necessarily guaranteed to restructure the old concept and replace the old concept with a new concept. However, there will be other possibilities where they will maintain the old concept so that there is no conceptual change in students. This depends on the students' conceptual status. As explained by Duit et al. (2008), if the new conception reaches a higher status than the previous concept, accommodation can occur. This accommodation is a condition for conceptual change (Posner et al. 982). Conversely, if the old concept has a higher status in students, conceptual exchange will not be continued for a while. Therefore, the decision to change the prior conceptions of students basically lies in themselves (Posner et al., 1982). However, when there is a difference between the old conception and the new conceptions (cognitive conflict), students must have an awareness of contradictions, followed by an awareness of the need for change. Thus, the teacher as an external agent must play a role in convincing students that the current conception is not consistent with the scientific conception and convincing students of the need for conceptual change (Strike & Posner, 1985). Manshor et al. (2010) found that students' conceptual changes were also influenced by teachers' pedagogical content knowledge (PCK). In addition, there are affective aspects that influence students' conceptual, including students' goals, values, self-efficacy, interests, beliefs, and control (Pintrich et al., 1993; Strike and Posner, 1985). Cheyne, Carriere, & Smilek, (2006) suggested that the low interest in learning is related to cognitive failure.

**POE Strategy Assisted by Air Properties-Experimental Kit**

POE (Predict-Observe-Explain) is a learning strategy based on a constructivism approach in which new knowledge is built based on prior student knowledge (Barke et al., 2010; Joyce, 2006). This strategy is preferred to achieve conception changes in various studies (Küçüközer, 2013). This learning strategy involves students through three stages of activity to explore their understanding. At the beginning of POE, students predict the results of phenomena and provide reasons for their predictions (Bumbacher et al., 2015; Kibirige, et al., 2014; Yang et al., 2017). Then, the teachers conduct demonstrations or experiments. They describe what they observe (Hilario, 2015; Joyce, 2006). At this stage, students will see consistency between predictions and observations with each other. At the end of the POE, students provide explanations for their observations. When finished, they discuss their ideas with their teacher (Joyce, 2006).

In this study, we associate an an air properties-experimental kit with a POE strategy. This experimental kit contains a collection of experimental tools, a booklet listing equipment for experiments along with their instructions for use, and student worksheets that are packaged together for instructional tools to make it easier for students to understand the properties of air. Experimental equipment is used to support the "Observation" phase of POE learning. This will certainly eliminate the limitations of observations experienced by students as long as they are felt through traditional learning and minimize the confusion the teacher is looking for the right experimental tools for the topic of air properties. Booklets are made with the aim of introducing the experimental tools used and giving instructions to students and teachers about how to use and maintain the equipment. Meanwhile, student worksheets that contain material content of of air properties, tools and experimental materials, work steps based on POE syntax, and questions that students must answer, of course, can facilitate the teacher in presenting learning, clarifying instructions for students, and understanding the concept. The material in the worksheet can help students provide an explanation for their observations (Explain Stage).

The advantages obtained from the air properties-experimental kit are in line with the opinions of many experts. They reveal that science kits are authentic inquiry tools that provide material and formats for inquiry teaching and facilitate teachers in science teaching to build understanding of content in students (Dickerson et al., 2014; Dickerson et al., 2006, Jones et al., 2012; Rubino et al., 1994; Young and Lee, 2005). We can say that during learning, there is a cognitive process in which students build their initial concepts into new concepts. Other opinions reveal that using a science kit stimulates students 'cognitive potential, enhances science processes and thinking skills, develops students' interests, improves student attitudes, and promotes understanding concepts and processes of science through pleasant investigations (Jaimini, 2014; Houston et al., 2008; Rubino et al., 1994). This is supported by Hong et al. (2014) which states that visual and vocal observations can strengthen students' understanding of natural phenomena. Also important, science kits can also enhance knowledge content, pedagogy, teacher attitudes toward science (Dickerson et al., 2006) that contribute to changes in student conceptions (Mansor et al., 2010).

## 2. Material and Methodology

### a. Data

The data was collected by looking at the students' answers in the "Prediction" stage in the POE and the posttest results using six-tier diagnostic tests which developed from the instrument four-tier test made by Kaltakci (2012). This test related to the topic of air properties, namely air has pressure. Six-tier test in this study has six levels. The first level contains several choice questions about the prediction of a phenomenon with two choices of answers prepared (wrong answers) and one blank answer that can be filled by the student itself. The second level is the level of confidence in the choice of answers at level one. Third level, students provide reasons for answers in the first level. The fourth level, namely the level of confidence in the answers at the third level. While the fifth level, namely students are asked to make illustrations / pictures that support the first and third level answers. Finally, the sixth level is the level of trust in the answer to the fifth level. This test is given to fifth graders (average age 10-11 years) Primary School as many as 18 people who have followed the POE learning strategy assisted by the experimental kit of air properties.

### b. Method

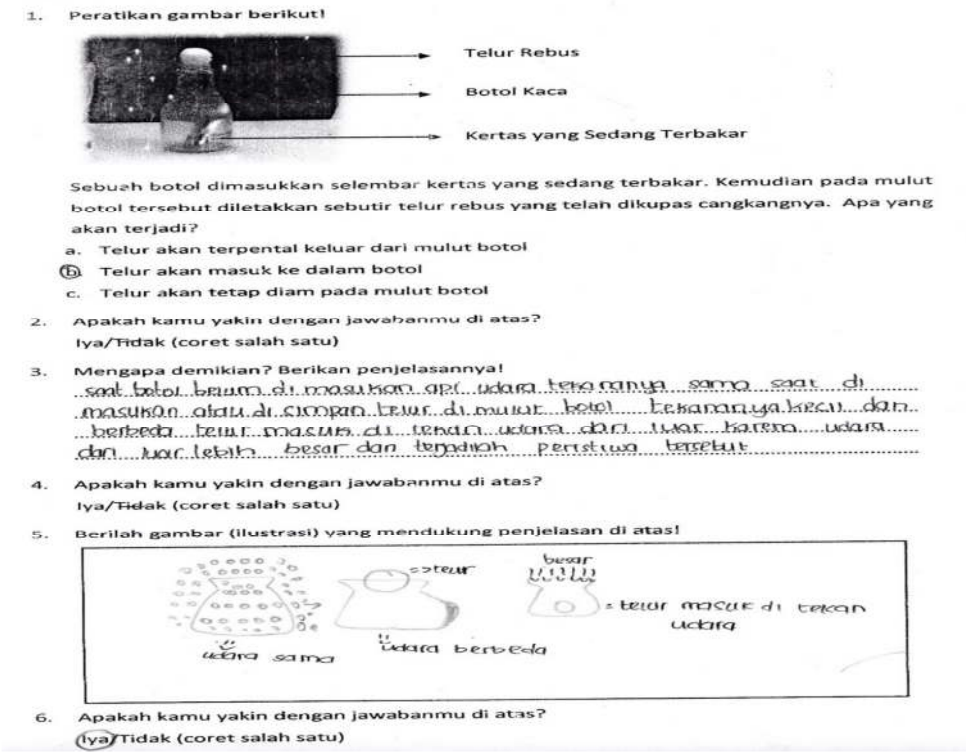
This research uses a descriptive method. With this data, data can be collected and concluded. The research stages are as follows: 1) Planning and making of air properties-experimental kit that contains a booklet listing equipment and using instructions, equipments, and worksheets; 2) Trial and judgment kit by experts; 3) Compilation of instrument six-tier diagnostic tests; 4) Judgment instrument tests by experts; 5) Preparation of an assisted POE strategy lesson plan by an air properties-experimental kit; 6) Implementation of POE strategy assisted by air experimental-kit properties and data retrieval; 7) Process and analyze data; and 8) Conclusions.

## 3. Results and Discussion

### a. Result

This section addresses the results of qualitative analyses. Based on the students' answers in the "Prediction" stage about the phenomenon that describes an Erlenmeyer inserted a piece of paper that is burning and the mouth of the Erlenmeyer is placed with a boiled egg that has been peeled off the shell, as many as 18 students (100%) had the wrong conception about about air pressure. As many as 5 out of 18 students believe that the egg will enter the Erlenmeyer. This is in accordance with the expected answer. However, they give inappropriate reasons. Of the five people, 2 people believed that the temperature of the heat in the Erlenmeyer made the egg melt so that the egg entered the Erlenmeyer. Whereas, 3 other people believe that the temperature of the heat in the Erlenmeyer makes the pressure in the Erlenmeyer high and pulls the egg into the Erlenmeyer. This is certainly not in accordance with the scientific concept. As many as 13 out of 18 students gave predictions and wrong reasons. They predict that the eggs will bounce from the mouth of the Erlenmeyer. The reason is that the burning paper makes the temperature in the Erlenmeyer high so that it pushes the egg out of the Erlenmeyer. This is certainly not in accordance with the scientific concept because the answer that should be the egg will enter the Erlenmeyer because the burning paper makes the temperature in the Erlenmeyer high. Furthermore, the increased temperature makes the air particles in the Erlenmeyer become tenuous so that the air pressure in the Erlenmeyer becomes lower than the air pressure outside the Erlenmeyer. Finally, the air from outside the Erlenmeyer presses the egg into the Erlenmeyer.

After learning through the POE assisted by an air properties-experimental kit, seen changes in students' conceptions about air properties. This is showed by the results of the post-test of 18 students. A total of 16 out of 18 students (89%) gave predictions and reasons that were in accordance with scientific concepts. However, most of them cannot represent their answers in the form of images, for example see Figure 1. Of the total number of students, as many as two students gave correct predictions, but did not provide the right reasons. The reason for these two people is different from one another and the same as the reason given at the prediction stage of POE. One person argued that the entry of eggs into a Erlenmeyer containing burned paper is because the eggs melt. Whereas one other person, argued that the presence of fire in the Erlenmeyer made a high pressure in the Erlenmeyer and pulled the egg into the Erlenmeyer.


1. Peratikan gambar berikut!



Sebuah botol dimasukkan selembar kertas yang sedang terbakar. Kemudian pada mulut botol tersebut diletakkan sebutir telur rebus yang telah dikupas cangkangnya. Apa yang akan terjadi?

a. Telur akan terpental keluar dari mulut botol
(b) Telur akan masuk ke dalam botol
c. Telur akan tetap diam pada mulut botol

2. Apakah kamu yakin dengan jawabanmu di atas?
Iya/~~Tidak~~ (coret salah satu)

3. Mengapa demikian? Berikan penjelasannya!
saat botol belum di masukan api udara tekanannya sama saat di masukan atau di simpan telur di mulut botol tekanannya kecil dan berbeda telur masuk di tekan udara dari luar karena udara dan luar lebih besar dan terjadilah peristiwa tersebut

4. Apakah kamu yakin dengan jawabanmu di atas?
Iya/~~Tidak~~ (coret salah satu)

5. Berilah gambar (ilustrasi) yang mendukung penjelasan di atas!



6. Apakah kamu yakin dengan jawabanmu di atas?
(Iya)/Tidak (coret salah satu)

Figure 1. Representation of Students' Postest Answers in Inappropriate Image Forms

Figure 1 shows that even though students provide the right predictions and reasons, they have not been able to represent their explanations in the form of image. The information they gave to the picture was not clear enough. This fits the case found by Ainsworth (2004). This course needs further research. However, in generally their conception of "Air Has Pressure" undergoes change after learning using POE strategy assisted by air properties-experimental kit from misconception becomes a conception in accordance with scientific rules.

**b. Discussion**

As a result of this study, it can be said that the application of POE learning strategies assisted by an air properties-experimental kit has a positive effect on changing students' conceptions of air properties. We argue that the active participation of students by taking part in investigative activities through an assisted POE learning strategy kit of the properties of air can improve their conceptions. This is supported by Posner (1982), Ching She (2014), and (Pintrisch, 1992) who argued that inquiry learning using authentic tasks is the best way for conceptual change. In the first stage of the POE, students predict the results of phenomena and explain the reasons for their predictions (Bumbacher et al., 2015; Kibirige, et al., 2014; Yang et al., 2017). In this study, the teacher demonstrated the phenomenon of the inclusion of burning paper into an Erlenmeyer flask (one of the tools in the kit), then the student predicted what will happen if a shelled egg is placed in the mouth of the Erlenmeyer flask. Students wrote down their predictions and reasons on the student worksheets contained in the kit. At this stage we can know the students' initial knowledge that is needed in the change of conception. According Posner et al. (1982), the initial conception of students is used to learn new knowledge called assimilation. In the second stage, the students conducted a demonstration (Hilario, 2015; Joyce, 2006) which was supported by air properties-experimental kit and described what they observed on their worksheets. Some experts argued that science kits are authentic inquiry tools that help students develop their understanding of content (Dickerson et al., 2014; Dickerson et al., 2006; Jones et al., 2012; Rubino et al., 1994; Young and Lee, 2005), and improve science processes, thinking skills, develop student interest, and improve student attitudes (Jaimini, 2014; Houston at al., 2008; Rubino et al., 1994). These things can certainly help students understand scientific concepts.

After observation, the students clarify their own individual ideas. They evaluate whether the experimental results match predictions or not. When their predictions and observations are not consistent with each other, students face conditions of dissatisfaction or cognitive conflict. This is the first step to achieving the conceptual changes needed in the accommodation stage to acquire new concepts (Limon, 2001; Posner et al., 1982) where students must realize that they need to rearrange, restructure, or change previous concepts (Posner, 1982). At the end of the POE, students provide explanations and illustrations for their observations by looking for information from the material about the properties of the air provided on the student worksheets contained in the kit. Next, they discuss their ideas with their teacher (Joyce, 2006). The teacher gives an explanation that is based on the material of the student worksheet contained in the experiment kit of air properties. The information students get from the text of the material in the worksheet and from the teacher's explanation will also increase students' dissatisfaction with the answers to the prediction activities. In these conditions students must have an awareness of contradictions, followed by an awareness of the need for change and the teacher helps convince students that the current conception is not consistent with domain standards and convinces students of the need for conceptual change (Strike & Posner, 1985). When competing conceptions do not produce dissatisfaction, new conceptions can be assimilated along with old conceptions (Duit and Treagust, 2008). He said that if students were not satisfied with the previous conceptions and the available substitution conceptions could be intelligible, plausible and fruitful, then the accommodation process of new conceptions could occur. The new concept is intelligible, plausible and fruitful will make the new concession status higher than the old conception and the creation of conceptual change (Duit and Treagust, 2008).

It is through this air properties-experimental kit that we designed to help students to acquire intelligible, plausible and fruitful conceptions that encourage students' conceptual change. The experimental kit of air properties is equipped with experimental tools and student worksheets consisting of material and work steps that make it easy for students to understand the concepts and phenomena of air properties and provide a pleasant learning environment. As experts argued that science kits are authentic investigative tools that provide material and formats for inquiry teaching and facilitate teachers in science teaching to build understanding of content in students (Dickerson et al., 2014; Dickerson et al., 2006, Jones et al., 2012 ; Rubino et al., 1994; Young and Lee, 2005). Science kits stimulate students' potential cognitive, enhance science processes and thinking skills, develop students' interests, improve student attitudes, and promote understanding concepts and processes of science through pleasant investigations (Jaimini, 2014; Houston et al., 2008; Rubino et al., 1994). This is supported by Hong et al. (2014) which states that visual and vocal observations can strengthen students' understanding of natural phenomena. Also important, science kits can also enhance knowledge content, pedagogy, teacher attitudes toward science (Dickerson et al., 2006) that contribute to students' conceptual change (Mansor et al., 2010).

There is still a false conception after learning shows that the old conception of students has a higher status than a new conception. We assume that this is caused by a lack of interest from two students to take part in learning. We observed during learning, they were only interested in "observe" activities, but did not have the interest to find the right answers to their previous answers, which could be obtained by reading the material in the student worksheets and to hear the teacher's explanation. In fact, student interest in learning plays an important role in conceptual change (Pintrich et al., 1993; Strike and Posner, 1992). Lack of interest causes obstacles in the acceptance of new knowledge. Finally, they use the previous concept based on everyday experience. This finding is consistent with other previous findings regarding the relationship between low interest in learning and cognitive failure (Cheyne et al., 2006).

The discovery of the case in this study, namely the lack of students' ability to represent their answers (text) into the form of illustrations shows their representation power is still low. This means, they are still lacking in the ability to think visually. In fact, the ability to visualize is one of the most important components for the fundamental part and the process of unique and absolute perceptions that are needed to express visually and symbolically an idea or thought (McLoughlin, 2001). One of the reasons can be because before the teacher was not used to providing contextual learning in accordance with the development of elementary school children and not giving students the opportunity to represent ideas on a scientific phenomenon, whether in the form of tables, graphics, or pictures. Environments that can be created to visualize scientific phenomena include videos, animations, simulations, and dynamic graphics (Ainswort, 2008). Regarding this research, what might need to be added to the air properties-kit is the CD of air properties animation or video. It will helps the students represent their ideas in the form of images.

## 4. Conclusion

In this paper, the students' conception change using POE strategy assisted by air properties-experimental kit is presented. The study results show that using POE strategy assiset by air properties-experimental kit can change students' conceptions about air properties concept. This is because the POE strategy and air properties-experimental kits can help students' cognitive processes by inducing cognitive conflicts needed in the accommodation process to gain new concepts (Posner, 1982). In addition, this strategy can increase students' interest shown by students during the lesson. Student interest also influences student conceptions change (Pintrich at al., 1993; Strike and Posner, 1985). Students 'interest in using POE strategy assisted by air properties-experimental kits and their influence on students' conception change needs to be carried out further research. Integrated air properties-experimental kit and POE strategy is potential and efective way to helps student for better learning in science. The findings in this study are the low ability of students' representation in the form of images. Therefore it is recommended to add animation or videos about the properties of water in CD form to help develop their visual thinking abilities.

Based on the results of the research, a comprehensive conspecific there are several recommendations related to this research, such as: 1) POE strategy assisted by air properties-experimental kit can be a learning alternative for elementary school teacher specially in improving students' concept; 2) The application of POE strategy assisted by air properties-experimental kit limited to the subject of air has pressure. For futher research, it can be used on other subjects or natural phenomenas related to air properties concepts; 3) The application POE strategy assisted by air properties-experimental kit in this research is limited to students' conception change. For further research, it can used on other variables; 4) The lack of students' ability to differentiate needs to be examined further.

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