The Conceptual change of human respiratory system through POE-Based Learning

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Abstract. Study to analyse the effect of Predict-Observe-Explain (POE)-based learning to the conceptual change of high school students on human respiratory system concept has been done. This study was a weak experimental with one group pre-test and post-test design. The data were obtained by a pencil and paper test in the form of reasonable-multiple choice with two tiered test items. The data were analysed by mean of difference test between pre-test and post-test scores. The finding of study shows that a significant change in the percentage of students scientific conception between pre-test and post-test. The result shows that the increase of student conceptual change with N-gain average is 0.52 (moderate category). In addition, the result also shows that a pattern of student conceptual changes that positive changed is 44.3%, positive survival is 20.5%, negative change is 11%, and negative survival is 24.2% respectively. Based on result shows that POE-based learning strategy can be developed in high school to support students in resolving conceptual change of scientific concept.

1. Introduction
Unlike empty glasses that students enter to the classroom have an initial conception of content learning before engaging in learning activities. In the classroom learning, the initial of student conception is very important part due to often personal and incompatible with scientific concepts [1]. In learning, the initial conception plays part of important role in achieving a scientific conception, the initial students conception that are inconsistent with scientific concepts is called misconception [2].

In fact in education, teachers tend to focus on learning activities regardless of the initial student conception [3]. Misconceptions can also be caused by the content explanation of textbook as source of learning, teacher explanation, and the teaching and learning methods [4]. Students experiencing misconception do not realize that their conception is false. Student misconceptions often difficult to recognize, especially if the student has upgraded in the long term [5].

If the new concept conforms to the initial concept, student can use his knowledge to the new situation. If the new concept is different from the initial concept, the student needs to change their conceptions, so that there will be a conceptual change. Through the conceptual change, students can learn the science actively build their knowledge to achieve meaningfulness [6]. According to Köse [2] there are several methods commonly used to identify students' misconceptions, i.e. open questions, two-tier diagnostic tests, concept maps, prediction-observation-explanation (POE) , interviews about events, interviews on concepts, word association and drawing.
The misconceptions that occur in the student should be, since misconceptions are repetitive and firmly attached to the student, due to disturbing the next conception [6]. Therefore, it is important for teachers to identify students’ conceptions, both before and during teaching and learning [7].

The POE (predict-observe-explain) is one of the learning strategies used in the learning activities, helping students shape their investigation, and strengthening student prediction and conception. Application of POE learning has a positive effect on reducing student misconceptions in learning [8].

The human respiratory system concepts are difficult to convey if only based on teacher explanation or reading a textbook. Students have often misconceptions on sub concepts as well as respiratory mechanisms, respiratory processes, and differences between respiration and breathing [5]. Therefore, its need to develop teaching and learning strategies that can help students to acquire new knowledge without misconceptions. Conceptual change is not exactly a scientifically appropriate concept so that the development of student’s comprehension will be in accordance with scientific concepts that have been agreed upon.

The general purpose of this study is to apply the POE-based learning strategy on human respiratory system concept in senior high school and so to analyse its influence in facilitating of students conceptual changes on the human respiratory system. However, there are much research on POE-based learning activities, but there is a little scientific publication about its effect on the conceptual changes of biological concepts in senior high school.

2. Methods
The research method was weak experimental with one group pre-test and post-test design. The study was conducted in one of senior high school in Bandung. The sums of participants’ were 44 students of second grade by cluster random sampling technique. POE-based learning was conducted in two meetings.

The instruments which validated by expert judgment consist of reasonable-multiple choice test of two-tiered of 20 items and questionnaire. Identification of conceptual change has been analysed by comparing the result between pre-test and post-test. To analyse the students’ responses of POE-based learning used Likert scale with four categories: strongly disagree (SD), disagree (D), agree (A), and strongly agree (SA). The conversion of scale form into the score was SD (1), D (2), A (3), and SA (4) respectively.

Data analysis used the scoring criteria proposed by Costu et al. [9] Scoring of student answer consists of the true response-true reason (3 points), false response-true reason or true response-no reason (2 points), true response-false reason (1 point), false response-no reason or false response-false reason or no response-no reason (0 points). Meanwhile, to see the significance of POE-based learning effect on conceptual change of students, data was analysed using one sample t test statistic.

3. Result and Discussion
Average score comparison between pre-test and post-test is presented in figure 1.

![Figure 1. Average value of pre-test and post-test scores.](image-url)
Based on Figure 1 there is different score before and after POE-based learning on the concept of the human respiratory system. Maximum score according to the adaptation scoring criteria of Costu et al. [9] is 100. The highest score achieved by students is 90.

The test data prerequisite of this research has normal and homogeneous. To find out whether there are differences in the average of two paired samples used paired sample t test. Based on the paired sample t test, there is effect of POE-based learning on student’s conceptual changes. Based on the significant difference between the pre-test to post-test, comprehension students’ concept through POE-based learning a viable alternative teaching strategy to improve right understanding of the scientific concept [10].

To analyse improvement of conceptual changes that occur in students after POE-based learning was measured by N-gain calculations [11]. The average N- gain is obtained 0.52 (moderate category). This means that the average of students conceptual changes after Predict-Observe-Explain ( POE )-based learning is included in the medium category. Based on this finding that Predict-Observe-Explain (POE)-based learning has an influence on students’ conceptual change of the human respiratory system concept.

The conception of students in accordance with the scientific concept increase in final test, but there are still a small number of students whose conception not in accordance with the scientific concept on some existing concepts. This is due to there are some students who do not participate actively during the process of POE-based learning, so students conception still maintain that is not in accordance with the scientific concept. To facilitate understanding the results on the student’s conception before and after POE-based learning of the human respiratory system concept show in Figure 2.

![Figure 2. Students conception before and after POE-based learning.](image)

Based on Figure 2 the general students’ conception before and after POE-based learning clearly show difference. The pre-test results show students' conceptions are at a high level of no understanding (52.7%) on the concept of the human respiratory system. However, some students already have an pre-instructional conception that includes the category of understanding (21.1%) which means that students have been able to determine the true-responses and so true-reasons of two tiered test items, while the students have the concept of partial understanding (7.1%) which means the student able to answer and the reason correctly, the student chooses true-response but no-reasons. In addition, the students' misconception is quite high (19.1%) which means that the conception of students is not in accordance with the scientific concept or the students are able to answer correctly but the false reason [10].

Post-test scores show the final conception of students after POE-based learning. Most of the students’ conceptions who do not understanding change to understanding, other than that student who have specific misconception also changed to understanding. The percentage of categories of students’ conception of understanding criteria increased up to 43.3% and there were also students who entered the partial understanding category (27.3%). Percentage of misconception categories decreased to 16.7%.
The lowest student perception is in the category of no understanding that is equal to 12.4%. POE-based learning activities have provided meaningful opportunities for students to criticize their initial ideas and discuss with their friends to encourage a scientifically correct conceptual conformity understanding [12]. The pre-test data of all concepts on the various categories of understanding are combined show in Figure 3.

![Figure 3](image)

**Figure 3.** Initial conception of students on each concept of human respiratory system.

Based on Figure 3, the student conception is in the understanding category differ from concept 1 to concept 6. Generally the conception is in the no understand category. Only a small number of students exist in concepts 1 through 6 in the category of partial conception and understanding, that means student is able to answer the reason correctly, but the double choice is false, and the student is able to make the true choice, but does not choose the reason. Then the number of category of misconception is quite a lot on each concept. Because at this early knowledge the students' conception is still incompatible with scientific conception. In addition, everyone has different experiences and the concepts created by each person may be different. Although the concept of each person is different, we can communicate using the terms we give to the concept based on mutual agreement. Students build their own conceptions so that they are personal.

Furthermore, the data of the final conception of students (post-test) in different categories of understanding are combined; it will look like in Figure 4.

![Figure 4](image)

**Figure 4.** Final conception of students on each concept of human respiratory system.
Based on Figure 4 the final conception of students is variety of understanding categories. Generally the final conception of student is in the sound understanding category. Only a small proportion of students are misconception category. The POE-based learning strategy is effective for facilitating teachers to monitor student learning progress. It so can be used to design learning activities that start from the student's point of view, provide opportunities for students to re-construct and change their initial conceptions as a result of differences in conceptions between observation and prediction [13]. Then the number of No understand categories reduced from pre-test scores result, but the No understand category still high on the concept 2, due to there are still students who do not participate actively during the learning process of POE-based learning activities.

**Table 1. Percentage of student’s conception patterns of each indicator**

| No. | Concept                                                                 | I (%) | II (%) | III (%) | IV (%) |
|-----|-------------------------------------------------------------------------|-------|--------|---------|--------|
| 1.  | Relationship of the respiratory system with other related systems       | 47.5  | 12.5   | 15.9    | 24.1   |
| 2.  | Structure and function of human respiratory organs and abnormalities and disorders | 39.6  | 16.4   | 24.9    | 19.1   |
| 3.  | Exchange process of O₂ and CO₂                                          | 44.9  | 4.50   | 20.5    | 30.1   |
| 4.  | Respiratory mechanism                                                    | 34.5  | 7.90   | 25.8    | 31.8   |
| 5.  | Frequency and volume of respiratory air in the lungs                     | 43.7  | 4.30   | 26.6    | 25.4   |
| 6.  | Understanding of human respiratory system                               | 55.8  | 20.4   | 9.10    | 14.7   |
|     | **Average**                                                             | **44.3** | **11.0** | **20.5** | **24.2** |

**Description of patterns:**
Pattern I: Conception turns positive (−, +)
Pattern II: Conception changed negative (+, −)
Pattern III: Positive survival (+, +)
Pattern IV: Negative persisted conceptions (−, −)

Based on Table 1 shows that the highest average pattern of student conception is the pattern I, that means the conception of positive change (there is a conceptual change) with an average is 44.3% while the lowest average in pattern II (conception changed negatively) is 11%. Although pattern I has the highest average, the IV pattern (negative persisted conception) has a fairly high average score a little bit than pattern I. After POE-based learning there are still many students who maintain a conception that is not in accordance with its scientific conception. Student’s conceptions on some concepts of pattern IV is higher than pattern I, namely the concepts of frequency and volume of respiratory air in the lungs (25.4%), respiratory mechanism (31.8%) and exchange process of O₂ and CO₂ (30.1%). The student’s conceptions are still maintained and inconsistent with scientific conceptions.

There is one concept that has the highest average for the conceptual pattern III (persisted positively), i.e. the respiratory mechanism (25.8%). Some students already have scientific conception an initial concept as well as after learning still persisted change (positive survival). During the observation on POE based learning in practicum activities of human respiratory system, students respond well to the activity and agree that students understand the prediction question (63%), understand to search data or information (70%), understand the steps work and use of materials (75%), easily to write data and answer discussion questions (71%), understand explanation of work (66%), and easily make conclusions of observations and relate to predictions (73%). This is in line with research conducted by Zulaeha et al. [14], there is the influence of POE-based learning on student’s science process skills.

Most students responded fairly well and said they disagreed that POE-based learning is difficult (64%). Students disagreed that POE-based learning not attract students’ interest (79%), students also disagreed that POE-based learning not stimulate learning activities (76%). Based on students responses were in line with the study that POE-based learning has a best way to make science learning more interesting [15].
4. Conclusion
Based on the findings and results of the study, it can be concluded that POE-based learning has a significant effect on the conceptual changes of high school students of human respiratory system concept. Students' conceptions of each concept are different; consist of understanding, partial understanding, no understanding and misconception.

POE-based learning can be used as an alternative of biology teaching and learning strategy. Initial conception of the student needs to be known before learning, to identify the prior students’ knowledge, so that the teacher can determine the most appropriate learning strategy.

5. References
[1] Gunstone R D and Mitchell I J 1997 Metacognition and Conceptual Change (Melbourne: Monash University)
[2] Kose S 2008 Diagnosing student misconceptions: using drawing as a research method World Applied Sciences Journal 3 2 283-293
[3] Ormrod J E 2009 Psikologi Pendidikan, Membantu Siswa Tumbuh dan Berkembang: 6th Ed. (Jakarta: Erlangga)
[4] Suratno T 2008 Konstruktivisme, konsepsi alternatif dan perubahan konseptual dalam pendidikan IPA Jurnal Pendidikan Dasar 10 1 1-3
[5] Tekkaya C 2002 Misconception as A Barrier to Understanding Biology Journal of Education 23 259-266
[6] Dahar R W 2011 Teori-teori Belajar dan Pembelajaran (Jakarta: Erlangga)
[7] Khristiani Y 2013 Analisis Ragam dan Perubahan Konsepsi Kalor (Malang: Universitas Negeri Malang)
[8] Kibrige 2014 The Effect of Predict-Observe-Explain Strategy on Learners Misconception about Dissolved Salts Mediterranean Journal of Social Sciences 5 4 305
[9] Costu B, Ayas A and Niaz M 2012 Investigating the effectiveness of a POE-based teaching activity on students’ understanding of condensation Instr Sci 40 47–67
[10] Mahadewi L P, Kusmiarlyati N N and Udayani K M 2016 Penerapan StrategyPembelajaran Predict-Observe-Explain (POE) Untuk Meningkatkan Hasil Belajar IPA Siswa. E-journal PGSD Universitas Pendidikan Ganesha 4 1 16
[11] Meltzer D E 2002 The Relationship Between Mathematics Preparation and Conceptual Learning Gains in Physics: A Possible: Hidden Variable in Diagnostic Pre-test Scores American Association of Physics Teachers 70 12 1259-1628
[12] Humaira I 2012 Perubahan Konseptual Siswa SMA Kelas IX Melalui Penggunaan Strategy Siklus Belajar 5E pada Konsep Sistem Pernapasan. Bandung: Universitas Pendidikan Indonesia
[13] Treagust D F and Duit, R 2009 Multiple perspective of conceptual change in science and the challenges ahead Journal of Science and Mathematics Education in Southeast Asia 32 2 89-104
[14] Zulacha 2014 Pengaruh StrategyPembelajaran Predict, Observe, and Explain terhadap Keterampilan Proses Siasn Siswa Kelas X SMAN 1 Balaesang Jurnal Pendidikan Fisika Tadulako (JPFT) 2 2
[15] Karamustafaoglu O 2013 Relationship between Teacher Candidates’ Literacy of Science and Information Technology Mevlana International Journal of Education 3 2 151-156

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