The development of student worksheet based on predict observe explain to increase students’ conceptual understanding of the reaction rates

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Abstract. The objective of this research is to develop student worksheet based on POE strategy on the topic of reaction rate. The sequence of research methodology was to assess the feasibility of worksheet and to find out the effectiveness of learning by using POE-oriented worksheet on students’ conceptual understanding. The method used in this study was R&D and ADDIE development model with one group pretest-posttest design as its research design. The sample of the study was 30 students from XI science-3 class selected randomly. The data were collected from 20 multiple-choice items through pretest and posttest. The percentage of eligibility obtained from worksheet validator and chemistry teacher was 94.42% and 93.82% respectively showed POE-oriented worksheet was highly feasible to use. The average score from pretest was 63.16, posttest was 85.16, and N-Gain was 0.59. The normality test for pretest showed that L_{test} = 0.150, while posttest L_{test} = 0.125. It can be concluded that the data to be normally distributed and the t-test result was t_{test} > t_{table}, 11.417 > 1.697. Based on these results, it can be concluded that the use of POE-based worksheet in chemistry learning process effectively increases students’ conceptual understanding.

1. Introduction

One of the compulsory subjects for senior high school students is Chemistry. This subject is regarded to have a very significant position within the curriculum of senior high school. For this reason, it is important for students to understand it as its application will contribute to their daily life to some extents [1]. Chemistry is one of the lessons considered a difficult one by students. In relation to this, many terms and jargons given to this subject as several concepts of abstracts that seem difficult to learn and understand [2]. Therefore, to be able to master the subject, a good learning condition is needed to activate not only their physical but also mental capacity. In addition, the role of teachers and their creativities is necessary so that a conceptual abstract can be adequately transferred [3]. Furthermore, teachers ought to recognize the behavior of each student since it will assist and support the teaching and learning process [4].
The decline of score within National Examination experienced by senior high school students of Banda Aceh during 3 years (from 2015 to 2017) on the reaction rate topic which discussed the factors that influenced the rate of reaction with average score respectively attained is 78.50, 37.50 and 25.00 respectively [5]. From the observations can be concluded that a teacher still holds authority within the teaching and learning process which may cause boredom on students and tend to make them be an inactive participant during the learning practice. The interview results showed that the use of teaching topics, such as student worksheet was an uncommon practice and if there was a worksheet only contained a brief explanation of the topic and list of questions. Consequently, students cannot freely develop their knowledge. Moreover, the teachers only used textbooks that were available at the library and laboratory practice was rarely conducted by students. They only acquired knowledge in the classroom. To overcome these problems, it is needed an effort of improvement carried out by the teachers especially in terms of providing teaching topics which are easily understandable by students. Hopefully, it can improve students’ conceptual understanding.

In reality, students require direct experiences in learning and it can be achieved by practicing and conducting some experiments at the laboratory to support every knowledge that has been done in the classroom. If it is compared to some other schools, senior high school Banda Aceh can be categorized has adequate facilities and well-supported infrastructures. Selecting the appropriate methods and models for learning brings an impact on students’ activities. The use of conventional learning is still frequently used by teachers today. They neglect students’ skills and productivities [6]. Hence, teachers must be able to master various techniques and methods of teaching. Selecting the appropriate methods that agree with the learning topic makes students easily understand a concept and they will be more active in learning. In addition, students’ activities during the learning process will affect the learning outcomes [7]. A learning process that encourages students to be active will be able to enhance their knowledge, develop thinking skills, and increase their learning motivation [8].

The use of POE-oriented worksheet model is an alternative model that will support the teaching and learning process for a better conceptual understanding. The POE model trains and prepares students actively to be a problem-solver [9]. POE is also able to deepen students’ understanding by following these 3 steps namely prediction, observation, and explanation [10]. The implementation of POE procedure starts giving a hypothesis which is then proven by data obtained from observation before it is finally discussed in depth [11].

The objective of this study is to determine the feasibility of POE-oriented worksheet which has been tested to the learners and to determine the effectiveness of the worksheet on students’ conceptual understanding on the reaction rate topic at senior high school Banda Aceh.

2. Methods
The method used in this study was research and development (R&D) with the ADDIE model which consists of 5 stages, namely analyze, design, develop, implement, and evaluate. The research design is one-group pretest-posttest design. The research was conducted at senior high school Banda Aceh, from October to November 2018, 2018/2019 academic year. 30 students from XI science-3 class were randomly selected as the sample of the study. The instrument used to assess students’ conceptual understanding was a test that consisted of pretest (initial test) and posttest (final test) which contained 20 multiple choice questions with reliability scores of $r_{xy} = 0.703$ (high). The technique of data analysis regarding pretest given before the implementation of POE-based worksheet and posttest provided after the implementation of POE-based worksheet. The data were analyzed by using a normality test. Students’ conceptual understanding whether it increases or decreases can be identified by analyzing $N$-Gain and t-test based on the pretest and posttest results. Furthermore, each indicator on the reaction rate concept analyzed to determine how far the percentage increased.
3. Results and Discussion

3.1. Feasibility analysis of POE-oriented worksheet

3.1.1. Analysis stage, analyzing all of the problems that existed in the school based on the results of observations conducted at senior high school Banda Aceh. The result can be used to determine the kind of necessity that was needed by students to support their learning progress in order to achieve the learning objectives. The priority arrangement was based on a series of analysis such as the curriculum which includes the order of core competencies (KI) and basic competencies (KD), and learning indicators. Moreover, the analysis was also carried out on the participants’ characteristics and teaching topics. Therefore, the types of necessities required accordance with students’ need.

3.1.2. Design stage, the design phase conducted after all the findings were discovered in the analysis stage. This stage began by designing the appropriate learning tool in order to support the learning objectives. Besides, focusing on the format and the design became the primary focus on every specific aspect developed in this study which the POE stage was highlighted. Several references that supported the design and development of the worksheet from scientific articles, journals, books, and other sources were employed.

3.1.3. Development stage, to find out the feasibility of the test, the POE-oriented worksheet validated by validators and chemistry teachers. The input, suggestions, and comments were from the experts (lecturers) and the teachers were gained for a revised worksheet 1. The second revision was also carried out based on the considerations mentioned early.

The validation results from the experts on the students’ worksheet feasibility focused on 7 aspects had an average score of 94.42%. It was categorized as highly feasible. While the teachers’ validation results based on 3 aspects received an average score of 93.82% which was also considered to be highly feasible. From the results showed that POE-oriented worksheet developed in this study was feasible to be used. In order to obtain a valid and reliable question for pretest and posttest activity; each item was analyzed using Proanaltest [12].

3.1.4. Implementation stage, The teacher prepared students within their learning environment as the beginning of this stage. The learning process initiated by using the validated worksheet as a way to measure students’ understanding concept. It proceeded by following the POE model stages that had been listed in the lesson plan (RPP). Students were given opportunity to prepare and inquire every point and stage how to operate the POE-based worksheet. This phase was undertaken before the researcher started the research to make sure that the learning objective can be achieved during learning process.

3.1.5. Evaluation stage, the appropriate evaluation stage was needed to assess the quality of learning using POE-oriented worksheet. This strategy of learning encourages students’ curiosity and enthusiasm regarding the topic is learned. The implementation of POE-oriented worksheet consists of 3 stages. The first stage is a prediction, where students were required to guess or predict an event related to the reaction rate topic. The next stage is observation by making observations to find out previous answers. The last stage is an explanation. Students were required to connect their predictions with the results obtained after observations.

3.2. Analysis of students’ conceptual understanding
The teaching and learning process uses the POE-based worksheet is able to improve each understanding of concepts possessed by students especially in the reaction rate topic. This can be seen based on the average score of the pretest obtained by students; 63.17, while the average posttest score was 85.17. After obtaining the score of the pretest and posttest, the N-Gain calculation was then done.
to determine students’ conceptual understanding. The percentage of the average score on students’ improvement was presented on Figure 1.

Figure 1. The average score of pretest and posttest.

The calculation results acquired indicated an increase of average score obtained by students between the pretest and posttest. From these results, the N-Gain score was 0.59. From this result it can be concluded that the increase of conceptual understanding was categorized as moderate [13].

The data from the pretest and posttest were tested for normality. The purpose of this test was to determine whether the data were normally distributed or not. This normality test was carried out by using the Liliefors test with the help of Microsoft Office Excel 2010 software. The level of significance was 0.05. The results of the normality test were presented in Table 1.

| Type of data | L\text{test} | L\text{table} | Category          |
|--------------|--------------|---------------|-------------------|
| Pretest      | 0.150        | 0.161         | Normally distributed |
| Posttest     | 0.125        |               |                   |

Based on the normality test on students’ pretest score in the reaction rate topic concluded that L\text{test} =0.150<L\text{table}=0.161 while the posttest score was L\text{test}=0.125<L\text{table}=0.161. The results were accordance with the normality test criteria, which if L\text{test}>\alpha=0.05 and L\text{test}<L\text{table} the data were normally distributed. The improvement of conceptual understanding can also be seen based on the indicators of the reaction rate topic. There were six indicators analyzed in this study and the results were presented in Figure 2.
Figure 2. The improvement percentage of students’ comprehension score test based on indicators of reaction rate.

Figure 2 explained that the concept of reaction rate consisted of 6 indicators which represented each concept in the topic. Students’ conceptual understanding increased in all indicators subsequent learning by using the POE-based worksheet. The first indicator was to describe the factors that influenced the improvement of reaction rate by 26.67 from the pretest result. The second factor explained the concentration effect on reaction rate which improvement result was achieved from the pretest; 24.16. The third factor influenced the improvement of the surface area on the reaction rate by 22.22. The fourth factor described the effect of temperature on the reaction rate; 19.16. The fifth factor concluded that the catalyst effect on the reaction rate increased by 27.78. The students’ improvement on the concept was based on reaction rate indicators. The sixth factor was to determine the equation order of reaction which increased by 18.33 based on experiment results. From these results, it is clear that each indicator experiences some kinds of improvement on students’ conceptual understanding. Hence, it can be concluded that the use of worksheet in learning can improve students’ understanding concepts.

Learning through POE stages provides an opportunity for students to develop their mental and physical capacity in order to improve their understanding [14]. In the POE-based strategy, the role of the teacher during learning process is to encourage students to think freely and to make it more memorable [15]. The POE-model provides opportunities for students to reduce misunderstandings among them due to differences in predictions because it will be proven by means of observation stage before providing discussion in order to find out the relationship that has been predicted [16]. Students’ conceptual understanding can be improved by implementing the POE-based worksheet. Thus, helping learners find their own concepts independently [9]. This discovery stage is arranged based on POE step which directs learners within each of steps [17]. The use of worksheet as one of teaching topics in supporting the teaching-learning process is very effective mainly in delivering information to students. The POE learning strategy is classified under the constructivism theory of learning [18] which means students are required to be active during learning process [19].

An analysis was also conducted on students’ answers in their worksheets by following the stages of the POE-model analysis. The first stage is prediction where students predict the answers to problems presented in the worksheet along with a coherent reason. Students formulated individually a prediction according to their respective capabilities. Next is an observation or direct observation in order to acquire the real answer that they wrote everything found during the observation and complete it in the worksheet. The third stage is an explanation which the explanations were given by the
students regarding the suitability and relevance of the predictions using the observations that had been made. The ability of students to answer POE-oriented worksheet can be seen on Figure 3.

![Figure 3. The ability of students to answer POE-oriented worksheet.](image)

Figure 3 showed that the three stages of POE which were applied to the worksheet in order to be completed by the students. In the prediction stage, the number of students who were able to accomplish was 80.83%, that illustrated a good result at the beginning of the use of the POE-based worksheet. The second stage is observation in which students who were able to provide the answers according to the instruction stated in the worksheet reached 89.17%; while, the results of the third stage is explanation around 86.67%. Based on these results can be stated that students are able to complete the stages of POE well as stated in the instruction on the worksheet. It can motivate students to be active and directly involved in the teaching and learning process. The learning activities that are carried out in the laboratory designed based on the students’ needs in order to make knowledge are reachable and oriented on the learners [20].

The implementation of POE-oriented worksheet in learning does not directly seem. There are obstacles to be considered such as sound that occurs during the learning process due to the fact that students are not familiar with the POE model. In addition, teachers must be able to manage time effectively and efficiently and is not interfered with other lessons. The role of the teacher is prominent especially before conducting observation and checking the availability of topics and tool are used. However, teachers are able to overcome these problems and the goals of learning are accomplished. The benefits of the use of POE-based worksheet in learning encompasses a great influence and can be used as a tool to identify the learners’ early conceptual understanding ability [21].

POE is able to stimulate eagerness in conducting an investigation at the observation phase. Apart from this, it also explores students’ capabilities and is able to improve students' understanding concept [22]. POE is incredibly effective when it is applied in the learning process that involves group works and it helps students interact [23]. Therefore, the use of POE-oriented worksheet is considered to be effective in teaching-learning process as well as able to evoke active discussions from the participants [24].

3.3. Hypothesis testing on students’ conceptual understanding

T-test correlation can be used to compare the results of treatment conducted either before or after the treatment. T-test correlation indicated that the $t_{test}$ score at a significant level ($\alpha=0.05$) and degree of freedom $df = 30-1=29$ was 1.697 (see the t-test table) while the score of $t_{test}=11.417$. The result was $t_{test}>t_{table}$ which is 11.417>1.697. It can be concluded that there is a significant influence on students’ understanding of the concept before and after the implementation of POE-based worksheet in learning. It revealed that by implementing the POE-based worksheet students’ confusion of the topic studied can be overcome and subsequently improved students’ learning capability [25]. It means that there is
an increase in students’ understanding of concepts after the application of learning by using the POE-based worksheet carried out. Aside from this, the use of POE technique in learning can help students deepen their understanding without making them curious about the topic [10]. The practical activities in learning are also extremely helpful for students in shaping their own concepts for whatever topic is being studied.

4. Conclusion
From the results of the data analysis and the discussion can be concluded that: (1) POE-oriented worksheet develops using the ADDIE model; (2) The validation results of the POE-oriented worksheet in the reaction rate topic are categorized as valid and highly feasible to be used in assisting the learning process; (3) POE-based worksheet is effective used in Chemistry learning process as well as to increase students’ understanding of concepts in the rate of reaction topic.

5. References
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