Students’ worksheet development on salt hydrolysis material through Problem-Based Learning to improve science process skill

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Abstract. This research aims to improve science process skill within the topic of Salt Hydrolysis and to indicate students’ responses upon the implementation. This is an R&D research conducted at a High School in Banda Aceh. The data obtained were analyzed using several techniques, including feasibility test, student science process skill test, and responses of both students and teachers. The result showed that the product was a very feasible category by an average percentage of 93.75%. Limited trial to chemistry teachers at research school exhibited a similar category with an average percentage of 88.17%. For the final result, the comprehensive test was conducted by chemistry teachers among MA/MAS in Banda Aceh expressing the same category with an average percentage of 85.58%. The dissemination and implementation of developing SW for students of MAN Banda Aceh 1 obtained a very good percentage of 86.04% for science process skill. Besides, it showed both students and teachers have positive responses toward the implementation of this technique with an average percentage of 88.50% and 83.33%, respectively. Therefore, it can be concluded that the SW is feasible to be used for practical study on Salt Hydrolysis topic.

1. Introduction

Learning is the main activity for school and education, which is directly related to students as it consists of three key domains which are cognitive, affective and psychomotor domain. Chemistry subject which is taught at school has its own characteristics. Thus it needs typical skills to solve several chemistry problems such as concept, theories, laws, and facts. The objective of chemistry learning is to lead students to understand chemistry concepts, including their relation and application for the sake of life and technology. During observation and interview with chemistry teachers at MAN 1 Banda Aceh, it revealed that the chemistry concepts used in class at the recent time have not emphasized on science process skill. Besides, the students hardly participate during the practical studies. Further, the learning process did not embody the relationship between concepts of learning and their application in daily life. One of the key factors affecting this condition is the lack of facilities available in the science laboratory.

BSNP data exhibited the result of the national examination of SMA/MA on Salt Hydrolysis topic in MAN 1 Banda Aceh, which decreased from 2014 to 2017. By year 2014/2015, it escalated up to 83.22%, but then gradually decreased to be 71.69% and 20% in 2015/2016 and 2016/2017, respectively. The very low percentage obtained in 2017 is caused by the level of difficulty that becomes higher than the year of 2015 and 2016. Thus difficult for students to solve chemistry problems. The national examination has also accommodated questions that support students to create their science process skill.
In 2016, the questions required the students to analyze pH, and it is one of the science process skills indicators about doing observation. In 2017, the indicator was not only for observing the pH, but to determine the hydrolysis type and reaction equation of salt hydrolysis solution, and the question is appropriate with the application of science process skill indicator, which is concept applying.

Science process skill (SPS) is one of the skills that are very crucial for students to develop their potency [1]. SPS is important for each student as it is deemed as a potential capacity to use the scientific method. In order to develop students’ science process skill, it is expected that they acquire new knowledge or to develop their own existing skill [2]. It showed that the students’ SPS could be observed during the practical study. For special topics that need direct experiences are better to be treated through the experimental method, thus the students will be more active and skilful in learning. The practical study requires learning source in the form of a worksheet (also known as Students’ Worksheet abbreviated as SW) which is used as the guideline for a student in conducting the experiments.

SW is a worksheet that contains tasks and must be done by students and usually presented in the form of systematic rules to solve the given tasks and can be used for all subjects [3]. SW that frequently used by teachers in MAN 1 Banda Aceh was still simple and only contained material and questions without any components of students’ skills development. Consequently, it needs to be developed in order to let the SW improve the students’ SPS. One model that can improve the cognitive achievement and science process skill is problem-based learning (PBL) model.

Research by Nurhayati, et al. [4] revealed that the PBL application in the learning of petroleum concept in the class of X-6 Al- Islam 1 improved the students’ creativity and learning outcomes of students. Afterwards, learning with PBL also increased the students’ learning activities and conceptual comprehension [5]. Another fact showed that the PBL application improved the students’ science process skill and motivation significantly [6].

2. Method
The method used for this research is research and development (R & D), where the method aims to create the product of worksheets. The model of education research and development, as suggested by Borg and Gall in [7] was adopted. The model consisted of ten steps of development, namely: (1) research and collecting information, (2) planning, (3) product development, (4) product design validation, (5) design revision, (6) limited trial (7) limited trial revision (8) comprehensive trial, (9) revision of comprehensive trial, and (10) product distribution. Further, this study applies the pre-test and post-test design.

The population chosen for this research were all students of class XI at MAN 1 Banda Aceh, which are divided into five classes, and each class has about 32-34 students. Specifically, for sampling, the purposive sampling was employed to determine the sample. The sample is 32 students of class XI-IPA 3, and the implementation of SW was conducted during February – March 2019. The feasibility of developing SW was assessed by validators.

3. Findings and Discussion
The development of PBL-based SW on salt hydrolysis topic was done according to Borg and Gall [8] as clearly elaborated in the following:

3.1. Research and collecting information
Several literature reviews were carried out to find information that can be used as fundamental SW development. Besides, the information was collected in accordance with previous research from various journals, textbooks, and teaching materials to support SW development. This step was conducted to identify the potential problem through field study which was executed using survey by distributing questionnaire of needs in order to obtain data related to the learning process, as well as about teaching and learning materials. The result of this activity showed that students are lacked science process skill in learning of chemistry which is associated with the national examination result of 2016/2017.

3.2. Planning
SW is arranged in conformity with the syllabus. The time allocated in the syllabus for *Salt Hydrolysis* material is 6 hours of study. Meanwhile, the competence is taken in accordance with the indicators of the *Salt Hydrolysis* material. Each indicator is used for the implementation of learning in three meetings. So that from these indicators, three types of SW are developed in the salt hydrolysis material, namely (1) the type of salt and hydrolysis reaction for the first meeting, (2) the nature of the salt solution in the second meeting and (3) pH of the salt solution at the third meeting.

3.3. Product development
The SW design was constructed based on PBL, which was generated from the results of previous research. Previous SW, which was used by the teacher, did not list all the stages of PBL so that researchers developed more complex stages to clarify the stages of PBL. Besides, the researchers also added stages of SPS to practical study using SW so that later it could facilitate the assessment of SPS for students. The design contains the main components, such as the competencies to be achieved, the content of the material and supporting information, learning instructions, activity sheets, and exercises. The well-developed SW must be able to increase students’ SPS. Product design before validation can be seen in figure 1.

![Product before validation](image)

Figure 1. Product before validation

3.4. Product design validation
The components evaluated in the testing of the first field trial were the materials, the languages used in concern of correct spelling, including the images prepared for the SW and the material used. The initial testing for SW validation was carried out by two expert validators from the Chemistry Department of Syiah Kuala University, a lecturer who is expert in evaluation, and a linguistic lecturer. The results obtained showed that the average score of the feasibility value of PBL-based SW was at 93.75% which

3.5. Design revision
The revision of the SW design at this stage is an initial improvement from the results of the validation obtained from suggestions and input by 4 expert validators. One of the recommendations given by expert validators is to improve the words and sentences contained in the contents of the material, work instructions, and instructions in designing work procedures. In addition, the images should also be adjusted with the material or activity instructions.

3.6. Limited trial
Field trial I was conducted by providing PBL-based SW to chemistry teachers. The teachers selected for this test were six chemistry teachers from three Islamic schools in Banda Aceh. The three schools were selected based on accreditation and the results of the 2016/2017 national examination. Therefore, the suggestions given by the teachers were used as considerations to evaluate the SW, and further improvements were made.

3.7. Limited trial revision
This stage is the second improvement to the product, namely the design of the development of PBL-based SW that has not met the results of the earlier limited trials conducted by chemistry teachers in three schools. The improvements gained in this stage were not abundant because the teachers conveyed that, in general, the SW development was good.

3.8. Comprehensive trial

Further stages of the trial were carried out by distributing PBL-based SW to twelve Chemistry teachers of Islamic high schools in Banda Aceh. The results obtained from the chemistry teachers were some suggestions concerning several components that must be revised again to make the SW better. The suggestions provided by these teachers are the final input of the deployment of PBL-based development SW products. Based on the expansion trials, the results of the feasibility assessment of the SW are included in the very good criteria with a value of 85.58%. The results of the assessment of each component in general in the SW such as the material presented, the components of learning, language, physical appearance, illustrations provided, and the completeness of the components is in the category of ‘very good’.

3.9. Revision of comprehensive trial

This stage is the final revision, and the improvement has been made based on the suggestions from the expansion trials. This revision was the last step to complete the SW that would be used in the Salt Hydrolysis learning process. The results of the feasibility assessment revision, more materials should be developed in all SW and statements should be added in the form of directives sentences. And additional information regarding the benefits of studying salt hydrolysis in daily life should also be highlighted. The overall improvement of SW can be seen in Figure 2 below.

![Figure 2](image_url)

**Figure 2.** The results of the overall revision of the type of SW for the type of salt and hydrolysis reaction

3.10. Product distribution

The final revision of the PBL-based SW which was then applied to one of the Islamic high schools in Banda Aceh. The teaching and learning process was carried out in accordance with previously prepared lesson plans so that it is in conformity with the Salt Hydrolysis material. The assessment of the results of the PBL-based SW implementation was seen from two aspects; they are SPS when students were conducting practices and the learning outcomes, which was measured by administering the pretest and posttest. The results of the N-gain score analysis are in the ‘high’ category with a value of 72.35. This shows that the test score increased from pretest to posttest, with an average of 36.77 to 85.16. According to research conducted by Suharta dan Luthan [9] stating that the PBL model can improve students’ cognitive learning outcomes in chemistry learning.

The results of the KPS in MAN 1 Banda Aceh on the Salt Hydrolysis material practice were seen based on 8 SPS indicators; they are formulating hypotheses, planning experiments, conducting experiments, observing, interpreting, predicting, applying concepts, and communicating [10]. An
assessment of SPS was carried out by several observers when students were doing the practice. The results of the percentage of SPS students can be briefly seen in Figure 3 below.

![Figure 3. Percentage of Student SPS of class XI-IPA 3](image)

Based on Figure 3 above, it can be seen that in each aspect of the SPS shows that there are different averages obtained. Overall, the average percentage for students is 86.04%, and it is included in the ‘excellent’ category. These results unveil that each student has a very good SPS in practising Salt Hydrolysis material with the application of PBL-based SW. According to research by Haqwi [11], the PBL model influences cognitive learning outcomes and impacts on self-confidence shown in cognitive abilities and skills in learning. Further, Hidayah and Pudjiastuti [12] urge that the PBL model has a positive and significant influence on science process skills and cognitive learning outcomes in class V SD 3 Cluster Kotagede. Furthermore, the PBL model can also improve SPS and students’ learning motivation [13]. Later, a study by Safrina and Hasan [14] shows that the application of the PBL model influenced the SPS and the understanding of class VIII students of MTsN Meureudu on chemical substances in food. After being applied progressively in the learning process, at the end of the study also conducted questionnaires on students' responses to PBL-based SW.

The researcher gave a questionnaire to determine the students' responses to the use of PBL-based SW in learning. The percentage of their responses who choose the "Yes" option was 88.50%, while those who choose the "No" option was 11.50%. This percentage shows that more students like the implementation of PBL-based SW compared to those who do not like it. This is in line with the study of Chih, et al. [15] that the presence of PBL in learning has an effect on a significant and positive increase in learning outcomes.

4. Conclusion

Based on the results shown above, it can be concluded that the development of PBL-based SW to increase SPS is effective since it obtained a design validation value of 93.75%, trial I of 88.17% and trial II of 85.58%, and all of these three values are classified as very feasible criteria. SPS assessment of students using PBL-based SW obtains an average percentage value of 86.04%, which is categorized as very good. In addition, the students’ and teachers’ responses toward the application of PBL-based SW received positive results which are 88.50% from the students and 83.33% from the teachers. Thus, PBL-based SW that was developed within this study can increase students SPS on Salt Hydrolysis material.

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