The effectiveness of nature-based practicum worksheet on acid-base titration material towards students’ science process skills

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Abstract. The study aimed to find out the eligibility, effectiveness, and practicality of Nature-Based Student Practicum Worksheet on Acid-Base Titration towards students’ Science Process Skills. Research and Development method was used in this study. The research was conducted at SMAN 1 Kendal. The result of the validation assessment showed that the developed worksheet was eligible, with an average score, given by the validators, was 89.58% for its materials and 90.28% for its media. The analysis result of the students’ science process skills in performing practicum activities showed that 60 students reached a “very good” category and 9 students reached a “good” category; and the result of evaluation test revealed that 62 out of 69 students passed the minimum passing criteria (≥75). The reliability of the questionnaire for the students’ responses was also tested; and it was revealed that its reliability was 0.89. According to the validation stage, the test results on a small and a large scale showed that the nature-based practicum worksheet on acid-base titration material towards students’ science process skills was eligible, effective, and practical to be implemented.

1. Introduction
Chemistry learning processes in schools are carried out in order to achieve the learning goals. The implementation of Curriculum 2013, which was first applied in the year 2013/2014, proposes some core competences the students must have in the end of the class; that was that they were supposed to be able to apply, analyze, and evaluate the factual, conceptual, procedural, and metacognitive knowledge, based on their curiosity in science and technology, regarding to the causes of some phenomena and events; as well as apply procedural knowledge on specific subject based on their talents and interests in order to solve a problem. This competence would be achieved if learning processes in the classroom were able to incorporate the students actively and optimally in gaining the knowledge. Conducting practicum in the learning processes is one means in achieving such competence.

Practicum activities enable the students to incorporate in some processes, such as observing, comparing, composing hypotheses and setting up some experiments. Besides, doing such activities in chemistry learning processes can improve the students’ science process skills [1]. For that
reasons, practicum activities takes roles as a source of science process skills [2]. A practicum activity allows the students to observe the occurring events directly rather than only visualize them in their minds [3]. The practicum method enables the students to be more active and creative [4].

An acid-base titration is one of the chemistry materials demanding the students to conduct practicum activities. It refers to a basic competence of acid-base titration material in Indonesia Curriculum year of 2013 released, which states that the students are supposed to be able to determine pH changes of some indicators extracted from nature materials. According to the results of interviews and observations in two high schools in Semarang, practicum activity has already been applied for chemistry learning processes on acid-base titrations. However, synthetic materials were still used as indicators instead of the nature ones. Nature materials, indeed, would not solve any environmental issues; but, their roles have some contributions for living things preservation [5].

Another result of an observation in one high school in Kendal Regency also revealed similar data. Besides using some synthetic indicators, publisher-made student worksheets were used in the learning processes instead of teacher-made worksheets (the worksheets provided by the teacher). Therefore, a nature-based practicum worksheet is required to be developed, adjusted to the demands of the basic competences of this material.

The goals of composing practicum guidance have to include some aspects; some of which are to enable the students not only to acquire the knowledge but also to actively manage the result of it and the learning skills as well by themselves, and help the students to improve their science process skills through the activities in it [6]. Student practicum worksheets as media learning can deliver information from the sender (teacher) to the recipient (students) so that what is delivered can be well received [7].

One skill that can be developed in conducting a scientific research is science process skills [8]. The developed abilities in these skills are observing, classifying, interpreting, predicting, proposing questions, hypothesizing, planning some experiments, utilizing some tools/materials, applying conceptions and communicating. Science process skills involve cognitive or intellectual, manual, social, and communication skills; all of which are needed to acquire, develop, and apply the conceptions, principals, laws, and theories of science [9].

2. Method
Research and Development (R&D) design was used in this study. It is a research method used to produce certain products, and assess the effectiveness of those products. This research contains three steps. Those are defining, designing and developing stages, which refer to 4-D procedural model [10]. Nonetheless, this study only used those steps until the third step, which is development.

The first step was defining. An introduction of the study (survey, observation, interview, literature study) was explained in this stage, up to some problems of the study were identified. In this step, a needs analysis was carried out in order to identify the potency and problems in those schools.

The second step was designing. It was a stage where a development and treatment to solve the problems of the study were designed. The nature-based practicum worksheet on acid-base titration material towards students’ science process skills was arranged. This design product then had to be validated by some experts and be tested on a small scale. The result data of the test was then analyzed to figure out the practicality of the design.

The third step was developing. It was a completion of the tested design. However, the product of this stage was not a final one, since it must be tested one more time on a big scale (real teaching). The result data of it was then analyzed to perceive its effectiveness and practicality, as well as give description of the product. The nature-based worksheet on acid-base titration towards students’ science process skills which had been validated and tested were then analyzed in order to find out their eligibility, effectiveness, and practicality, so that it became a final product that was ready to be implemented. The data collected through the research instruments was then processed and
analyzed so that it could answer the research problems or test the hypothesis. Statistical calculation was used in this stage.

3. Result and Discussion
The study was conducted in order to find out the eligibility and effectiveness of a nature-based practicum worksheet and the perception of the users (students and teacher). The 4-D development research approach was used in this study. The data obtained consist of the data of its product eligibility assessment, the data of its effectiveness assessment, and the data of users’ responses from the students and the teachers. The product eligibility was tested by some experts (validators), viewed from its material side and media one. The data of product’s effectiveness test is in the form of students learning outcome, viewed from cognitive and psychomotor aspects, and the data of the students and teacher’s responses collected through a questioner.

The product feasibility test of the student practicum worksheet consisted of its materials and media component eligibility test. The result of the material component was given an average score by 43 with a “very eligible” category by the 5 validators. Meanwhile, the result of the media component which was assessed by three validators obtaining an average score by 34.33 with a “very eligible” category. The next step was testing the effectiveness of the product, which consisted of a small scale test, an observation result of students’ science process skills, a students’ knowledge test result, and a large scale test.

The students’ science process skills were measured indicator such as: a) Formulating general problems, b) Writing observations, c) Formulating specific problems, d) Formulating hypotheses and predictions, e) Identifying variables f) Writing operational definitions of variables, g) Writing tools and materials, h) Writing test procedures, i) Organize data of experimental results in the observation table, j) Analysis of experimental data, k) Make a conclusion [11].

The small scale test involved 30 students of grade nine one of central java senior high school by conducting a learning process using the nature-based students’ practicum worksheet on acid-base titration material towards their science process skills. The result of this test in presented in the Table 1 as follows.

| Interval Score | Student Response Score (%) | Criteria     |
|---------------|----------------------------|--------------|
| 39 ≤ score ≤ 48 | 26.67                      | Very impressed|
| 39 ≤ score ≤ 48 | 73.33                      | Impressed    |
| 21 ≤ score < 29 | 0                          | Less impressed|
| 12 ≤ score < 20 | 0                          | Not impressed|

Table 1 showed that 26.67% of the students were very impressed and 73.33% of them were impressed with the students’ practicum worksheet. Nontraditional laboratory experiences provided the students with freedom to perform experiments of personal relevance in authentic contexts. Students learned to (a) identify and define pertinent variables, (b) interpret, transform, and analyze data, (c) plan and design an experiment, and (d) formulate hypotheses. Science process skills of the students need not be taught separately and need to develop gradually and reach a high level of sophistication when experiments are performed in meaningful context [12].

Afterwards, the effectiveness of the worksheet could be viewed from the students’ science process skills data, which were assessed using an observation sheet, and the result data of students’ knowledge test was assessed with evaluation test. The result of the observation on the students’ science process skills is presented in Table 2 as follows.
According to the Table 2, there were 60 students who reached a “very good” criterion, and there were 9 students who reached a “good” criterion on their science process skills, with the total number of the students were 69. It showed that the students’ practicum worksheet was effective for their science process skills.

Meanwhile, the result data of the students’ knowledge is presented in Table 3 as follows.

| Interval Score | Total Number of Students | Students’ Science Process Skills (%) | Criteria |
|----------------|--------------------------|-------------------------------------|----------|
| 29.25 ≤ score≤ 36.00 | 60 | 86.96 | Very good |
| 22.50 ≤ score≤ 29.24 | 9 | 13.04 | Good |
| 22.50 ≤ score≤ 29.24 | 0 | 0 | Quite good |
| 9.00 ≤ score≤ 15.75 | 0 | 0 | Not good |

Based on the Table 3, it could be seen that 62 out of 69 students achieved the minimum passing criteria. It proved that the effectiveness of the worksheet in this study was achieved. Hands-on activities incorporating inquiry based science teaching to science instruction will improve science attitudes and science process skills [13] and laboratories have long been recognized for their potential to facilitate the 62 learning of science concepts and skills [14]. Employing inquiry based science teaching in science education has some positive effects on cognitive achievement, process skills and attitude towards science but it is relative [15].

The last data was the effectiveness test of the student practicum worksheet on the large-scale test, including the students and teachers’ responses; the result of which is presented in Table 4 as follows.

| Interval Score | Result Score (%) | Criteria |
|----------------|------------------|----------|
| 39 ≤ score≤ 48 | 39.13 | very impressed |
| 30 ≤ score< 38 | 60.87 | impressed |
| 21 ≤ score< 29 | 0 | less impressed |
| 12 ≤ score< 20 | 0 | not impressed |

According to Table 4, the students’ responses on the nature-based worksheet were “very impressed” by percentage of 39.13 and were “impressed” by percentage of 60.87. Meanwhile the teachers’ response is presented in Table 5 in the following.

| Participant | Result Score | Criteria |
|-------------|--------------|----------|
| G-01        | 45           | very impressed |
| G-02        | 46           | very impressed |
| Average Score | 45.5       | very impressed |
According to the Table 4 Both of the chemistry teachers gave “very impressed” responses with the average score by 45.5. It proved that the worksheet valid to be implemented in the learning processes. Teachers should first follow a program that would make students acquire the science process skills. Then they should integrate that program with the science curriculum since science process skills have a hierarchic structure. A student who does not have the basic skills could not improve the skills about performing experiments easily. Whereas, what we firstly do at schools is making students do experiments. That is starting from the end and a big mistake. For this reason, teaching science process skills should never be neglected giving such excuses as shortage of time and overloaded syllabuses [16].

4. Conclusion
It was concluded that the nature-based student practicum worksheet on the acid-base titration material is eligible to be used according to the validators’ assessment. The nature-based student practicum worksheet on the acid-base titration material effective to enhanced the students’ science process skills and practical to be used in chemistry learning activities.

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