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Project-Based Learning-Oriented Worksheet Based on Local Wisdom and Green Chemistry

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Abstract

This study aims to determine the feasibility of worksheets and the science process skills of students using worksheets based on local wisdom-oriented projects in Central Java, with insights from green chemistry. The research follows the Research and Development (R&D) methodology, specifically the modified 4D development procedure, which includes define, design, and develop stages. The study was conducted at UIN Walisongo Semarang with 60 chemistry education students participating. Expert validation results indicated that the worksheet, based on local wisdom-oriented projects with green chemistry insight, was feasible, achieving a validity percentage of 86.53%, categorized as very valid. Observations of students' science process skills using project worksheets 1, 2, and 3 yielded an average score of 78.6%. Pretest and post-test data on students' science process skills showed scores of 29.8 and 70.5 for the experimental class, and 29.64 and 54.46 for the control class, respectively. The average n-gain score for the experimental class was calculated to be 58%, indicating it falls within the moderately effective category. In conclusion, the worksheet, which leverages the local wisdom of Central Java and incorporates green chemistry principles into the study of acid-base material, is feasible and can be effectively used as a learning resource for students.

Keywords: green chemistry; local wisdom; project-based learning; worksheet

Abstrak

Penelitian ini bertujuan untuk mengetahui kelayakan lembar kerja dan keterampilan proses sains siswa menggunakan lembar kerja berbasis proyek berorientasi kearifan lokal di Jawa Tengah, berwawasan *green chemistry*. Penelitian mengikuti metodologi *Research and Development* (R&D), khususnya prosedur pengembangan 4D yang dimodifikasi, yang meliputi tahap-tahap pendefinisian, perancangan, dan pengembangan. Penelitian dilakukan di UIN Walisongo Semarang dengan melibatkan 60 mahasiswa Pendidikan Kimia. Hasil validasi ahli menunjukkan bahwa lembar kerja berbasis proyek berorientasi kearifan lokal berwawasan *green chemistry* ini layak dengan persentase validitas sebesar 86,53% dikategorikan sangat valid. Observasi keterampilan proses sains siswa menggunakan lembar kerja proyek 1, 2, dan 3 menghasilkan rata-rata skor sebesar 78,6%. Data pretest dan postes keterampilan proses sains siswa menunjukkan skor masing-masing sebesar 29,8 dan 70,5 untuk kelas eksperimen, serta 29,64 dan 54,46 untuk kelas kontrol. Rata-rata skor n-Gain kelas eksperimen dihitung sebesar 58%, yang berarti termasuk dalam kategori cukup efektif. Simpulannya, lembar kerja yang memanfaatkan kearifan lokal Jawa Tengah dan memasukkan prinsip-prinsip kimia hijau ke dalam pembelajaran materi asam basa ini layak dan efektif digunakan sebagai sumber belajar siswa.

Keywords: green chemistry; kearifan lokal; lembar kerja; project-based learning

Introduction

Development trends of the industrial era 4.0 necessitate that education emphasizes students, both individually and in groups, actively seeking, exploring, and discovering the concepts and principles of science learning in a real and holistic manner. It is hoped that students will develop the ability to solve problems, think critically, be creative, communicate verbally, and have expertise in the field of technology.

Observations at UIN Walisongo Semarang indicate that many students are not yet motivated to study optimally. Students are not accustomed to solving questions that require divergent and convergent thinking skills. This is evident when students struggle to complete assignments involving complex questions about the application of the material being studied.

Furthermore, it was found that educators still primarily use lecture-based teaching, which emphasizes memorization, note-taking, and practicing questions. These methods are no longer relevant for students as they do not include efforts to enhance creative problem-solving skills. Consequently, students exhibit low creativity in problem-solving, minimal participation, sub-optimal teamwork, inefficient learning activities, and poor learning outcomes (Fajri, et al., 2012). Student learning outcomes were categorized as poor, with an average score of 59.

To enhance student skills, an appropriate learning model is needed. One such model is project-based learning (PjBL), which actively engages students. Project-based prioritizes forming students' interest in designing, problem-solving, investigating, making decisions, and working in teams to produce products through research activities (Thomas, 2000; Damiri, 2012). Students' ability to gain new understanding increases when they engage in meaningful problem-solving activities and are guided to discover facts relevant to their expertise (Bransford, et al., 2000).

Additionally, it was observed that the learning media currently used do not meet the criteria for developing students' process skills. Learning processes that rely heavily on textbooks are still prevalent on campus. These textbooks contain only material and questions, failing to guide students toward understanding concepts. Students do not grasp the relationship between material concepts to solve problems. Therefore, appropriate learning resources are necessary for students in the form of learning activity guides, such as worksheets, to develop all aspects of learning through investigation or problem-solving according to the indicators for achieving learning outcomes (Trianto, 2010).

Silaban et al. 2015) stated that in some schools, educators still tend to use conventional learning methods and have not developed worksheets that are suitable for the needs of students. Most commonly used worksheets only present quality material and do not encourage critical thinking skills. The development of quality worksheets, tailored to student conditions and based on project-based learning, aims to make the worksheets structured and directed, thereby achieving learning objectives.

Project-based learning based on local wisdom-oriented worksheets can be beneficial for students if they utilize materials from their surrounding environment as learning resources. This approach can foster a love for the environment and encourage efforts to preserve the earth, including the application of green chemistry principles. This aligns with the vision of UIN Walisongo, which employs the revitalization strategy of local wisdom as part of its paradigm to create a leading research-oriented Islamic university based on the unity of science for humanity and civilization in 2038.

With the development of the industrial era 4.0, many foreign cultural influences have emerged, causing the values of local wisdom in Indonesia,particularly in Central Java, to gradually diminish. Local wisdom encompasses all the unique and abundant resources of an area that have not been fully utilized. If this trend continues unchecked, the cultural value of Indonesia may become extinct, replaced by foreign

cultural values. Therefore, preserving local wisdom is crucial for maintain national identity.

Efforts to preserve local wisdom can be achieved through education. Chemistry is a dynamic science that evolves with the changing times (Oxtoby, Gillis, and Nachtrieb, 2001). Abonyi (1998) suggested making chemistry easier to study by linking it to the local wisdom surrounding students. Acid-base material in chemistry often involves practical activities that can utilize local wisdom. Central Java, for example, has abundant plants such as turmeric, teleng flower, soka flower, flowers, and natural dyes for fabrics, which can be applied in acid-base learning. Natural indicators can be made from colored plant parts like turmeric, hibiscus, and purple cabbage leaves (Lestari, 2016). Research by Saputra et al. (2016) indicates that learning resources utilizing local potential can improve learning outcomes, scientific attitudes, and environmental awareness.

Researchers developed a PjBL-based chemistry worksheet oriented towards the potential of Central Java's local wisdom with insights from green chemistry insight on acid and alkaline solutions. The local wisdom includes the use of natural indicators from plants/fruits, fabrics dyeing with natural dyes, herbal villages, and batik villages in Semarang. This worksheet will guide students to discover concepts themselves, beginning with local wisdom in Semarang and leading to the concept of acid and alkaline solutions.

Based on preliminary observations made at UIN Walisongo, chemistry lessons rarely incorporate local wisdom. The strategy of implementing the unity of science from the vision of UIN Walisongo is still predominantly focused on the humanization of Islamic science and the spiritualization of modern science. Therefore, it is crucial to implement a strategy of uniting knowledge through the revitalization of local wisdom by conducting project-based lectures on the potential of local wisdom in Central Java with insights from green chemistry . Chemistry learning that integrates local wisdom provides meaningful learning experiences, improving student achievement and science process skills.

Efforts to educate and train prospective chemistry educators at UIN Walisongo should emphasize the use of worksheets tailored to the needs of their future students. This will prepare them to think creatively when designing worksheets for their students. To achieve this, learning resources are needed that connect science to everyday life and local wisdom.

Based on the background description above, the researchers aimed to develop worksheets based on project-based learning, incorporating the potential of local wisdom in Central Java with a focus on green chemistry, to evaluate their feasibility and the science process skills of chemistry education students of UIN Walisongo Semarang.

Method

We conducted a survey to gather information about victims of cybercrime and the resources vulnerable to such offenses. It included different questions answered by students. The responses were analyzed and discussed to identify tools and solutions to prevent any type of cybercrime in the future. The survey involved ninety one students who were asked ten different questions about cybercrime. We collected various data through these questions and then performed statistical analysis to finalize the results. The questions related to cybercrime were presented to each participant in the survey.

This research employs the research and development (R&D) methodology. This method is chosen because R&D produces specific products and assess their effectiveness (Sugiyono, 2010). The study aims to develop a product in the form of a worksheet, referred to as a student worksheet. The worksheets developed in this research are based on project-based learning and are oriented towards the potential of Central Java's local wisdom, incorporating green chemistry insight. The development model used is the instructional system designed by Thiagarajan et al (1974), known as the Four-D model, which includes define,

design, develop and disseminate stages. Due to time constraints, the Disseminate stage is not conducted.

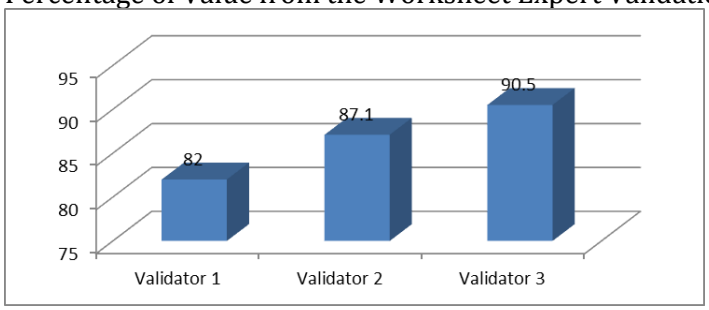
The define stage involves preliminary research to analyze campus characteristics, educator needs, concepts/materials, tasks, and objectives. The design stage involves creating a student worksheet model and determining an attractive worksheet design. The development stage includes validation of the worksheet products, small-scale trials, and large-scale trials.

The research subjects for product testing on a small scale include 9 students, comprising 3 students with high, medium, and low levels of understanding. For the large-scale trial, 32 second semester chemistry education students participated. Data collection techniques include observation, interviews, questionnaires, documentation, and tests. Data analysis techniques involve analyzing questionnaire data, conducting Worksheet Expert Validation Test, analyzing Student Response Questionnaire, and assessing aspect of students' science process skills.

Results and discussion

In this research, a worksheet was developed in accordance with the principles of project based learning, with a primary focus on utilizing materials derived from the local wisdom of Central Java in projects created by students. This approach is a step towards implementing a local wisdom revitalization strategy to realize the vision of UIN Walisongo Semarang. Additionally, the worksheet incorporates green chemistry insights to align with the UIN Walisongo campus program, which is designated as a green campus. The results obtained from the worksheet expert test are presented in Figure 1.

Figure 1
Percentage of Value from the Worksheet Expert Validation Test Results

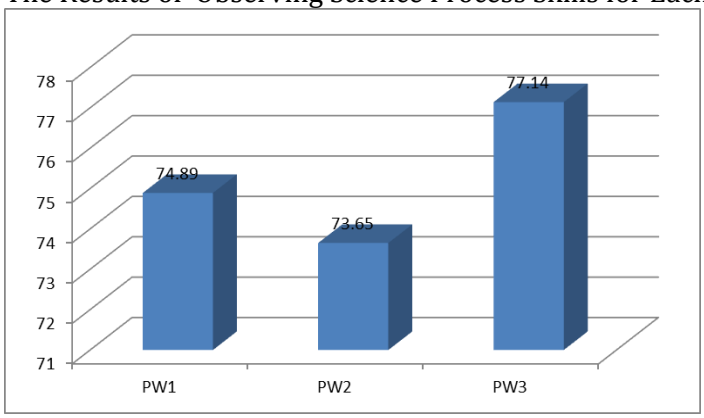


During the implementation of the small class trial, 9 students were selected as respondents based on their low, medium, and high levels of understanding. This trial stage utilized the developed worksheet to assess its effectiveness and determine whether it could be easily understood by the students. The results of the worksheet feasibility test, which involved observing the science process skills of students in small groups, provided several suggestions and feedback for improving the worksheet.

Additionally, in the small class test, the average score of science process skills was observed to have increased after utilizing the worksheet. The improvement in the value of these skills is illustrated in Figure 2. Based on the picture above, that the science process skills of students in the small class trial generally increased, although there was a decline in their second worksheet project.

The large-scale trial was implemented after completing a series of small trials.This trial involved 32 second-semester chemistry education students. The data obtained from the small trial were used to inform the large-scale trial. In the large-scale trial, the activities conducted were the same as in the small trial, but the learning tools used were more refined.

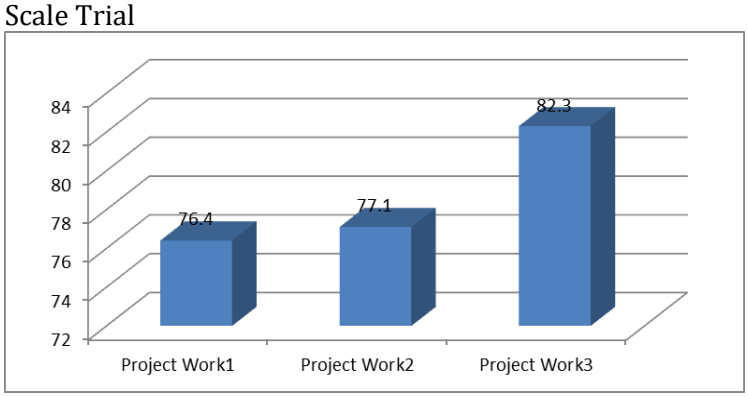
Figure 2
The Results of Observing Science Process Skills for Each Worksheet Project in the Small Trial



The large-scale trials began with a pretest and concluded with a post-test, conducted over five sessions. In the first session, a pretest was administered to assess students' initial science process skills and knowledge of acid-base solutions. In the second session, students were introduced to the PjBL-based chemistry worksheets, which incorporate local wisdom from Central Java and insights from green chemistry. The third meeting involved practical exercises in dyeing fabrics with natural dyes. In the fourth session, students used worksheets to identify natural and synthetic dyes in food samples reflecting local wisdom. This project aimed to help students apply the concepts of acid-base solutions to real life situations by exploring the potential of local wisdom in their areas, grounded in the cultural values of Central Java. In the final session, a post-test and a questionnaire were administered to gather student responses regarding PjBL-based chemistry worksheets oriented to the potential of Central Java local wisdom with green chemistry insight. The pretest and post-test aimed to measure student's science process skills using the developed worksheet. The post-test comprised 10 descriptive questions. The results of this post-test were then used to assess science process skills in learning based on the PjBL Project, covering 8 aspects of these skills.

The observation of science process skills in the experimental class resulted in an average score of 78.6%. The results of the first, second, and third worksheet projects are illustrated in Figure 3.

Figure 3
The Results of Science Process Skills Observations for Each Worksheet Project in the Large-Scale Trial



The results of the observations of science process skills for each aspect can be seen as follows in Figure 4 and the post-test results of science process skills can be seen in Figure 5.

Figure 4
The Results of Observations of Science Process Skills for Each Aspect in Large Class Trials

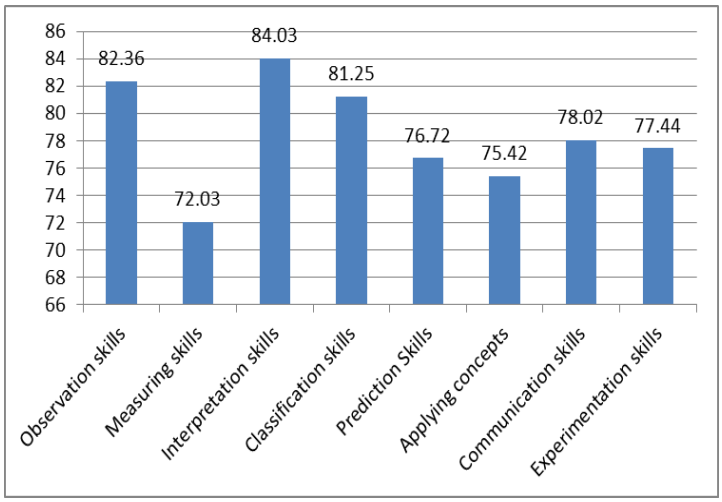
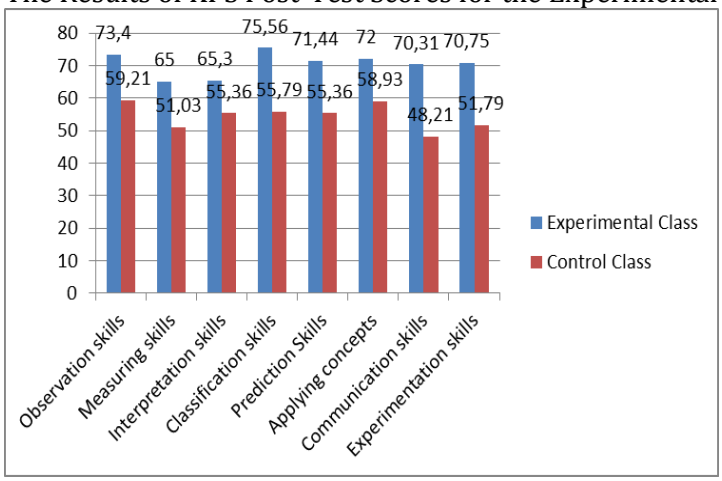


Figure 5
The Results of KPS Post-Test Scores for the Experimental and Control Classes



The difference between the post-test results of the experimental and control classes is quite significant. For the aspect of science process skills, the highest score in the experimental class was 75.56, classified as 'good', while the highest score in the control class 59.21, classified as sufficient. The lowest percentage in the experimental class for the aspect of science process skills was the measuring aspect, with a score of 65, while in the control class, it was the communication aspect, with a score of 48.21.

The results of the science process skills test for the pretest and post-test in the experimental and control classes are presented in Table 1.

The assessment of the science process skills observation sheet was conducted to evaluate the feasibility of using the PjBL-based learning model worksheet in the experimental class, as shown in Figure 4. The final test (post-test) was conducted to evaluate the achievement of acid-base material with indicators of science process skills. The results of the pretest and post-test for the experimental and control classes are presented in Table 1. Based on the results of the data obtained through the observation

sheet of science process skills over five meetings, and the pretest and post-test, it is evident that there is a difference between the experimental class using the PjBL-based learning model oriented to the potential of Central Java local wisdom with green chemistry insight, and the control class using conventional learning. The experimental class achieved an N-Gain Percent of 58%, categorized as quite effective. This indicates that the experimental class using PjBL-based worksheets developed better science process skills compared to the control class using conventional learning. As stated by Wahyudi et al., (2015), project-based learning has a significant effect on students' science process skills.

Table 1
The Results of the Science Process Skill pretest and Post-Test Scores for the Experimental and Control Classes

Class	Pretest	Post-test	N-Gain Percent
Experimental Class	29.8	70.5	58%
Control Class	29.6	54.5	35%

Conclusion

The analysis of research results and discussion of worksheets based on the potential of local wisdom in Central Java with green chemistry insight into acid-base material are summarized as follows. The feasibility of a worksheet based on project-based learning, oriented towards the potential of Central Java local wisdom with a green chemistry insight on acid-base material, received an average score of 86.53%, categorized as very valid. This indicates that the worksheet is suitable for use in class trials. Student science process skills, based on observations of project worksheets 1, 2, and 3, obtained an average score of 78.6%. The data from the pretest-posttest of students' science process skills were 29.8 and 70.5 for the experimental class, while the control class scores were 29.64 and 54.46, respectively. Based on the feasibility test results for each aspect, it can be concluded that the worksheet, which is based on the potential of Central Java local wisdom with green chemistry insight into acid-base material, is feasible and can be used as a learning resource for students.

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