

# The Application of Project-Based Learning to Improve Students' Assessment Literacy in the Course on the Assessment of Chemistry Learning Processes and Outcomes

Firdiawan Ekaputra

Universitas Jambi, Indonesia

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## Abstract

Assessment literacy is an essential competency for prospective teacher students because it relates to the ability to understand, select, develop, apply, and interpret learning assessments. However, assessment instruction still needs to provide experiences that allow students to directly connect concepts with assessment practices. This study aims to analyze improvements in students' assessment literacy through the implementation of Project-Based Learning in the course Assessment of the chemistry learning process and outcomes. The study employed a quantitative approach with a one-group pretest-posttest pre-experimental design. The research subjects were 20 Chemistry Education students from the Regular B class at the University of Jambi. Assessment literacy was measured using a case-based test covering aspects of conceptual understanding, selection of assessment methods, analysis of assessment instruments, interpretation of assessment results, and decision-making. Data were analyzed using descriptive statistics, the Shapiro-Wilk normality test, and a paired-samples t-test. Based on the assessment literacy data obtained, the average score increased from 70.50 on the pretest to 88.50 on the posttest. The results of the paired-samples t-test showed a significant difference with a p-value of 0.000. These results indicate an improvement in students' assessment literacy following the implementation of Project-Based Learning through the design, presentation, evaluation, and revision of chemistry learning assessment packages.

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## Corresponding Author:

Firdiawan Ekaputra

Universitas Jambi

Email Coresspondent: [firdiawan.ekaputra@unja.ac.id](mailto:firdiawan.ekaputra@unja.ac.id)

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## 1. INTRODUCTION

Assessment is a crucial component of the learning process because it not only serves to determine students' learning outcomes but also provides information that can be used to improve the learning process. Therefore, prospective teachers must possess the ability to understand the purposes of assessment, select appropriate techniques and instruments, interpret assessment results, and use assessment information to determine follow-up learning strategies. Assessment competence is related to assessment literacy, which is an essential part of prospective teachers' pedagogical competencies. Assessment literacy encompasses the ability to select and develop assessment methods, manage and interpret assessment results, utilize assessment results, develop assessment procedures, communicate results, and identify inappropriate assessment practices [1].

Assessment literacy should not be understood merely as theoretical mastery of concepts. Prospective teachers need to gain experience applying assessment knowledge in real-world learning contexts. Assessment literacy relates to the conceptual and practical abilities to select, apply, and interpret various forms of assessment [2]. Knowledge of assessment must be put into practice in the classroom, while time constraints, workload, and the diversity of student characteristics can be factors that affect the optimal implementation of assessment [3]. Therefore, higher education programs that prepare prospective teachers must provide experiences that enable students not only to understand assessment concepts but also to analyze problems, select assessment formats, justify assessment decisions, and evaluate the quality of assessment instruments.

Assessment skills are becoming increasingly important in chemistry education because the nature of chemistry learning demands not only mastery of conceptual knowledge but also process skills, higher-order thinking skills, scientific attitudes, and laboratory skills. The nature of chemistry is multidimensional because it involves macroscopic, microscopic, and symbolic aspects, thus requiring assessment tools capable of evaluating students' laboratory skills and critical thinking—not merely their memorization of concepts [4]. Therefore, prospective chemistry teachers must be able to select assessment formats appropriate for the competencies to be measured. Teachers require assessment literacy to design and implement authentic assessments that align with the learning process [5].

Based on the results of a pretest administered to 20 students, the average assessment literacy score was 70.50 out of a maximum score of 100. Most students still face difficulties in determining assessment techniques appropriate for specific competencies, analyzing the quality of assessment instruments, interpreting assessment results, and determining follow-up actions based on those results. Therefore, one learning approach that has the potential to address these issues is the Project-Based Learning model, which positions students as active participants. The implementation of Project-Based Learning in chemistry education provides students with opportunities to connect concepts with practice, work collaboratively, and engage in relevant and meaningful learning activities [6]. Project-based learning can encourage students to construct their knowledge independently while producing learning outcomes that are applicable and provide practical benefits [7].

In this study, students not only received material on concepts, functions, principles, cognitive, affective, and psychomotor assessments, classroom-based assessments, and portfolios, but were also guided to identify assessment issues, design assessment solutions, produce outcomes, present their work, receive feedback, and make improvements. Based on this background, the objective of this study is to investigate the changes in students' assessment literacy before and after the implementation of Project-Based Learning in the Assessment of Chemistry Learning Processes and Outcomes course. By employing a one-group pretest-posttest design, this study is expected to provide empirical evidence on the effectiveness of this model as an alternative learning strategy for developing the assessment literacy of Chemistry Education students at the Universitas Jambi.

## 2. METHOD

This study employed a quantitative approach using a pre-experimental method with a one-group pretest-posttest design. This design was used to determine changes in students' assessment literacy before and after the implementation of project-based learning. The study was conducted among students in the Chemistry Education Program at the Universitas Jambi during the 2026/2027 academic year. The sample was selected using a saturated sampling (total sampling) technique, wherein all 20 students enrolled in Regular Class B for the Assessment of Chemistry Learning Processes and Outcomes course were included as research subjects. The main characteristic of these subjects is that they are pre-service chemistry teachers who are required to develop pedagogical competencies, specifically in designing and evaluating educational assessments, making them a highly relevant target group for this study.

The research began with a pretest to assess the students' initial assessment literacy skills. The pretest was administered before the implementation of Project-Based Learning using a case-based test via the Quizizz platform. Subsequently, the students participated in learning activities using Project-Based Learning. The learning was focused on a project involving the analysis and development of chemistry learning assessments. Students worked in groups to analyze assessment issues, determine appropriate assessment formats, develop assessment instruments, present project results, receive feedback from the instructor and other groups, and refine the developed products. After the entire learning sequence was completed, students took a posttest using an instrument equivalent to the pretest, which aimed to determine changes in assessment literacy skills after students completed the course. The instrument used to measure assessment literacy consisted of a 20-question case-based assessment literacy test designed around several aspects of assessment literacy: understanding assessment concepts, selecting assessment methods or formats, analyzing the quality of assessment instruments, interpreting assessment results, and making decisions based on assessment results. The assessment literacy data collected were then subjected to a normality test and a Paired Samples t-test.

### 3. RESULTS AND DISCUSSION

Students' assessment literacy was measured before and after instruction using a case-based test consisting of 20 items. The instrument was designed to measure five aspects of assessment literacy: understanding of assessment concepts; the ability to select assessment methods and formats; the ability to analyze the quality of assessment instruments; the ability to interpret assessment results; and the ability to make decisions based on assessment results. The implementation of case-based learning and assessment for students not only serves to foster analytical skills and the application of theory to real-world problems but also effectively trains students to measure and improve problem-solving skills relevant to actual contextual situations [8], [9].

**Table 1.** Assessment Literacy Results

| <b>Statistical Parameters</b> | <b>Pretest</b> | <b>Posttest</b> |
|-------------------------------|----------------|-----------------|
| Number of Subjects            | 20             | 20              |
| Minimum Score                 | 60             | 70              |
| Maximum Score                 | 85             | 100             |
| Mean                          | 70.50          | 88.50           |
| Standard Deviation            | 7.05           | 9.75            |

Based on the assessment literacy data in Table 1, there was a change in students' assessment literacy scores following the implementation of Project-Based Learning. The students' average pretest score was 70.5 with a standard deviation of 7.05, and it increased to 88.5 with a standard deviation of 9.75, representing an average increase of 18.00 points. This increase in the standard deviation indicates that although there was a high overall average increase, the level of assessment literacy among students became more varied. The assessment literacy results in Table 1 show that before project-based learning, students' ability to use assessment concepts to solve problems was still relatively diverse, whereas after the learning process, there was an upward trend in scores. This improvement can be attributed to the characteristics of the learning activities, which provided students with the opportunity to learn assessment concepts while simultaneously applying them to complete projects. Students not only received explanations regarding cognitive, affective, and psychomotor assessment concepts but were also required to identify assessment problems, determine appropriate assessment formats, design instruments, develop rubrics, present their products, gather feedback, and make improvements to the products they had developed.

Assessment literacy is a mandatory skill for prospective teachers, encompassing the setting of objectives, the development of test blueprints or methods, management, scoring, administration,

test interpretation, and the use of assessment results for instructional improvement and reporting [10]. In this study, students gained experience in linking learning objectives to indicators, determining the form of assessment appropriate for the competencies to be measured, designing assessment instruments, establishing scoring criteria, and considering how assessment results are used as a basis for instructional decision-making. Thus, project-based activities provide a more practical experience compared to learning that is solely focused on the delivery of content.

In the early stages of the course, students are presented with fundamental issues related to the practice of assessing chemistry learning. Working in groups, students determine the competencies or chemistry topics that will serve as the context for the assessment, identify learner characteristics, select assessment techniques and formats, and develop instrument designs. Next, students develop assessment products that include a test blueprint, indicators, test or non-test instruments, rubrics, scoring guidelines, and a plan for interpreting results. The implementation of Project-Based Learning in higher education positions students as active participants through various learning stages that provide opportunities to discuss, investigate, and build group collaboration to hone their collaboration, communication, and problem-solving skills [11], [12]. Project-based learning provides students with the opportunity to relate abstract chemistry concepts to the creation of real-world, contextual products or projects [13].

**Table 2.** Statistical Test Results

| Test                  | Test Results |
|-----------------------|--------------|
| Shapiro-Wilk          | 0.264        |
| Paired samples t-test | 0.000        |
| N-gain                | 0.61         |

The obtained assessment literacy data were subsequently analyzed for normality using the Shapiro-Wilk test. The normality test results in Table 2, derived from the difference between the posttest and pretest data, revealed a significance value of 0.264. Since this value is greater than 0.05, the assessment literacy data are normally distributed. Based on these results, the examination of score differences before and after the learning process proceeded using a paired samples t-test. The analysis of the assessment literacy data yielded a significance value of 0.000. Because this significance value is less than 0.05, this study demonstrates a significant difference between the assessment literacy scores before and after the implementation of the Project-Based Learning model. This aligns with the findings of [14] and [15] indicating that learning through the application of the project-based learning model can enhance students' literacy skills. The N-Gain analysis results in Table 2 present a value of 0.61, which is classified in the moderate category. This value falls within the range of  $0.30 \leq g \leq 0.70$ , indicating that the effectiveness of applying the Project-Based Learning model in enhancing students' assessment literacy in the Assessment of Chemistry Learning Process and Outcomes course is categorized as moderate.

This moderate but significant enhancement provides deeper insights when compared to previous studies. Authentic assessment requires teachers and prospective teachers not only to understand the theory, but also to be able to design performance tasks and artifacts that demonstrate real-world skills [16], who reported that constructing authentic assessment artifacts—rather than merely studying them theoretically—yields moderate to high gains in pre-service teachers' assessment capabilities. Prospective teachers often face difficulties if assessment literacy is taught only through theory and lectures in the classroom [17], the Project-Based Learning approach in this study succeeds by requiring students to negotiate real-world educational constraints. Furthermore, consistent with the findings of [15], Project-Based Learning is effective in improving students' analytical skills, emphasizes the importance of the feedback cycle, and focuses on quantitative research methods [18].

Guided training based on project-based learning as an intervention to help teachers develop a deeper understanding and practical skills in designing and administering assessments [19], the current study confirms that the active, product-oriented nature of Project-Based Learning provides a substantially more effective environment for multidimensional skill development.

Overall, the results of this study indicate that the implementation of Project-Based Learning has the potential to provide relevant learning experiences to develop the assessment literacy of Chemistry Education students at the Universitas Jambi. The strength of this approach lies in the students' active involvement in solving concrete assessment problems through a product that must be designed, presented, evaluated, and revised. These activities provide students with the opportunity to integrate their knowledge of assessment concepts, principles, techniques, instruments, and interpretation into a single, cohesive series of activities. Therefore, this study suggests that learning in the course Assessment of Chemistry Learning Processes and Outcomes can be enhanced not only through the presentation of concepts and practice problems but also through the experience of designing contextual assessment instruments. Students need to be given the opportunity to experience the entire assessment process, from determining objectives, selecting techniques, developing instruments, establishing criteria, interpreting results, communicating results, to determining follow-up actions.

#### 4. CONCLUSION

Based on the research findings and discussion, the implementation of Project-Based Learning in the Assessment of Chemistry Learning Processes and Outcomes course demonstrated an increase in students' assessment literacy. According to the assessment literacy data, the average assessment literacy score increased from 70.50 on the pretest to 88.50 on the posttest—an increase of 18.00 points. The results of the paired samples t-test revealed a significant difference between students' abilities before and after the implementation of Project-Based Learning, with a significance level of 0.000. This improvement is supported by the characteristics of Project-Based Learning, which provide students with hands-on experience in identifying assessment problems, planning projects, developing assessment instruments and rubrics, presenting their work, receiving feedback, and conducting evaluations and revisions. This process enables students to integrate conceptual understanding with practical skills in selecting, applying, and evaluating chemistry learning assessments. Thus, project-based learning can be used as an alternative instructional approach to provide hands-on experience in developing assessment literacy among prospective chemistry teachers.

However, these findings should be interpreted with caution due to several limitations. This study utilized a one-group pretest-posttest design without a control group and involved a small sample size of only 20 students within a specific university context, which limits the broader generalizability of the results. Therefore, while Project-Based Learning shows strong potential as an alternative instructional approach to develop assessment literacy among prospective chemistry teachers in this context, further research with larger sample sizes, control groups, and diverse educational settings is recommended to confirm these findings.

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