

Enhancing Students' Self-Efficacy in Understanding Learning Assessment Concepts through Project-Based Learning

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Abstract

This study aimed to examine the improvement in students' self-efficacy in understanding learning assessment concepts following the implementation of Project-Based Learning in the course Assessment of Chemistry Learning Processes and Outcomes. A quantitative approach was employed using a pre-experimental method with a One-Group Pretest-Posttest Design. The participants were 21 students enrolled in the Chemistry Education Study Program at Universitas Jambi, Regular Class A. The research instrument was a self-efficacy questionnaire designed to assess students' confidence in understanding learning assessment concepts and consisting of 24 items. The data were analyzed using descriptive statistics, a normality test, N-Gain analysis, and a paired-samples t-test. The results showed that the mean self-efficacy score increased from 70.54 on the pretest to 82.99 on the posttest, representing an increase of 12.45 points. The difference scores between the pretest and posttest were normally distributed, with a significance value of 0.185. The mean N-Gain score was 0.429, indicating a moderate level of improvement in students' self-efficacy. Furthermore, the paired-samples t-test yielded a significance value of 0.000 ($p < 0.05$), indicating a statistically significant difference between students' self-efficacy scores before and after the intervention. These findings suggest that the implementation of Project-Based Learning can enhance students' self-efficacy in understanding learning assessment concepts in the Assessment of Chemistry Learning Processes and Outcomes course.

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1. INTRODUCTION

Self-efficacy is an important component of the learning process because it is associated with individuals' beliefs in their ability to complete tasks and cope with academic demands. Students with higher levels of self-efficacy tend to be more confident when facing academic tasks, demonstrate greater persistence when encountering difficulties, and are better able to regulate their efforts toward achieving learning goals [1]. Therefore, a high level of self-efficacy contributes positively to students' academic achievement and overall learning success.

One area of pedagogical knowledge that prospective teachers need to master is learning assessment. Assessment is not merely concerned with assigning grades to students but involves a process of obtaining, interpreting, and using information to make informed instructional decisions [2].

Understanding the concepts of measurement, assessment, and evaluation; the functions of formative and summative assessment; validity and reliability; cognitive, affective, and psychomotor assessment; classroom-based assessment; and portfolio assessment constitutes an important component of the professional competence of prospective chemistry teachers [3], [4]. Teachers need to understand the hierarchy and distinctions among educational measurement, assessment, and evaluation to ensure that academic assessment results are valid, objective, and accountable [5]. Therefore, prospective teachers need to develop confidence in their ability to understand various assessment concepts and apply them appropriately in chemistry learning contexts.

Preliminary interviews indicated that students in the Chemistry Education Study Program at Universitas Jambi had not yet developed optimal confidence in their ability to understand learning assessment concepts. Initial classroom observations also indicated that some students expressed uncertainty when asked to explain assessment concepts, distinguish among measurement, assessment, and evaluation, describe the functions of assessment, or identify the characteristics of different forms of assessment. This condition warrants attention because Chemistry Education students are prospective teachers who will eventually be required to select and implement assessment methods that are appropriate to specific learning objectives. Thus, limited confidence in understanding assessment concepts may constitute a barrier to the development of students' pedagogical competence.

This issue is particularly relevant because the course Assessment of Chemistry Learning Processes and Outcomes plays a strategic role in preparing students to become competent prospective teachers. To bridge the gap between conceptual understanding and authentic practice, the course was designed using the Project-Based Learning model. Project-based learning has been reported to effectively promote active student engagement, develop metacognitive skills, and optimize content mastery through direct investigative experiences[6], [7].

Previous studies have reported that Project-Based Learning can improve students' communication [6], creative thinking [7], pedagogical knowledge [8], self-efficacy and learning outcomes [9], conceptual understanding [10], and readiness to complete a research project [11]. Nevertheless, these studies were conducted mainly in other subject areas (e.g., economics education and physics) or focused on cognitive and skill-related outcomes such as communication, creative thinking, and conceptual understanding. Studies related to assessment in chemistry education have mostly addressed the development of assessment instruments [3] and teachers' readiness to implement the curriculum [4]. Consequently, empirical evidence on whether Project-Based Learning can strengthen prospective chemistry teachers' self-efficacy in a specific pedagogical domain such as learning assessment remains limited. This domain is demanding because students must understand abstract concepts, such as measurement, assessment, evaluation, validity, and reliability, and must also feel confident in applying them when designing assessments for chemistry learning. This research gap motivated the present study.

The implementation of Project-Based Learning provides students with extensive opportunities to engage directly in authentic problem-solving activities, which can contribute to strengthening their self-efficacy. Accordingly, this study was conducted to examine changes in students' self-efficacy in understanding learning assessment concepts after participating in the Assessment of Chemistry Learning Processes and Outcomes course through Project-Based Learning. The self-efficacy examined in this study encompassed students' confidence in understanding the

concepts of measurement, assessment, and evaluation; the functions of assessment; assessment principles; cognitive, affective, and psychomotor assessment; classroom-based assessment; and portfolio assessment. Therefore, this study focused not only on students' ability to successfully complete an assessment project but also on the extent to which Project-Based Learning could foster strong beliefs in their ability to master assessment concepts as an essential competency for future chemistry teachers. The hypothesis tested was that students' self-efficacy scores after the Project-Based Learning intervention would be significantly higher than those before the intervention.

2. METHOD

2.1 Research Design

This study employed a quantitative approach using a pre-experimental method with a One-Group Pretest–Posttest Design [12]. A single group of students was measured before the intervention (O_1), received the treatment in the form of Project-Based Learning (X), and was measured again after the intervention (O_2). The improvement in self-efficacy was determined from the difference between O_2 and O_1 . Because no control group was involved, this design does not permit strong causal inference, and the results are interpreted as the change associated with the intervention. The research flow is presented in Figure 1.

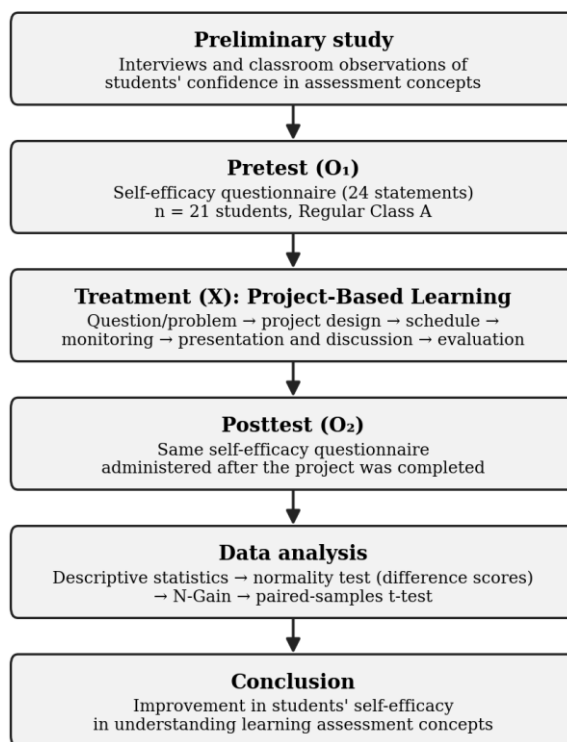


Figure 1. Research flow

2.2 Participants

The participants were 21 students enrolled in the Chemistry Education Study Program at Universitas Jambi who were taking the Assessment of Chemistry Learning Processes and Outcomes course in Regular Class A.

2.3 Intervention: Project-Based Learning

The intervention was implemented in the Assessment of Chemistry Learning Processes and Outcomes course. Learning activities followed the Project-Based Learning syntax, namely (1) determining the project question or problem, (2) designing the project, (3) preparing the project schedule, (4) monitoring the progress of the project, (5) presenting and discussing the project results, and (6) evaluating the learning experience. Students worked collaboratively in groups to complete. Each group presented its results to the class and responded to questions and feedback from peers and the lecturer.

2.4 Research Instrument

The research instrument was a self-efficacy questionnaire designed to measure students' confidence in understanding learning assessment concepts. The questionnaire consisted of 24 statements covering the concepts of measurement, assessment, and evaluation; the functions of assessment; assessment principles; cognitive, affective, and psychomotor assessment; classroom-based assessment; and portfolio assessment. Total scores were converted to a scale of 0–100 so that pretest and posttest scores could be compared directly. The same questionnaire was used as the pretest, administered before the intervention, and as the posttest, administered after the project-based learning activities had been completed.

2.5 Data Analysis

The data were analyzed using descriptive statistics (minimum, maximum, mean, and standard deviation). Before hypothesis testing, the difference scores between the posttest and pretest were tested for normality at a significance level of 0.05; the scores were considered normally distributed when the significance value was greater than 0.05. When the normality assumption was satisfied, the improvement in students' self-efficacy was analyzed using a paired-samples t-test at a significance level of 0.05. The null hypothesis (H_0) stated that there was no difference between the mean pretest and posttest scores, and the alternative hypothesis (H_1) stated that there was a significant difference between them. In addition, the magnitude of the improvement was determined using N-Gain analysis [13], calculated as follows:

$$g = (S_{\text{post}} - S_{\text{pre}}) / (S_{\text{max}} - S_{\text{pre}})$$

where S_{post} is the posttest score, S_{pre} is the pretest score, and S_{max} is the maximum possible score (100). The N-Gain was interpreted as high ($g \geq 0.70$), moderate ($0.30 \leq g < 0.70$), or low ($g < 0.30$) [13].

3. RESULTS AND DISCUSSION

This study aimed to examine the improvement in students' self-efficacy in understanding learning assessment concepts following the implementation of Project-Based Learning in the Assessment of Chemistry Learning Processes and Outcomes course. Data were collected through a pretest administered before the intervention and a posttest administered after the project-based learning activities had been completed. The descriptive statistics of students' self-efficacy scores are presented in Table 1.

Table 1. Pretest and Posttest Results of Students' Self-Efficacy

Descriptive Statistics	Pretest	Posttest
Number of participants	21	21
Minimum score	45.83	72.92
Maximum score	79.17	100.00
Mean	70.54	82.99
Standard deviation	7.88	8.13

As shown in Table 1, the mean pretest self-efficacy score of the 21 students was 70.54, with a standard deviation of 7.88. Following the implementation of Project-Based Learning, the mean posttest score increased to 82.99, with a standard deviation of 8.13. Thus, the mean self-efficacy score increased by 12.45 points. This increase indicates a positive shift in students' confidence in their ability to master chemistry learning assessment concepts after participating in the Project-Based Learning-based course.

To determine whether the increase in self-efficacy scores before and after the learning intervention was statistically significant, the difference between the posttest and pretest scores was analyzed. In this study, the normality test was conducted on the difference scores because these scores served as the basis for the paired-samples t-test.

Table 2. Statistical Analysis of Students' Self-Efficacy

Statistical Test	Result
Normality test	0.185
N-Gain	0.429
Paired-samples t-test	0.000

The normality test presented in Table 2 yielded a significance value of 0.185, which is greater than 0.05. Therefore, the difference scores between the pretest and posttest can be considered normally distributed. Because the normality assumption was satisfied, the analysis proceeded with a paired-samples t-test to determine whether the change in students' self-efficacy was statistically significant. The N-Gain analysis yielded a mean score of 0.429. Based on the N-Gain classification criteria, this value indicates a moderate level of improvement in students' self-efficacy. Thus, the increase in self-efficacy following the learning intervention occurred at a moderate level. The paired-samples t-test yielded a significance value of 0.000 ($p < 0.05$), indicating a statistically significant difference in students' self-efficacy scores before and after the implementation of Project-Based Learning. The higher mean posttest score compared with the pretest score further indicates an improvement in students' self-efficacy following the learning intervention.

The significant improvement in students' self-efficacy following the implementation of Project-Based Learning suggests that authentic problem-solving learning experiences can contribute to the development of prospective teachers' academic and pedagogical confidence. Engagement in authentic project-based problem-solving activities has been reported to improve self-efficacy, pedagogical knowledge, and students' teaching readiness [8], [9].

At the pretest stage, students tended to demonstrate uncertainty and relatively lower levels of self-efficacy, particularly when dealing with specific indicators such as distinguishing between

measurement, assessment, and evaluation and designing instruments for cognitive, affective, and psychomotor assessment. Such uncertainty may arise because assessment content requires both conceptual understanding and practical skills. Through the Project-Based Learning syntax, however, students became actively involved in the learning process, allowing their initial uncertainty to be reduced through investigation and collaborative activities. The integration of Project-Based Learning into a structured instructional process has been shown to contribute significantly to students' conceptual understanding while also fostering responsibility, independence, and confidence in scientific communication [10], [11].

The improvement in self-efficacy may also be associated with students' involvement in presentation and discussion activities. When students presented assessment-related materials, their peers were not merely passive recipients of information. Instead, they were required to organize their understanding, explain concepts, respond to questions, and defend their arguments. Successful engagement in these activities may serve as a mastery experience (performance accomplishment), which Bandura identified as one of the main sources of self-efficacy alongside vicarious experience, verbal persuasion, and emotional arousal [14]. Such experiences strengthen students' beliefs in their academic capabilities. Interactive learning approaches such as Project-Based Learning can shift students' roles from passive recipients of information to active learners [15]. Through the responsibility of elaborating concepts, expressing opinions, and defending arguments before peers, students not only develop critical thinking skills but may also strengthen their academic self-efficacy [16], [17].

The findings may also be explained by the relationship between self-efficacy and students' success in addressing learning demands. A strong positive relationship has been reported between chemistry problem-solving ability and self-efficacy, with a correlation coefficient of 0.814 and a significance value of 0.000 [18]. In the present study, as students developed a better understanding of assessment concepts and gained successful experiences in explaining and discussing those concepts, their confidence in their ability to deal with subsequent learning tasks may have increased.

The improvement found in this study is consistent with previous findings that Project-Based Learning enhances self-efficacy and learning outcomes [9] as well as pedagogical knowledge among university students [8]. However, the comparison should be made with caution, because those studies were conducted in different subjects, populations, and learning contexts, and their outcomes were not specific to learning assessment concepts. The present study therefore extends the existing evidence by showing a similar tendency among prospective chemistry teachers in a pedagogical course. The magnitude of the improvement also deserves attention. The N-Gain of 0.429 falls in the moderate category, meaning that, on average, students closed less than half of the gap between their pretest scores and the maximum score. The standard deviation also remained similar from pretest (7.88) to posttest (8.13), indicating that differences in self-efficacy among students persisted after the intervention. At the same time, the lowest posttest score (72.92) was higher than the pretest mean (70.54), suggesting that the improvement was not limited to a few students.

Several factors beyond the instructional model itself may have contributed to this improvement. First, group work and class discussion provided opportunities for vicarious experience, in which students observed how their peers explained and solved assessment-related problems, as well as for verbal persuasion through feedback from peers and the lecturer; both are recognized sources of

self-efficacy [14]. Second, the lecturer's teaching approach and guidance during the project may have supported students' competence development [15]. Third, as students gained knowledge about assessment through the project, their increased understanding may have been reflected in higher confidence, in line with the positive relationship between competence and self-efficacy reported in chemistry learning [18]. Fourth, the initial level of self-efficacy (pretest mean of 70.54, with a minimum of 45.83) left room for improvement, which may have contributed to the observed gain. These factors were not measured separately in this study; therefore, their relative contributions cannot be determined.

Several limitations should also be acknowledged. Because the study used a one-group pretest–posttest design without a control group, the improvement cannot be attributed solely to Project-Based Learning. Threats to internal validity, such as history, maturation, and testing effects (in which familiarity with the same questionnaire may influence posttest responses), cannot be excluded [12]. The data were based on students' self-reports, which may be affected by social desirability, and the questionnaire measured perceived confidence rather than actual conceptual understanding or assessment skills. In addition, the small sample from a single class limits the generalizability of the findings. Future studies should use a quasi-experimental design with a control group, involve larger and more diverse samples, combine self-efficacy measures with tests of conceptual understanding and assessment performance, and examine which components of Project-Based Learning contribute most to the increase in self-efficacy.

4. CONCLUSION

The implementation of Project-Based Learning in the Assessment of Chemistry Learning Processes and Outcomes course was associated with a statistically significant, moderate improvement in students' self-efficacy in understanding learning assessment concepts ($N\text{-Gain} = 0.429$; $p < 0.05$). These findings suggest that Project-Based Learning, through authentic project work, presentation, and discussion, can help build prospective chemistry teachers' confidence in mastering assessment competencies. Given the one-group design and the small sample, the results should be interpreted cautiously, and future research should use a control group and combine self-efficacy with measures of actual conceptual understanding.

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