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Description of the Level of Student Understanding in the Chemistry Learning Planning Course through Teaching Module Products in the Context of Project-Based Learning

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A B S T R A C T

This study aims to describe the level of understanding of prospective teacher students in the subjectChemistry Learning Planning through teaching module products in the context of project-based learning. The method used is quantitative descriptive with descriptive statistical analysis techniques. A total of 28 teaching modules were designed byProspective teacher students are assessed using an assessment rubric with six main assessment indicators, namely:Learning Objectives, Teaching Materials, Activity Steps, Media and Learning Resources, Student Worksheets (LKPD) and Learning Assessments.The results show that most students have a high level of understanding, especially in formulating learning objectives., materials, media, and learning assessments, while the activity steps and LKPD aspects are in the moderate category. These findings indicate the effectiveness of the project approach in assessing students' conceptual and applicative understanding. In addition, the project approach also provides implications for curriculum development and learning strategies in higher education.

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INTRODUCTION

Chemistry Learning Planning is the main foundation in educational practice, especially for prospective teacher students who will manage the learning process in the classroom. In the Chemistry Learning Planning course, students are required to understand and apply various important components such as learning objectives, teaching materials, learning strategies, media, and assessments that are integrated with each other. Their success in mastering this course will greatly determine their professional abilities in the future as educators. However, many studies show that students still have difficulty in compiling comprehensive and systematic learning tools. This indicates that their conceptual understanding of Chemistry Learning Planning is not yet fully mature.

These difficulties are not only found in technical aspects, but also in the basic understanding of how to organize student-centered learning. Research by Niwangtika (2025) revealed that PGSD students had difficulty in connecting basic science concepts with classroom learning practices, especially when compiling activity steps that are in accordance with learning outcomes. This shows a gap between the theoretical understanding obtained in lectures and the application ability in designing meaningful learning experiences. In the context of science and chemistry education, this problem becomes even more complex because the material taught is abstract and conceptual, requiring the right approach so that it can be understood properly.both by students. Despite the growing number of studies highlighting these obstacles, there remains limited research that directly assesses students' actual products—such as teaching modules—as a concrete representation of their understanding. Most studies focus on perceptions, challenges, or theoretical planning, without delving into the quality and depth of the learning artifacts students produce in real educational contexts.

Research conducted by Laurens, et. all (2024), revealed that there were obstacles for students in compiling science learning tools that were integrated thematically and contextually. This is closely related to students' ability to formulate SMART learning objectives, choose appropriate methods, and compile assessments that are capable ofvalidly measure the achievement of objectives. The inability to connect these components often causes the learning plans that are prepared to be less effective and not implementable. This weakness can ultimately impact the quality of learning that they will provide in the future.

Rozhana, et all (2025) added that many students in science education programs still experience difficulties in designing active and project-based learning. They often fail to integrate objectives, materials and assessments, so that the learning they design does not reflect an approach oriented towards meaningful learning. This condition is a serious challenge, especially in the Independent Curriculum era which encourages comprehensive and contextual competency development. This curriculum requires teachers, including prospective teachers, to design learning that is flexible, student-centered, and based on clear learning outcomes. However, a clear understanding of how these competencies are manifested in student-produced teaching modules is rarely explored in empirical studies. There is a lack of analysis focusing specifically on how well students integrate theory into practice through their project outputs in the Chemistry Learning Planning context. This represents a significant gap in existing literature.

In line with these challenges, the Project-Based Learning (PjBL) approach is one of the relevant learning strategies to be applied in higher education learning, especially in the Chemistry Learning Planning course. PjBL allows students to learn through authentic activities and produce real products that reflect their thinking processes and understanding. In this context, the preparation of teaching modules becomes a project assignment that can measure the extent to which students understand the course material as a whole. Teaching modules are not only final assignments, but also a reflection tool on students' abilities in designing a planned, systematic, and contextual learning process. Research by Allo, et all (2025) specifically shows that students show increased abilities when involved in the preparation of teaching modules based on the independent curriculum through discovery learning, which shows the importance of teaching module production activities as a measure of understanding.

The teaching module prepared by students in the project-based learning approach functions as a concrete representation of the integration of theoretical knowledge and practical skills. In the teaching module, it can be analyzed to what extent students are able to formulate clear objectives, compile learning activity steps, choose appropriate methods, and design assessments that support the achievement of objectives. Therefore, the analysis of this teaching module can be used to describe the level of students' understanding of the substance of the subject.Chemistry Learning Planning lecturescomprehensive. Thus, the products produced by students are not only assessed from the aesthetic or completeness aspects, but more on the depth of understanding that is reflected through the compilation of the contents of the teaching module (Allo, 2021). Yet, few studies have employed these modules as primary data sources for evaluating conceptual mastery. As a result, educators and curriculum developers still lack clear, evidence-based insights into which specific aspects of chemistry learning planning students struggle with when translating theory into structured teaching documents.

Research that examines students' understanding through products such as teaching modules is important to be carried out as an evaluation of the effectiveness of ongoing learning. Through a quantitative descriptive approach, researchers can map aspects of students' understanding objectively based on indicators in the teaching module assessment rubric. The results of this analysis can provide a more complete picture of the areas of competence that students have mastered or that still need strengthening. In addition, the results of the study can also be used as a basis for improving the curriculum, lecturers' teaching approaches, and learning evaluation strategies.

Based on the description, this study is directed to describe the level of students' understanding of the Chemistry Learning Planning course through the teaching module products that they compile as part of the project assignment.

This teaching module is analyzed based on indicators in the assessment rubric that includes learning objectives, activity steps, materials, media, and assessments. By analyzing the contents of the teaching module, it is expected to obtain a picture of the extent to which students understand and are able to apply the core concepts in Chemistry Learning Planning. The results of this study not only contribute to the development of learning strategies at the tertiary level, but can also be a reference in improving the quality of education for prospective teachers, especially in the field of chemistry.

THEORETICAL REVIEW

Learning Planning Theory

Learning Planning is a systematic process for designing structured learning experiences that are directed at achieving learning objectives. According to Gagné and Briggs (1979), Chemistry Learning Planning includes needs analysis, setting learning objectives, strategy design, media selection, and evaluating learning outcomes. A prospective teacher is required to not only understand this theory, but also be able to apply it in the form of a comprehensive learning document.

Research by Niwangtika (2025) shows that PGSD students have difficulty in compiling learning plans, especially in compiling objectives and activity steps that are in accordance with learning outcomes. This reflects the lack of integration between theoretical understanding and practical skills in compiling learning tools. Therefore, product-based evaluation (teaching modules) is needed to determine their level of understanding of the theory.Chemistry Learning Planning.

Theory of Teaching Modules as a Representation of Understanding

The teaching module is one of three newly developed teaching tools in the Merdeka Curriculum, namely examples of teaching modules, learning objective flows, and Pancasila student profile strengthening projects. The teaching module is a development of the learning implementation plan (RPP) which is equipped with more detailed guidelines, including student activity sheets and assessments to measure the achievement of learning objectives. It is called a module because this tool can be used modularly.The teaching module presents all the important components inLearning Planning: learning objectives, materials, strategies/methods, media, assessments, and student activities. In the context of teacher education, teaching modules function as a medium for practicing systematic and pedagogical thinking (Educational Standards, Curriculum, and Assessment Agency, 2024).

Laurens,*et all*(2024) found that science education students still have difficulty in compiling integrative and thematic teaching materials. The teaching modules they produce do not yet show coherence between learning objectives, activities, and assessments. This indicates that the quality of teaching modules can be used as a direct indicator of the level of student understanding of effective and competency-oriented learning design.

Project-Based Learning Theory

Project-Based Learning (PjBL) is a learning approach that focuses on in-depth investigation and real products as a result of the learning process. According to Thomas (2000), PjBL involves complex activities based on real-world problems, encouraging students to collaborate, think critically, and build knowledge actively.

In the context of teacher education, the preparation of teaching modules as a final project encourages students to integrate theoretical concepts with practical applications. Rozhana,*et all*(2025) noted that students who participated in project-based learning still often failed to integrate objectives, materials, and assessments. This is an important challenge in measuring the extent to which PjBL supports students' understanding ofChemistry Learning Planning.

Research Hypothesis

Based on the literature and previous findings, the research hypothesis is formulated as follows: "The majority of prospective teacher students who design project-based teaching modules in the Chemistry Learning Planning course demonstrate a high level of understanding, particularly in the indicators of learning objectives, teaching materials, media, and assessment; whereas their understanding of activity steps and student worksheets (LKPD) falls within the moderate category."

METHODOLOGY

This research uses an approachquantitative descriptive study aimed at describing the level of students' understanding of the Chemistry Learning Planning course through teaching module products arranged in the context of project-based learning. The main focus of this study is not to test the relationship between variables, but rather to map the achievement of learning indicators depicted in the structure of the teaching module. The conceptual framework of this study is grounded in three interconnected theoretical foundations:

1. **Chemistry Learning Planning Theory**: which outlines the essential components of instructional design, including objectives, materials, strategies, media, and assessments.
2. **Project-Based Learning (PjBL)**: serving as the pedagogical approach used to facilitate students' construction of teaching modules.
3. **Teaching Modules as Assessment Artifacts**: functioning as the empirical representation of students' conceptual and practical understanding.

The population in this study were all class A students of the Chemistry Education study program who took the Chemistry Learning Planning course in the odd semester of the 2024/2025 academic year. The sampling technique used was total sampling because the number of students was manageable, which was 31 active students. This means that there are 31 teaching modules that have been designed by prospective teacher students that will be analyzed.

The instrument used is a teaching module assessment rubric, which includes six main indicators: (1) Learning Objectives; (2) Teaching Materials; (3) Activity Steps; (4) Media and Learning Resources; (5) Student Worksheets (LKPD) and (6) Learning Assessment. Each indicator is assessed on a Likert scale of 1 to 4, then added up and averaged to obtain a final score as a representation of student understanding. The assessment is carried out by the lecturer using a standardized rubric instrument.

To support data interpretation, descriptive statistical techniques are used in the form of average, minimum value, maximum, median, and standard deviation. Furthermore, the average results per indicator and the final value are categorized into three levels of understanding:

Table 1. Likert scale score categories

Score Range	Category
3.26 – 4.00	Tall
2.51 – 3.25	Currently
1.00 – 2.50	Low

This categorization refers to the principle of dividing score intervals evenly on a 4-point Likert scale, and has been used in various similar educational studies (Muslihuddin, Jusuf, & Santoso, 2024; Wahidin, Badriah, & Dewi, 2025).

RESULTS

This study aims to describe the level of understanding of prospective teacher students regarding the subject.Chemistry Learning Planning through teaching module products that are compiled independently in the context of project-based learning. Teaching modules are assessed using a rubric that includes six main indicators: (1) Learning Objectives, (2) Teaching Materials, (3) Activity Steps, (4) Media and Learning Resources, (5) LKPD, and (6) Learning Assessment. Scores for each indicator are given on a Likert scale of 1–4, and the final value is obtained from the accumulation of assessments of all indicators.

Of the total 31 registered prospective teacher students, 28 students were considered valid because 3 students withdrew. Data from the 28 teaching modules designed by these students were analyzed using descriptive statistics to determine the distribution and tendency of scores.

Table 2. Descriptive Statistics of Students' Final Grades

Statistics	Mark
Number of Active Students	28
Average value	92.5
Standard Deviation	2.20
Minimum Value	90.0
Maximum Value	98.0

Table 2 shows that the understanding of prospective teacher students is generally in the high category. The average final score of 92.5 shows consistency in the achievement of understanding between students. The minimum score that remains at the level of 90.0 and the low standard deviation indicate that almost all students have succeeded in meeting the competency demands measured through the teaching module product.

Next, an analysis of the average score for each indicator was carried out to determine the specific aspects ofChemistry Learning Planning that has been well understood by students and which still needs to be improved.

Table 3. Average Student Understanding Score per Indicator

Indicator	Average Score	Category
Learning objectives	3.6	Tall
Teaching Materials	3.4	Tall
Activity Steps	3.2	Currently
Media & Learning Resources	3.3	Tall
Worksheet	3.1	Currently

Indicator	Average Score	Category
Learning Assessment	3.3	Tall

DISCUSSION

The results of this study indicate that most of the prospective teacher students are able to produce good quality teaching modules, especially in the indicators of learning objectives, teaching materials, media and learning resources, and learning assessments that are in the high category. This finding is in line with the main principle of Project-Based Learning (PjBL), where learning products (teaching modules) are a direct representation of the understanding and competencies obtained by students through active involvement in the learning process (Darmawang et al., 2022).

The students' ability to formulate learning objectives and compile relevant teaching materials shows that they have mastered the basics of good pedagogical construction. This supports the argument of Wahyudi & Anugraheni (2018) that student involvement in the teaching materials development project encourages them to think more deeply about the structure of learning content and its relationship to learning outcomes. Accuracy in compiling materials and objectives also indicates that students are able to translate curriculum learning outcomes into practical implementation.

High achievement in media and learning resource indicators and assessments shows that students have the ability to choose tools that are appropriate to the characteristics of the material and learning approach. They are also considered to have compiled evaluations that are oriented towards the learning process and outcomes. According to Purba & Harahap (2023), students' success in determining media and assessments is greatly influenced by their direct experience in designing learning through project activities. In this context, project-based learning is not only a delivery strategy, but also a means of pedagogical reflection.

However, there are two indicators that fall into the moderate category, namely activity steps and LKPD. This shows that some students are not yet optimal in compiling a systematic activity flow and reducing learning activities into applicable worksheets. Similar problems were also found in a study by Wahyudi & Anugraheni (2018), which revealed that students often have difficulty in formulating structured learning activities and encouraging student activity progressively. This problem indicates that students' procedural skills in compiling learning scenarios still need to be improved, especially in terms of sequence, clarity of teacher and student roles, and strengthening process skills.

As an output of the project-based approach, the teaching modules developed by students reflect the process of critical thinking, decision-making, and responsibility for work results. According to Darmawang et al. (2022), project-based learning can be an effective means of evaluating students' pedagogical abilities as a whole, because the skills measured cover the cognitive, affective, and psychomotor domains. This can be seen in the success of students in designing learning evaluations that not only measure knowledge but also involve students in the assessment process contextually.

This finding also provides evidence that product-based assessment in this case, teaching modules, can be a valid alternative to replace conventional evaluations such as end-of-semester exams. When students are asked to comprehensively construct a complete and usable teaching module, they are challenged to understand not only the content, but also the process and implementation of learning. This approach is considered more authentic and reflects the real capabilities of students in the real world of education (Purba & Harahap, 2023).

Thus, project-based learning has made a real contribution in fostering students' understanding of the concepts in Chemistry Learning Planning. However, the evaluation of the product results also underlines that technical procedural aspects such as activity steps and LKPD need to be further emphasized in the guidance process. This emphasis is important to ensure that students' conceptual understanding is also reflected in the clarity and functionality of the learning activity design.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Based on the results of the analysis of the teaching modules prepared by chemistry education students, it can be concluded that the level of student understanding of the Chemistry Learning Planning course is generally in the high category. This is reflected in the high final grades and the dominance of indicator scores in the good category. Students demonstrate a solid understanding of conceptual aspects such as learning objectives, teaching materials, learning media, and assessments.

However, students' understanding is not evenly distributed across all components. Two indicators, namely activity steps and LKPD, are still in the moderate category. This indicates that students need further guidance in compiling a systematic learning activity flow and in developing learning tools that can facilitate student activities optimally.

This finding also proves that the project-based learning approach can be an effective method in evaluating students' understanding authentically through concrete products. The teaching module as a project output is able to represent the integration between theory and practice of Chemistry Learning Planning.

Recommendations

Based on the results of this study, it is recommended that lecturers in charge of the Chemistry Learning Planning course strengthen mentoring in the aspect of compiling activity steps and LKPD through simulations or case study-based exercises, considering that these two indicators show a moderate category. In addition, project-based learning approaches and product-based assessments, such as teaching modules, can be continued because they have proven effective in describing students' understanding as a whole. The teacher education curriculum also needs to continue to accommodate learning models that encourage students to produce real work that reflects the integration of theory and practice. To enrich the study, further research can be conducted with a mixed approach, involving qualitative data to explore students' thinking processes in compiling teaching modules.

FURTHER STUDY

This study has limitations in terms of the approach used, namely quantitative descriptive based on product analysis, so it has not been able to explore the thinking process or strategies used by students in compiling teaching modules. In addition, the focus of the study was only limited to one class in one study program, so the results cannot be generalized to a wider context. Therefore, further research is recommended to use a mixed methods approach by adding interviews, observations, or process analysis as qualitative data.

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