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Improvement of Pre-Service Chemistry Teacher Skills in Designing Learning Materials through Curriculum Study to Realize Quality Education

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ABSTRACT

Education has a central role in developing superior and competitive human resources, one of which is improving the quality of prospective educators, playing a direct role in the learning process. Achievement SDGs 4: Quality Education requires educators with the skills to design learning materials that meet national standards and student needs. This research aims to improve the skills of pre-service chemistry teachers in planning learning devices covering the Semester Program (Prosem), Learning Objective Flow (ATP), and Teaching Module as a form of implementation of SDG 4: Quality Education through curriculum study. The research method used is a quantitative descriptive design with a case study approach. The research subjects were 25 Chemistry Education Study Program students from Semarang State University. Data collection was carried out through peer assessment sheets and response questionnaires. The results of the study show an increase in the skills of pre-service chemistry teacher students in designing learning materials, semester program, ATP, and teaching modules as high as 32%, 28%, and 21%. The percentage of student responses regarding the perception of curriculum studies was 82.63%, with an outstanding category. This study concludes that curriculum studies can provide theoretical and practical experience, so it is effective to improve the skills of pre-service student teachers to design learning materials so that quality education is realized (SDGs 4).

Keywords: Curriculum Studies, Learning Materials, Quality Education

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1. INTRODUCTION

Education is key to creating superior and competitive human resources (Sanga, 2023). In a global context, the Sustainable Development Goals (SDGs) establish Goal 4: Quality Education, which emphasizes the importance of inclusive and quality access to education and promotes lifelong learning opportunities for all (Arifin, 2025). A crucial aspect in achieving this goal is the readiness of prospective educators to understand and implement a curriculum that aligns with national standards and student needs (Safitri, 2022).

Vygotsky's constructivist theory emphasizes the importance of active and contextual learning experiences in building conceptual understanding. Social interaction and the role of educators are crucial in shaping students' knowledge. Students have a greater and more active role in learning activities (Casfian, 2024). During the implementation of the education of pre-service teachers, designing curriculum-based learning materials is an essential part of building professional competence (Zulyanty, 2024). Developing learning tools aligned with the independent curriculum is a pressing need today. Educators are required to innovate in education independently (Satyawati et al., 2022). Learning materials include Semester Programs (Prosem), Learning Objective Flow (ATP), and Teaching Modules, which serve as guidelines for effective teaching (Diva, 2024).

However, the facts show that many student teachers still experience difficulties in systematically compiling learning materials. The results of observations of 30 student teachers in the Chemistry Education Study Program showed that 50% of students experienced difficulties in compiling Prosem, 57% experienced obstacles in designing ATP, and 60% had problems compiling Teaching Modules. The main factors causing these difficulties were a lack of understanding of the curriculum concept (61% of students stated that they did not understand the structure of the applicable curriculum), minimal practical experience (70% of students only had limited experience in implementing the curriculum in schools), and learning approaches in lectures that were still theoretical and less applicable.

Study of Agustina (2023) states that prospective educators must possess in-depth curriculum analysis skills, link theory to practice, and have reflective experience in developing learning tools. Kolb's Experiential Learning Theory model also emphasizes that students must be allowed to experience directly the development and implementation of learning tools to deepen their understanding (Wahyuni, 2024).

Uswamp To address these problems, this study proposes a curriculum study approach that integrates theory with field experience. This approach differs from previous research because students are given practical experience. Students will go directly to schools to observe and practice the preparation of curriculum-based learning devices.

Research on improving students' skills in developing learning materials has been extensively conducted, particularly in the context of curriculum implementation in higher education. Several previous studies, such as those undertaken by Wulandari (2024) and Merdekawati (2024), highlight the importance of student teachers understanding the

curriculum to design effective learning. Another study by Sukmawati (2019) showed that a curriculum-based approach can help students understand the relationship between theory and practice in developing learning materials. However, these studies still focus on theoretical aspects without systematically measuring student skill improvement after using specific learning strategies.

The novelty of this research lies in applying a quantitative descriptive method to the curriculum study based on case studies. Unlike previous research that emphasized only theoretical understanding, this study combines theoretical presentation, direct observation in schools, and the practice of developing learning materials with intensive guidance. Its effectiveness is evaluated quantitatively through peer assessment and analysis of the percentage change in the quality of students' learning materials before and after the curriculum study.

Furthermore, this research contributes to the achievement of SDG 4: Quality Education by producing a learning model that enhances the skills of pre-service educators in developing learning materials in accordance with curriculum standards. Thus, this research enriches the academic literature and has a tangible impact on improving the quality of higher education, particularly in pre-service teachers' learning.

This study aims to analyze the improvement of students' skills in compiling Semester Programs (Prosem), Learning Objective Flow (ATP), and Teaching Modules before and after curriculum studies, as well as to determine students' perceptions of curriculum studies in improving their understanding and skills in compiling learning materials.

2. RESEARCH METHODS

This study uses a quantitative descriptive method with a case study approach, which aims to describe the effectiveness of curriculum studies in improving students' skills in compiling learning tools, namely Semester Programs (Prosem), Learning Objective Flow (ATP), and Teaching Modules (Datu, 2024; Mudarris, 2024). The case study approach is used because it allows for in-depth analysis of specific phenomena in a particular context (Ardiansyah, 2023). Meanwhile, using percentage analysis techniques, the quantitative aspect measures student skills before and after the curriculum study. The research subjects were 25 Chemistry Education Study Program students at Semarang State University in 2025.

This research was conducted in several stages. The first stage was needs analysis and problem identification, which aimed to identify students' challenges in developing learning materials. This process was conducted through questionnaires and interviews, measuring students' initial understanding of curriculum concepts and their difficulties in developing Prosem, ATP, and Teaching Modules. This analysis helps determine the appropriate learning strategy to improve students' skills in compiling Prosem, ATP, and Teaching Modules (Ayu, 2024; Winarsih, 2024). In addition, a literature review was conducted on curriculum standards and learning planning principles to strengthen the basis of this research.

The second stage is the implementation of curriculum studies, where students are given a theoretical understanding of the curriculum, including the principles. The students also conducted observations at schools in Semarang City to observe the curriculum's implementation, the learning strategies used by teachers, and the obstacles encountered in its implementation. These observations aimed to provide students with practical insights so they could develop more applicable learning materials. Based on these observations, students began developing learning materials tailored to the real-world conditions in their schools.

The third stage is intensive mentoring and guidance, where students receive feedback and guidance at every stage of developing learning materials. This support is provided through group discussions, consultations with lecturers, and revision sessions to ensure that the materials meet curriculum standards and learning needs. Based on the evaluation results, students can refine and perfect their learning materials through this support.

The fourth stage is evaluation and reflection, which aims to assess the effectiveness of curriculum studies in improving students' skills. Evaluation was conducted using peer assessment, in which students evaluated each other's learning materials using a predetermined rubric. Additionally, student questionnaire responses were analyzed to determine their perceptions of the benefits of curriculum study in improving their skills.

The results of this study are expected to demonstrate an improvement in the quality of learning materials developed by students after participating in curriculum studies. Furthermore, this study also provides insight into the effectiveness of curriculum studies in enhancing students' understanding of developing learning materials that align with applicable educational standards.

Data collection techniques in this study included documentation to record the process of preparing and revising learning devices and the results of initial and final assessments through peer assessment. Interviews with student teachers were conducted to explore difficulties in preparing learning devices, understanding of the curriculum, and challenges in its implementation. The research instruments consisted of: (1) a peer assessment sheet to assess the quality of the devices before and after revision, and (2) a response questionnaire to determine students' perceptions of curriculum study. Data were analyzed using a percentage score test to see changes in the quality of learning devices before and after implementing the curriculum study strategy.

The data analysis technique in this study uses a Likert scale analysis to measure the quality of learning materials and student responses to curriculum studies. Analysis was conducted on peer assessment sheets and response questionnaires. Percentage scores were calculated using the formula as follows.

$$P = \frac{f}{N} \times 100\%$$

Information:
P = percentage of score obtained
f = number of scores obtained
N = maximum number of scores

The percentage results are then converted into the following criteria:

Table 1. Criteria Quality of Learning Tools and Student Responses

Percentage (%)	Criteria
81.25 < score ≤ 100	Very good
62.50 < score ≤ 81.25	Good
43.75 < score ≤ 62.50	Enough
25.00 ≤ score ≤ 43.75	Not enough

Learning devices are considered good quality if the score exceeds 62.50%. The questionnaire responses were analyzed using descriptive percentage analysis with an adapted Likert scale (Sugiono, 2023). Data were analyzed using the same formula, and then the results were converted into the same categories as the quality of the learning devices. Student responses were considered good if the score was greater than 62.50%. If ≤ 62.50%, then the curriculum study needs to be evaluated and refined.

By applying quantitative descriptive methods, this research is expected to provide an objective overview of the effectiveness of curriculum studies in improving student skills. Furthermore, this research also contributes to improving the quality of pre-service teachers and supporting the achievement of SDG 4: Quality Education by producing educators who are more competent in lesson planning.

3. RESULTS AND DISCUSSION

Research started before the curriculum study; students taking the Chemistry Curriculum Review course in the even semester of 2024/2025 were tasked with designing learning tools in Prosem, ATP, and teaching modules based on their initial understanding. The curriculum study was then conducted.

The curriculum study implementation procedure consists of several stages. The following are research results obtained from each stage.

1. Providing Materials

The curriculum study begins with presenting material related to learning materials and the current independent curriculum. The material is delivered over a 2-credit unit (SKS) period. This presentation provides students with theoretical knowledge. The material covers the independent curriculum and its components. It also explains how to develop practical learning tools that meet student needs. A question-and-answer session is held during the presentation to allow students to explore the curriculum and learning materials in depth.

2. School Observation Activities

Next, students observed several high schools in Semarang City to understand better the learning materials and curriculum used in those schools. Some targeted schools were SMA Negeri 1 Semarang, SMA Negeri 14 Semarang, and SMA Ksatrian 2 Semarang. The results obtained from the school observations were that students could find inspiration for

materials or completeness of learning tools that have been implemented. The curriculum implemented is the independent curriculum. Some of these schools use learning approaches such as Technological Pedagogical Content Knowledge (TPACK) and the scientific approach. Before entering the new academic semester, teachers at these schools are required to create learning tools.

3. Practice of Developing Learning Tools

After receiving materials and observing the school's curriculum, students practice designing learning materials based on their knowledge. Learning materials are developed individually.

Each student receives intensive mentoring to improve the learning materials they initially designed. Assistance with developing learning materials can help students acquire chemistry material and find inspiration for materials (Burhanuddin, 2023). During the mentoring activities, researchers review the designed learning materials and identify areas for revision. Intensive mentoring activities are conducted in groups for four credit hours, followed by revision and individual guidance.

Learning materials prepared at the beginning and after the curriculum study were assessed using peer assessment sheets. Based on the initial peer assessment results, 64.67% was obtained, indicating that the quality of the learning materials prepared was classified as good, but still needed to improve skills so that the designed learning materials met the applicable criteria and curriculum. Figure 1 shows the percentage of students' skills in preparing initial learning materials before the curriculum study.

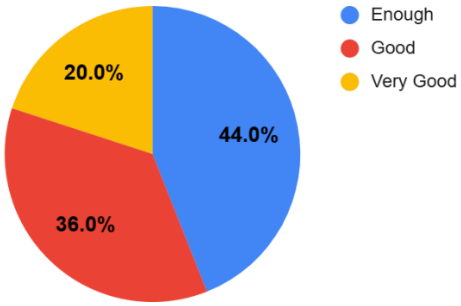


Figure 1. Student Initial Skills

Figure 1 shows that 20% (5 students) had excellent skills in designing learning devices, 36% (9 students) had good skills, and 44% (11 students) had adequate skills in designing learning devices before the curriculum study. This means these prospective teacher students still need training in designing learning devices.

The following are the results of assessing students' skills in designing learning devices before and after the curriculum study, based on the quality of the learning devices.

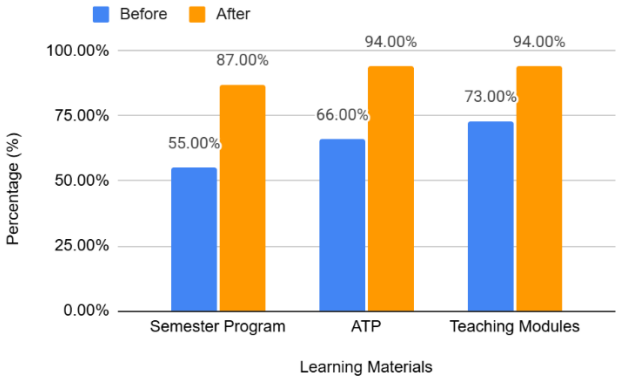


Figure 2. Student Skills in Preparing Learning Materials

Based on the results of the analysis of the quality assessment data for the learning devices prepared before and after the curriculum study in Figure 2, there was a significant increase in the skills of prospective chemistry teacher students in preparing learning devices. The increase in skills occurred in each learning device. Student skills in preparing semester programs (prosem) increased from 55% to 87% with an increase of 32%, an increase in ATP preparation skills of 28% from 66% to 94%, and an increase in preparing teaching modules of 21% from 73% to 94%. Based on these results, after conducting the curriculum study, students can develop learning materials per the applicable independent curriculum standards. This aligns with research by Sukmawati (2019) that the preparation of learning devices according to curriculum standards can be done through curriculum study activities.

Student Skills in Designing Semester Programs

After completing the curriculum study, students' skills in designing semester programs were categorized as very good. Before the curriculum study, students still experienced difficulties in linking learning outcomes with the sequence of materials and time distribution. The compiled semester program tended to be general and did not show integration between the flow of learning objectives, learning goals, sequence of materials, and meeting time allocation. Before the curriculum study, the difficulty experienced in compiling the semester program was aligning ATP with the allocation of learning time. Students could not allocate learning time for each primary material to achieve learning objectives throughout the semester. In addition, students still had not included additional information such as vacation time, midterm exams (UTS), and final exams (UAS), which must be included in the semester program to make activities during the semester more focused. However, after the curriculum study, the compiled semester program was better—the quality of the prose compiled after the curriculum study is shown in Figure 3.

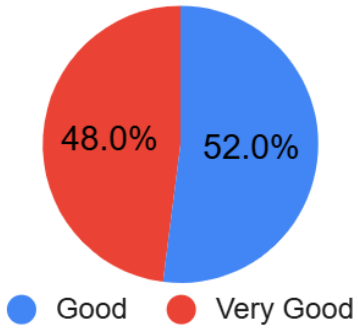


Figure 3. Semester Program Quality

Figure 3 shows that 52% of the designed semester programs are in the good category and 48% are in the outstanding category. The skills of designing Prosem are reviewed from the completeness of the components, which is in accordance with the curriculum, including school identity, learning achievements, learning objectives, ATP, primary material, learning activities, assessment, learning resources, and time allocation (Arwasih, 2025). The following is a display of prose that complies with the standards of the independent curriculum.

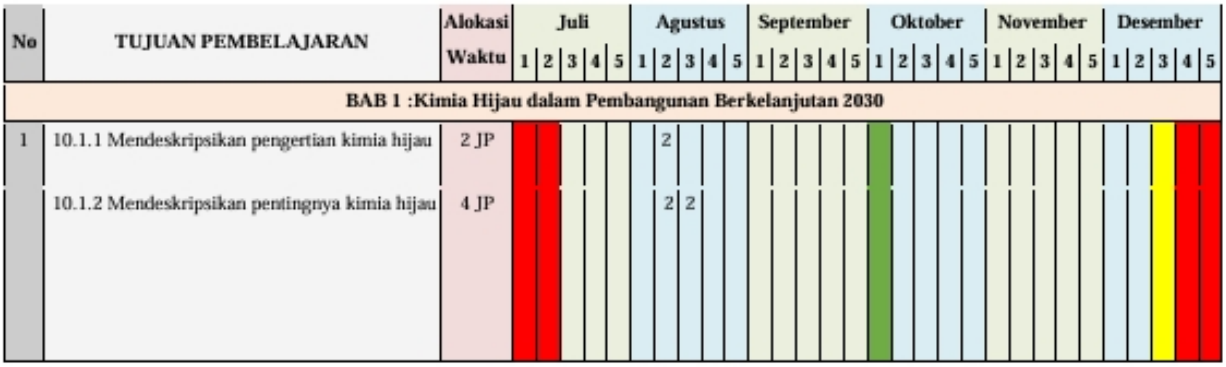


Figure 4. Prosem according to the Independent Curriculum Standards

Based on Figure 4, the prosem is structured more systematically, in a focused manner, and in accordance with the principles of the independent curriculum. Learning materials are presented coherently, and time allocation is effectively distributed. A coherently designed semester program can guide the learning process throughout the semester.

Student Skills in Designing Learning Objective Flow (ATP)

The Learning Objectives Flow is a series of learning objectives that must be arranged logically and systematically within the learning phases so that students can achieve the Learning Outcomes. ATP is one implementation of the independent curriculum. The following are the results of the ATP quality assessment following the curriculum study.

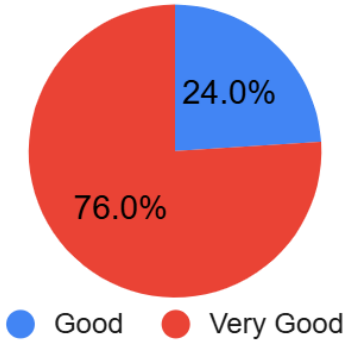


Figure 5. ATP quality

Based on picture 5, the results showed that 24% of the ATP compiled were in the good category and 76% were in the outstanding category. Before the student curriculum study, the findings showed that most students still encountered difficulties compiling ATP. These difficulties included a lack of understanding of learning outcomes at specific phases, which were then translated into Learning Objectives. Furthermore, the Learning Objectives compiled in sequence were still not coherent and systematic. The following is a display of the ATP research results in Figure 6.

ALUR TUJUAN PEMBELAJARAN (ATP)

No.	Tujuan Pembelajaran	Alokasi Waktu	Kata Kunci	Profil Pelajar Pancasila	Glosarium
	Semester Genap				
10.4	Melalui pengamatan tabel periodik dan diskusi kelompok, peserta didik mampu menjelaskan fungsi sistem periodik unsur dan mendeskripsikan tren keperiodikan sifat unsur, serta mengaitkannya dengan posisi unsur secara tepat.	8 JP	• Sistem periodik unsur • Konfigurasi elektron • Jari-jari atom • Energi ionisasi • Elektronegativitas • Keperiodikan • Golongan dan periode	1. Gotong Royong: Berdiskusi dan berkolaborasi dengan kelompok dalam menganalisis tren keperiodikan unsur. 2. Mandiri: Menggali data dari tabel periodik secara mandiri untuk membuat generalisasi ilmiah.	1. Sistem Periodik Unsur: Tabel yang mengelompokkan unsur berdasarkan kenaikan nomor atom dan kemiripan sifat kimia. 2. Keperiodikan: Pola keteraturan sifat-sifat unsur yang berulang secara periodik dalam sistem periodik.
	10.4.1. Peserta didik mampu menjelaskan sistem periodik unsur sebagai alat untuk memahami keteraturan sifat unsur melalui pengamatan tabel periodik dan				

Figure 6. ATP, according to the Independent Curriculum Standards

Through curriculum study, students can better understand how to develop a flow of learning objectives from essential material. They can sequence learning objectives from the lowest to the highest level according to their level of thinking. This improvement can also be observed in students' ability to integrate the values of the Pancasila Student Profile into the ATP. This demonstrates that ATP is not solely focused on cognitive aspects but also connects learning with character dimensions and 21st-century skills. Good skills in compiling ATP can ensure the direction of learning remains consistent and aligned with the objectives of the Merdeka Curriculum (Bait, 2025).

Student Skills in Designing Teaching Modules

A good teaching module design aligns with the curriculum and adapts to the needs of students. The quality of a teaching module can be assessed based on its systematic nature, time allocation, accuracy of learning objectives, learning strategies, models, and teaching materials used. Furthermore, according to curriculum requirements, learning activities can utilize various approaches such as STEAM, TPACK, and others. The following are the results of the teaching module quality assessment after the curriculum study.

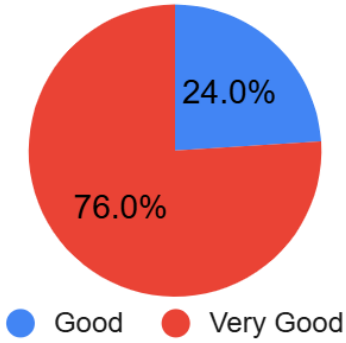
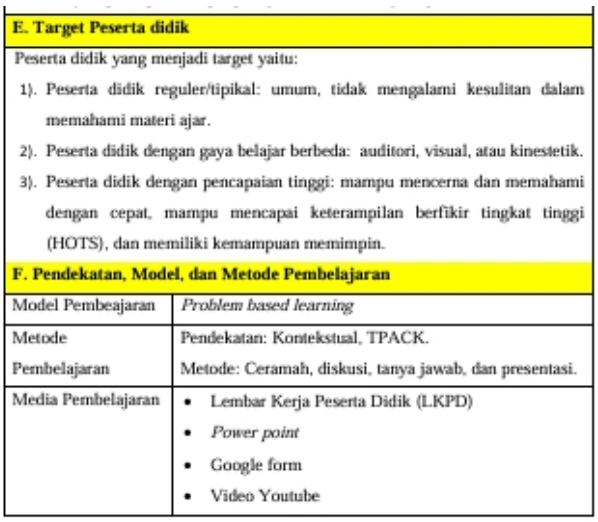


Figure 7. Quality of Teaching Modules

Based on picture 7, the results showed that 24% of the teaching modules were categorized as good and 76% as good. Before the curriculum study, the teaching modules designed by students did not integrate technology or detail the syntax of learning models such as inquiry, problem-based learning (PBL), or project-based learning (PjBL). Furthermore, the learning modules were not contextualized and did not include components such as prompting questions. Teaching modules must be designed contextually to facilitate students' understanding of the learning material and their ability to relate it to their daily lives (Yolanda, 2021). Complete teaching materials, such as Student Worksheets (LKPD), modules, or learning resources like YouTube, were not included in the teaching modules. However, after revisions through the curriculum study, students could develop complete teaching modules with all their components. The following is a display of the research results teaching module in Figure 8.



E. Target Peserta didik

Peserta didik yang menjadi target yaitu:

1). Peserta didik reguler/tipikal: umum, tidak mengalami kesulitan dalam memahami materi ajar.
2). Peserta didik dengan gaya belajar berbeda: auditori, visual, atau kinestetik.
3). Peserta didik dengan pencapaian tinggi: mampu mencerna dan memahami dengan cepat, mampu mencapai keterampilan berfikir tingkat tinggi (HOTS), dan memiliki kemampuan memimpin.

F. Pendekatan, Model, dan Metode Pembelajaran

Model Pembeajaran	*Problem based learning*
Metode Pembelajaran	Pendekatan: Kontekstual, TPACK. Metode: Ceramah, diskusi, tanya jawab, dan presentasi.
Media Pembelajaran	• Lembar Kerja Peserta Didik (LKPD) • *Power point* • Google form • Video Youtube

Figure 8. Teaching Modules according to the Independent Curriculum Standards

Based on Figure 8, the revised teaching module contains trigger questions, uses a specific learning model or approach, is contextual, student-centered, and is equipped with teaching material sources. According to Vygotsky's constructivist theory, the teaching module is designed to involve the active role of students during the learning process.

Student Perceptions on the Implementation of Curriculum Studies

The results of student perceptions regarding the existence of curriculum studies in improving skills in designing learning devices are presented in Table 2.

Table 2. Results of Student Response Questionnaire Recapitulation

Percentage (%)	Criteria	Number of Students	Percentage (%)
81.25 < score ≤ 100	Very good	15	60
62.50 < score ≤ 81.25	Good	10	40
43.75 < score ≤ 62.50	Enough	-	-
25.00 ≤ score ≤ 43.75	Not enough	-	-

Table 2 shows that 60% of students (15) gave excellent responses and 40% (10) gave good responses, indicating that the curriculum study significantly impacted learning device design skills. The average percentage of student responses to the curriculum study was 82.63%, with an outstanding category. The findings of this study are that there are curriculum studies that can improve students' understanding of the importance of designing learning materials that align with curriculum standards, their confidence in designing learning materials, and their knowledge of the structure of Prosem, ATP, and teaching modules that are appropriate and systematic to the curriculum. Students can learn theoretically and in the field through observation and direct practice, designing these learning materials (Erika, 2025). Therefore, curriculum studies effectively improve students' skills in designing learning materials. They must be implemented more widely so prospective teacher students can prepare themselves and have good teaching skills to become quality teachers. Quality teachers can realize learning according to national goals and improve Indonesia's education quality. This reflects the actualization of the fourth SDGs, namely, quality education. By improving the skills of prospective teacher students in designing learning materials, they will be better prepared to become professional educators capable of creating a quality education in schools (Saputri, 2023). According to Ariani's research (2024), in achieving SDG 4: Quality Education, educators must have skills in designing learning tools that meet national standards and student needs to impact improving the quality of education directly.

4. CONCLUSION

Based on the research that has been conducted, it can be concluded that curriculum studies can improve the skills of prospective teachers in developing learning materials. The results of the improvement in the skills of prospective teachers in preparing the semester program (prosem), ATP, and teaching modules, namely by 32%, 28%, and 21%. Students'

perceptions of implementing curriculum studies reached 82.63%, categorized as very good. Curriculum studies can provide prospective teacher students with theoretical and practical experience designing learning materials to improve and achieve quality education (SDGs 4).

This study recommends implementing curriculum study policies in higher education to equip pre-service teacher students with the skills to develop learning materials per curriculum standards by improving the quality of education. Furthermore, recommendations for future research include expanding the sample size and using experimental research methods to in-depth test the effectiveness of the curriculum study.

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