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Empowering Future Educators through Team-Based Projects: A Pathway to SDG 4 in Teaching Material Development

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Abstract: Teaching materials are a cornerstone of effective learning, yet many educators struggle with designing resources that truly meet classroom needs. This study investigates the capabilities of prospective biology teachers in developing teaching materials that are responsive to real educational challenges and student needs, facilitated through team-based project learning in the Teaching Material Development course. Using a descriptive-analytical method, the research analyzed student-created materials and accompanying reports. Results revealed that 44.44% of participants successfully produced printed materials, while 55.55% developed digital resources aligned with contextual problems. Although students generally demonstrated technical proficiency in formatting their products, many fell short in addressing pedagogical relevance and learner-centered design. These findings highlight a critical need to enhance teacher education by emphasizing the development of teaching materials that are not only visually appealing but also pedagogically sound and contextually grounded. To support the goals of Sustainable Development Goal 4 (SDG 4), teacher training programs must prioritize equipping future educators with the skills to create impactful, inclusive, and needs-based learning resources.

Keywords: development of teaching materials; prospective teacher; teaching materials; SDG 4; students' ability.

A. Introduction

The success of implementing learning is determined by several factors, including the support provided by the teaching materials used by the teacher. Teaching materials are learning tools used by teachers that contain a set of learning materials arranged systematically using a specific learning method and are often accompanied by learning media to convey information (Asrial et al., 2021; Fedotova, 2023). The use of teaching materials is essential for learning, helping students achieve learning goals that align with curriculum demands (Putri et al., 2019; Ridha et al., 2020; Wanti & Chastanti,

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2023). With the presence of teaching materials, students can learn independently, reducing the teacher's dominant role (Hasibuan et al., 2019; Kartikasari, 2021; Sembiring et al., 2021). The presence of teaching materials supports the implementation of student-centered learning as demanded by the current curriculum (Aprima & Sari, 2022; Ramadani & Desyandri, 2022).

When developing teaching materials, teachers must pay attention to several key factors. Because teaching materials aim to help students achieve their learning goals, they must be developed to overcome students' learning problems (Ilfiana et al., 2021; Usmeldi & Amini, 2022). Teaching materials must also be developed based on student needs (Chen et al., 2020; Hasanah et al., 2022; Wati et al., 2020). Apart from complying with curriculum demands (Astiti et al., 2021; Choppin et al., 2022; Dewi & Suniasih, 2023), it must also be developed in accordance with the characteristics of students (Afrina et al., 2021; El-Sabagh, 2021).

In the process of developing teaching materials, teachers are also required to master the skills in developing teaching materials (Cahyaningsih & Nahdi, 2020; Kartini et al., 2020; Khasanah et al., 2019; Ridha et al., 2020). To keep up with the times, teachers not only have to be skilled in developing printed teaching materials but also digital-based teaching materials (Artacho et al., 2020; Falloon, 2020; Guillén-Gámez et al., 2021; Rasmitadila et al., 2020; Starkey, 2020). In line with the function of teaching materials in supporting the realization of student-centered learning, one of the competencies that teachers must possess is mastery of information technology. (Rivalina & Siahaan, 2020; Zhang et al., 2021).

A common issue in schools is that many teachers struggle to develop their own teaching materials. Teachers more often use textbooks from publishers (Mitha Frilia et al., 2020; Wahyudi et al., 2022; Zakiyah et al., 2022). Many teachers also rely solely on using videos from YouTube as teaching materials without creating their own videos (Sarkity et al., 2021). One of the reasons is the lack of skills of teachers in developing teaching materials (Patimah et al., 2021; Saadi et al., 2023; Supriatno et al., 2023). Apart from that, lack of mastery of technology (Aryzona et al., 2023; Hamzah et al., 2021; Istiqomah et al., 2022; Jiménez-Hernández et al., 2020; Muzaini, 2023; Susanto et al., 2020) and lack of time to develop teaching materials (Arief et al., 2021; Lubis et al., 2022; Sanasintani, 2022; Sarkity et al., 2021) are also a problems for teachers in developing teaching materials. For this reason, teachers are often encouraged to

participate in training to enhance their skills in developing teaching materials (Anwar et al., 2023; Haryandi et al., 2023; Supriatno et al., 2023).

A prospective teacher must also have the ability to develop teaching materials. This ability is crucial so that teachers can facilitate students' learning with teaching materials that are tailored to their needs and help students overcome learning difficulties (Yudistira et al., 2021). Because teachers are the ones who best understand the characteristics and needs of their students, they are the ones who must develop teaching materials to create student-centered learning (Tiningrum et al., 2025; Wulandari et al., 2023). At universities, these skills are provided to prospective teachers through lectures, such as in the Teaching Material Development Course. This course is typically found in study programs that produce prospective teachers because skills in developing teaching materials are essential for prospective teachers. For example, in the Biology Education study program, prospective teacher students are equipped with the skills to develop biology teaching materials, so that when they become teachers, students will no longer encounter various problems in developing biology and science teaching materials.

One of the forms of lecture implementation that aims to instill students' ability in developing teaching materials is a team-based project. Implementing team-based projects offers various benefits, including enhancing students' understanding of lecture topics and improving learning outcomes (Joshi et al., 2020; Peters et al., 2020; Santyasa et al., 2020). Students can also enhance their collaboration skills in finding solutions to problems (Nurpratiwi et al., 2022; Wright & Boggs, 2002). Implementing team-based projects also enhances students' creative thinking skills (Andini & Rusmini, 2022; Mursid et al., 2022; Sumarni & Kadarwati, 2020; Yustina et al., 2020) and students' critical thinking skills (Adekantari et al., 2020; Andini & Rusmini, 2022; Sumarni & Kadarwati, 2020).

In contrast to previous studies that tend to emphasize teachers' abilities in developing teaching materials in general or in the context of training (Asih et al., 2023; Fernando et al., 2021), this study offers novelty by examining the abilities of prospective biology teacher students in developing teaching materials based on real problems found in schools and the needs of students. Through the application of a team-based project approach, this study provides students with an opportunity to develop critical, creative, and collaborative thinking skills in designing teaching materials that are contextual and tailored to their individual characteristics. In

addition, this study also contributes to filling the gap in previous studies by using document analysis of student project results as the primary data, which authentically reflects their abilities in designing teaching materials that are responsive to the curriculum and student-centered learning practices. Therefore, the results of this study are expected to contribute to the development of learning models in higher education that are more effective in equipping prospective teachers with the professional competencies needed in the field of education. For this reason, this study aims to determine the ability of prospective biology teacher students to develop teaching materials based on problems encountered in the school field and the need for such materials through the implementation of team-based projects in the Teaching Material Development course.

Due to the problems found in the school field where there are still many teachers who are not able to develop their teaching materials and tend to use existing teaching materials that are not necessarily by the characteristics and needs of their students, this study was conducted on prospective teacher students who are agents of change in the world of education in the future. The study focused on how students' abilities are developed through the implementation of team-based projects, based on the analysis of student project document results. For this reason, this study aims to determine the abilities of prospective biology teacher students in developing teaching materials based on problems encountered in the school field and the needs for such materials.

This effort is in line with the objectives of Sustainable Development Goal (SDG) 4, which aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. By equipping future teachers with the competencies to create teaching materials based on contextual school problems and student needs, this study contributes to advancing educational quality and inclusiveness in Indonesia.

B. Method

This research is a descriptive-analytical study, namely a research that aims to provide an overview of the object being studied (Sugiyono, 2019). In this study, the object to be described is the skills of prospective teachers in developing teaching materials. The data collection technique used in this study is the documentation technique. The documents analyzed in this study are products of the Teaching Material Development course project, carried out as a Team-Based Project in the Odd Semester

of the 2022-2023 Academic Year in the Biology Education Study Program, which was attended by 39 students in their 3rd year of lectures. The documents analyzed were in the form of papers and teaching material. Students were divided into 9 groups and assigned projects to conduct research at schools, exploring problems with the use of teaching materials and the need for new materials. They then reported their findings in the form of research papers. The problems and needs of teaching materials identified by each group in the research carried out served as the basis for developing both printed and non-printed teaching materials. The entire Project was completed in 8 weeks, with 2 weeks allocated to research on teaching materials and the presentation of papers, 3 weeks dedicated to developing printed teaching materials, and 3 weeks devoted to developing non-printed teaching materials. During the development process, the supervising lecturer provided input and feedback prior to the final deadline for submitting the project. Data from the analysis of the product of Teaching Material Development course are presented descriptively by:

1. Describe the problems and needs for teaching materials found by each group in research on teaching materials in schools through an analysis of a research paper.
2. Describe the teaching materials developed by each group and carry out a suitability analysis between the teaching materials and the problems and needs for teaching materials. This analysis stage involves examining teaching material documents developed by each group, including both printed and non-printed materials. The indicators and assessment categories are outlined in the assessment rubric presented in Table 1.

Table 1. Rubric for assessing the suitability of teaching materials

No.	Indicators	Trigger Questions	Suitability Criteria	
			Appropriate	Inappropriate
1	Relevance to the problem	Are the developed teaching materials effective in overcoming the problems students experience in learning?	The developed teaching materials overcome the problems faced by students	The developed teaching materials do not overcome the problems faced by students
2	Relevance to student needs	Are the teaching materials developed by the students' needs?	The teaching materials developed are by the students' needs	The teaching materials developed are not by the students' needs

This study does not merely focus on evaluating students' technical abilities in developing teaching materials but also aligns with global educational goals. The implementation of team-based projects and the contextual analysis of school-based challenges are intended to foster pedagogical competence among future educators.

This methodological design reflects the aims of Sustainable Development Goal 4 (SDG 4)—specifically Target 4.c, which calls for a substantial increase in the supply of qualified teachers through improved teacher education . By engaging prospective teachers in real-world educational contexts and encouraging them to design relevant and inclusive instructional materials, this study contributes to the broader agenda of ensuring equitable, inclusive, and quality education for all.

C. Result and Discussion

The development of teaching materials remains a central challenge in achieving effective, relevant, and inclusive learning, especially in diverse educational contexts. This study explores three key aspects: the problems and needs related to the use of teaching materials in schools, the extent to which student-developed materials align with those identified needs, and how these efforts contribute to achieving Sustainable Development Goal 4 (Quality Education). Through field-based research and team-based projects, prospective teachers engaged in practical material development that not only addresses local learning challenges but also reflects a broader commitment to equitable and quality education.

1. The Gaps Between Teaching Material Design and Classroom Needs

This description was obtained through the analysis of papers resulting from research on teaching materials conducted by students in groups. The research locations carried out by each group were also varied and spread across several schools in districts and cities in the Riau Islands Province, where three groups conducted research in Tanjungpinang City, 1 group conducted research in Bintan Regency, two groups conducted research in Batam City, 1 group conducted research research in Karimun Regency, and two groups conducted research in Lingga Regency. The problems related to teaching materials and the need for teaching materials discovered by each group through their research are summarized in Table 2.

Table 2. Problems related to teaching materials and the needs for teaching materials based on research

Group	Teaching Material Problems and the need for teaching materials	
1	The Problems	The teaching materials that are often used include student worksheets with learning forms, such as article or video analysis. The use of student worksheets and this form of learning makes students bored. Apart from that, non-print teaching materials, such as videos, must be accessed using a personal data package with a large quota, as there is no Wi-Fi available at the school.
	The Needs	Students need teaching materials that are both visually appealing and effective in learning. If the teaching materials are non-printed, students

		need teaching materials that can be accessed offline or online teaching materials that do not require a large amount of internet quota.
2	The Problems	Teachers have developed several teaching materials, such as modules and student worksheets, but only for a few of them. Consequently, there are several materials whose learning is not supported by appropriate teaching materials.
	The Needs	Students prefer teaching materials that stimulate their learning, such as hands-on learning activities in the field, where they can observe objects and engage in other interactive experiences.
3	The Problems	Learning is facilitated through teaching materials equipped with videos that are linked directly to YouTube. Although teaching materials are provided to students, they rarely review their learning at home.
	The Needs	Students need interesting teaching materials so that when they are at home, they remain interested in revisiting the learning.
4	The Problems	Teachers have developed teaching materials, but the learning presented is still not contextual, so students continue to struggle with relating the material to everyday life.
	The Needs	Students need interesting teaching materials that can help them relate the material to everyday life.
5	The Problems	Learning is carried out using student worksheets and textbooks obtained through publishers. With so many assignments, teachers often find it difficult and lack the time to develop effective teaching materials. One of the ineffectivenesses of teaching materials is shown by the learning outcomes in cell material, where, on average, the majority of students do not reach the minimum completeness criteria.
	The Needs	Students need teaching materials that can stimulate student activity in learning, rather than just focusing on reading textbooks and completing questions on student worksheets.
6	The Problems	Teachers have utilized modules and LKPD in their learning, but specific problems were identified with the topic of metabolism due to the extensive coverage of the material and the difficulty in finding supporting references for creating teaching materials.
	The Needs	Students need appropriate teaching materials to learn about metabolism because their learning is not yet supported by suitable instructional materials.
7	The Problems	With the location of the school in the disadvantaged, frontier and outermost area which is not supported by adequate electricity facilities and coupled with the economic conditions of the average student which are less supportive, the teaching materials used are limited to printed teaching materials such as textbooks, the use of which makes students easily bored.
	The Needs	Teaching materials are needed that can stimulate student activity, especially in disadvantaged, frontier, and outermost areas, which have their own limitations, and enable students to achieve learning goals similar to those in urban areas.
8	The Problems	Even though teachers have developed teaching materials, such as modules and student worksheets, their implementation often results in learning that takes longer and fails to stimulate student activity, as students tend to be passive in their learning. Apart from that, because there is no laboratory, practical work can only be done on certain materials, such as germination.
	The Needs	Students need teaching materials whose use can stimulate student activity and make learning more effective and efficient. Apart from that, students also need teaching materials that can provide alternative practical activities without the need for a laboratory.
9	The Problems	The teaching materials that teachers often use are textbooks and videos. The frequent use of these teaching materials can make students bored because the videos used mostly come from YouTube, which are not necessarily adapted to the characteristics and needs of students.

The Needs	Students need teaching materials that are creatively and interestingly designed, which can increase student motivation in learning and stimulate their activity.

In Table 2, it can be seen that most of the problems faced by schools regarding teaching materials are similar, namely that the teaching materials used cannot stimulate student activity. Several groups also received information that teachers had developed their teaching materials, which were dominated by the use of modules and student worksheets. However, when teaching materials were applied, they were not effective and efficient because they made the learning duration longer, so that the learning objectives were not achieved within the planned period. The use of teaching materials should make learning more effective and efficient (Boari et al., 2023; Kraugusteeliana et al., 2023).

Regarding the need for teaching materials, prospective teachers should also ask specifically what kind of teaching materials the students need. Almost all groups collect data primarily through interviews with subject teachers, without directly gathering information from students. In analyzing the need for teaching materials, the information obtained will be better if it is obtained through subject teachers and from students (Mardiana et al., 2019; Septiani & Wardhani, 2022; Trinaldi et al., 2022) because no matter how the teaching materials are developed by a teacher, they will be used by their students. Teaching materials are developed by teachers to help students achieve their learning goals (Anggriani et al., 2022).

In the need for teaching materials, prospective teachers should also include an analysis of student characteristics. Teaching materials developed according to the characteristics of students will support the achievement of learning objectives tailored to their learning methods (As-Syiba et al., 2023; Azizah & Syamsurizal, 2022). One of the teaching materials needed by students is adapted to their learning style or the most effective learning method they use to achieve their learning goals.

2. The Fit Between Teaching Materials and Real Classroom Demands

Based on the problems and needs identified by prospective teachers through research on teaching materials at the school, groups of prospective teachers develop appropriate teaching materials to address the issues found and meet the school's need for teaching materials. The teaching materials developed by each group consist of two types of teaching materials, namely printed teaching materials and non-printed teaching materials. A description of the printed teaching materials developed by each

group as well as an analysis of their suitability to the problems and needs of teaching materials is given in Table 3.

Table 3. Analysis of the suitability of printed teaching materials to problems and needs

Group	Teaching materials	Conformity Level	Explanation
1	Module	Appropriate	The module developed has complete content. This module was also developed with an attractive appearance and is accompanied by interesting pictures, which can motivate students to participate in learning and reinforce it at home.
2	Module	Appropriate	The module contains learning activities that can stimulate student engagement, as it includes practicums and observation activities.
3	Handout	Inappropriate	This handout has a similar appearance to other handouts, with no updates. Teaching materials that only contain a summary of the material without any activities that stimulate student engagement are unable to encourage students to reinforce their learning at home.
4	Student Worksheets	Appropriate	The student worksheets are on the material of classification of living things. The activities contained in these student worksheets are contextual because students can connect learning topics with the surrounding environment, such as living creatures.
5	Module	Appropriate	This module has complete and appropriate content. The learning activities presented can also stimulate students' activity in learning. The material chosen is also adapted to the topic of experiencing problems, namely Cell material.
6	Module	Inappropriate	The research results show that teachers have used Modules and student worksheets; however, on the topic of metabolism, teachers have difficulty creating appropriate teaching materials. The module created by Group 6 was on the topic of Motion Systems. The chosen topic is not suitable for the problem, and the type of teaching material on that topic could have been created by the subject teacher at the school.
7	Student worksheets	Inappropriate	The student worksheets are on the topic of metabolism. Learning activities contained in teaching materials require learning to be carried out in the laboratory or using practical equipment available there. Considering that research was conducted at schools in disadvantaged, frontier, and outermost areas, and the results showed that the schools had many shortcomings, learning activities would be better if carried out using simple equipment.
8	Student worksheets	Inappropriate	These student worksheets are presented in an unattractive appearance and do not solve the problems found. The research results indicate that schools require teaching materials that offer alternative practical activities, as they lack laboratory facilities. In these student worksheets, germination learning activities are still presented, which is not a problem at the school.
9	Student worksheets	Inappropriate	The learning activities contained in these student worksheets are still focused on activities that require students to read more literature in order to answer each question given. Student worksheets do not contain learning activities that can engage students, so they do not overcome the identified problems.

In Table 3, it can be seen that the types of printed teaching materials developed by each group are dominated by modules created by four groups and student worksheets, which are also created by four groups. Apart from these two teaching materials, another group developed a handout. The results of the analysis of the suitability of teaching materials to the identified problems showed that only 4 groups (44.4%) were able to develop teaching materials that addressed the problems and needs. It is similar to the description of the issues that exist in the school field, where many teachers still struggle to develop teaching materials that align with the problems and needs of students (Difinubun et al., 2022; Rafiudin et al., 2021). The reasons are pretty diverse, ranging from lack of skills (Noorhapizah et al., 2023; Sarkity et al., 2021), lack of time, to the tendency to use ready-made teaching materials made by others (Sari & Atmojo, 2021; Talitha et al., 2023), without paying attention to whether the teaching materials are by the needs or problems of students or not. In developing teaching materials, it is crucial to consider several key aspects, including the problems encountered in learning related to its use (Chen et al., 2020; Hasanah et al., 2022; Ulandari et al., 2019; Wati et al., 2020). Effective teaching materials must also be tailored to meet the needs and characteristics of individual students (Afrina et al., 2021; El-Sabagh, 2021). This aligns with the new learning paradigm, as outlined in the independent curriculum, which emphasizes student-centered learning by attending to students' needs and characteristics (Irvani et al., 2023; Prabawati et al., 2023).

In addition to developing printed teaching materials, each group also creates non-printed teaching materials. Non-printed teaching materials should also be developed based on problems found and should be able to meet students' needs. The results of the analysis of the suitability of non-printed teaching materials developed by each group to problems and needs are given in Table 4.

Table 4. Analysis of the suitability of non-printed teaching materials to problems and needs

Group	Teaching materials	Conformity Level	Explanation
1	Learning website	Appropriate	This teaching material has an attractive appearance, and the activities contained within are also interesting, stimulating student engagement. This teaching material is also what students need, namely teaching materials that do not require a large quota to access. The quota required to access this teaching material is lower than that for video teaching materials accessed online.
2	E-Module	Appropriate	This electronic module contains learning activities that can stimulate student activity. In terms of components, this electronic module is well-packaged and complete. This module can also accommodate the diverse learning styles of students.

3	Podcast	Appropriate	Regarding the problem, it was found that students felt bored with the use of videos that only explained the material, as they did not engage them. Students need interesting teaching materials that they can repeat at home. This podcast is presented in an interesting way, discussing the learning material through simple and engaging conversations that can be replayed by students, considering that podcasts are also widely enjoyed by teenagers.
4	Video	Appropriate	This teaching material is in response to the challenges encountered in learning, specifically the difficulty of developing contextual teaching materials. The material presented in this video addresses environmental pollution, a topic closely related to students' daily lives, encouraging them to be more mindful of activities that can cause environmental damage.
5	E-Module	Appropriate	This teaching material was developed based on identified needs and problem-solving approaches. The cell material was chosen because it addresses existing problems, and this teaching material is also presented in an attractive flipbook format, equipped with audiovisual elements and activities that support student-centered learning.
6	E-Module	Inappropriate	In terms of components, this teaching material can be considered a complete module; however, problems were found in schools with the implementation of the learning material. This module is made for digestive system material, not the metabolism material required by schools.
7	Video	Inappropriate	Considering that these teaching materials will be used in disadvantaged, frontier, and outermost areas, video teaching materials will be more difficult to use due to inadequate electrical facilities. Even if these teaching materials can be used with a single device owned by the teacher, allowing enough teachers to display them, they are unable to support student activity.
8	Video	Inappropriate	This teaching material primarily focuses on explaining the material, making students passive because they only listen to the explanation. The video also presents germination material again, which is not the type of material that typically experiences problems found in schools.
9	Interactive Power Point	Inappropriate	This teaching material does not address the problems found in schools because, just like videos often used by teachers in learning, this interactive PowerPoint also has content that focuses on explaining the material without any learning activities that can stimulate student engagement.

Table 4 shows that as many as 5 groups (55.55%) were able to make non-printed teaching materials that suited their problems and needs. The non-print teaching materials developed were primarily electronic module teaching materials created by three groups and videos produced by two groups. Other teaching materials developed include interactive PowerPoint presentations, podcast teaching materials, and a learning website. Overall, students have actually been able to develop teaching materials well. The teaching materials created are also presented creatively by utilizing the advantages of various technologies. Just like printed teaching materials, some non-

printed teaching materials are not suitable because the teaching materials developed do not suit the problems and needs. It is essential for teachers to tailor the teaching materials developed to address the specific problems and needs, and even the materials should be adapted to the individual characteristics of students. The characteristics of students will determine the type of teaching materials suitable for use in a lesson (Lisgianto & Mulyatna, 2021; Nurmala & Susanti, 2019).

In addition to teaching materials that must be developed to meet the needs and characteristics of students, the Teaching Material Development course must also be carried out by paying attention to specific materials where students encounter learning difficulties. The study's results showed that only a few groups specifically analyzed materials that caused difficulties for learners. For example, Group 5 developed teaching materials on cell materials due to problems found in these materials. Although Group 6 found problems in facilitating students with teaching materials on metabolism, the teaching materials developed by the students were actually teaching materials on other subjects. This indicates that prospective teachers often focus solely on the visual aspect of developing teaching materials, despite the need for content that addresses students' learning difficulties (Awalludin et al., 2022; Sari & Avianty, 2023). When analyzing problems related to teaching materials, it is essential to identify the specific materials that students encounter difficulties with, so that the solutions to these materials can address the issues within them (Nisak, 2021). Despite the discrepancy between the developed teaching materials and the identified problems and needs, the teaching materials developed by students demonstrate that students possess good skills in using technology. It is very important for teachers to have because it supports the implementation of student-centered learning (Rivalina & Siahaan, 2020; Zhang et al., 2021). The results of this study highlight a challenge for higher education in preparing teachers who are skilled in developing teaching materials that address problems and meet students' learning needs. In this case, the implementation of the Teaching Material Development course must be carried out by focusing on developing aspects of teacher skills in creating teaching materials, rather than solely focusing on the theory of how teaching materials should be developed.

3. The Contribution of Research Results to the Realization of SDG 4

The implementation of team-based project learning in the Teaching Material Development course demonstrates a tangible contribution to advancing Sustainable Development Goal (SDG) 4, which advocates for inclusive, equitable, and quality

education for all. Through this pedagogical approach, prospective teachers are actively engaged in designing both printed and digital teaching materials that address authentic educational challenges and learner needs. This not only cultivates essential pedagogical competencies but also promotes innovation and contextual sensitivity within teacher preparation programs (Prahani et al., 2025).

This approach directly supports Target 4.1 (ensuring free and quality primary and secondary education) and Target 4.c (increasing the supply of qualified teachers) by preparing future educators to develop responsive, inclusive, and locally relevant learning resources. This is particularly significant in regions with limited infrastructure, where disparities in educational access and quality remain a persistent challenge (Silo & Ketlhoilwe, 2020).

Furthermore, the integration of diverse instructional formats, such as podcasts and offline-accessible digital content, enhances educational inclusivity by addressing the needs of learners facing economic hardships or lacking stable internet connectivity. These inclusive strategies align with the principles of education for sustainable development (ESD), which emphasize participatory, learner-centered approaches that are socially and contextually grounded (Lozano et al., 2022).

In sum, the findings underscore the strategic role of higher education institutions in advancing the 2030 education agenda by embedding sustainability-oriented innovation within teacher training and curriculum design. The research highlights persistent gaps between the design of teaching materials and the actual needs encountered in classrooms, signaling the urgency for more responsive and student-centered development processes. Moreover, the study reveals that only a portion of the teaching materials produced by prospective teachers were truly aligned with the identified instructional problems and learner needs, both in printed and digital forms. These results emphasize the necessity of equipping future educators with analytical and design competencies that are context-sensitive and rooted in real educational demands. From the lens of Sustainable Development Goal 4 (Quality Education), such alignment not only fosters inclusive and equitable learning but also strengthens the capacity of teacher education programs to contribute meaningfully to long-term educational reform and global sustainability targets.

D. Conclusion

Based on the research conducted, the ability of prospective teachers to develop both printed and digital teaching materials based on classroom problems and student needs cannot yet be considered fully adequate. Only 44.44% of prospective teachers successfully developed printed teaching materials that were aligned with specific problems and needs, while 55.55% managed to create appropriate digital materials. In terms of technical skills and the completeness of the teaching materials, some prospective biology teachers demonstrated competence. However, effective teaching materials should be designed to directly address the actual problems and learning needs within the specific educational context. A notable shortcoming in the prospective teachers' analysis lies in their failure to consider student characteristics and specific learning needs, as they did not gather data directly from students. Instead, their needs analysis was solely based on interviews with teachers.

Therefore, it is essential for prospective teachers to understand, from the outset, the importance of developing teaching materials that are tailored to students' needs rather than merely reflecting teachers' preferences. Such alignment is crucial to helping students achieve their learning objectives. Moreover, the Teaching Material Development course should emphasize the development of teaching materials that consider all relevant aspects: pedagogical, contextual, and technical. Prospective biology teachers must be trained to focus not only on the visual design of materials but also on their substantive content, particularly in addressing instructional challenges. Through this course, it is expected that students will be able to produce high-quality teaching materials that meet the criteria of effective and pedagogically sound educational resources.

In line with the global agenda of Sustainable Development Goals (SDG 4), the ability of prospective teachers to design teaching materials that are relevant, inclusive, and responsive to student needs is a key step toward ensuring quality education. This study illustrates how higher education, through courses like Teaching Material Development, plays a strategic role in preparing future educators who are not only technically competent but also aware of their contribution to achieving equitable learning opportunities for all students, including those in marginalized or underserved communities.

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