

Toward innovative learning: Needs analysis of TPACK-based digital modules in primary teacher education

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Abstract: This study investigates the development of digital modules based on the Technological Pedagogical Content Knowledge (TPACK) framework for the ICT-Based Media and Elementary Learning Resources course in the Elementary School Teacher Education (PGSD) Study Program at the University of Muhammadiyah Makassar. The research aims to address the limited availability of systematically developed ICT-based teaching materials and the absence of TPACK-integrated digital modules, which have contributed to low student engagement and less optimal creative thinking skills. Using observation and questionnaires with 83 seventh-semester students, the study identifies student needs, learning characteristics, curriculum gaps, material suitability, and readiness of the technology infrastructure. Findings indicate that 59% of students experience difficulties without digital modules, and 57.8% explicitly require them. The analysis reveals that kinesthetic learning styles dominate, highlighting the importance of interactive and contextual learning media. Curriculum evaluation shows adequate alignment with graduate profiles but limited integration of TPACK and 21st-century competencies. Technology analysis confirms that the SPADA LMS provides a solid foundation for digital learning, though digital material availability remains limited. The results conclude that TPACK-based digital modules are urgently needed, feasible, and effective in enhancing student engagement and creative thinking, thereby supporting the demands of 21st-century education.

Keywords: Digital modules, Innovative learning, Needs analysis, Primary teacher education (PGSD), TPACK.

1. Introduction

The integration of technology in learning can be achieved by developing digital modules based on TPACK (Technology, Pedagogy, and Content Knowledge). This framework combines technology, pedagogy, and content knowledge, as introduced by Koehler, et al. [1]. TPACK provides a comprehensive framework that aligns technology integration with pedagogical strategies and content-specific knowledge [2-4]. One teaching module that facilitates students in developing high-level thinking skills and answering the challenges of 21st-century learning is currently the TPACK-integrated digital module [5, 6]. The implementation of TPACK aligns with the demands of the 21st century, which utilizes technology in learning [7, 8].

Digital modules are learning resources systematically designed based on a specific curriculum and time units presented using computers or devices [9, 10]. These modules can be easily accessed, help students learn independently, and provide complete and up-to-date teaching materials [11, 12]. A sound digital module must be packaged attractively according to the subject and equipped with text, images, illustrations, videos, and audio, as well as examples of questions or contextual cases that are adequate to achieve learning objectives [13-15].

The Elementary School Teacher Education Study Program organizes education based on the fundamental principles developed in the KKNI and is oriented towards Higher Order Thinking Skills in the learning process. Creative thinking skills are one part of higher-order thinking skills in the cognitive realm [16, 17]. This pattern must be a construction in learning, and students as subjects must practice high-level thinking and develop creative habits. Therefore, creative thinking skills (Creative Thinking) are critical to be instilled in students, especially PGSD students who are prospective elementary school teachers [18]. These skills are essential to help them adapt to a competitive future society, which demands 21st-century competencies beyond basic literacy and numeracy [19, 20].

Based on the results of observations made in the Media and Learning Resources course for students in the Elementary School Teacher Education study program, problems related to using teaching modules were identified. The observations indicate that, in implementing Media and Learning Resources courses, technology, pedagogy, and content knowledge have not been effectively integrated [21, 22]. Additionally, based on interviews with lecturers, it was found that students have never been taught using TPACK-based digital modules. Students are only asked to create media and analyze problems in the learning environment [23]. This integration of technology, pedagogy, and content knowledge in practice has not been fully implemented in media and learning resources courses [24-26].

These learning activities significantly impact the lack of student engagement in learning, resulting in a less optimal ability to think creatively. This can be seen from the analysis of documents in media courses and learning resources for students of the 2018, 2019, and 2020 batches. The average learning outcome was 3.12 (on a 4.0 scale). Based on the needs analysis, several problems were found: (1) the lack of ICT-based teaching materials that have been developed systematically; (2) the absence of digital modules integrated explicitly with the TPACK framework [15]. The lack of initiative among lecturers in developing teaching modules is attributed to several factors, including low motivation, time constraints, and involvement in other academic activities such as research and community service [27, 28].

In the data analysis conducted on students in the Elementary School Teacher Education Study Program at the Faculty of Teacher Training and Education, it was found that students continued to have difficulty understanding the material. The student need level for digital modules reached 83.1% in the "urgently needed" category [29]. Therefore, a digital module is urgently needed to help students and lecturers during the lecture process. Students require digital teaching materials in the form of modules that can be used independently or with the assistance of a lecturer [30-32].

The challenges students face in understanding ICT-based Media and learning resources mark a critical starting point for this study. Students often struggle to access integrative and contextual teaching materials that effectively combine technology, pedagogy, and content [15]. At the same time, lecturers also face limitations in providing such resources. This situation drives the need for an in-depth analysis of the needs related to TPACK-based digital modules. The primary focus is to uncover the perceptions, expectations, and challenges encountered by both students and lecturers in technology-based learning environments [33, 34]. The results of this analysis are expected to serve as the foundation for designing digital modules that are not only academically relevant but also practical and innovative in supporting the teaching and learning process in the Elementary School Teacher Education Study Program [1, 2, 4].

2. Methodology Section

This research was conducted at the Elementary School Teacher Education Study Program (PGSD), Faculty of Teacher Training and Education, University of Muhammadiyah Makassar, located at Jalan Sultan Alauddin No. 259, Makassar. The research implementation time lasts from November 2024 to February 2025. The PGSD Study Program was chosen as the research location because the ICT-Based Elementary School Media and Learning Resources course is very relevant to the needs of students in developing competencies in the use of technology in learning. The research subjects consist of 7th-semester students from the 2024/2025 academic year who are enrolled in the course. PGSD students

are considered appropriate because they are prepared as classroom teachers who must master various subjects, so it is important to have the ability to design and utilize ICT-based learning media. In addition, the diversity of student backgrounds and the condition of the technology infrastructure available in this study program are important aspects to consider when analyzing the needs for developing digital modules. Research subjects and locations are selected with a purposeful sampling approach to ensure the suitability between the research context and the objectives.

In this study, observation is conducted to focus attention on specific objects and gather data relevant to learning activities. Observation was conducted directly at the Elementary School Teacher Education Study Program, FKIP Unismuh Makassar, to identify learning conditions and the availability of digital modules in ICT-based elementary media and Learning Resources courses. Additionally, observation aims to record student activity during the learning process to support research data needs. In addition to observation, another data collection technique used is questionnaires, which are indirect methods in which researchers do not interact directly with respondents. This questionnaire consists of several closed questions that lecturers and students must answer as respondents. The questionnaire's primary purpose is to measure the extent of the need for digital modules in the learning process. Additionally, the questionnaire was used to capture respondents' opinions on the level of practicality of the digital modules developed.

3. Results

The analysis stage is the initial stage for determining the situation in the field and identifying learning problems. It involves gathering data about the teaching modules that have been developed to determine whether they are needed and whether further development is required. The purpose of this study is to analyze the needs of TPACK-based digital modules in ICT-based media courses and elementary school learning resources for students at the Elementary School Teacher Education Study Program. Some of the analyses conducted by the researcher at this stage include a needs analysis, an analysis of student characteristics, a curriculum analysis, a material analysis, and a technology analysis.

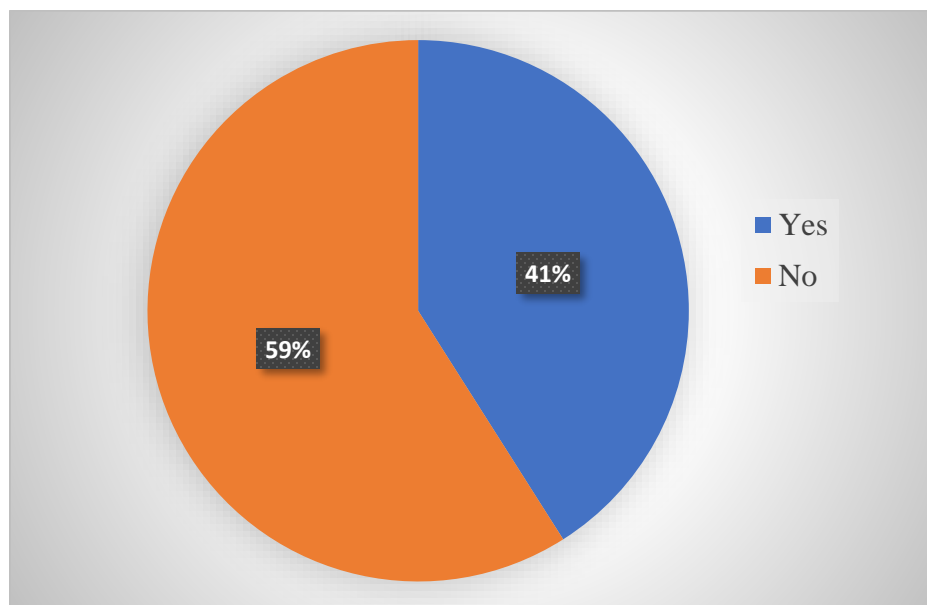


Figure 1.
Diagram of Types of Teaching Material Needs.

3.1. Needs Analysis

A needs analysis is conducted to determine the types of modules that lecturers and students require. The form of modules needed was obtained from the results of interviews with lecturers and students, as well as the distribution of questionnaires to students who had completed programming ICT-based elementary media and Learning Resources courses. Based on the results of interviews conducted with lecturers regarding the use of digital modules, it was found that, to date, students have not been taught the concept using TPACK-based digital modules. The results of student interviews revealed that the lack of interaction with lecturers and fellow students is one of the obstacles to learning. Therefore, the modules developed must be equipped with features that facilitate interaction between lecturers and students. Additionally, students suggested that learning modules be integrated with the latest technology. The results of the analysis suggest that the development of learning modules should consider various aspects, including relevant and easy-to-understand material content, an attractive and interactive design, and learning support features that cater to students' needs. The resulting digital modules are expected to enhance learning effectiveness and achieve the established learning goals.

Perception of students' needs for digital module teaching materials in learning ICT-based media courses and learning resources, as well as students' expectations for the digital modules to be used. A perception analysis was conducted with 83 students to gather information about classroom learning using modules. The results of the survey of students who experienced difficulties in lectures without using teaching modules revealed that 49 (59%) students reported difficulties, while 34 (41%) did not. Based on the analysis information, students who experience difficulties in lectures without using the teaching module can be seen in the following Figure 1:

The results of the questionnaire analysis of responses to information on the types of teaching materials needed for ICT-based Elementary Media and Learning Resources courses found that as many as 48 (57.8%) students needed digital modules, 5 (6%) students needed textbooks, 2 (2.4%) needed *handouts*, 1 (1.2%) needed Student Activity Sheets (MFIs), and 27 (32.5%) had other needs. Based on the analysis of information on the types of teaching materials needed, it can be seen in the figure as follows:

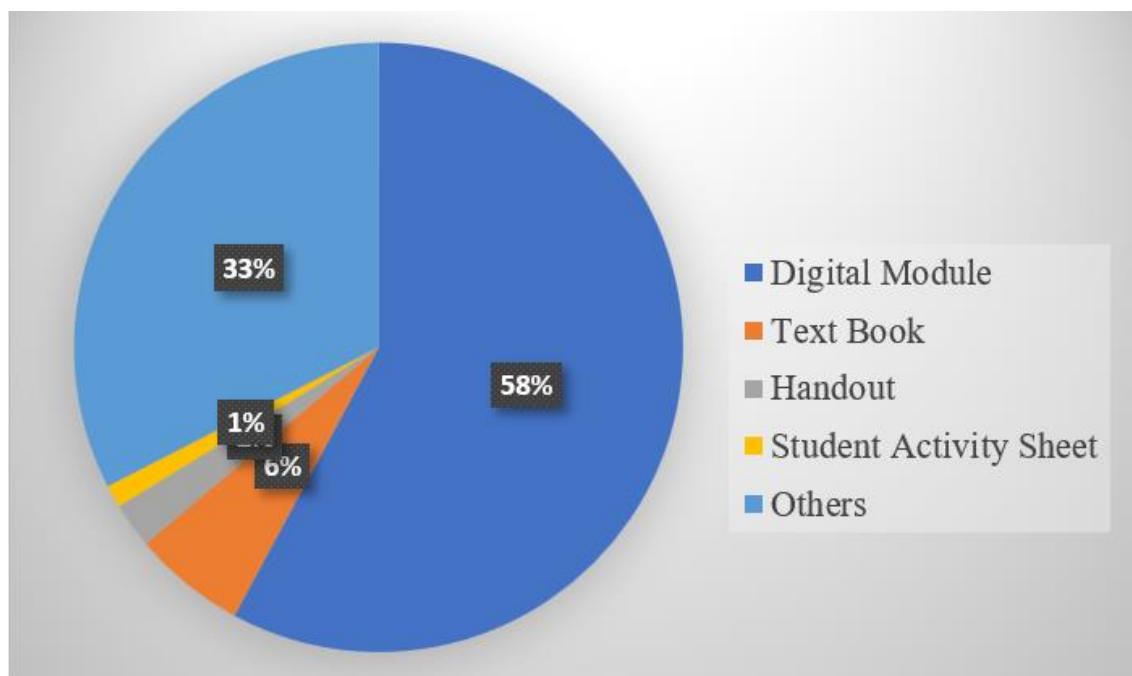


Figure 2.
Diagram of Types of Teaching Material Needs.

Based on the needs analysis conducted with students, it is evident that they require digital teaching materials for lecture activities in the form of digital modules. The results of student responses indicate that learning will be more effective with digital modules because the material is integrated with technology.

Furthermore, based on the results of observations made in the ICT-based Elementary School Media and Learning Resources course, students of the Elementary School Teacher Education study program found problems related to the use of digital-based modules. Based on the results of the needs analysis that has been carried out, several problems were found (1) the unavailability of teaching materials and ICT-based learning resources that have been developed systematically; (2) the absence of digital modules in the ICT-based Media and Learning Resources subjects which are specifically integrated with the framework of content mastery, pedagogical knowledge and technology utilization known as TPACK.

Based on the analysis of student needs in the ICT-based Elementary Media and Learning Resources course, it can be concluded that students generally prefer learning modules that are interactive, contextual, and easily accessible. The analysis reveals that students prefer modules tailored to their learning styles. Additionally, the flexibility aspect is a significant concern, as students expect to be able to access modules at any time and from anywhere through their devices.

The findings of the field-based needs analysis concluded that it is necessary to develop teaching materials in the form of digital modules that integrate technology, pedagogical content knowledge (PCK), and pedagogical content knowledge (PCK) with content, also known as TPACK. Based on this, the researcher developed a TPACK-based digital module for the ICT-based Elementary School Media and Learning Resources course, which can be accessed by students, allowing them to learn anywhere and at any time through digital devices to achieve the set learning goals.

3.2. Student Characteristics Analysis

Understanding student characteristics is a crucial foundation for designing a more effective learning process. One of the characteristics of students that needs to be understood is their learning style. One of the characteristics of learning related to absorbing, processing, and conveying information is the learning style. Learning styles are divided into three main types [35]: visual, auditory, and kinesthetic. Learning styles refer to an individual's preference for absorbing, processing, and retaining information, which directly impacts their learning outcomes.

Based on the results of the data obtained on the learning style of PGSD Semester 7 students, they have varying learning styles, with the frequency of learning styles as shown in Table 1 as follows:

Table 1.
Distribution of PGSD students' learning styles.

No.	Learning Style	Sum	Percentage
1	Kinesthetic	35	42.17%
2	Visual	27	32.53%
3	Auditorium	21	25.30%
Sum		83	100%

Based on the table above, the most dominant learning style is the kinesthetic learning style, accounting for 42.17% with 35 students out of a total of 83. The visual learning style accounts for 32.53%, with 27 students out of a total of 83. In comparison, the auditory learning style accounts for 25.30%, with 21 students.

There are 83 students out of a total of 83. The findings regarding student learning styles indicate that PGSD FKIP Unismuh Makassar students exhibit a varied learning style, with the kinesthetic learning style being the most dominant, followed by the visual learning style, and then the auditory learning style. For more details, you can see the percentage level of student learning style in the following diagram:

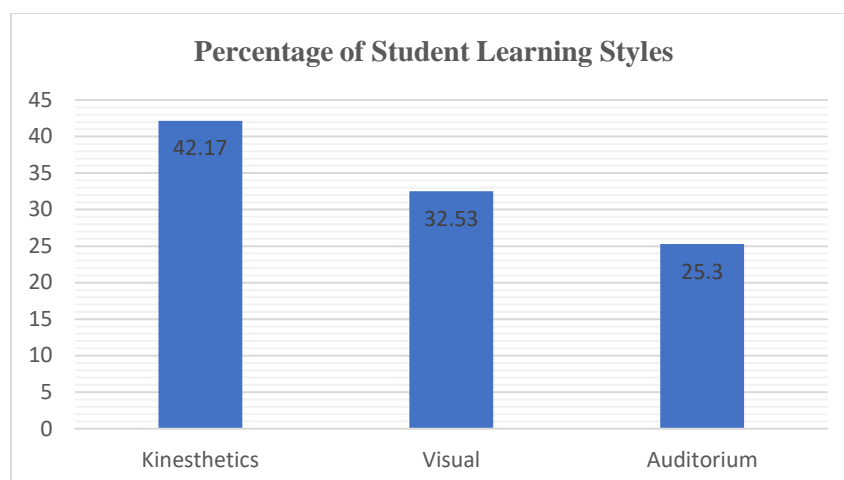


Figure 3.
Percentage Level of PGSD Student Learning Style Semester 7.

Recognizing the diverse learning styles of students is crucial in developing teaching materials that incorporate multiple modes of communication to convey messages effectively. One approach that can be taken is to develop a digital module using the TPACK framework. Digital modules developed with the TPACK principle can be a facility for students, namely, enabling them to choose their learning approach. This means that modules need to provide a learning path that can be personalized according to their abilities. The preparation of learning materials in the form of TPACK-based digital modules is expected to support students' success in achieving learning goals.

3.3. Curriculum Analysis

Based on the results of the curriculum analysis, six main aspects are the focus of the assessment. Specifically, it can be seen on the following:

Table 2.
Results of media course curriculum analysis and ICT-based learning resources.

No	Assessment Aspects	Percentage
1	CPMK compatibility with CPL	83%
2	Integration of CPMK, Sub-CPMK, and Materials	87%
3	Compatibility with the Graduate Profile	80%
4	Availability of Learning Resources	70%
5	TPACK Integration	78%
6	Conformity with 21st Century Competencies	79%
Overall Average		80%

The aspect of CPMK's conformity with CPL obtained a score of 83% in the good category, indicating that the learning outcomes of media courses and ICT-based learning resources align with those of study program graduates. Furthermore, the Integration aspect between CPMK, Sub-CPMK, and Materials shows that the integration between curriculum components in these aspects is in the good category with a score of 87%.

Conformity with the Graduate Profile achieved a score of 78%, indicating that the curriculum has been designed to support the formation of graduate competencies as set by the study program; however, it still lacks suitability. Meanwhile, the Availability of Learning Resources received the lowest score of 70%, indicating limitations in the provision of teaching materials or inadequate supporting media.

Regarding TPACK Integration, a score of 78% was achieved, indicating that the technological, pedagogical, and content aspects have begun to be integrated but still require strengthening in

materials, learning strategies, and evaluation. Conformity with 21st Century Competency obtained a score of 79%, indicating that the curriculum remains less responsive to the needs of 21st-century skills, such as critical thinking, creativity, collaboration, and digital literacy.

Overall, the average score for the evaluation aspect was 80%, indicating that the curriculum falls into the good category. However, there is room for improvement, particularly in aspects such as providing learning resources and integrating TPACK more effectively into the learning process. Thus, strengthening the aspect of learning technology, the relevance of materials to 21st-century skills, and the provision of learning resources are priorities in improving the curriculum to be more responsive in supporting the quality of learning and the achievement of graduate profiles. The following is a bar graph of the results of the curriculum analysis of ICT-based media courses and learning resources:

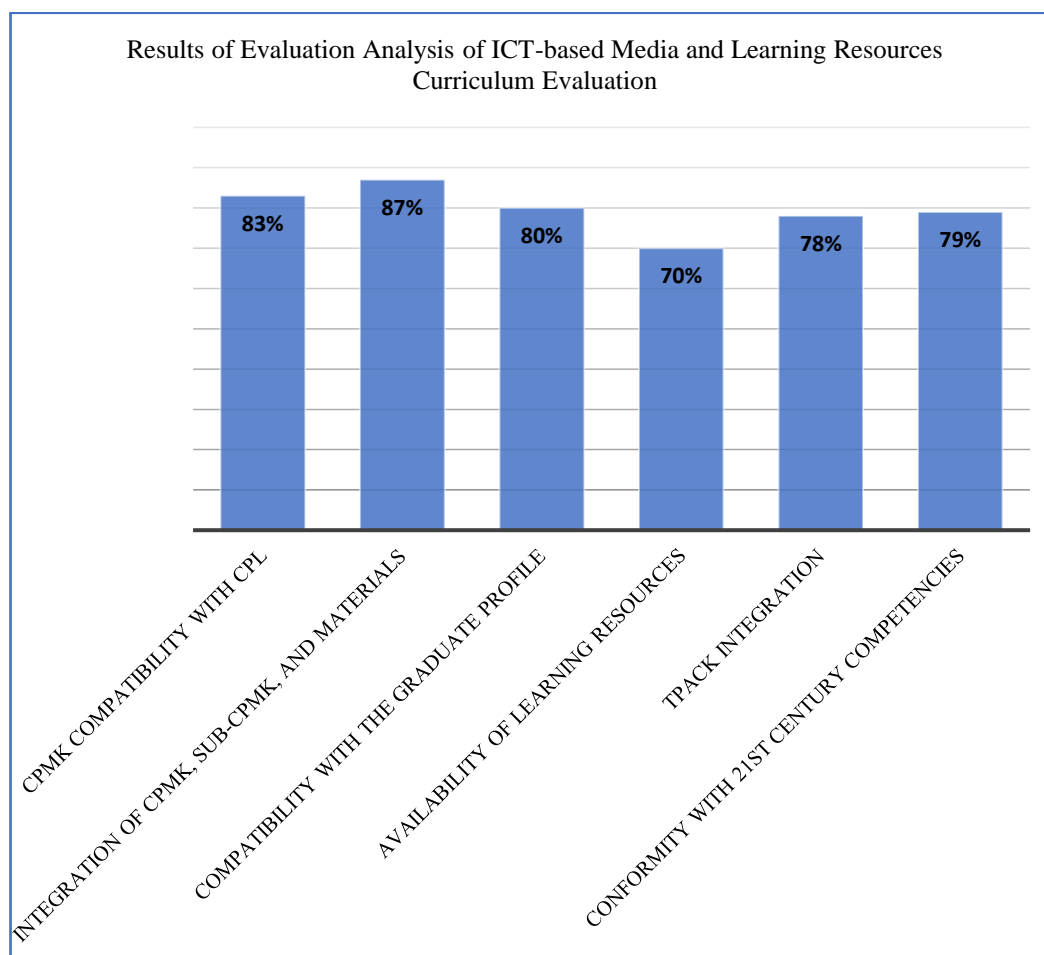


Figure 4.
Diagram of Curriculum Evaluation Analysis.

In curriculum analysis, the development of TPACK-based digital modules is a stage that ensures the material prepared is relevant to students' needs. In general, this course aims to equip prospective teachers and educators with the knowledge and skills necessary for designing, selecting, and utilizing learning media and resources effectively in the learning process. However, the results of the RPS (semester learning plan) analysis indicate that the integration between content, pedagogy, and technology has not been clearly outlined in terms of detailed learning outcomes.

The results of the curriculum evaluation indicate that courses continue to primarily focus on mastering software or applications (technological knowledge components). However, there is less emphasis on aligning technology with the teaching approach (pedagogical knowledge) and content knowledge. The curriculum tends to focus on teaching theory or mastery of the material, without inviting students to integrate content into an interactive digital format. The current course curriculum still requires adjustments to effectively encourage students to design, select, and utilize learning media and resources.

Curriculum analysis is one of the steps researchers take in developing digital modules for courses to identify learning outcomes that align with the KKNI in the Elementary School Teacher Education Study Program. So that learning outcomes can be adjusted to the needs of the community. As in the development of digital modules, it is adjusted to the implementation of the curriculum, namely the KKNI-based curriculum. In the development of the module, considering the National Standards for Higher Education (SN-DIKTI), which stipulate that each course must have clear learning outcomes, as specified by the Indonesian National Qualifications Framework (KKNI) [36].

The demands of the KKNI curriculum that have been determined are 4 (four) abilities that students, namely, must master; 1) Attitude (S); 2) Knowledge (P); 3) General Skills (KU); and 4) Special Skills (KU). These competencies are the basis for the development of study program learning outcomes, and course outcomes are formulated as follows:

3.3.1. Study Program Learning Outcomes

- S1 : Fearing God Almighty and being able to show a religious attitude
- S8 : Internalize academic values, norms, and ethics.
- S9 : Demonstrate responsibility for work in his/her area of expertise independently
- P4 : Master curriculum concepts, approaches, strategies, models, methods, techniques, teaching materials, media, and innovative learning resources as a classroom teacher in elementary school.
- KU1 : Able to apply logical, critical, systematic, and innovative thinking in the context of the development or implementation of science and technology that pays attention to and applies humanities values by their field of expertise;
- KU2 : Able to demonstrate independent, quality, and measurable performance
- KU3 : Able to examine the implications of the development or implementation of science and technology that pays attention to and applies humanities values by their expertise based on scientific rules, procedures and ethics in order to produce solutions, ideas, designs or art criticism, compile scientific descriptions of the results of their studies in the form of a thesis or final project report, and upload them on the university website;
- KK1 : Able to apply logical, critical, systematic, and innovative thinking in the context of the development or implementation of science and technology that pays attention to and applies humanities values in five areas of expertise

3.3.2. Course Learning Outcomes

The learning outcomes of ICT-based Media and Learning Resources courses:

- a) Students can understand the concept of Information Technology and Communication in 21st-century learning
- b) Students can understand and compare media, multimedia, and learning resources theoretically and practically in learning
- c) Students can understand the concept of Interactive Learning Media and Multimedia effectively
- d) Students can understand basic concepts and technology in digital-based learning
- e) Students can compare media applications in learning

- f) Students can design and create media, multimedia, and ICT-based elementary school learning resources

3.4. Material Analysis

The course material taught is essential to determine, so a material analysis is necessary because it is a core element in the learning process in higher education. The consistency of each topic taught must align with the graduate learning outcomes (CPL) and the teaching materials studied. The ICT-based Elementary School Media and Learning Resources Course is a course that provides students with knowledge and experience in designing, developing, and utilizing learning media in the classroom, particularly in elementary schools. However, the results of the analysis of lecture materials show that improvements are still needed in terms of structure, content, learning approaches, and technological integration. Lecture materials still need to be strengthened, especially in the explicit integration of the three elements in each learning. Lecture materials should be designed to create a learning experience that is reflective, contextual, and integrated across content, pedagogy, and technology.

Based on the analysis of the course material, the focus is on the following topics: ICT Basic Concepts, ICT-Based Learning Media, Learning Media Development, Digital-Based Learning, Interactive Learning Media, and Media Applications in Learning. The material was chosen to direct and equip students in designing, developing, and utilizing effective learning media that integrate technology, knowledge, and content in learning, thereby enhancing students' creative skills.

3.5. Technology Analysis

Research findings at this point focus on six aspects of Technology Analysis of SPADA Used, which can be seen clearly in the table below:

Table 3.
Results of Technology Analysis of SPADA Used.

No.	Assessment Aspects	Percentage
1	Utilization of SPADA by Lecturers	89%
2	Integration with Learning Design	78%
3	Availability of Digital Materials	68%
4	Student Engagement	79%
6	User Satisfaction	83%
Overall Average Rating		79%

The results of the analysis indicate that the use of SPADA (Online Learning System) technology in the learning process has been successful in some aspects, but still requires improvement in others. The aspect of SPADA Utilization by lecturers received an assessment of 89%, indicating that lecturers have actively utilized the SPADA platform in managing lecture activities, such as delivering materials, assigning assignments, and setting up discussion forums. The Integration with Learning Design aspect achieved a score of 78%, indicating that lecturers have effectively integrated the use of SPADA into the learning plan. However, there is still room for improvement in terms of continuity between online and offline meetings.

In terms of Digital Material Availability, a score of 68% was obtained, indicating that the types of digital materials available at SPADA are still limited, particularly in the form of interactive media such as videos, simulations, or multimedia-based digital modules. Student involvement achieved a score of 79%, indicating that students are quite active in participating in learning through SPADA; however, participation in online discussions or forums still needs to be increased. User Satisfaction was achieved with a score of 83%, indicating that users are generally satisfied with the ease of use and benefits of the SPADA platform in supporting online learning.

Overall, the use of SPADA technology in learning showed quite good results, with an average score of 79%. This shows that SPADA has become an effective platform in supporting online learning,

especially in terms of lecturer involvement and user satisfaction. However, the availability of digital materials remains an aspect that needs improvement, both in terms of quantity and quality. Additionally, further training and mentoring are necessary for lecturers to develop learning content that is more interactive and aligned with the characteristics of online learning. With improvements in these aspects, it is hoped that the use of SPADA can be more optimal and have a direct impact on the quality of learning in the digital era. The following is a graph of.

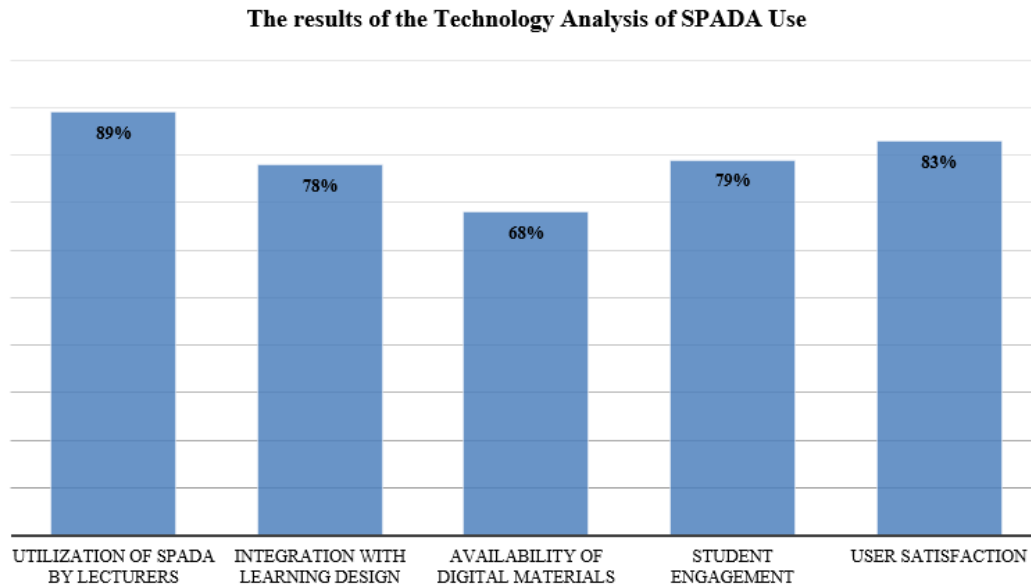


Figure 5.

Diagram of the Technology Analysis of SPADA Use.

The purpose of technology analysis in this development research is to identify learning facilities that can be accessed and utilized optimally for digital modules designed to be integrated with university technology infrastructure. Currently, the learning facilities at the University of Muhammadiyah Makassar are well-organized and adequately equipped with the use of the Learning Management System (LMS) or an existing e-learning application, namely the Online Learning System (SPADA), available on the <https://spada.unismuh.ac.id/> website. The technology, in this case, the SPADA platform, is compatible with various devices, including computers, tablets, and multiple operating systems (Windows, macOS, Android, iOS), ensuring wide accessibility.

Based on the current condition of learning facilities at the University of Muhammadiyah Makassar (Unismuh), especially with the availability of the SPADA (<https://spada.unismuh.ac.id/>) Learning Management System (LMS), the analysis for the development of digital modules shows that Unismuh has a digital system to support technology-based learning. The existence of SPADA as an online learning platform provides a foundation for the development of digital modules that not only present content but are also systematically integrated into learning activities.

The ease of access and compatibility of the module with various devices are also concerns. Digital modules should be designed responsively to ensure they can be accessed through various platforms, including computers, tablets, and smartphones, thereby providing a seamless user experience across all devices.

Thereby providing a seamless user experience across all devices. Considering this technological aspect, digital modules can later be optimized to meet more effective learning needs and be accessible to a broader range of students. Adequate facilities to support learning activities enable lecturers to facilitate students in improving their creative thinking skills through various media. This analysis

emphasizes that digital modules that utilize technology strategically can enhance the quality of learning and the relevance of materials to students' needs in the digital era.

Based on the analysis of the conditions at the analysis stage, it can be concluded that a TPACK-based digital module is necessary in the ICT-based Elementary Media and Learning Resources course to enhance creative thinking skills by incorporating an analysis of needs, student characteristics, curriculum, materials, and technology.

4. Discussion

A needs analysis is conducted to ensure that the modules created align with the needs of students and learning objectives. Analysis of needs in the development of digital modules based on *Technological Pedagogical Content Knowledge* (TPACK) for ICT-based Media and Elementary Learning Resources courses that can be accessed by students so that they can learn anywhere and anytime through digital devices to achieve the learning goals that have been set. The needs analysis conducted reveals that the development of digital modules is necessary for learning ICT-based Media and Learning Resources courses that are interactive, flexible, and easily accessible. TPACK is a framework that integrates technological knowledge, pedagogy, and content to create effective learning. In the context of higher education, the application of TPACK in developing learning modules enables lecturers to present material in a more engaging and interactive manner, aligning with technological advancements and student needs. Technology-based learning that incorporates interactive features can enhance student engagement, enabling them to learn at any time and from anywhere. Suyamto, et al. [37] In their research, they stated that TPACK relies on the expertise of educators in integrating technology into the classroom to enhance learning effectiveness and efficiency. In this context, the use of TPACK-based digital modules will help students gain a deeper understanding of the material by connecting theory and practice through technology. Therefore, developing interactive and contextual digital modules is necessary to meet the needs of students.

Based on the results of the needs analysis carried out, it was found that students face difficulties in accessing teaching materials in a systematic and structured manner. In addition, there is no digital module that specifically integrates TPACK aspects, which hinders students' understanding of the relationship between learning content, pedagogy, and the use of technology in learning. The effectiveness of technology-based learning depends on a good integration between technology, pedagogy, and material content [4]. This aligns with research indicating that integrating technology into the learning process can enhance students' effectiveness and engagement process [38]. Other research suggests that technology-based learning, when systematically designed, can enhance student engagement and understanding of the material [2]. Therefore, the development of TPACK-based digital modules considers appropriate pedagogical aspects, enabling students to develop creative thinking skills in their learning. Thus, the development of TPACK-based digital modules is expected to answer the needs of students and support the achievement of their learning goals.

The analysis of needs in the development of digital modules is reviewed in terms of the characteristics of students as users, particularly about their learning styles. By understanding the variety of learning styles, the development of digital modules can be more targeted and tailored to user characteristics. The findings regarding student learning styles indicate that PGSD FKIP Unismuh Makassar students exhibit a varied learning style, with the frequency of learning styles being dominated by the kinesthetic learning style, followed by the visual learning style, and then the auditory learning style. Each student has different learning tendencies; some are more responsive to visual material, some are more comfortable with verbal or auditory approaches, and some are even more kinesthetically active [39]. Their study found that students tend to have more dominant visual and kinesthetic learning styles, which is why the digital modules developed accommodate the presentation of material in the form of interactive multimedia, such as videos, animations, and simulations. Additionally, research by [40]. Indicates that students tend to learn independently by utilizing digital technology, necessitating the development of TPACK-based modules.

Furthermore, the curriculum analysis in the development of TPACK-based digital modules is a stage to ensure that the material prepared is relevant to the students' needs. According to Wiggins and McTighe [41]. Curriculum design requires designers to determine the outcome first before determining the content of the material and learning methods. This ensures that the course curriculum is designed systematically with a focus on achieving the desired outcomes. According to Bhatti, et al. [42]. Curriculum analysis aims to align the learning content with the learning objectives that students must achieve.

The curriculum analysis in the development of the module considers the National Standards for Higher Education (SN-DIKTI), which stipulate that each course must have clear learning outcomes and be aligned with the Indonesian National Qualifications Framework (KKNI) [36]. The KKNI curriculum that has been determined has 4 (four) abilities that students must master, namely: 1) attitude (S); 2) knowledge (P); 3) general skills (KU); and 4) special skills (KU). Additionally, mapping involves conducting a gap analysis between the current curriculum and the competency needs of graduates in the workforce [43]. The results of the analysis of the course curriculum needs indicate that the curriculum preparation is adaptive, based on learning objectives, and aligns with applicable educational standards, enabling the TPACK-based digital modules developed by students to meet the needs that increase the effectiveness of the learning process.

A needs analysis in terms of materials is prepared by identifying learning objectives relevant to the curriculum that support the achievement of expected competencies. According to Dick, et al. [44]. Material analysis involves identifying key concepts, necessary skills, and systematic delivery structures so that learners can understand them well. Students tend to understand the material better when it is presented in a clear hierarchy of information, ranging from basic concepts to applications in authentic contexts. The suitability of the material with the needs and development of technology is an important factor in material analysis [45]. Therefore, the integration of technology in learning is highly recommended, as it enables students to become accustomed to the modern work environment. When course materials are packaged with the right digital approach, such as a learning management system (LMS), students not only become recipients of information but can also learn actively, independently, and in a contextually relevant manner [46, 47].

Based on the analysis of the course material, the focus is on the following topics: ICT Basic Concepts, ICT-Based Learning Media, Learning Media Development, Digital-Based Learning, Interactive Learning Media, and Media Applications in Learning. The material in this course already covers the conceptual and practical aspects necessary for the development and use of ICT-based media. The analysis of the material shows that all the topics covered are directly related to the abilities needed by students to become independent developers and users of information technology-based media.

Analyzing the needs in terms of technology, the current learning facilities at the University of Muhammadiyah Makassar (Unismuh), particularly with the availability of the Learning Management System (LMS) SPADA (<https://spada.unismuh.ac.id/>), indicate that Unismuh has a digital system to support technology-based learning. The existence of SPADA as an online learning platform provides a foundation for the development of digital modules that not only present content but are also systematically integrated into learning activities. The analysis of technology needs aims to ensure that the systems used can operate optimally within the available infrastructure, thereby supporting operational efficiency [48-50].

The use of Unismuh's SPADA LMS is one of the advantages that greatly support the implementation of digital learning innovations. PGSD students, as prospective educators, need to be trained in the use of Learning Management Systems (LMS), interactive learning applications, and digital content production techniques to create innovative learning experiences that meet the needs of elementary school students. Learning in elementary schools has begun to shift from conventional models to more flexible, technology-integrated, and adaptive learning to meet the characteristics of the digital generation [51]. The modules that are compiled accommodate the use of digital technologies, such as e-learning, blended learning, and other interactive media [52]. In the digital era, prospective

teachers not only master the concept of learning media theoretically but must also be able to adapt the latest technology in teaching.

5. Conclusion

Based on the research results and discussions conducted, it can be concluded that the development of digital modules based on Technological Pedagogical Content Knowledge (TPACK) in ICT-based Elementary Media and Learning Resources courses has high urgency. This research aims to improve the creative thinking skills of students of the Elementary School Teacher Education Study Program (PGSD). TPACK-based digital modules are considered capable of bridging the needs of 21st-century learning, integrating technology, pedagogy, and content in a balanced manner. PGSD students as prospective teachers need learning resources that are not only informative but also applicable and interactive. ICT-based learning encourages the need for teaching materials that support students' exploration and creativity. Therefore, the TPACK approach provides a crucial foundation for designing digital modules that align with the curriculum's demands and technological advancements.

The needs analysis conducted among lecturers and students reveals a gap between the existing digital teaching materials available and those required for effective learning practices. Both lecturers and students expressed the need for digital modules that not only present material but also encourage active student involvement in the learning process. The modules developed must be able to facilitate collaborative, creative, and student-centered learning. This need reinforces that TPACK, as a framework for module development, is highly relevant in the context of learning in PGSD. TPACK-based digital modules enable the integration of technology with an in-depth pedagogical approach and meaningful content. Thus, the results of the needs analysis provide a clear direction for designing effective and contextually relevant modules.

Based on the entire research and development process, it can be concluded that the existence of TPACK-based digital modules significantly supports the improvement of students' creative thinking skills. This module can serve as an innovative learning medium, facilitating students' development of ideas, problem-solving skills, and open-minded thinking. The responses of lecturers and students show that the digital modules developed are not only practical to use but also relevant to learning needs. Expert validation confirms that the module meets the eligibility criteria in terms of content, design, and technical requirements. Additionally, field trials demonstrated that the modules had a positive impact on student engagement in the learning process. Thus, the development of TPACK-based digital modules has proven to make a significant contribution to creating more creative, effective, and appropriate learning in response to today's basic education challenges.

Institutional Review Board Statement:

The study was reviewed and approved by the Institutional Review Board (IRB) of [Universitas Muhammadiyah Makassar]. Participation was voluntary and anonymous, and informed consent was obtained from all respondents prior to data collection.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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