Digital Learning Media Project as an Essential Solution in Developing TPACK for Prospective Indonesian Language Teachers through Project-Based Learning Methods

Putri Kumala Dewi[1], Justsinta Sindi Alivi[2]

{phoe3_kumala@ub.ac.id[1], s.alivi@warwick.ac.uk[2]}

Universitas Brawijaya[1], The University of Warwick[2]

Abstract. The challenge of 21st-century education is the rapid flow of information, so it is necessary for teachers to master ICT. This research invited 97 students of the Indonesian Language Education and Literature Study Programs to participate in TPACK survey. The result showed that they are not yet skilled at combining mastery of material and pedagogy to develop digital learning media to support learning effectiveness. This research aims are to determine (1) the role of the project-based learning method and (2) students' perception as prospective Indonesian Language teachers on implementing the method in developing TPACK. The results show that the project-based learning method can develop students' TPACK with indicators of mastering material and pedagogy as well as having skills in creating digital learning media, and designing strategies for their implementation in Indonesian language learning.

Keywords: digital learning media; TPACK; project-based learning methods; prospective Indonesian Language teacher

1 Introduction

The 21st-century era has significantly impacted the world of education because science and technology are also overgrowing. It makes educators need to master Information Technology (IT). According to Trilling & Fadel (2009), the challenge of 21st-century education is the rapid flow of information that requires IT mastery competence. The need for mastery of IT has been increasingly felt since the online learning era due to the Covid-19 pandemic. It makes lecturers

ICEL 2022, November 07-08, Malang, Indonesia
Copyright © 2023 EAI
DOI 10.4108/eai.7-11-2022.2329256

of the Indonesian Language and Literature Education Study Program responsible for equipping themselves and students as prospective Indonesian language teachers with knowledge of the study field, innovation learning, and IT or TPACK (Technological Pedagogical Content Knowledge). TPACK indicators include the ability to combine materials, pedagogy, and media for the effectiveness of the learning process (Schmidt, 2011). Stapf & Martin (2019) state that the TPACK indicator is when a teacher knows the right time to use IT in learning. Thus, educators are considered to have TPACK if they can choose the types of IT relevant to the applied learning methods to improve collaboration, learning interaction, and students' motivation.

However, data from the distributing questionnaires on February 10, 2022, to 97 students shows that (1) 89% of students are not familiar with the types of IT platforms to create learning media, (2) 89% of students are not yet skilled at making IT-based learning media, (3) 88% of students have not been able to link IT-based learning media with the timeliness of their application, and (4) 92% of students have not been able to link IT-based learning media with learning methods to achieve effective learning.

An essential solution to meet student needs for TPACK competencies is to involve students in digital media production projects in the Indonesian Language and Literature Learning Media course. It is relevant to the objectives of this course that students are expected to be innovative in creating Indonesian language learning media within the TPACK framework. For this reason, this research will be carried out in this course with a total of 97 students.

The learning method applied is the project-based learning method. Data from the questionnaire analysis showed that 63.6% of Indonesian Language and Literature Learning Media course students hoped to be allowed to practice directly, even in online learning situations. To understand the material, 87.9% of students think the combination of synchronous and asynchronous will help them master the learning material to the maximum. 93.9% of students are more interested if asynchronous learning is used for self-finding activities, exploring, researching, and practicing hands-on experience. Meanwhile, 62.1% of students expect synchronous learning to be used for discussion activities, product presentations, verification of work results, and material reinforcement. For material, 63.6% expect lecturers to provide material in a multimodal form.

Project-based learning methods are directed at experiential learning activities to analyze, evaluate, and create products by optimizing IT as a medium within a certain period (Bayer, 2016). This method allows students to observe problems and analyze the need for digital learning media in schools. Then students practice producing digital learning media following the observation data and analysis of these needs.

Based on the background, this research is significant to be carried out. The aim is to determine (1) the role of project-based learning methods and (2) the perception of prospective Indonesian teachers on implementing project-based learning methods through the creation of digital learning media as an essential solution to develop TPACK. Digital learning media production projects with this project-based learning method can equip students as prospective Indonesian language teachers with TPACK to have the necessary competencies to face the 21st-century era.

2 Method

This type of research is an evaluative model case study. According to Balbach (1999), the aim of case studies with evaluative models is to study an object including what happened, why it happened, and how an event relates to other events intensively. It was chosen because it aimed to find cases related to student TPACK competencies in the Indonesian Language and Literature Education Study Program Class of 2020. Then to find out the role of project-based learning methods through making digital learning media an essential solution to develop student TPACK at the planning, implementation, and evaluation stage. Then find out the perception of Indonesian language teacher candidates on the implementation of project-based learning methods through the project of making digital learning media an essential solution to develop TPACK. The case study of the evaluative model aims to study an object intensively, including what happened, why it happened, how an event relates to other events, and finding out the benefits/value of an educational program to another object in a single program (McMillan & Schumacer, 2010).

The research subjects were students as prospective Indonesian Language teachers in the Class of 2020 Indonesian Language and Literature Learning Media course, totaling 97 students. The technique of taking this research subject was done by purposive sampling. The research procedure includes the planning stage; making case descriptions; problem analysis, determination of data sources and research instruments; data collection, processing, and interpretation; evaluation, and follow-up.

The types of data include (1) student TPACK competency data before implementing project-based learning methods, (2) data on the role of project-based learning methods through digital learning media preparation projects at the planning, implementation, and evaluation stages, and (3) student perceptions as Indonesian language teacher candidates on implementing project-based learning methods and developing TPACK. The questionnaire was used to get the first data. The second data was obtained using the observation guideline instrument, student TPACK assessment rubric, digital learning media product assessment, product presentation assessment, self-assessment, and peer assessment. The student perception questionnaire on TPACK before and after lectures was used to obtain the third data. Data were analyzed by data reduction, presentation, conclusion drawing, and verification.

3 Results and Discussion

3.1 The Role of Project-Based Learning Methods through the Development of Digital Learning Media Projects and Basic Solutions to Develop Student TPACK

The project-based learning method is a method that involves students learning knowledge and skills by observing authentic cases and then working on project tasks systematically. The role of the lecturer is to develop project-based learning method procedures, from understanding the material, project activities, competency achievement for each project procedure, and the learning media used to the accuracy of the synchronous distribution or asynchronous online learning activities.

In terms of Technological Knowledge (TK) competence, the efforts made by lecturers are to ask students to (1) understand the flow and objectives of learning. (2) understand and identify media concepts, media functions, objectives of media application, case studies and analysis of the importance of media, and media theory foundations through synchronous meetings with Zoom Meeting media. Furthermore, students are asked to identify and understand the types of digital learning media based on the functions and characteristics of each media and the criteria for selecting digital learning media for learning Indonesian in sync with the Vocaroo, Screencast O'Matic, and Oodlu media packaged on Google Classroom. The results are presented in the following diagram.

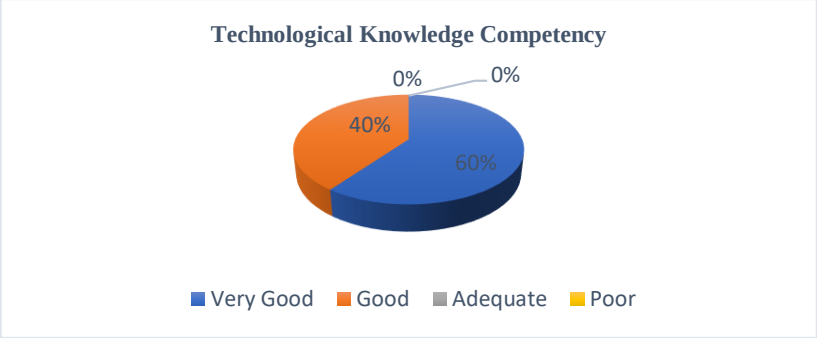

Fig. 1 Technological Knowledge Competency of Prospective Indonesian Language Teachers

As a result, 60% of students mastered more than 50% of the types of digital learning media and their application in learning Indonesian. By delivering material interactively through Vocaroo, Screencast O'Matic, and Oodlu media, students learn by being active, interacting self-paced, understanding content at a time that can be arranged according to their needs, and making learning more fun (Smith & MacGregor, 1992; Surjono, 2017).

In terms of Content Knowledge (CK) competence, the lecturer asks students to identify and understand the basic concepts of learning and teaching, types, phases, the embodiment of learning behavior, as well as the relationship between technology-based learning media and learning theory with Screencast O'Matic and Quizizz packaged in Google Classroom. Furthermore, students are asked to reflect on various Indonesian learning strategies taught in the Indonesian Language and Literature Learning Strategy course with the question feature media in Google Classroom. This strategy is carried out as a solution to develop student metacognition.

Metacognition competence encourages students to prioritize exploring activities, thinking about knowledge already and not yet known, knowing the modalities of knowledge possessed and using the knowledge to solve problems (Puspitasari, 2019). The results are presented in the following diagram.

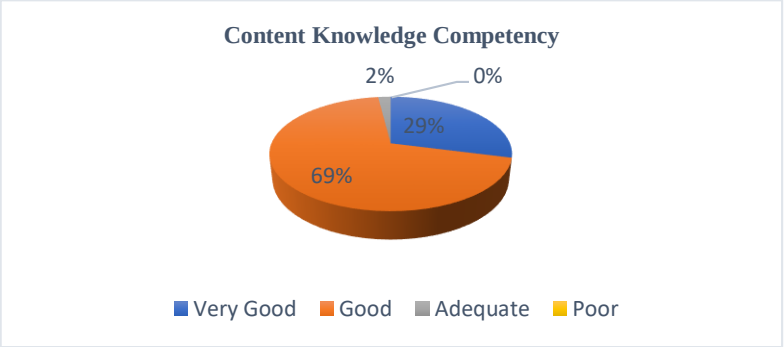

Fig. 2 Content Knowledge Competency of Prospective Indonesian Language Teachers

As a result, 69% of students have CK competence in the good qualifications with indicators (1) having good knowledge in two fields between the fields of education, linguistics, or Indonesian literature, (2) having good knowledge in teaching Indonesian subject matter because have mastered the basic competencies and are quite capable of creating them into systematic learning objectives, (3) have creativity in teaching Indonesian language subject matter later, and (4) master 5-9 innovative learning strategies. This learning strategy innovation is supported by the role of the media as a tool for delivering learning materials.

Regarding Pedagogical Knowledge (PK) competence, the lecturer asks students to understand the working steps of the project-based learning method synchronously with the Zoom Meeting media. Then students observe the problems of learning media at school. Of the 27 schools observed, some teachers have not mastered digital learning media. As a result, students lose motivation to learn and experience delays in receiving material and working on assignments. Madrasa-based schools also limit devices outside the classroom, creating challenges for teachers to package learning materials with effective technology-based media.

Furthermore, students collaboratively think critically, and communicate with group members to decide the type of digital learning media that suits the school's needs. According to Smith & MacGregor (1992), students will have intellectual synergy by learning collaboratively to contribute to each other's thoughts and decision-making in groups. For example, one of the observational data in this study shows that SMA BSS Malang for reading poetry and short stories requires media that is low in bandwidth and makes students understand the material first before practicing. Then it was decided to create digital media with Wakelet, Voicethread, and Power Director platforms. The three platforms were chosen because they are low bandwidth and make students understand the material before practicing. The results are presented in the following diagram.

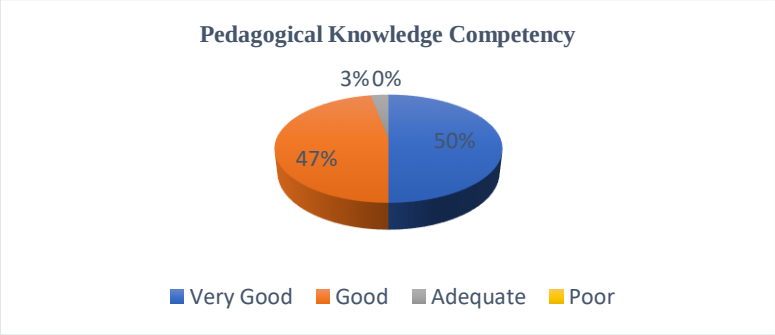

Fig. 3 Pedagogical Knowledge Competency of Prospective Indonesian Language Teachers

As many as 50% of students have PK competence in the very good qualifications with indicators (1) knowing how to apply media to increase student's motivation in class, (2) having more than 10 learning strategies by applying various media to manage classes, (3) being able to adjust media which is used when later dealing with students with different characteristics, (4) with mastery of the media, the prospective Indonesian Language teachers can help solve students' learning difficulties.

In Pedagogical, Content, and Knowledge (PCK) competencies, students are directed to be skilled in critical thinking in analyzing information and observing findings using Zoom Meeting media. For example, one of the observational data in this study shows that SMA An-Nur Bululawang for material analyzing values in novels, writing scientific papers, analyzing short stories and poetry, understanding types of phrases and sentences, students and teachers need effective media for classroom learning because in the cottage prohibits the use of devices outside the classroom. After discussing with the lecturers, students create visual media with Anyflip, audio media with Voicethread and audiovisual media with Power Director. The results can be packaged in one multimedia on Anyflip. It can be seen that the teacher's role in project-based learning is as a creative facilitator in providing facilities and learning experiences for students through the application of specific learning strategies and media (Sari et al., 2021). The results are presented in the following diagram.

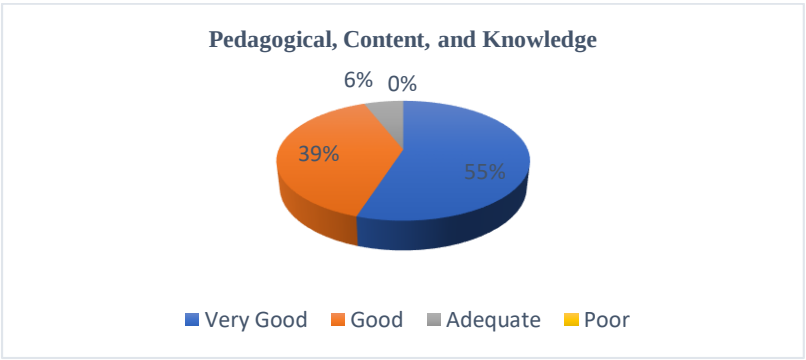

Fig. 4 Pedagogical, Content, and Knowledge Competency of Prospective Indonesian Language Teachers

As a result, 55% of students have PCK competence in the very good qualifications with indicators of mastering knowledge in the study field, with pedagogy built along with the knowledge gained from pedagogical science courses in the study program.

Regarding Technological, Content, and Knowledge (TCK) competencies, the lecturer asked each group to present the results of observations and needs analysis in schools through Zoom Meetings prior to project activities. The goal is that students can develop metacognition and creative, critical thinking skills in creating authentic and contextual digital learning media with school needs. According to Markham, Larmer, & Ravitz (2003), in the project-based learning method procedure, this stage determines the project scope, linking the project tasks to be carried out by students with contextual observation data. Muslich (2009) states that learning carried out in an authentic context can lead students to the achievement of skills in the context of real life. Then each group identifies the types of digital media, various IT platforms for creation, the importance of producing digital media, and how to optimize learning with learning theory. The role of the lecturer is as a creative facilitator in providing learning facilities and experiences for students through the application of specific learning strategies and media (Sari et al., 2021). The results are presented in the following diagram.

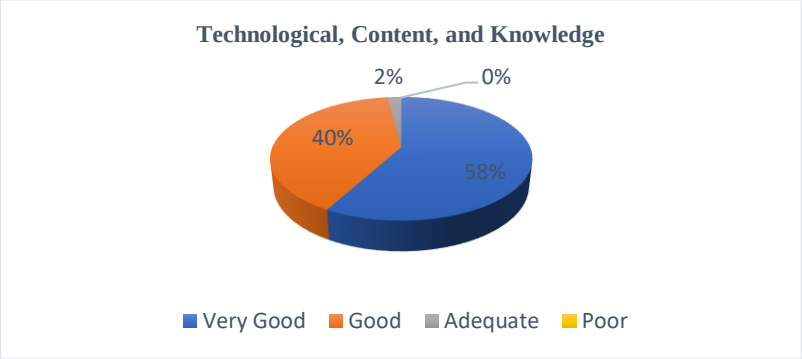

Fig. 5 Technological, Content, and Knowledge Competency of Prospective Indonesian Language Teachers

As a result, 58% of students have TCK competence in the very good qualifications with indicators of knowing the types and functions of digital learning media to support the effectiveness of learning Indonesian. Including media for brainstorming, delivering material, building concepts, question and answer, interactive games, collaboration, and assessment. This increase in student competence is also supported by the role of lecturers in providing modeling. Modeling makes students learn with authentic instruction. Students are given learning experiences in a meaningful context through developing critical thinking and problem-solving skills in real-life contexts (Muslich, 2009).

In terms of Technological, Pedagogical, and Knowledge (TPK) competencies, each group of students contributes to selecting, evaluating media strengths and weaknesses, deciding, and creating digital learning media. According to Smith & MacGregor (1992) in this collaboration, each group will face differences of opinion, build an agreement that respects all voices, work in

teams, and train the leadership skill so that not students will obtain only skills but also aspects of character. The results are presented in the following diagram.

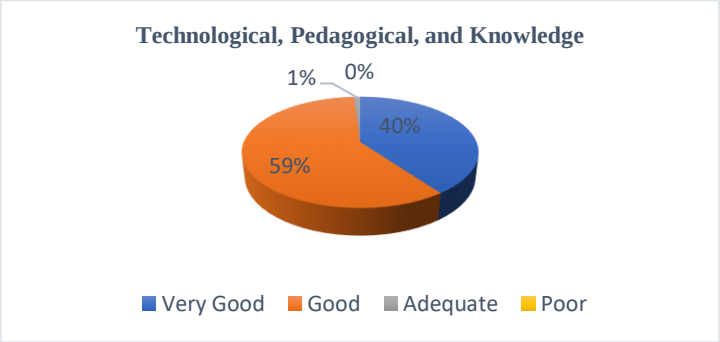

Fig. 6 Technological, Pedagogical, and Knowledge Competency of Prospective Indonesian Language Teachers

As many as 59% of students have TPK competence in the good qualifications with indicators (1) being able to choose the types of digital learning media include media for brainstorming, material delivery, question and answer, and assessment to support the strategy applied, deepen students' understanding of the material being taught, and provide learning experiences to students, (2) capable enough to think critically to evaluate the advantages and disadvantages of digital learning media to be used in learning, (3) skilled enough to guide students to learn the material and operate digital learning media properly, and (4) sufficiently able to choose digital learning media, at least media for brainstorming, delivering material, debriefing, and assessment so that it can improve collaboration, learning interaction, and student learning motivation in the field of Indonesian studies well.

In terms of Technological, Pedagogical, Content, and Knowledge (TPACK) competencies, students are directed to think critically to design learning activities with digital learning media that can be used offline as well as synchronous and asynchronous online. The results are presented in the following diagram.

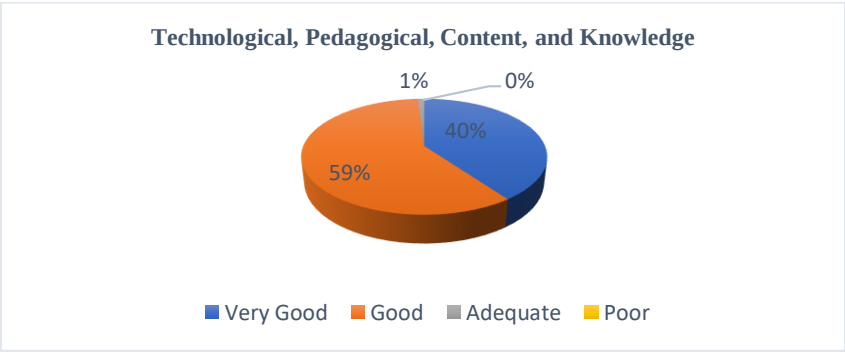

Fig. 7 Technological, Pedagogical, Content, and Knowledge Competency of Prospective Indonesian Language Teachers

As a result, 59% of students have TPACK competence in the good qualifications with indicators (1) knowing the right time to use digital learning media offline and sufficiently knowing when to apply media in online learning, (2) knowing the right time to use digital learning media synchronously and enough to know when to apply the media at the asynchronous time, (3) able to choose offline learning activities with the integration of digital learning media so that it supports learning effectiveness and capable enough for online application, (4) able to choose learning activities with the integration of digital learning media so that it is effective for applied synchronously and capable enough for the asynchronous application, and (5) confident that the combination of material, pedagogy, and media applied will be effective in achieving learning objectives.

This questionnaire is also supported by the results of the lecturer's assessment of student digital media products. 80% of students' digital visual media products achieved very good qualifications, 89% of student audio media products achieved very good qualifications, and 67% of student audiovisual media products achieved very good qualifications. Meanwhile, according to individual student assessments, 80% of students consider themselves very good when producing digital visual media, 87% consider themselves very well qualified when producing audio media, and 67% consider themselves very well qualified when producing audiovisual media. Furthermore, from the results of the peer assessment, 71% of students are in very good qualifications when producing digital visual media, 57% are in very good qualifications when producing audio media, and 67% are in very good qualifications when producing audiovisual media.

It shows that this digital learning media project equips students as prospective teachers to master TPACK. The TPACK indicators are being able to design learning activities by utilizing IT-based media, mastering good classroom management, and knowing the right time to use IT in the context of offline and synchronous or asynchronous online learning (Schmidt, 2011; Sabrina, 2017); Stapf & Martin, 2019). First, students identified the concept of digital learning media with Vocaroo, Screencast O' Matic, and Oodlu media packaged in Google Classroom collaboratively. This activity allowed students to study materials while learning to operate digital media. Second, students observed the types of learning media, learning problems, students' needs for learning media, and the teacher's role in the application of learning media in schools. With this observation, students discovered the problems and needs of learning media in schools. Third, students presented their results. Fourth, students created digital learning media according to school needs collaboratively. This activity equips each student in the group to design, evaluate the strengths and weaknesses of media, create, and present digital learning media contextually. It also combines students' knowledge of materials, pedagogy, learning activities, and learning media to achieve learning objectives. This learning method provides experience for each student in a group to contribute ideas to each other, to be responsible for achieving group learning outcomes, have good communication skills, and comply with the jointly formulated project timeline.

3.2 Indonesian Language Teacher Prospective' Perceptions of The Project-Based Learning Methods Implementation

The prospective Indonesian Language teachers' perceptions of implementing the project-based learning method for creating digital media were obtained through questionnaires distributed to students after learning the Indonesian Language and Literature Learning Media course. At the concept understanding stage, according to the questionnaire results, they thought that the project-based learning method allowed them to be actively involved in building knowledge about media concepts. Lecturers invited them to understand concepts using interactive Vocaroo, Screencast O'Matic, and Oodlu. They can learn actively and construct knowledge in a fun way. The application of digital media is also a model for students. Learning in a fun situation will make it easier for students to understand the delivered material, and their learning motivation will increase (Wahyudi & Azizah, 2016).

At the stage of observation and need analysis, according to the questionnaire results, students as prospective Indonesian Language teachers get experiential learning because they are given stimulus ideas in the form of authentic cases at schools. This kind of contextual learning strategy will create a scientific learning climate because students "work" and "experience" what they learn for themselves, not just "knowing it" so that student learning outcomes will be more meaningful (Kadir, 2013). This learning activity aims to develop students' Pedagogical Knowledge competencies as prospective Indonesian Language teachers. They can directly see learning processes and practices, student characteristics, and class management with the implementation of learning media.

The observation results showed that of the 27 schools observed, some teachers have not mastered digital learning media, both in terms of the skills in making it, operating it, and managing the time to use it. From the students' point of view, students lost their motivation to learn because the teacher seemed to only transfer offline learning materials to online learning materials. Most students were constrained by signals when studying the material. It had an impact on delays in receiving material and doing assignments. In terms of school infrastructure, many schools do not yet have adequate infrastructure for implementing digital media, especially for high-bandwidth digital learning media. Madrasah-based schools also limit the use of devices outside the classrooms. It is a challenge for students as prospective Indonesian Language teachers to package learning materials with effective technology-based media.

At the discussion stage connecting the observations with the design of digital learning media, choosing the right IT platform, evaluating its strengths and weaknesses, and designing digital learning media, according to the questionnaire results, they argue that this learning method develops metacognition. Students as prospective Indonesian Language teachers also work actively, take the initiative, are critical, creative, and exploratory, and gain experience solving problems. This activity aims to develop competence in Technological Knowledge (TK); Technological, Content, Knowledge (TCK); and Technological, Pedagogical, Knowledge (TPK). TK competence is the competence to recognize the types of digital learning media and skills in operating them. Meanwhile, TCK competence is the competence to understand the types and functions of digital learning media to support learning effectiveness. TPK competence is the competence to combine pedagogical knowledge with technology so that it underlies students as prospective teachers to choose the right type of digital learning media for learning management and the learning needs of students. According to Kadir (2013), this kind of learning

method can strengthen comprehensive understanding by linking the meaning or intent of the knowledge students learn with direct experience in real life.

At the stage of creating digital learning media, according to the results of the questionnaire, students as prospective Indonesian Language teachers argue that the project-based learning method provides a creative learning experience. Each group expresses ideas to each other, respects friends' ideas, communicates, and collaborates in realizing their ideas into digital learning media products to solve problems at school. Critical thinking, communication and collaboration skills, communication, creative thinking, and solutions are needed in the 21st-century education era (Dewi, 2015; Nirmayani & Dewi, 2021). This activity aims to develop TPACK competencies. TPACK competence is the competence to integrate pedagogy, fields of study, and ICT. It is also in the form of competency in determining when, where, and how to optimize the application of technology-based media to assist students in increasing their knowledge and skills in a field of study. The following is a display of these digital visual media products.

Fig. 8 Digital Visual Media Display with Anyflip, Book Creator, Genially, and Piktochart Platform

Figure 8 above shows digital visual media created with the Anyflip, Book Creator, Genially, and Piktochart platforms and integrated with other platforms, namely Wordwall, Quizizz, Padlet, Live Worksheet, and Trello. The use of various platforms on one main platform is carried out to create interaction, collaboration, and engagement with students. The following is a display of these digital audio media products.

Fig. 9 Audio Media Display with Voicethread, Genially, Chatterpix, and Vocaroo Platform

Figure 9 above shows audio media created with the Voicethread, Genially, Chatterpix, and Vocaroo platforms. Students as prospective Indonesian Language teachers filled each platform with brainstorming, questions and answers, collaborations, games, and assessments activities. The goal is to meet the needs of students in schools who need audio media that is multimodal and can build interaction, collaboration, and engagement. The following is a display of these digital audiovisual media products.

Fig. 10 Audiovisual Media Display with Genially Platform

Figure 10 above shows audiovisual media created with the Genially platforms and integrated with other platforms, namely Power Director dan Adobe Spark. Students as prospective Indonesian Language teachers choose Genially as the main platform because it has collaboration interaction feature consisting of presentation, interaction, and quiz. They can also link other platforms to it to add an element of interaction and collaboration. Students at school can learn content in Genially anytime and anywhere. This platform can be stored in the form of links. This platform is low bandwidth.

In addition, in terms of character or affective aspects, students as prospective Indonesian Language teachers assume that the project-based learning method provides experience to train leadership skills, responsibility, and discipline. According to Gerlach (1994), the project-based learning method emphasizes group collaboration between students to solve problems, complete tasks, and create products. Each group member contributes ideas to each other, is responsible for achieving learning outcomes in groups or individually, and adheres to the project timeline that is formulated together in class.

At the product presentation stage, each group presented digital learning media products and the procedures for their implementation in learning Indonesian. Presentations are carried out per stage after each media, both digital visual media, audio and audiovisual has been produced. This activity aims to equip students as prospective Indonesian Language teachers with communication skills. The following is documentation of students' presentations.

Fig. 11 The Documentation of Students' Presentations

According to the questionnaire results, students as prospective Indonesian Language teachers thought that the project-based learning method made them build good communication with group friends, build self-confidence, and train them to be skilled in verbal communication. The active involvement of each group member will make them master the presentation material. Meanwhile, verbal communication skills are formed because each group must support its

members to present digital learning media products in communicative and exciting language. The failure of one group member will lead to the group's failure (Johnson & Johnson, 2009).

4 Conclusion

1) The project of creating digital learning media implemented through the Indonesian Language and Literature Learning Media course for 97 students makes 60% of students develop Technological Knowledge (TK) competencies. 69% of students develop Content Knowledge (CK) competencies, 50% develop Pedagogical Knowledge (PK) competencies. Students develop Pedagogical, Content, and Knowledge (PCK) competencies about 55%, 58% of students develop Technological, Content, and Knowledge (TCK) competencies, 59% develop Technological, Pedagogical, and Knowledge (TPK) competencies and 59% of students develop Technological Pedagogical, Content, and Knowledge (TPACK) competencies. The indicators are mastering the material and pedagogy, being skilled at creating digital learning media, and designing implementation strategies in learning Indonesian.
2) Students' perceptions of the learning method implementation of this digital learning media project are that students think (1) can be actively involved in building knowledge in a fun way, (2) get experiential learning, (3) students "work" and " experience" what they learn for themselves, not just "knowing it" so that student learning outcomes will be more meaningful, (4) provide learning experiences for creative, collaborative, social interaction with teachers and colleagues, and communicative, (5) train the leadership skill, responsibility, and discipline.

References

[1] Bayer, T. J. Bayer, Timothy J. (2016). *Effects of Guided Project-Based Learning Activities on Students' Attitudes Toward Statistics in an Introductory Statistics Course*. Disertasi. STEM and Professional Studies Old Dominion University, Norfolk, Virginia.

[2] Balbach, E. D. (1999). 9 California Department of Health Services. *Using Case Studies to Do Program Evaluation*, 3–4. Retrieved from http://www.case.edu/affil/healthpromotion/ProgramEvaluation.pdf.

[3] Dewi, F. (2015). Proyek Buku Digital: Upaya Peningkatan Keterampilan Abad 21 Calon Guru Sekolah Dasar melalui Metode Pembelajaran Berbasis Proyek. *Metodik Didaktik*, *9*(2), 1–15.

[4] Gerlach, J.M. (1994). *Is this Collaboration? In Bosworth, K. & Hamilton, S. J. (Eds.), Collaborative Learning: Underlying Processes and Effective Techniques, New Directions for Teaching and Learning*. San Fransisco: Jossey-Bass Publishing.

[5] Johnson, D. W., & Johnson, R. T. (2009). An Educational Psychology Success Story: Social Interdependence Theory and Cooperative Learning. *Educational Researcher*, *38*(5), 365–379.

[6] Kadir, A. (2013). Konsep Pembelajaran Kontekstual di Sekolah. *Dinamika Ilmu*, *13*(1), 17–38.

[7] Markham, Thom, John, Larmer, & Jason, Ravitz. (2003). *Project Based Learning Handbook: A Guide to Standards-Focused Project Based Learning for Middle and High School Teachers*. California: The Buck Institute for Education.

[8] McMillan JH, Schumacer, S. (2010). *Research in Education: Evidence Based Inquiry*. New Jersey: Pearson Education Inc.
[9] Muslich, M. (2009). *Pembelajaran Berbasis Kompetensi dan Kontekstual*. Jakarta: Bumi Aksara.
[10] Nirmayani, L. H., & Dewi, N. P. C. P. (2021). Model Pembelajaran Berbasis Proyek (Project Based Learning) Sesuai Pembelajaran Abad 21 Bermuatan Tri Kaya Parisudha. *Jurnal Pedagogi Dan Pembelajaran*, *4*(3), 378.
[11] Puspitasari, I. (2019). Penerapan Metakognitif dalam Media Pembelajaran. *Tadarus: Jurnal Pendidikan Islam: Jurnal Pendidikan Islam*, *8*(1), 1–10.
[12] Sabrina, I. R. (2019). Technological Pedagogical Content Knowledge (TPACK): Integrasi ICT dalam Pembelajaran IPA Abad 21. *Prosiding Seminar Nasional Pendidikan IPA IX*, 1–14.
[13] Sari, R. A., Musthafa, B., & Yusuf, F. N. (2021). Persepsi Guru terhadap Pembelajaran Berbasis Proyek di Sekolah Menengah Kejuruan. *Jurnal Penelitian Pendidikan*, *21*(2), 1–11.
[14] Schmidt, Denise A., et. al. (2011). Survey of Preservice Teacher's Knowledge of Teaching and Technology. *Air & Space Power Journal*, *25*(4), 121
[15] Smith, B. L., & MacGregor, J. T. (1992). *Collaboration Learning: A Sourcebook for Higher Education*. University Park, PA: National Center on Postsecondary Teaching, Learning, and Assessment (NCTLA).
[16] Stapf, K., B., Martin. (2019). TPACK + Mathematics: A Review of Current TPACK Literature. *International Journal on Integrating Technology in Education*, *8*(3), 13–19.
[17] Surjono, H. D. (2017). *Multimedia Pembelajaran Interaktif: Konsep dan Pengembangan*. Yogyakarta: UNY Press.
[18] Trilling, Bernie & Charles, Fadel. (2009). *21st Century Skills: Learning for Life in Our Times*. San Fransisco: Jossey-Bass.
[19] Wahyudi, D., & Habibatul, Azizah. (2016). Strategi Pembelajaran Menyenangkan dengan Konsep Learning Revolution. *Attarbiyah*, *26*, 1–28.