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THE INFLUENCE OF PEDAGOGICAL SKILLS, CONTENT, AND TECHNOLOGY ON TPACK AND HOTS IN TEACHER PROFESSIONAL EDUCATION STUDENTS

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Abstract: The learning process in the 21st century is inseparable from pedagogic abilities, content, and technology, known as technological pedagogical content knowledge (TPACK). Research on TPACK is often carried out to discover TPACK knowledge in teachers and prospective teachers. There needs to be more TPACK research on teacher professional education (TPE) students and TPACK based on the skills possessed by teachers who take TPE. This study aims to determine the effect of pedagogic knowledge (PK), content knowledge (CK), and technological knowledge (TK) on TPACK and higher-order thinking skills (HOTS) on lesson plan. This quantitative research was conducted on TPE students at UIN Sunan Ampel Surabaya with 20 people from regions throughout Indonesia. Data were collected from student lesson plan, which were analyzed based on the TPACK and HOTS indicators developed by the researcher. The resulting scores were analyzed path analysis with smartPLS. The results showed that pedagogic knowledge (PK) influenced content-based technology (TCK), technological knowledge (TK) influenced pedagogic-based technology (TPK), and pedagogic-based technology (TPK) influenced technological pedagogical content knowledge (TPACK). Content, pedagogy, and technology do not affect HOTS.

Keywords: teacher professional education (TPE); technological pedagogical content knowledge (TPACK); higher-order thinking skills (HOTS)

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INTRODUCTION

The development of science and technology affects various aspects of life, including education. Students' mastery of technology must be carried out in this century, so teachers must have technological knowledge and skills to facilitate students' learning. Good mastery of technology will make it easier for students to search, find, and use technology to improve their understanding. The material taught with the help of technology will be easy to understand because students cannot be separated from technology in their lives. Teachers' ability to search for and access technology-based materials is needed to make learning more interesting (Wakhidah et al., 2022).

Teachers must master the content of the material they teach so that the content of the material can be transferred to students during the learning process. Teacher quality is also determined by how high the teacher's level of understanding of the material they teach. Apart from that, the teacher's teaching ability greatly determines success in the learning process because the material students learn is related to the extent to which the teacher can design the learning process and the teaching process for students. The three things, namely material content (content knowledge/CK), pedagogical skills (pedagogical knowledge/PK), and technological skills (technological knowledge/TK), must be mastered by teachers to become professional teachers. Technology-based content taught is often called teacher content knowledge, which determines technology-based learning. Mishra and Kohler consider technology-based content knowledge and pedagogy essential, known as technology pedagogical and content knowledge (TPACK) (Mishra & Koehler, 2006).

The use of technology in learning began widely due to the Covid-19 pandemic (Amit et al., 2020; Anugrahana, 2020; Onyema, 2020; Poe, 2020; Reich et al., 2020; Richter, 2020; Wakhidah et al., 2021). Even though the pandemic has ended, students are already familiar with using technology. Difficulties in life can be solved by looking at online information, including when experiencing learning difficulties. The combination of content mastery and technology-based pedagogy as an indicator of professional teachers is often indicated by teachers who understand TPACK. TPACK has been widely researched by prospective teachers using questionnaires to determine teachers' understanding of TPACK abilities as knowledge. However, there still needs to be more research on TPACK as a skill carried out by teachers, for example, TPACK, which is included in their lesson plans. TPACK research is often carried out on student teachers during college and research on teachers who are currently teaching in schools. There needs to be more TPACK research on professional teacher education (TPE) students aiming to produce professional teachers.

TPE is an activity designed consciously and continuously to improve teacher quality. In-service TPE is attended by teachers who have taught for more than five years so that the teacher's teaching experience is long enough to design learning tools. The content and pedagogical abilities of teachers who have been teaching for more than five years are beyond doubt. However, content knowledge and technology-based pedagogy must be researched to understand pre-service teachers' TPACK abilities. TPACK research on teachers participating in the TPE program still needs to be higher. Researchers collected data using a questionnaire (Akhwani & Rahayu, 2021). This research also needs to analyze the components of TPACK, so it does not provide an overview of the capabilities of content, pedagogy, technology specifically, and TPACK as a whole. At UIN Mataram, in Islamic religious education studies, they also research TPE Daljab but

Vol. 1, pg. 316 - 328
ISSN: 3046-594X

have yet to analyze the TPACK components. This research only shows how to implement online TPE using LMS. So far, TPACK research has been carried out using survey techniques using questionnaires to find out teachers' TPACK knowledge (Ambaryati, 2019; Azhar & Muchtar, 2022; Fajero et al., 2021; Graham et al., 2009; Kaplon-Schilis & Lyublinskaya, 2020; Manik & Shareef, 2014; Sativa et al., 2023; Yurinda & Widyasari, 2022). Only a little has been studied about TPACK, which results from teacher performance, such as learning implementation plans, especially for teachers taking professional education. TPACK ability is the ability that teachers have in designing learning plans and implementing them in learning.

TPE is carried out to improve teachers' quality so that they become professional teachers. The "Daljab" TPE learning model is carried out online, allowing teachers to learn technology. Technology learning for TPE teachers begins when teachers register for the TPE program. When implementing TPE, teachers are provided with content appropriate to their subjects. TPE teacher TPACK analysis must be carried out as reflection material for TPE managers. The TPACK of teachers who take part in TPE can be used as a guide to determine the program's effectiveness. The TPE program deepens the material and pedagogy, followed by workshops to design learning implementation plans and classroom action research. At the end of the TPE program, students carry out online teaching practice. The implementation of TPE is carried out online so that all activities, including giving and carrying out assignments, are carried out through an application, namely the learning management system (LMS).

Teaching practice is also carried out online, and students are assigned to make learning videos after teaching practice. The PTK report is prepared at the end of the TPE program, namely when students take part in practical field experience. Knowledge and skills in using technology are applied in TPE so that after graduating TPE students are expected to master technology-based content and pedagogy. Even though they have been equipped with TPACK, in reality, there are still many TPE students who are unable to use technology in learning because they are assisted by friends or family when doing assignments, so it is necessary to know in detail the actual capabilities of TPACK from the learning tools they have prepared. The learning plan is one part of the learning tool

The learning implementation lesson plan is a learning design designed by the teacher and has the potential to use TPACK (Harris and Hofer, 2011). The lesson plan design is an indicator for measuring teacher quality (Astawa, 2015). Teachers who can design TPACK-based learning mean they have good TPACK skills. Teachers' mastery of content and technology-based teaching methods encourage students to think higher. Teachers who design TPACK-based lesson plans have the opportunity to improve higher-order thinking abilities (HOTS) (Manik & Shareef, 2014). This research aims to find out (1) how the components of pedagogical knowledge (PK), content knowledge (CK), and technological knowledge (TK) influence TPACK? (2) the influence of TPACK and its

TPACK components (TK, PK, CK, TPK, TCK, and PCK) in lesson plan design on high-order thinking skills (HOTS) abilities.

METHOD

The type of research used is quantitative descriptive (Creswell, 2014) to determine the influence of pedagogical knowledge (PK), content knowledge (CK) and technological knowledge (TK), pedagogy-based content knowledge (PCK), technology-based content knowledge (TCK), knowledge technology-based pedagogy (TPK) on TPACK and HOTS and the magnitude of the influence of each TPACK component on TPACK (Creswel and Clark, 2007). The research subjects were TPE Madrasah Ibtidaiyah UIN Sunan Ampel Surabaya students in 2022. The respondents involved in this research were 20 people from cities throughout Indonesia. The research steps include (1) collecting TPE student lesson plans, (2) preparing lesson plan assessment rubrics with indicators for each TPACK component, and (3) assessing TPE students' lesson plans. Data on TPACK ability scores and their components and higher thinking abilities were obtained based on an assessment of the TPACK and HOTS indicators. The data was then analyzed by path using SmartPLS with details of model accuracy testing, hypothesis testing, and the influence of exogenous variables on endogenous variables.

RESULT AND DISCUSSION

TPACK components have the potential to influence TPACK abilities (Habibi et al., 2020; Kaplon-Schilis & Lyublinskaya, 2020; Masrifah et al., 2018; Santos & Castro, 2021; Tanak, 2020) and higher-order thinking (Goradia, 2018; Long et al., 2022; Wijnen et al., 2021). The research results show that pedagogical abilities (PK) influence technology-based content (CTK), technological abilities (TK) influence technology-based pedagogy (TPK), and technology-based pedagogy (TPK) influence technological pedagogical content knowledge (TPACK). Content, pedagogy, and technology do not influence HOTS. Complete hypothesis test results can be seen in Table 1.

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Vol. 1, pg. 316 - 328
ISSN: 3046-594X

Table 1. Hypothesis Test Results for Exogenous and Endogenous Variables

TPACK and HOTS	Original Sample (O)	T Statistics (|O/STDEV|)	P Values	conclusion
PK -> CTK	0.734	9.937	0.000	Significance
CK -> HOTS	-0.064	0.176	0.430	No Significance
PCK -> HOTS	0.601	1.570	0.059	No Significance
TK -> HOTS	-0.015	0.025	0.490	No Significance
TPACK -> HOTS	-0.276	0.618	0.269	No Significance
TPK -> HOTS	0.619	1.102	0.136	No Significance
CK -> PCK	0.335	0.616	0.269	No Significance
PK -> PCK	0.372	0.723	0.235	No Significance
CK -> TPACK	-0.080	0.357	0.361	No Significance
CTK -> TPACK	-1.104	1.522	0.064	No Significance
PCK -> TPACK	0.071	0.321	0.374	No Significance
TK -> TPACK	0.443	1.095	0.137	No Significance
TPK -> TPACK	1.525	1.850	0.032	Significance
PK -> TPK	0.016	0.097	0.461	No Significance
TK -> TPK	0.887	5.782	0.000	Significance

The calculation of the R square value can be seen in Table 2.

Table 2. R square value of TPACK and HOTS components

Component of TPACK dan HOTS	R Square	R Square Adjusted
CTK	0.539	0.514
HOTS	0.680	0.565
PCK	0.474	0.412
TPACK	0.828	0.767
TPK	0.812	0.790

Based on Table 2. above, the regression equation obtained is as follows:

1. CTK = 0.734*PK, R square = 0.539
2. HOTS = -0.064*CK + 0.601*PCK – 0.015*TK – 0.276*TPACK + 0.619*TPK, R square = 0.680
3. PCK = 0.335*CK + 0.372*PK, R square = 0.474
4. TPACK = -0.080*CK – 1.104*CTK + 0.071*PCK + 0.443*TK + 1.525*TPK, R square = 0.828
5. TPK = 0.016*PK + 0.887*TK, R square = 0.812

In equation 1, the R square value of CTK is 0.539, meaning that CTK is influenced by PK by 53.9%, and other variables influence the rest. The PK path coefficient value is 0.734 (positive). If PK increases by one, then CTK increases by 0.734, and vice versa.

International Conference on Teaching and Learning Proceeding
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UTCC, South Tangerang, Banten, November 18th 2023
Vol. 1, pg. 316 - 328
ISSN: 3046-594X

Equation 2 The R square value of HOTS is 0.680, meaning that HOTS is influenced by CK, PCK, TK, TPACK, and TPK, 68.0% of which is influenced by other variables. However, the path coefficient value of the CK variable is -0.064 (negative). If CK increases by one, then HOTS decreases by 0.064. The P value shows that CK does not affect HOTS. The PCK path coefficient value is 0.601 (positive). If PCK increases by 1, HOTS increases by 0.601, but PCK does not affect HOTS. The TK path coefficient value is -0.015 (negative). If TK increases by 1 unit, HOTS decreases by 0.015, and TK does not affect HOTS. The TPACK path coefficient is -0.276 (negative), and TPACK does not affect HOTS. The TPK path coefficient is 0.619 (positive). If TPK increases by 1, HOTS increases by 0.619, and TPK does not affect HOTS.

Equation 3 shows the R square PCK value of 0.474, meaning that CK and PK influence PCK, while other variables influence the remaining 47.4%. The CK path coefficient is 0.335 (positive), but CK does not affect PCK. The PK path coefficient value is 0.372 (positive), and PK does not affect PCK

Equation 4 shows the R square value of TPACK 0.828, meaning that TPACK is influenced by CK, CTK, PCK, TK, and TPK, and the remaining 82.8% is influenced by other variables. The CK path coefficient is -0.080 (negative), and CK does not affect TPACK. The CTK path coefficient is -1.104 (negative). If CTK increases by 1, TPACK decreases by 1.104, and CTK does not affect TPACK. PCK path coefficient 0.071 (positive). If PCK increases by 1, TPACK increases by 0.071, but PCK does not affect TPACK. The TK path coefficient value is 0.443 (positive), but TK does not affect TPACK. The TPK path coefficient is 1.525 (positive), and TPK influences TPACK.

In equation 5, the R square value of TPK is 0.812, meaning that TPK is influenced by PK and TK by 81.2%, and other variables influence the remaining 81.2%. The PK path coefficient is 0.016 (positive), but PK does not influence TPK. TK path coefficient 0.887 (positive). TK has a significant influence on TPK. The relationship and magnitude of the influence of the TPACK. TPACK components (TK, CK, PK, TPK, TCK, and TPK) on TPACK and HOTS can be seen in Image 1.

Vol. 1, pg. 316 - 328
ISSN: 3046-594X

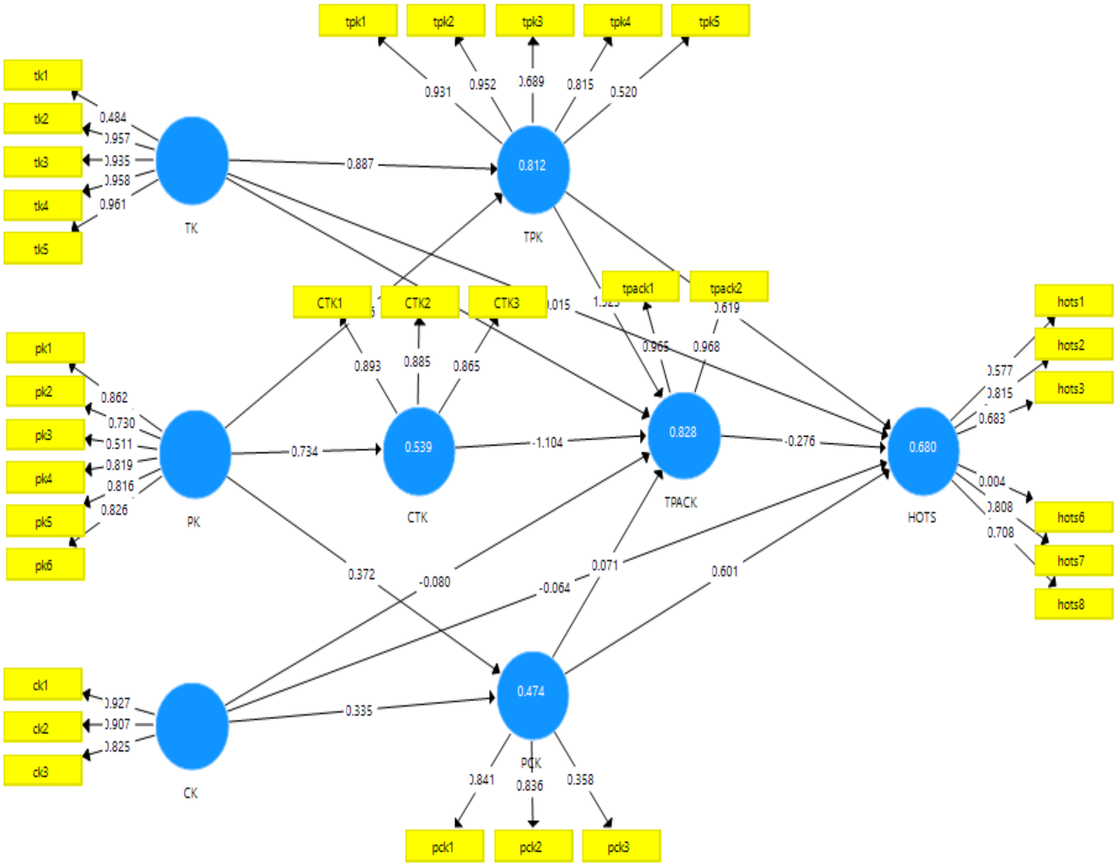

Image 1. Path Analysis of the Relationship Between TPACK Components (TK, CK, PK, TPK, TCK, and PCK) and HOTS

The research results show that pedagogical knowledge (PK) influences technology-based content knowledge (CTK), technological knowledge (TK) influences technology-based pedagogical knowledge (TPK), and technology-based pedagogy (TPK) influences technology-based pedagogical content knowledge (TPACK). Content knowledge, pedagogy, and technology did not influence HOTS. Pedagogical knowledge (PK) influences technology-based content knowledge (CTK). This means that teaching ability influences the way technology-based material is delivered. A teacher must have knowledge about how to develop learning indicators and learning objectives from basic competencies which are part of the curriculum. Pedagogical knowledge also includes adjusting competence to the material, suitability of the material to the character of the students, organization of the material (related to the consistency and systematics of the material), suitability of the material to the time allocation and depth and breadth of the material based on previously prepared indicators. The ability to select and organize material greatly determines the capabilities of technology-based content. TPE students know how to organize and select teaching materials so that they influence technology-based content knowledge. Students understand how to teach the content so that it is better understood by students using technological assistance following the objectives and indicators, time allocation, characteristics of students, and depth and breadth of material that students must learn.

This pedagogical knowledge is essential to facilitate students understanding of the content they are studying. This is under research results that TPE students' pedagogical abilities and knowledge (PK) influence technology-based content knowledge (CTK). The path analysis results show that the PK path coefficient value is 0.734 in a positive direction. This means that if PK increases by 1 unit, CTK increases by 0.734. Increased pedagogical knowledge will improve the ability to teach technology-based material because teachers better understand how to teach the material to increase student understanding. For example, to teach the solar system, a teacher uses internet-based audiovisual learning media taken from the YouTube platform to teach the material. Madrasah Ibtidaiyah students have concrete thinking characteristics, so teaching this material requires technology to increase students' understanding. If the teacher does not have pedagogical knowledge, the teacher will not have time to think about taking videos on YouTube to teach the material. Videos about the solar system vary widely, from simple ones for early childhood students to junior high school. Selection of videos related to the depth and breadth of material about the solar system is essential so that the material taught follows the objectives and indicators that have been previously designed.

Teaching knowledge influences the teacher's ability to select and organize material content into content-based technology that is easier for students to understand. Pedagogical capabilities make it easier for teachers to design learning media with unique learning content, for example, creating video-based learning media that can be uploaded to YouTube or images that are easier to understand. Video media increases understanding of content (Ampomah, 2018). Making learning media on this material is mainly based on complex and abstract material. Learning digestive system material using technology-based media helps students observe the abstract digestive process. Pedagogical abilities are closely related to technology. Teachers who understand technology can teach material according to the material's characteristics, the students' characteristics, and the infrastructure that supports learning. This research shows that technological knowledge (TK) influences knowledge of technology-based pedagogy (TPK). The path analysis results show that the TK path coefficient is 0.887 in a positive direction. This means that if TK increases by 1 unit, TPK increases by 0.887.

A person's ability to use technology inspires him to teach better using technology. Technology-based pedagogical capabilities relate to the teacher's ability to teach using technology. Flip learning is an example of teacher technology capabilities for technology-based learning. This flipped learning increases student involvement in the learning process inside and outside the classroom. Student activity and involvement have the potential to increase understanding. The technological ability to create Google Forms will increase teachers' abilities in technology-based teaching by utilizing technology to make

Vol. 1, pg. 316 - 328
ISSN: 3046-594X

the assessment process more accessible and the results more accurate. Teachers' knowledge in the technology field makes it easier for teachers to teach, for example, when compiling technology-based student worksheets, which makes it easier for students and saves time because it can be done through an application. When carrying out attitude assessments that require time and speed, appropriate technology can help. Technology can increase student learning activities (Ashoumi & Shobirin, 2019). For example, when students use Google Classroom, students can carry out discussion processes online.

Technology-based pedagogical knowledge (TPK) influences technology-based pedagogical content knowledge (TPACK). The indicator of a teacher with technology-based pedagogical abilities is using technology to introduce it to the real world in learning, using technology in accordance with learning strategies/models/methods. Teachers can use technology in learning activities and assessments, teachers can facilitate students to think at a higher level through the use of technology to build knowledge and are able to provide technology-based classrooms/learning environments. Knowledge of technology-based pedagogy facilitates students using technology to build knowledge. Information and knowledge are available online and can be accessed anytime and anywhere. Teachers must help students build their knowledge based on the information available in the technology space. The path analysis results show that the TPK path coefficient is 1.525 in a positive direction. This means that if TPK increases by 1 unit, TPACK will increase by 1,525. The analysis results also show that TPK influences TPACK. Teachers who have TPACK knowledge will use content knowledge, technology, and pedagogical knowledge to realize effective learning.

Teachers who can use technology to introduce the real world to learning or bring learning into other situations will cause learning to become more meaningful. Technology-based pedagogical knowledge and skills, such as using technology to introduce students to the real world in learning, for example, with augmented reality, can facilitate students to achieve their learning goals (Costa et al., 2020; Hwang et al., 2016; Wu et al., 2018). For example, using technology, teachers can show food moving along the digestive tract and heart rate. Teachers with knowledge of technology-based pedagogy will be able to use technology in accordance with learning strategies/models/methods and use technology in learning and assessment activities. Teachers who can use technology for learning activities and assessments are millennial teachers who are suitable for teaching the millennial generation. Professional teachers are teachers who can teach according to student characteristics so that students can learn comfortably and achieve learning goals.

Increasing higher thinking abilities through technology is realized if technology is used following the learning model. Technology only helps TPE students to complete their pedagogical abilities to improve higher-order thinking skills (Esomar et al., 2022) and build knowledge, even though all TPACK components do not directly influence higher-order thinking abilities (HOTS). TPE students have gained pedagogical and

Vol. 1, pg. 316 - 328
ISSN: 3046-594X

content knowledge during their studies at college. Most of the teachers who take part in the TPE program do not receive technology learning, but when taking part in TPE, the technology that supports the learning process is taught starting from the TPE registration process. Teachers who do not have technological knowledge will need help teaching using technology (Wakhidah et al., 2021). Technology can be learned quickly because, currently, all activities are carried out through technology-based applications. During the Covid 19 pandemic, teachers had no difficulty teaching using technology.

The 21st century requires high-level thinking taught in formal education, so it needs to be taught to TPE students. The research results of all TPACK components do not affect TPE students' HOTS, so it is recommended for TPE managers consider modules that teach higher-level thinking and train TPE students to design learning to foster higher-level thinking in students. This thinking skill is essential in problem-based learning and project-based learning. These two learning models are following the implementation of the Merdeka curriculum. Students need to learn HOTS from modules and workshops in the TPE program on an ongoing basis.

CONCLUSION

When students participate in TPE, they learn about material content according to the subjects they teach, get a refresher on teaching and assessing learning outcomes, and gain technological knowledge from registration to the final test. The research results show that pedagogical abilities (PK) influence technology-based content (CTK), technological abilities (TK) influence technology-based pedagogy (TPK), and technology-based pedagogy (TPK) influence technological pedagogical content knowledge (TPACK). Content, pedagogy, and technology do not influence HOTS.

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Vol. 1, pg. 316 - 328
ISSN: 3046-594X

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