Technological Pedagogical Content Knowledge Analysis

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Article Info	Abstract
	The ability to understand content and pedagogical knowledge are two non-negotiable things that must be mastered by teachers. In today's digital era, teachers are required to understand and be adaptive to the use of technology, so that knowledge of content, pedagogy, and technology becomes an important point of teacher knowledge today. This study purpose to analyze the ability of students' technology pedagogic content knowledge of prospective mathematics teachers by using qualitative descriptive methods. The research subjects are prospective students of mathematics teachers at universities in Bandung Indonesia who are researching the final project of scientific work in junior high school. The research instruments were in the form of questionnaires, observations and interview formats. Activities in data analysis include data collection, data reduction, data presentation and data verification. Document analysis includes the learning process, lesson plans, implementation of learning, use of information technology-based learning media, evaluation of learning, reflection of the learning process, results of questionnaires and interviews. The findings show that students' abiligy to have knowledge of technology pedagogical content for prospective mathematics teachers is in a good category. Students are already skilled at deciphering big ideas. Prospective teachers have been able to develop learning implementation plans and carry out learning in accordance with the 2013 curriculum companion guidelines. Overall, understanding of the pedagogical content knowledge of teachers' technology needs to be improved when utilizing integrated and effective learning technology, so that teachers are more adaptive to the technology used appropriately and effectively wise.

INTRODUCTION

Application of technology plays an important role in the development of learning devices, based on Technological Pedagogical Content Knowledge (TPCK) as one of them to design abstract mathematics learning materials into concrete through the software application. TPCK is a key component of the combination of technological knowledge, curriculum, mathematical and pedagogical content, which influences the learning process of professional teachers. The professionalism of teachers has important roles, develops and enhances effectiveness of learning through competence in making learning process planning, conducting teaching activities, implementing appropriate learning strategies, analysis of students' character, encouraging participants students to reveal their ideas more creatively and respect each other's opinions, as well as the implementation of evaluation to achieve effective learning objectives [1]–[3]. ducators must have a high level of competence and commitment in carrying out their responsibilities, nurturing, improving, and expanding knowledge and skills to professionally implement the learning process.

Empirically, in reality there are still low quality academic competence of some educators that not in accordance with the expected potential because of technophobia. The results of the survey

include finding a number of mathematical activities that are deemed difficult, whether by students or educators to learn it, even teach it. Mathematics is a science that is difficult to learn and teach [4]. Many educators use teaching materials and student worksheets, just use it, just buy it, instant, and without effort to plan, prepare, and organize themselves. So the learning is meaningless. Educators are lacking the basic knowledge to make learning planning programs more effective [5].

Mathematics teachers lack control over technology used, insufficient school facilities, and less commonly students in using technology while learning [6]. It seems that the complexity of the problem that educators are facing, how the math learning situation is now, the view of mathematics is different from time to time, it actually does not alter the mathematical structure itself, but it gives implications on how to learn math better and how to teach more meaningful math. As an effort to improve educators' quality in mathematics learning. TPCK needs to be socialized to educators to face challenges and anticipate issues in the classroom.

PCK can be achieved through education reform that relies on the role of professional educators as a central agent of learning in the classroom, which reform the knowledge and character and culture of the students. Quality improvement became very crucial and focused on the attention of many parties [7]. The professionalism of educators needs to be developed by enhancing the pedagogic competencies developed Shulman [7], [8]. There are seven components of PCK knowledge formulated by Shulman (1) material; (2) Pedagogic; (3) Pedagogic content; (4) Curriculum; (5) Learners and their characteristics; (6) Teaching strategies; (7) Context of learning. [9] states that the 7 components have a positive and significant relationship. [10] simplified 7 components into 6 by combining TPK and TCK into TPTCK. Research using the TPACK framework has been conducted to explore the use of ICT in learning mathematics subjects [9], [11], [12]. Research on understanding TPACK is also related to age and length of teaching [12], [13] or by sex [14], [15] where these three factors affect several TPACK components. In accordance with the results of research [16] that TK, PK, and TPK and TCK are considered to have a positive direct effect on teacher TPCK.

Pedagogical Content Knowledge (PCK) educators can influence teaching styles in a better direction, and can influence educators in implementing learning strategies, valuation techniques and general issues such as class management and time management [17]. One representation of PCK is CoRe (content representation) and PaP-eR (pedagogical and professional experience repertoire), the CoRe developed by [18]contains descriptions of material, students, learning and assessment strategies, and PaP-eR is a teacher's reflection in the form of narrative after practicing. CoRe, PaP-eR is a resource folio that represents PCK's ability of an educator.

Technological Pedagogical Content Knowlegde (TPCK) became a topic lately discussed in the educational world, to maximize the process and outcomes of learning especially in mathematics learning that requires special attention. For prospective teachers, the TPCK research has become an alternative in understanding the complex relationship between content knowledge and pedagogic knowledge through classroom learning. The findings of [19], [20] that the enhancement of PCK is able to articulate the knowledge of educator content as well as knowledge in the academic domain with general pedagogical knowledge, in addition PCK established a knowledge base for educators, guiding decisions and actions in the classroom. The TPCK framework has served as a guide to dismantle lessons integrated with ICT; to develop ICT competencies among teachers in teacher education, to design the use of ICT in the classroom and to compile literature reviews

relating to ICT or educational technology [21]. TPCK has been described as located, complex, diverse, integrative and/or transformative in the knowledge domain [22].

The study [18], [23] indicates that for beginners the prospective teachers desperately need a TPCK because they can contribute in informing effective methods for the implementation of learning in the classroom. [24] reveals related CoRe, that students of mathematics teacher candidate can plan activities in the learning process that has the appropriate content of material taught with his pedagogically, CoRe developed by asking teachers or prospective teachers to think about what they consider "great ideas" related to a specific topic based on their experience. The use of technology, CoRe, PaP-eR for the development of prospective teachers has a lot of impact because of the thought outcomes found from novice teachers or prospective teachers can be applied directly in the classroom so that when finding lack in the ideas they pour, they can rethink to improve the quality in the next learning process [23], [25] uncover that TPCK's learning design improves the quality of teacher mathematics learning.

The role of teachers cannot be replaced even with very sophisticated technology, responding to this requires teachers who are ready to take advantage of technology. The hope of students that they are able to use technology properly must be supported by the competence of teachers in applying or delivering the technology. TPACK and the ability to arrange learning tools for prospective teachers have increased due to the treatment given[26] Content representation (CoRe) has a role in supporting teacher professionalism in teaching through the development of pedagogic content knowledge (PCK), however, especially novice teachers do not have a knowledge base that combines content knowledge and pedagogy called pedagogic content knowledge (PCK) [23]. The focus of this research is to analyze the ability not only on PCK but on TPCK which is viewed from the ability of prospective mathematics teacher students in designing lesson plans, implementing the learning process, evaluating learning at each meeting, the ability to narrate PaP-eRs during reflection, and the ability of prospective teachers to integrate technology in the learning process of mathematics based on the pedagogic content knowledge framework of technology. Through qualitative descriptive methods, the analysis indicate that the TPCK ability of the prospective mathematics teacher students in preparing CoRe, narrating PaP-eRs, and integrating technology in the mathematics learning needs to improve specifically when creating integrative and effective learning technologies.

RESEARCH METHOD

Qualitative descriptive methode, the subject of five students of mathematics teachers who conducting they research in junior high school using media-based information technology in Bandung. The instrument consists of the CoRe aspects, the format of learning Implementation plan, the format of learning process, learning format based on information technology, learning evaluation format, PaP-eRs aspects format, poll, observation format and interviews.

The procedure consists of (1) preparations, including: performing observations for the identification of problems, determining the source of the data, arranging the instruments in the form of an observation sheet, infiltrates the CoRe documents, PaP-eRs, and learning implementation plan, questionnaire sheet, interview guidelines. The last phase of validation of instruments performed by experts, (2) Implementation stage, filling in CoRe document, Analysis of learning implementation plan, documentation of learning process, observation analysis, narrative of reflection form that will be analyzed based on PaP-eRs document analysis guidelines.

Furthermore, researchers give questionnaire sheets to prospective teachers to fill out and conduct interviews as follow-up from the questionnaire responses (3) The final stage of research is the conclusion. In the conclusion, analysis, discussion, and conclude the results of the study in a descriptive form of analysis of observation formats, documentation, questionnaires, and interviews must be done.

RESULTS AND DISCUSSION

The ability of prospective mathematics teachers to build CoRes with an average acquisition of 77.2% (good). According to [27] that prospective teachers are only able to identify a common misconception in students and are still general in identifying factors that affect the extent of supporting facilities. The ability in the process of implementing average learning achievement every aspect is 81% (very good). As in one study shows that the teacher's skills in conducting an apperception still exist ignoring very basic skills such as at the beginning the teacher directly go into the core learning activities and cause the students lacks mentally in learning [28].

The ability of students of teacher candidate to target PaP-eRs earns an average of 77.4% with good categories.The ability of students of mathematics teacher candidate in applying technology in the process of mathematics learning in the framework of technological knowledge, technological content knowledge, and technological pedagogical knowledge. The results of the research of [29] revealed that in TPCK component the most affecting capability is the integration of technological knowledge and pedagogical content knowledge components. Teacher's pedagogical content knowledge relates to how teachers teach a content to be easily understood by students. Through this TPCK capability, it will affect prospective teachers' knowledge related to the learning technology used to facilitate students to understand the material to be taught. Technological capability is a highly contributing capability to the learning process [30]. Prospective teachers are required to have sufficient technological knowledge. So they can adapt to changes in the field of technology and information according to daily life. Technology utilization can be an alternative to improving the learning process.

The utilization of website media on the learning plan already included in the very good category. Media made in accordance with the steps, before the implementation of learning, materials and ICT-based application media has validated by the experts, the planning process in the category is very good at the level of 91%, producing media websites in the category quite 75% has been adjusted to the ability and has participated in training or learning related to website creation on computerized-based mathematics learning courses 75%. Then the utilization of media based on information technology in the implementation of learning has a very good category (83%) Increasing students' knowledge of technology, abstract material into concrete by instructing the concrete media as in the steps on the website, can learn the material wherever and whenever and students can discuss with other students and teachers because there are columns that facilitate students to discuss. The Website is more simple, interesting, fun and make learning more meaningful, prospective teachers' ability in the evaluation of learning, overall is good. The following is a profile of the technology integration of five prospective teacher students.

Table 1. Technology Integration Profile in TPCK

Name	TK	TCK	TPK	Average	Criteria
A	77.24	75.30	76.00	76.18	Good
B	65.50	67.83	75.16	69.50	Good
C	76.00	72.42	77.52	75.31	Good
D	65.43	75.31	75.35	72.03	Good
E	75.00	74.24	77.24	75.50	Good

Based on the table 1 shows that all prospective mathematics teacher students are already accustomed to integrating technology in mathematics learning. The TK, TCK, and TPK frameworks are in the good category because they have already received ICT-based interactive media application courses in mathematics learning.
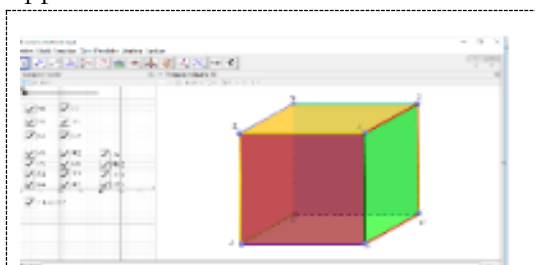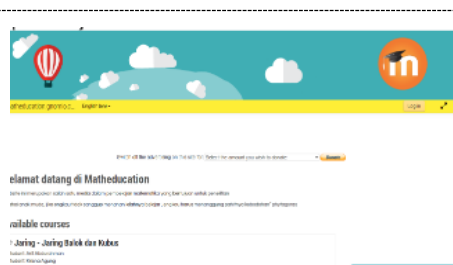

Figure 1. GeoGebra application
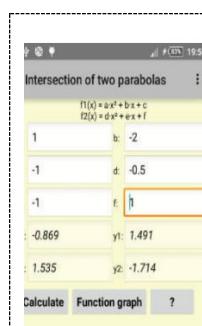

Figure 2. Moodle application

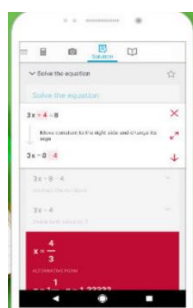Figure 3. Math Expert application

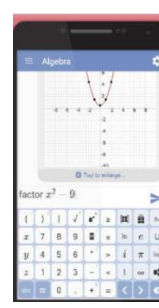Figure 4. Photomath application

Figure 5. MathWay application

The obstacles faced by prospective mathematics teachers based on the results of interviews and observations to the five prospective teachers who become the subject: Prospective teachers are struggling in expressing the CoRe poll answer because of the deeper peeling of every big idea,

difficulty in The PaP-eRs not in accordance with the implementation of the learning. Less equitable technology facility in schools, facilities and infrastructure including LCD projectors that are difficult to connect, LCD projector display is small and less well causing materials that have been made with various colors can not be displayed. There is no Internet access at school that causes prospective teachers to prepare their own Internet access for students to keep learning with technology. Overall, students struggle to resolve non-routine problems that are open ended that demand a varied solution. Students are not yet accustomed to use technology in the learning process, so they need the accompanying teachers to take advantage.

CONCLUSION

Pedagogical Content Knowledge capability of students of mathematics teacher candidate in drafting the CoRe, designing learning implementation plan has gained a good category, implementing the learning process is included in the excellent category, evaluation of learning at each meeting By providing students with a group's work sheet training in good category. Ability to narrate PaP-eRs during reflection is included in a good category. The ability of prospective teachers to integrate technology in the mathematical learning process based on the technological pedagogical content knowledge framework is already in good category. The involvement of applying technology to mathematics teaching conducted by prospective teachers, including the content taught, strategies used, school facilities, and the aspects used by prospective teachers consist of Internet, projectors, laptops, Mobile phones, Math Experts, Photomath, MathWay. GeoGebra, Moodle. Students of mathematics teacher candidate are troubled in arranging words in filling the CoRe poll and put the PaP-eRs and prospective teachers less skilled to master the technology used, the school facilities are inadequate, and students are less accustomed to use technology in the learning process, so the suggestion for further research is that all prospective teachers must deeply understand about TPCK and think about creating theirs mathematics learning device that suitable with the methods.

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