



Profile of Technological Pedagogical Content Knowledge (TPCK) of Prospective Teachers in Atomic Structure Material

Ferghana ✉, Sigit Saptono, Wiyanto

Universitas Negeri Semarang, Indonesia

Article Info

Article History:

Received January 2019

Accepted May 2019

Published December 2019

Keywords:

TPCK, Technology,
Atomic Structure

Abstract

The purpose of this study is to analyze the TPCK ability of the prospective teachers in preparing, planning, and implementing of learning on atomic structure material. The type of research is a descriptive study with qualitative design. The research subjects were ten prospective teachers who were implementing the PPL in five Senior High Schools in Banda Aceh. The data collection was done in three stages, identifying the CoRe instrument, analyzing the teaching plan, observing the prospective teachers learning. Firstly, the results showed the TPCK ability of the prospective teachers in preparing of learning is in a good category, but the ability in the CK, PK, TCK and TPK components are still low. Secondly, the TPCK ability of prospective teachers in the planning are at the moderate category, but average of the prospective teachers ability in the PK, TPK, PCK, and TCK components are still low. Lastly, the TPCK ability of prospective teachers in implementing of learning is in a good category, but the analysis of the components of PK, CK, TPK and TCK scores of prospective teachers are still low.

© 2019 Universitas Negeri Semarang

✉ Correspondence Address:

Campus Unnes Kelud, Semarang, 50232, Indonesia

E-mail: Ferghana@ymail.com

p-ISSN 2252-6412

e-ISSN 2502-4523

INTRODUCTION

The development of the 21st century has given the rise of a new paradigm in education. The change in the educational paradigm in the 21st century focuses on developing and mastering technological capabilities in learning. These changes include: easier to find learning resources, more choices for using and utilizing ICT, the increasing role of media and multi media in learning activities (Budiman, 2017). The creativity and the ability of prospective teachers to design interesting learning activities is very important. The skill of prospective teachers who are the focus of learning in the 21st century is in mastering information and technology media (ICT). The prospective 21st century teachers are required to not only be able to teach and manage classroom activities effectively, but also to build effective relationships with students and the school community, to use technology to support the improvement of the quality of learning, as well as to reflect and continually improve learning practices (Darling, 2006).

Technology is not a taboo for students, which is not directly for students, it must be for each student. They use internet, cellphones and SMS as daily life. Many students use social media such as Facebook and Twitter. It means that students are now familiar with technology while the teachers are not. As the result, there is a gap between students and teachers who do not use technology in their classrooms (Sari, 2014). Therefore, the prospective teachers in the 21st century are required to be literate in technology, so that there is no gap when the learning process takes place.

To integrate technology in learning is not easy, in order to be able to choose the right technology, prospective teachers must master the material to be taught. The basic problem is whether the prospective teachers know how to use technology effectively in their teaching. The method of technology utilization will depend on the subject being taught, the learning objectives and the nature of the students. The facts showed teachers are still lack in using technology in

teaching learning process because of several obstacles. It is supported by the statement of Putriani & Sarwi (2014) that teachers do not use technology because of the lack of infrastructure such as LCDs that are not installed in each class, so that most teachers prefer the lecture method which results in learning being teacher-centered. The teacher learning innovation only uses discussion and practicum methods in the process of learning physics without optimally utilizing technology. Dewi et al. (2015) also revealed based on the results of observations that there were still few teachers who used computer technology to explain the material to their students. Many teachers prefer the lecture method in explaining material to students. An educator must have the ability to integrate three domains of knowledge namely, knowledge of technology, pedagogical knowledge, and knowledge of content. To integrate all these components, the prospective teachers need to use , a theoretical framework known as Technological Pedagogic Content Knowledge (TPCK) to understand this knowledge.

The TPCK framework was firstly developed by Mishra and Koehler based on the knowledge concept Pedagogic Content Knowledge (PCK) proposed by Schulman. TPCK is a complex form of knowledge that is important for prospective teachers. TPCK is the necessary knowledge so that a prospective teacher can use the right technology based on the analysis of the character of the material and analysis on aspects of pedagogy (Mishra & Koehler, 2006). The TPCK framework has also been developed for 21st century skills, and is used as a framework to develop prospective teacher readiness for 21st century skills (Figg & Jaipal, 2012; Mishra et al., 2010).

Atomic structure material is one of the subject matter found in high school chemistry class X semester 1. This main material discusses the development of atomic theory, atomic structure, number of protons, number of electrons, number of neutrons, atomic numbers, mass numbers, isotopes, isobars, isotons, and relative atomic masses. Atomic structure is an abstract concept and difficult to visualize, so it is

possible to create a variety of conception of students when they try to build the concept. The skills and creativity of prospective teachers in teaching these atomic structure materials need to be developed so that students can understand this material well. The TPCK framework is very suitable to be implemented in this material.

Based on the description related to the ability that the teacher needs to have in learning, then a study was conducted on the ability of TPCK owned by prospective teachers under the title "Profile of Technological Pedagogical Content Knowledge (TPCK) of prospective teachers in Atomic Structure Material".

METHODS

This type of research is a descriptive study with a qualitative approach to determine the TPCK profile of prospective teachers. The research subjects were ten prospective teacher students who were implementing the Field Experience Program (PPL) in five Senior High Schools (SMA) in the city of Banda Aceh. This research begins with collecting data on the ability of TPCK prospective teachers. The data collection on the TPCK ability of prospective teachers is carried out in three stages. The first stage of the teacher candidates filled out the CoRe instrument to identify the TPCK capabilities of prospective teachers before the implementation of learning in a particular topic. The second stage is to analyzes the learning planning by prospective teachers in the Learning Implementation Plan (RPP) that has been made. The third stage of observation is the implementation of TPCK in learning practices. The details can be seen in Table. 1.

Table 1. Data Collection of the ability of prospective teacher TPCK

Stages of Data Collection	Data collected	Data Collection Strategy
Stage I	TPCK ability of prospective teachers on certain topics	Teacher candidates fill the instrument in the CoRe format adapted from Loughran consisting of ten components Conducting interviews with prospective teachers related to CoRe produced
Stage II	The ability of prospective teachers in planning the learning process	The prospective teachers make lesson plans in accordance with the material content and applicable curriculum. The preparation of lesson plans is conducted at home and submitted after one week.
Stage III	The ability to implement TPCK in teaching and learning activities	Teacher candidates practice teaching and are observed using an observation sheet.

The data obtained from research results are processed in accordance with the following steps:

Data Analysis on TPCK Ability of Prospective Teachers before Learning Implementation

The CoRe instrument was analyzed by using scoring based on 10 components adapted from Loughran. The score is given between 1-3 for each component described by the prospective teacher. The scoring criteria 1-3 can be seen in the CoRe format assessment rubric. The results of the assessment are then interpreted with the TPCK teacher candidate ability level criteria table.

Table 2. Criteria for the TPCK Capability Level of Prospective Teachers before Learning Implementation

Value	Category
	Low
	Moderate
	High

(Azwar, 2015)

Data Analysis of TPCK Ability of Prospective Teachers in Planning Learning

The analysis is done by scoring the components contained in the Learning Implementation Plan (RPP) of prospective teachers. The scoring ranging from 1-4 for each RPP component described by the prospective teacher. The TPCK ability of prospective teachers in planning learning is shown in the results of calculations interpreted in Table 3.

Table 3. Criteria for TPCK Ability Prospective Teachers in Planning Learning

Value	Category
	Low
	Moderate
	High

(Azwar, 2015)

Data Analysis of TPCK Ability of Prospective Teachers in Learning Implementation

Data analysis of the TPCK ability of prospective teachers in the implementation of learning is by calculating the implementation score of learning. The analysis is done by

providing scoring on each component contained in the assessment sheet for the implementation of learning. The provided scoring is in the range of 1-3 from each component. Scoring results are interpreted in Table 4.

Table 4. Criteria for TPCK Ability Level of Prospective Teachers in Learning Implementation

Value	Category
	Low
	Moderate
	High

(Azwar, 2015)

RESULTS AND DISCUSSION

TPCK Ability of Prospective Teachers Before Implementation of Learning

The results of observations conducted on ten prospective teachers who are conducting the Field Experience Program (PPL) are summarized in Table 5.

Table 5. TPCK Ability of Prospective Teachers Before Implementation of Learning

No	Code	Score	Category
1	CG1	13	Low
2	CG 2	27	High
3	CG 3	18	Moderate
4	CG 4	19	Moderate
5	CG 5	27	High
6	CG 6	13	Low
7	CG 7	22	Moderate
8	CG 8	12	Low
9	CG 9	12	Low
10	CG 10	18	Moderate

The lowest score was obtained by CG8 and CG9 with a total score of 12 and CG1 and CG6 with a total score of 13. The four prospective teachers almost got score of 1 in each question-answer that was in the CoRe instrument. This explains that TPCK knowledge of prospective teachers is still very low, especially in the component of *Content Knowledge* (CK). In question number 2 regarding

consideration of concept selection, the four prospective teachers with the lowest score did not associate the concept with the development of science and technology and the benefits of daily life and student interest. In addition, the selection of learning strategies by prospective teachers also does not consider the condition of students. This means that the knowledge of prospective teachers in the Pedagogical Knowledge (PK) component is still low. Based on the interviews with prospective teachers, they have not been able to arrange learning strategies based on consideration of student characteristics because this material is the first meeting between prospective teachers and students.

Knowledge of prospective teachers in the Pedagogical Content Knowledge (PCK) component is also low. This can be seen in the answers of prospective teachers in questions number 4 and 5 regarding the identification of initial knowledge and learning difficulties, and consideration of learning. In question number 10 regarding the measuring instrument used to determine students' understanding of the concept, the four prospective teachers only use tests in the form of questions. The results of interviewing prospective teachers revealed that evaluations carried out using several questions save more time and facilitate prospective teachers because these questions can be found in some of the learning resource books. Furthermore, the prospective teacher with the category of moderate TPCK capability, namely CG3, CG4, CG7, and CG10 has good TPCK capabilities. Teacher candidates with high TPCK ability categories are CG2 and CG5. The significant difference between prospective teachers with the medium category and high category, is in term of the PCK component. Based on the results, the CG2 and CG5 interviews are also working as a tutor in one of the tutoring (BimBel) in the city of Banda Aceh. Therefore, their teaching experience can be a reference when filling out the CoRe instrument.

Overall, the use of the technology has not been able to achieve learning objectives to the fullest. This is indicated that the ability of

Technological Content Knowledge (TCK) and Technological Pedagogical Knowledge (TPK) are still low. In the CoRe instrument, questions that can show TCK's abilities are number 6 and 7. The technology used by prospective teachers has not been able to build an interactive learning atmosphere between teachers and students. The selection of strategies by prospective teachers based on the answers in the CoRe instrument in question number 8 shows the ability of the TPK to be able to foster active participation between students and teachers. This means that the selection of strategies by prospective teachers has not yet integrated with technology.

TPCK Ability of Prospective Teachers in Planning Learning

The results of the analysis of the TPCK ability of prospective teachers in planning learning on atomic structure material can be seen in Table 6.

Table 6. TPCK Ability Prospective Teachers in Planning Learning

No	Code	Score	Category
1	CG1	18	Moderate
2	CG 2	26	Moderate
3	CG 3	24	Moderate
4	CG 4	20	Moderate
5	CG 5	26	Moderate
6	CG 6	23	Moderate
7	CG 7	25	Moderate
8	CG 8	18	Moderate
9	CG 9	18	Moderate
10	CG 10	26	Moderate

Based on the results shown in Table 6. TPCK's ten candidates' ability in preparing lesson plans is in the medium category. The preparation of RPP by prospective teachers is quite good, but if each component of the TPCK is analyzed, the ability of prospective teachers is still low on several components. The results of the analysis of six components, the average prospective teacher scored low on the PK, TPK and PCK components. The PK component is seen in the selection of learning resources by

prospective teachers who have not used integrated or non-printable learning resources (CD / DVD, CD-ROM, online learning materials), prospective teachers still use learning resources in the form of books and worksheets. The average prospective teacher also has a low score on the TPK component, this can be seen in the closing activity. In the closing activity, there are no prospective teachers who integrate technology. The TCK ability of prospective teachers is also low, this can be seen in the selection of learning media that are still not able to build an interactive learning atmosphere between students and teachers. Even though the media selection has integrated technology, but the learning media here are only visualizations which certainly make students bored during their participation in learning.

TPCK Ability of Prospective Teachers in Learning Implementation

The results of the analysis of the TPCK capabilities of prospective teachers in the implementation of learning are presented in detail in Table 7.

Table 7. TPCK Ability of Prospective Teachers in Implementing Learning

No	Code	Score	Category
1	CG1	11	Low
2	CG 2	19	Moderate
3	CG 3	15	Moderate
4	CG 4	11	Low
5	CG 5	17	Moderate
6	CG 6	13	Moderate
7	CG 7	16	Moderate
8	CG 8	12	Moderate
9	CG 9	11	Low
10	CG 10	16	Moderate

The results of the analysis show that there are three prospective teachers with a low TPCK ability and seven teacher candidates with a moderate category. If it is analyzed based on the six components of the TPCK the scores obtained are still relatively low. The total score obtained by the average teacher candidate is almost close

to the lowest score on the criteria on evaluating the TPCK ability of prospective teachers in the implementation of learning. Average low scores is obtained by prospective teachers on the Pedagogical Content (PK) component. Prospective teachers cannot master the class properly. The selection of learning strategies by the teacher does not consider the conditions and characteristics of students. High scores obtained on the CoRe instrument and preparation of lesson plans do not guarantee that they can get a high score on the implementation of learning. One of them is the Content Knowledge (CK) component, some prospective teachers still get low scores on the implementation of learning, while on filling the CoRe instrument and the preparation of lesson plans the average prospective teacher gets a high score. This can happen because in the preparation of RPP the teacher claimed that the teacher often take pre-existing RPPs and revise slightly as needed.

At the core activities all prospective teachers use PPT as a learning medium. The use of technology in the form of PPT displayed with the help of this projector has not been able to activate students effectively in the classroom. The prospective teachers use PPT only as teaching tools in the form of visualization which make students not fully focus. Prospective teachers still use the lecture method to present the material available on PPT and have not been able to create active interactions between students and the media. In the closing activities, almost all prospective teachers do not use technology, including the evaluation activities. Based on observations, there are no prospective teachers who utilize technology from the opening activities to closing activities. The average utilization of technology is only carried out on core activities and only limited to the tools for material presentation / visualization. It means that the ability of TPK and TCK teachers is still low.

Discussion

Good teaching with technology has three core components: content, pedagogy, and technology. The linkages between technology

knowledge, content, and pedagogy strongly support students' ability to master concepts. Teaching using technology will result in improving quality of learning. In accordance with the opinion of Taufik et al. (2016) that improving the quality of good learning can be done by making innovation by developing learning that uses technology access. Therefore, to support learning in accordance with the 21st century prospective teachers are required to have good TPCK skills.

The profile of the prospective TPCK is important as an initial description of pedagogic competence, mastering the content (material) and technology by prospective teachers before they implement realteaching or actual learning at schools (Sukaesih et al. 2017). The significant integration of technology in learning is not an easy thing, especially for prospective teachers, in order to be able to choose the right technology, prospective teachers must master the material to be taught so that they can analyze the character of the material. In addition, prospective teachers must also consider teaching strategies that are appropriate to the technology including pedagogical knowledge (Tan & Kim, 2012). In the TPCK framework, pedagogy is an important aspect that needs to be considered in learning activities. Pedagogy is not only how to develop the arts in teaching or designing the completeness of process and assessment instruments in learning, but it is also required to understand students psychologically and biologically.

Based on the results of the overall analysis, prospective teachers have used technology in learning, but the technology used has not been effective in supporting HOTS-oriented learning in accordance with the 21st century, and the selection of learning models by prospective teachers has also not integrated with the technology. The average teacher candidate scores low on integrated components of technology, namely TCK and TPK. This explains that the ability of prospective teachers to integrate technology is still low.

CONCLUSION

Based on the results of the research and discussion that have been described, it can be concluded as follows:

The results of the analysis of the TPCK ability of prospective teachers before the implementation of learning on atomic structure material based on the filling of the CoRe instrument were included in the good category, namely only four out of ten prospective teachers had the lowest score. Although in average the ability of the TPCK before the implementation of learning prospective teacher is in the good category, the ability of the TPCK for prospective teachers in the CK, PK, TCK and TPK components is still low. The prospective teachers have not been able to apply technology that can include students in their use. So far the selection of technology used by prospective teachers is still limited to tools for material presentation / visualization.

The TPCK ability of prospective teachers in planning learning includes the overall category. Analysis of the component-based capabilities of TPCK showed that the ability of PK, TPK, PCK, and TCK on average was still low. Broadly speaking, the learning model used by prospective teachers still uses conventional learning models without the varied learning models. Besides, the selection of learning models are not integrated with technology, as well as the selection of learning resources, prospective teachers only use textbooks. The selection of measuring instruments / evaluation also does not utilize technology, prospective teachers still use test questions to measure learning success.

The results of the observation of the TPCK ability of prospective teachers in the implementation of learning are three teacher candidates with a low category and seven prospective teachers in the medium category. These results indicate that the TPCK ability of prospective teachers in the implementation of learning on average has been good, but the analysis of the TPCK component of teacher candidates' scores on the PK, CK, TPK and

TCK components is still low. The use of technology by prospective teachers is only as a tool to explain the material. During the observation there were no prospective teachers who used technology from the opening activities to closing activities. The use of technology is only carried out by prospective teachers in the core activities and is only visualized.

ACKNOWLEDGEMENT

Thank you to the Head of Syiah Kuala University's Chemical Education Study Program for giving research permission. Appreciations are also addressed to professors Postgraduate Study Program IPA Semarang State University who has guided the writing of articles and has motivated the researcher to conduct the research. As well as gratitude to all those who have helped to the completion of the writing of this article.

REFERENCES

- Azwar, S. (2015). *Penyusunan Skala Psikologi*. Yogyakarta: Pustaka Belajar.
- Budiman, H. (2017). Peran Teknologi Informasi dan Komunikasi Dalam Pendidikan. *Al-Tadzkiyyah: Jurnal Pendidikan Islam*, 8(1), 31-43.
- Darling, L. H. (2006). Constructing 21st Century Teacher Education. *Journal of Teacher Education*, 57(10), 300-314.
- Dewi, A., R., Y., Sarwi, & Yulianto, A. (2015). Penerapan Model Pembelajaran Kontekstual dengan Teknologi Multimedia untuk Meningkatkan Penguasaan Konsep dan Pengembangan Karakter Siswa SMA Kelas XI. *Unnes Physics Education Journal*, 4(3), 1-9.
- Figg, C. & Jaipal, K. (2012). TPACK-in-Practice: Developing 21st Century Teacher Knowledge. *Books Proceedings of Society for Information Technology & Teacher Education International Conference*. Texas: Research Gate, 4683-4689.
- Mishra, P. & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teachers College Record* (Online), 108(6), 1017-1054.
- Mishra, P., Koehler, M. J., & Henriksen, D. (2010). The 7 Transdisciplinary Habits of Mind: Extending The TPACK Framework Towards 21st Century Learning. *Educational Technology*, 51(2), 22-28.
- Putriani, E. D. & Sarwi. (2014). Implementasi Strategi TPCK dengan Media Simulasi Berbasis Inkuiri Terbimbing Pada Konsep Getaran dan Gelombang. *Unnes Physics Education Journal*, 3(2), 34-41.
- Sari, M. (2014). Blended Learning, Model Pembelajaran Abad Ke-21 di Perguruan Tinggi. *Ta'dib*, 17(2), 126-136.
- Sukaesih, S., Ridlo, S., & Saptono, S. (2017). Analisis Kemampuan Technological Pedagogical And Content Knowledge (TPACK) Calon Guru Pada Mata Kuliah PP BIO. *Lembaran Ilmu Kependidikan*, 46(1), 68-74.
- Tan, K. C. D. & Kim, M. (2012). *Issues and Challenges in Science Education Research*. New York: Springer.
- Taufik, M., Sudarmin., Savitri, E. S., & Amalia, A. V. (2016). Media Electronic Portofolio untuk meningkatkan Trend Prestasi Belajar Mahasiswa. *Unnes Science Education Journal*, 5(1), 1057-1064.