



Pedagogical Content of Spatial Thinking Geography of Prospective Teachers in AUE and YSU

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Abstract. The research aims to describe the level of understanding of pedagogical content of spatial thinking geography of students of prospective geography teachers in Aichi University of Education (AUE) and Yogyakarta State University (YSU). The results of the descriptive evaluation indicate that the majority of YSU and AUE students know and have a good understanding of pedagogical content knowledge of spatial thinking geography. The main obstacle faced by students deals with the teaching ability especially assessment and evaluation as a strategy to know learning outcomes.

Keywords: *geography, pedagogic, teachers, spatial thinking, prospective teacher.*

Introduction

Many definitions indicate that geography is a scientific discipline that is a link between humans and physical environment phenomena and social dynamics through spatial thinking. Jo & Bednarz (2014) explain that spatial thinking is an ability that deals with knowledge and understanding of spatial concepts, uses knowledge abilities flexibly, skills and habits of thought to utilize aids, and provides reasons for solving problems and making decisions. Spatial depiction can be done through cognitive reflexes that affect the symbol system as in geography manifested in the form of maps (Uttal, 2012). Lambert & Morgan (2010) state that geography focuses on the study of the location and

organization of human activities on earth. Spatial thinking becomes the main characteristic of geography subjects as a form of multidisciplinary knowledge to solve problems and make decisions (Metoyer & Berdnarz, 2017).

Conceptually, the geography learning paradigm is in line with the view of Bruner (2006) and Gardner (2006), namely the thought process of individuals as students to develop spatial thinking as a form of multidisciplinary knowledge. Branch (2014) argues that spatial thinking is critical thinking that should be owned by anyone in the education sector such as teachers. Geography teachers are expected to have the ability to use their knowledge and skills required to encourage students' spatial thinking skills in learning geography. The ability of geography teachers in managing learning will determine the level of success and the learning outcomes of their students. This ability is not gained spontaneously but through continuous and systematic learning efforts, both in the education of prospective teachers and while in office, which is enhanced by their talents, interests and other potentials of each individual.

Yogyakarta State University (YSU) Indonesia and Aichi University of Education (AUE) Japan are educational institutions that prepare prospective geography teachers who are professionals. Graduates are prepared to have rich geographical content and are able to integrate it into curriculum, learning, and student characteristics. They will become geography teachers who can design a learning atmosphere based on the needs of individuals and groups of students. Such knowledge is referred to Pedagogical Content Knowledge (PCK). Loughran, et al. (2006) and (NRC, 1996) state that PCK is an academic construction which integrates Subject Matter Knowledge (SMK) with Pedagogical Knowledge (PK) as a strategy to improve student learning. Patra and Guha (2017) describe that PCK has a multilevel effect on self-efficacy, and self-efficacy positively contributes to the effectiveness of geography teachers in teaching. Reitano and Harte (2016) use two types of PCK from Shulman (1986, 1987) to explore PCK prospective geography teachers. The first type of PCK is teachers' representations of content that is pedagogically powerful for students; the second type of PCK refers to teachers' understanding of specific topics: easy or difficult for students. Clausen (2016) states that PCK influences the perspective of geography teacher candidates in which learning is not only to improve student's knowledge but also to equip students to develop their own ideas when dealing with social problems.

The author, as a lecturer of prospective geography teachers, finds the problems faced by the students, i.e. the difficulty of integrating pedagogical knowledge with the knowledge of geography material perspective of spatial thinking as its scientific core. Jo & Milson (2013) state that geography teachers must be able to apply the concepts of Geography appropriately and accurately. Bonnett (2008) says that there is an integrated spatial link between physical (environmental) phenomena and humans (society) in geography learning. Geography as a subject in high school is a science that describes aspects and processes of the earth, a causal relationship between spatial factors, humans and their environment that is directed to give a contribution to the development. The geographic perspective on

the dynamics of the physical environment and the community environment is viewed from the aspect of spatial integration and spatial interdependence both between places and scales. Integration of spatial thinking in geography learning is sustainable innovation in the digital era through the use of geographic information system technology.

Swasono (2014) found poor geographic awareness of the students to recognize the space of national identity. Prasetyo (2013) identifies that prospective geography teachers in his class still do not recognize the names of large islands, the names of big cities, and mountains in the territory of Indonesia. Holt-Reynolds (2000) illustrates that prospective teachers often feel that there are large gaps between teaching practices and the theories they obtain. Prospective teachers often understand subject matter knowledge (SMK) separately and are not well-organized, therefore they find difficulties in accessing that knowledge when they have to teach it (Gess-Newsome, 1999). Many prospective teachers view that teaching is merely conveying information. Munby, Russell, & Martin (2001) state that one of the obstacles faced by prospective teachers is that they tend to underestimate the cognitive aspects of teaching. Based on the exploration addressed to 27 teachers in Yogyakarta in developing geographic pedagogical content knowledge spatial thinking perspective, 57% of teachers have difficulty integrating spatial thinking aspects in learning. The findings of Darmawanti et al. (2012) reveal that 24% of the ability of geography teachers to develop aspects of professional competence, namely mastery of material, structure, concepts, and scientific mindset are still in the poor category.

The research aims at describing the level of understanding on pedagogical content knowledge of spatial thinking perspective geography of students of prospective geography teachers in AUE and YSU. The process of producing high-quality teacher candidates including geography teachers becomes the responsibility of educational institutions such as AUE and YSU. The institution is expected to produce geography teachers who have a set of competency, knowledge, skills, attitude values, and behaviors needed for enhancing the teaching profession. Geography teacher candidates should be equipped with intellectual and mental readiness. Readiness to become a teacher of geography is a condition in which the prospective teachers have met the pedagogical requirements to be a teacher. Geography teachers in Indonesia and Japan are professional educators who have met the required academic qualifications and competencies. Based on the description above, the authors are interested to conduct research. The formulation of the research problems are: 1) How is the level of pedagogical content knowledge spatial thinking geography understanding of prospective geography teacher students at YSU and AUE? 2) What are the obstacles faced by prospective geography teacher students to understand PCK competencies? 3) What are the solutions to reduce PCK understanding barriers in order to be professional geography teachers?

The results of this study are expected to be used as a reliable media to confirm the educational paradigm shift of prospective geography teachers to develop PCK in learning. This research can strengthen, distinguish, or reject findings of the old paradigm.

Practically for lecturers of prospective geography teachers, this research can encourage for the success of lecturing. For the government, this result can become an input for making policy regarding the development of curricula that meet the competency needs of geography teachers in the field. The results of this study are expected to provide good feedback for both institutions in improving the quality of graduates and the quality of prospective geography teachers. Researchers do not have preliminary data related to pedagogical abilities at AUE, only on the basis of relevant theories. The number of respondents has not represented the actual population statistically so that it is categorized as a case study research. Research has not followed up with the strength of the items, as there is still limited expert judgment.

Method

The design of this research is a simple evaluative descriptive which describes the condition of prospective geography teachers at Department of Geography Education, Faculty of Social Sciences, YSU and Department of Social Studies, Faculty of Education, AUE, Japan. The respondents of this research were 105 final semester students of prospective geography teachers which include 40 AUE students and 68 YSU students. They were randomly selected from approximately 210 students. Prospective teacher students have taken Pedagogical Content of Spatial Thinking Geography course in the final semester. This pedagogical ability is taught to students in at least six semesters that are spread differently based on the provisions of each curriculum. This search was conducted from December 2017 to February 2018.

The variable feasibility and pedagogical content of spatial thinking geography factors are based on the recommendations of nine learning experts as panelists using the validity formula from Aiken (1996, 91) which is > 0.6 . The factors that have been generated from the process of logical validity by nine experts (expert judgment) in four fields are relevant to learning Geography with the perspective of spatial thinking (logical validity), namely: evaluation of learning, spatial thinking, geography material, and Geography learning. Table 1. presents the results of a hypothetical pedagogical content analysis of spatial thinking geography which is hypothesized consisting of two components as latent variables, namely pedagogical knowledge that produces 14 factors and Content knowledge of spatial thinking geography perspective that produces 10 factors. The results of Aiken's validation to assess the accuracy of indicators against pedagogical content of spatial thinking geography variables are between 0.78–1.00 with an average of 0.89. It means that the indicators or factors developed are precisely used to detail each variable that follows.

Aspects and variables of understanding on pedagogical content knowledge of spatial thinking perspective geography of students of prospective geography teachers are presented in table 1.

Table 1

Aspects and variables of understanding on pedagogical content knowledge of spatial thinking perspective geography of students of prospective geography teachers

Pedagogical Knowledge	Content knowledge of spatial thinking perspective geography
1. Understanding the characteristics of learners including the physical, moral, spiritual, social, cultural, emotional, and intellectual aspects.	1. Where a feature is located
2. Mastering theories and principles of learning that educates.	2. The way that a place is linked to other places
3. Developing a curriculum related to the subject matter being taught	3. How a place compares to other places
4. Organizing learning which educates	4. The influence that a location or feature exerts on other places
5. Utilizing information and communication technology for learning purposes.	5. A group of adjacent locations that have similar conditions or connections
6. Enhancing the development of potential learners to actualize various potentials.	6. Nested areas of different sizes or importance
7. Communicating effectively, empathically, and politely with learners.	7. The nature of change in conditions between two places
8. Performing an assessment and evaluation of learning processes and outcomes.	8. The similarity in the conditions of places as a consequence of another shared trait
9. Utilizing assessment and evaluation results for learning purposes.	9. A non-random arrangement of features or characteristics
10. Performing reflective actions to improve the quality of learning.	10. The degree to which similar phenomena occur in similar locations
11. Mastering the standard of competence and basic competence of the subjects that are taught.	
12. Developing learning materials creatively.	
13. Developing sustainable professionalism by taking reflective actions.	
14. Utilizing information and communication technology to perform self-development	

Furthermore, the variables and factors of table 1 are designed to be an evaluation instrument. Data collection techniques include Closed Questionnaire, rating scale: 1–7, lowest to highest. The data were analyzed descriptively using percentage level categories namely, excellent, good, fair, and poor. The data were categorized using the ideal mean score (Mi) and the ideal standard deviation score (S_{Bi}) as the criteria. The tendency level is divided into four categories, namely:

Table 2

The category of evaluation results

Formula	Category	Score
$> (Mi + 1,5 SBi)$: excellent	>132
$Mi - (Mi + 1,5 SBi)$: good	96–132
$(Mi - 1,5 SBi) - Mi$: fair	60–95.995
$< (Mi - 1,5 SBi)$: poor	<60

Results

The geography teacher’s performance on the pedagogical content knowledge of spatial thinking perspective geography is defined as the teacher’s ability to use the knowledge and skills needed to encourage students’ spatial thinking skills in geography learning. The essence is that the ability of the teachers is utilized to carry out the functions and objectives of education based on the demands of the times. Pedagogical content of spatial thinking geography is a pedagogical competency that all educators should have as a basis to transfer knowledge and values in learning.

The results of data analysis from questionnaires show the level of understanding of content knowledge of spatial thinking perspective of the geography of prospective geography teachers in Aichi University of Education (AUE) and Yogyakarta State University (YSU) as presented below.

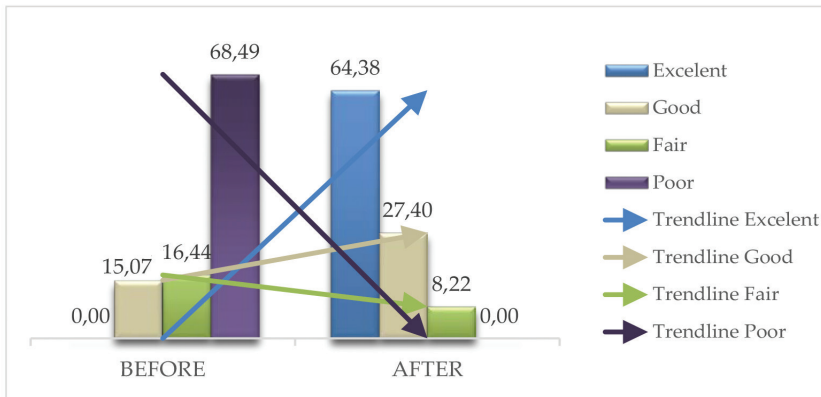


Figure 1. Percentage of pedagogical content knowledge of spatial thinking perspective geography before and after taking educational lecturing

Figure 1 shows that the pedagogical content knowledge of geography spatial thinking perspective before and after taking educational lecture experience positively opposite

conditions. The initial understanding of prospective teachers about pedagogical content knowledge of spatial thinking geography was in a low category (>68%). During the six semesters of the lecture, more than 90% of students belong to a good category.

The results of student evaluations of PCSTG understanding conditions at the beginning of the semester in the first year at YSU and AUE illustrate that the student's understanding of pedagogical content of spatial thinking geography has increased. Based on the categories of students' understanding of pedagogical content of spatial thinking geography before performing PCTSG learning, the composition is as follows: 68.49% belongs to the low category, 16.44% is a medium category, 15.07% includes a good category, and no one has a very good category. These percentages indicate that most students had an understanding in the low category before PCSTG learning. The reverse condition occurs after they learn about PCSTG. The student's understanding is as follows: no one is in the low category, 8.22% is in the medium category, 27.40% belongs to the good category, and 64.38% belongs to the excellent category.

This change was very possible to occur within the process of learning. The students said that the improvement was caused by, among others: awareness (self regulation) to become a geography teacher so that it motivated them to study PCSTG seriously. Research notes show that students assess teaching performance that is convincing, the availability of primary and supporting learning tools, interesting learning methods, and conducive classroom climate and geographic material content with a spatial thinking perspective which contribute to this increase. A more detailed description of the percentage of pedagogical content knowledge of spatial thinking geography at AUE and YSU is presented in figure 2.

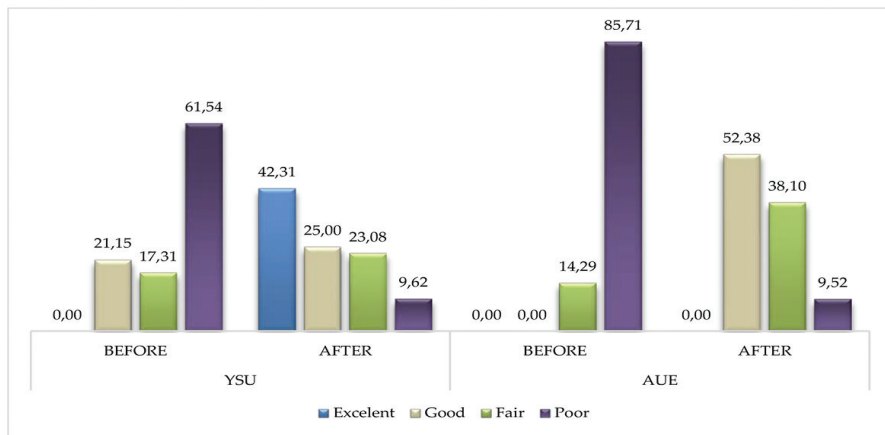


Figure 2. Percentage of pedagogical content knowledge of spatial thinking geography before and after taking educational lectures in AUE and YSU

The more detailed percentage about the understanding of pedagogical content knowledge of spatial thinking perspective geography before and after taking educational

lectures in AUE and YSU is presented in figure 2. The data shows the initial conditions with slightly different trendlines. 20% of prospective teachers at YSU have understood PCK spatial thinking geography. This contrasts to AUE which is almost 100% in the poor category. However, the situation after taking the lecture experienced an increasing trendline regarding the understanding of the geographical content knowledge of spatial thinking perspective geography.

Based on the analysis of item content or evaluation instrument factors, it can be explained that the components of Pedagogical Knowledge and Content knowledge of spatial thinking perspective geography separately show relatively different conditions. Prospective students from YSU prior to joining a lecture have a better initial understanding than that of AUE. YSU students stated that the understanding was derived from the initial information obtained when they were in high school. They receive information from the guidance and counseling teacher about the chosen course of study. Different conditions experienced by students at AUE in which they obtained an understanding of PCSTG through outside information. They hope not only to become geography teachers but also to become social science teachers. However, after studying PCSTG, the understanding of students at AUE and YSU were relatively the same.

Four geography education lecturers who were evenly divided between YSU and AUE assessed the students' PCSTG understanding during the lecture process due to many factors. A lecturer from YSU stated that they tried optimally in teaching thinking skills and spatial thinking skills in geography learning. The lecturers try to implement spatial thinking in the field of geography (spatial thinking in geography) so that students are able to understand explicit spatial concepts (explicit teaching of spatial concepts) and adopt spatial representations and geospatial technologies in teaching (adopting spatial representation and geographical technologies). The lecturers also stated that the learning facilities in the classroom were very supportive and meet the required facilities and geospatial technology during lectures optimally. The lecturers acknowledged that PCSTG material was indicated to have been conducted in lectures. A conducive classroom climate and methods that are oriented towards student activeness continue to be developed in order to stimulate students to easily process information (processing information) and answer the learning objectives regarding the abilities of students. During the lecture, the class climate encourages an effort to develop and strengthen classroom rules and norms, strengthen positive relationships between students, and positive relationships between lecturers and students. The understanding of pedagogical content knowledge of spatial thinking perspective geography of prospective geography teachers based on sex is presented in figure 3.

Figure 3 shows that in general, the understanding of pedagogical content knowledge of spatial thinking before and after taking educational lectures based on sex indicates an equal trendline condition. Men are slightly higher (0.4%) regarding the understanding of the content of spatial thinking geography.

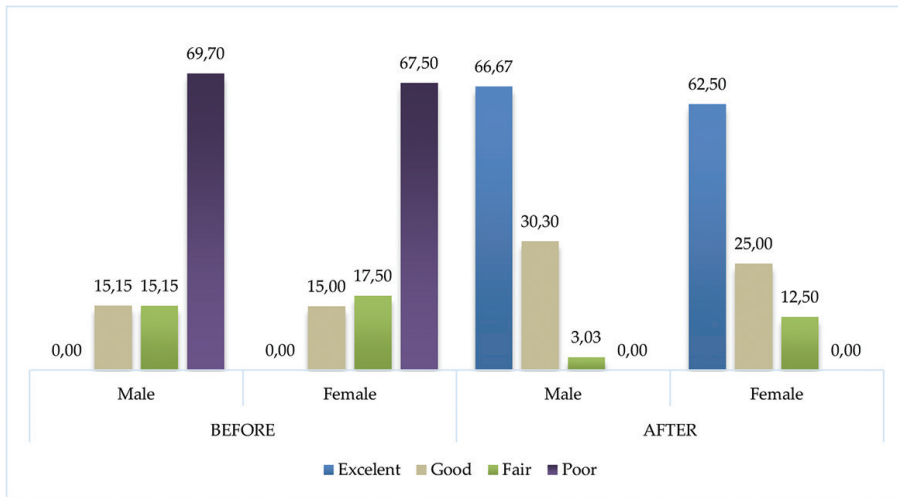


Figure 3. Percentage of pedagogical content knowledge of spatial thinking geography before and after taking educational lectures in AUE and YSU

The students of prospective geography teachers at YSU and AUE both men and women tried to follow the learning of Geography well. They focus on the ongoing process in order to meet the needs of Pedagogical content of spatial thinking geography. Description of learning outcomes shows that there is a relatively equal change between male and female students before and after learning Pedagogical content of spatial thinking geography.

Table 3

The obstacles faced by prospective geography teachers to understand PCK competencies

Yogyakarta State University (YSU)	Aichi University of Education
1. Understanding the characteristics of learners including the physical, moral, spiritual, social, cultural, emotional, and intellectual aspects.	1. Developing a curriculum related to the subject matter being taught
2. Mastering theories and principles of learning that educates.	2. Utilizing information and communication technology for learning purposes.
3. Developing a curriculum related to the subject matter being taught	3. Enhancing the development of potential learners to actualize various potentials.
4. Utilizing assessment and evaluation results for learning purposes.	4. Performing an assessment and evaluation of learning processes and outcomes.
5. Performing reflective actions to improve the quality of learning.	5. Performing reflective actions to improve the quality of learning.
6. Developing sustainable professionalism by taking reflective actions.	6. Mastering the standard of competence and basic competence of the subjects that are taught.
7. Utilizing information and communication technology to perform self-development	7. Utilizing information and communication technology to perform self-development
	8. The nature of change in conditions between two places (Material)

Further exploration with respondents in both universities provided an overview of some of the obstacles faced by prospective geography teacher students to understand PCK competencies. The obstacles faced by prospective geography teachers students to understand PCK competencies are presented in table 3.

Discussions

The research variable of this research, in general, shows the relevance of content and method with several previous studies. Jo & Berdnarz (2014) describe the characteristic of teachers for teaching spatial thinking in geography which includes: teaching thinking skill (Newman, 1990, 51–52), teaching spatial thinking skill (NRC, 2006, 12) dan (jo Berdnarz, dan Metoyer, 2010), spatial thinking in geography (Heffron dan Downs, 2012; dan Jo & Berdnarz, 2014), and explicit teaching of spatial concept (Jo & Berdnarz, 2014); dan adopting spatial representation and geographical technologies (Jo & Berdnarz, 2014). These concepts are a synthesis and simplification of the spatial representation of geography in the high school geography curriculum. Several other studies on Pedagogical Content Knowledge (PCK) in geography learning have a correlation between results, methods, and objectives, for instance, three studies of Patra and Guha in 2017. The first study has a similarity that PCK has a gradual effect on self-efficacy that has a positive effect on teacher effectiveness in teaching. In addition, the similarity with the second study is the existence of similar aspects with PCK standards for geography teachers which is developed. The third similarity is that there is no difference in PCK ability based on sex. PCK exploration of geography teacher candidates in Denmark using the Shulman (1986, 1987) category conducted by Reitano and Harte (2016) shows similar results in which PCK is teachers' representations of content that is pedagogically powerful for students; the second type of PCK refers to teachers' understanding of specific topics: easy or difficult for students. The similarity of this study is in line with Clausen (2016) in which PCK influences the teacher's perspective in teaching geography.

The Nilsson study (2008) has similar results which state that PCK enhances to determine subject matter knowledge (SMK), pedagogical knowledge (PK) and contextual knowledge (CK) as outlined in teaching practice for prospective teachers. Loughran, Mulhall and Berry (2008) and Rollnick, et. al (2008), conducted a Pedagogical Content Knowledge exploration on the education of prospective teachers using Co-Res (Content Representation) and PaP-eRs (Pedagogical and Professional-Experience Repertoires Representations). The results of the study indicate the similarity of the objectives of PCK learning for prospective teachers to prepare a clearer framework when preparing learning. The results of the research conducted by Henze, Driel and Verloop (2008) show the same core that there are two qualitatively different orientations in the PCK of prospective

teachers namely, 'body of establishment knowledge' and 'the experience of science as a method of generating and validating such knowledge'.

The level of understanding of PCK spatial thinking geography in this study may provide a recommendation to produce professional geography teachers like the opinion of Caena (2014). He synthesizes the opinions of Paquay & Wagner (2001) and Schratz et al. (2007) stating that the teacher profession paradigm is: a *reflective agent*, developing professional thinking and discourse on context issues and experiences; a *knowledgeable expert*, both subject-based and transversal, individual and in organisations; a *skilful expert* in deliberate, informed, effective professional thinking, knowledge and action; a *classroom actor*, entailing the competences to deal with diversity and inclusion; a *social agent*, oriented towards dialogue and cooperation in social contexts and professional communities; and a *lifelong learner*, with the responsibility of shaping and developing knowledge by specific action in a specific context. According to Cochran, et al. (1993), this paradigm explains that teachers are professional positions who always learn to teach and keep integrating their experiences to be taught.

The results of the above study illustrate that a good geography teacher candidate must master the substance of geography materials through spatial thinking and master the science of teaching (pedagogy). The taxonomy of spatial thinking in geography in this study refers to the opinion of Gersmehl and Gersmehl (2007). The taxonomy formulated by Gersmehl and Gersmehl is simple and easy to teach using the help of geospatial technology, for instance, using remote sensing imagery. The drawback is the absence of the scale concept as a very important concept in the context of spatial thinking. Gersmehl's taxonomy is used as the basis for evaluating the perspective of geography in the high school geography curriculum. The pedagogical variable in this study is a synthesis of the professional competencies of teachers in Permendikbud number 16 of 2007. Knowledge of content spatial thinking as the core of geography equips prospective teachers to be able to connect and see the relationship between concepts while pedagogical knowledge equips teachers to master the methods of transferring knowledge through the scientific approach. The similarity between the geographical content of the perspective of spatial thinking as content and constructs of pedagogy is known as pedagogical content spatial thinking geography.

Some obstacles experienced by geography teacher candidates in both universities (table 2) have produced several alternative solutions such as; several variables which have similar cases in the "poor" category are acted upon through joint research between YSU and AUE. The disadvantages of each different variable, potentially followed through the academic forums such as seminars and guest lecturers. Internally, each institution can hold PCK training with various combinations of various methods to deal with these problems.

Conclusions

Understanding of Pedagogical content of spatial thinking geography for prospective teacher students is very important to produce quality teachers. Geography learning activities in the classroom will be of quality if it is supported by competent teachers. The teacher as a learning designer has a role in producing graduates who have good academic ability, skill, emotional maturity, moral and spiritual. The results on the level of pedagogical content knowledge of spatial thinking perspective geography of students of prospective geography teachers in AUE and YSU show that 64% in the excellent, 27.40% in the good, and 8% in the fair category. These findings indicate that the majority of the student knows and understands well about pedagogical content knowledge of spatial thinking geography. These findings show that the majority of the student knows and understands well about pedagogical ability as a geography teacher. The main obstacle to understanding pedagogic ability is about teaching ability especially assessment and evaluation as a way to know learning outcomes. Several variables having similar cases in the “poor” category are potentially acted upon through joint research between YSU and AUE. The disadvantages of each different variable, potentially followed up through academic forums such as seminars and guest lecturer.

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Būsimų geografijos mokytojų erdvinio mąstymo pedagoginis turinys Aichi pedagoginiame universitete ir Jogjakartos valstybiniame universitete

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Santrauka

Tyrimu siekiama atskleisti būsimų geografijos mokytojų pedagoginio turinio žinių, susijusių su erdvinio mąstymu ir geografine erdvine perspektyva, lygį Aichi pedagoginiame universitete ir Jogjakartos valstybiniame universitete. Tai aprašomasis-vertinamasis tyrimas, kuriame dalyvavo 105 studentai – būsimi geografijos mokytojai, studijuojantys paskutiniame semestru Aichi pedagoginiame universitete (40 studentų) ir Jogjakartos valstybiniame universitete (65 studentai). Tyrimo imtį sudarė apytikriai 210 atsitiktinai atrinktų studentų. Tyrimas vykdytas nuo 2017 m. gruodžio mėn. iki 2018 m. vasario mėn. Duomenims rinkti pasitelktas uždaro tipo klausimynas, kurio vertinimo skalė yra nuo 1 iki 7, nuo žemiausio iki aukščiausio. Duomenys buvo analizuojami aprašomuoju būdu, naudojant procentines lygio kategorijas: puikiai, gerai, patenkinamai ir silpnai. Nustatyta, kad Aichi pedagoginio universiteto ir Jogjakartos valstybinio universiteto studentų, būsimų geografijos mokytojų, erdvinio mąstymo ir geografinės erdvinės perspektyvos žinių lygis yra puikus (64 proc.), geras (27,40 proc.) ir patenkinamas 8 (proc.). Šios išvados rodo, kad dauguma studentų žino ir gerai supranta erdvinio mąstymo geografinėje erdvinėje perspektyvoje pedagoginį turinį. Pagrindinė kliūtis pedagoginiam gebėjimui suvokti yra susijusi su mokymo gebėjimu, ypač su vertinimu ir įvertinimu, kaip strategija, siekiant suprasti mokymosi rezultatus.

Esminiai žodžiai: *geografija, pedagogika, mokytojai, erdvinis mąstymas, būsimas mokytojas.*

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