INNOVATIVE EDUCATION PROGRAMS WITH THE TECHNOLOGICAL PEDAGOGICAL AND SCIENCE KNOWLEDGE-CONTEXTUAL APPROACH AND ITS' EFFECTS TO SELF-EFFICACY

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ABSTRACT:
The effort to prepare prospective professional teachers is one of the keys to the success of improving the quality of education. The research aims to: (1) produce a suitable lecture program with the Technological Pedagogical and Science Knowledge-Contextual (TPASK-C) approach; and (2) investigating the effectiveness of the TPASK-C innovative lecture program on the self-efficacy of science teacher candidates.
This study was designed with research and development with the Gall, Gall & Borg model, with 10 steps taken. The subjects of this study were students majoring in Science Education from UNY and UST. The research instruments included a program validation questionnaire sheet, a self-efficacy questionnaire for science teacher candidates. Data analysis from program validation was carried out descriptively qualitatively and quantitatively, and self-efficacy data were analyzed descriptively and inferentially.
The results showed that the TPASK-C lecture program was declared very feasible by experts and practitioners. Program improvements were made in the inclusion of program technical instructions and instruments for achieving program targets. Also, the TPASK-C lecture program affects self-efficacy, which is shown based on the results of the t-test with a significance value (2-tailed) <0.05.

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Introduction

One of the keys to the success of improving the quality of education. The education system is required to produce superior competent human resources to be highly competitive in the global era. Of course, this also has an impact on the demands of teacher professionalism. The key to the success of improving the quality of education lies in the preparation of prospective professional teachers, who have the capacity and responsibility to plan for future education. Efforts to prepare these professional teachers are the responsibility of the prospective education program.

The preservice teacher education program has the responsibility to prepare future teachers to teach current students. A series of activities for the development of Educational Institutions and Education Personnel (or we can say it as LPTK) needs to be carried out to develop pedagogical competencies for prospective teachers. The profiles of LPTK graduates are by national standards that are synchronized with the uniqueness of higher education as mandatory actors of Higher Education Tridharma. This is in line with the goals of teacher education which refers to Government Regulation (PP) number 19 (Ministry of National Education, 2017) concerning teachers, namely teachers as professional educators who are national and have global insight according to national, local needs and / or developments in science, technology, and arts (Meng & Idris, 2014). What is crucial in teacher education is educating prospective teachers and preparing them to become teachers with high-quality teaching competencies.

LPTKs have a big challenge in realizing the figure of professional graduate teacher candidates, including compiling a curriculum that can guarantee the achievement of graduate competencies as level 6 of the Indonesian

National Qualifications Framework (KKNI). However, the quality of LPTKs is still a problem in Indonesia. The Center for Data and Statistics for Education & Culture provides data that out of 422 LPTKs in Indonesia there are still quality disparities, that is, there are still around 1,600 study programs accredited C from approximately 3,300 accredited LPTK study programs, still an oversupply of graduates from Academic Education / Undergraduate Education, and most of the LPTKs do not yet have a good partnership system with schools and do not have laboratory schools. Also, there is the challenge of the 4.0 industrial revolution which shifts the discipline of expertise that combines multiple technologies for automation performance and digitalization systems in various fields (Triyono, 2017; Muposhi, 2019; Meyer & Habanabakize, 2019; Moolman & Jacobs, 2019).

Recently, a framework has been developed that emphasizes the integration of technology in learning, teachers teach with technology, to design teacher education curricula, to design the use of technology in the classroom. This framework is known as TPACK, which can then be developed as an approach. Smetana & Bell suggest that TPACK offers a framework for understanding how teachers' flexible knowledge of content, pedagogy, and technology interacts and enables teachers to implement effective instructional practices during technology integration in teaching (Smetana & Bell, 2012). Of course, this is by the standard process for teacher education which is also stated in Minister of Research, Technology, and Higher Education Regulation number 55 of 2017 article 9, section 3 paragraph (4) states that learning in teacher education applies the principles: Lecturers as models, act as role models for prospective teacher students; and; (b) Students who are prospective educators gain authentic experience (direct learning as early as possible in real situations in educational units) (Permenristekdikti, 2017).

Science learning in junior high schools is carried out thematically. This raises certain concerns about the existence of science lessons, among others, teachers are worried that they cannot explain science concepts well and may ignore the integration of a concept in a theme, are unable to carry out simple experiments, and are unable to formulate scientific questions based on natural phenomena (Mohamad & Eng Tek Ong, 2013). Of course, these things will affect the quality of science learning. This concern is related to the science teacher self-efficacy (Atan & Chakrabarty, 2011). Of course, these concerns must be overcome by developing self-efficacy for teachers or prospective science teachers.

Based on the above reviews, it is also important that science teacher candidates have good self-efficacy. The development of self-efficacy in teaching prospective teachers is important to continue into the teaching profession and provide students with more opportunities to learn (Tajudin & Kadir, 2015). Self-efficacy is identified as a strength of overall teacher effectiveness (Pendergast, Garvis & Keoghe, 2011). Self-efficacy is believed to influence behavior and choices (Bandura, 1977). Self-efficacy influences the action is taken which can indicate improvement or prevention in the form of action and determine how environmental opportunities and difficulties are felt (Bandura, 2006). Several studies have shown the importance of teacher self-efficacy about the integration of technology in their future use of technology in learning (Koh & Frick, 2009; Abbitt, 2011; Al-Ruz & Khasawneh, 2011; Al-Awidi & Alghazo, 2012). Also, Raphael & Mtebe (2017) stated that prospective teachers with higher self-efficacy beliefs in technology tend to use and integrate technology more into the classroom than prospective teachers with lower self-efficacy beliefs. Therefore, it is important to investigate how the development of innovative lecture programs with the TPASK approach for prospective teachers and their effects on self-efficacy?

Methodology

This study uses a research and development model, or it can be called development research using Gall, Gall, & Borg (2007) development approach adapted from Dick, Carey & Carey. In more detail, the research procedure was developed into 10 stages as follows: (1) identifying program objectives and needing assessment; (2) identify specific skills, steps, learning tasks that are intended to achieve learning objectives; (3) identifying the input skills and attitudes of learners, and the characteristics of the learning setting, and the characteristics of the knowledge and skills to be used; (4) translating learning needs and objectives into specific performance objectives; (5) developing assessment instruments, (6) developing a specific learning strategy; (7) developing lecture devices; (8) developing products; (9) revising products; (10) summative evaluation, which is the summative evaluation stage. Product testing was carried out with an experimental design with a one-group pretest-posttest design. The research subjects were Science Education students at Yogyakarta State University and Taman siswa Undergraduate University.

The instrument used in this study was a program validation questionnaire, including the validation of teaching materials and a self-efficacy scale. The data obtained were analyzed descriptively qualitatively and quantitatively. For self-efficacy data, advanced statistics were tested parametrically with a paired t-test.

Results and Discussion

Teacher education programs in Indonesia have not been designed based on a specific framework for teacher professional development. This is not in sync with the report of the National Science Education Standards (Peterson & Treagust, 1995) argued that learning to teach science teachers requires an analytical component on Pedagogical Content Knowledge (PCK) which is called Science, learning, and teaching. Several higher education institutions implicitly use Shulman's PCK. Of course, this is inadequate in building the professional ability of future teachers to use integrated technology to improve learning and teaching in the 21st century. Therefore, there needs to be a shift about a more contemporary conceptualization, namely Technological Pedagogical Content Knowledge called TPCK, now known as TPACK.

The TPACK approach for science teachers and prospective science teachers is important to be combined with the Nature of Science (NoS) so that the TPACK abilities obtained by teachers and prospective science teachers are specific to teaching science as it is. The combination approach between the TPACK and NoS approaches, hereinafter referred to as the Technological Pedagogical And Science Knowledge approach, hereinafter referred to as TPASK (Hamid & Idris, 2014). The TPASK approach is unique because it has a specific subject matter, namely in the form of science, and is oriented to teach science by raising problems and phenomena in the surrounding environment, both in the family, school, and community environment (Osman & Kamis, 2019).

The results of the preliminary study show that: (1) The implementation of lectures in a course that facilitates content and learning has been programmed quite well; (2) The results of the student needs assessment questionnaire show that an understanding of the NoS is given to certain subjects (subjects that have competency rather than emphasizing mastery of content and how to teach science); (3) The results of the student needs questionnaire show that the teaching system for Science 1, IPA 2, IPA 3, and Basic Teaching Ability (KDM) has been implemented by grouping 5-6 students into one group. Monitoring progress of group assignments is less than optimal; (4) The results of lecture learning observations show that most students still have difficulty connecting natural phenomena and natural science content as well as difficulties in determining the appropriate form of learning technology to represent the science object being studied; (5) The results of the survey on the NoS understanding of science teacher candidates show that the NoS understanding of science teacher candidates is still wrong, for example, science is not influenced socio-culture, that scientific theories do not change, and that design investigations do not involve imaginative and creative thinking.

The TPACK approach for science teachers and prospective science teachers needs to be combined with NoS and contextual matters so that the TPACK abilities obtained by teachers and prospective science teachers are specific for science learning as it is. The combination approach between TPACK, Nature of S, as an approach hereinafter referred to as the Technological Pedagogical And Science Knowledge or TPASK approach. The TPASK approach will be unique because it has special subjects in the form of science and is oriented towards learning science by raising issues and phenomena in the surrounding environment, including the family, school, and community environment referred to as TPASK-C ('C "for Contextual) (Jimmoyiannis, 2010). Most of the research conducted with the TPACK approach emphasizes the technology element.

Based on the suggestions of five experts, the results obtained were in the form of suggestions for improvement of the TPASK-approached lecture program, including: (1) If the current TPASK was still an approach, and each stage was clear, a theoretical basis could be developed as a model; (2) The characteristics of the TPASK program are sufficiently detailed to realize the description of the TPASK program as intended by the developer based on the theory studied; (3) Removing the theoretical foundation that underlies the development of the lecture program and its objectives and avoiding conflicting theories; (4) Clarifying the stages of the TPASK-C program and the contents of NoS so that lecturers understand TPASK and NoS; (5) The mechanism for implementing the approach must be systematic. A brief description of the lecture program is shown in Table 1.

Table 1. Description of the TPASK Approach Lecture Program

Phase	Activity	The Component of TPASK
Phase 1: *Orientation*	Introducing students to the lecture program with the TPASK approach and its target achievements	
Phase 2: *Design*	Design mapping products as the basis for collaborative development of learning tools, in the form of a map of natural potential, a table of links between the curriculum and natural potential and learning activities, a mind map or concept map, and an NoS content map	TK, PK, and SK
Phase 3: *Develop*	Developing constructivism-based active learning products based on the results of the collaborative phase design.	PSK, TSK, TPK, TPASK

The TPASK-approached lecture program is intended for the education of prospective teachers to prepare prospective teachers who combine theoretical knowledge and field experience. This provision is intended to support and increase self-confidence so that prospective teachers can feel capable of becoming successful teachers or have self-efficacy. In addition to developing a strong understanding of educational theory and other knowledge about teaching in the classroom, prospective teachers must also be able to apply both pedagogical and subject matter knowledge that has been studied to demonstrate competence as a teacher.

TPASK is a new approach for the professional development of science teachers that is built with the integration of the TPACK approach and the authentic learning approach. The first step to develop a coherent TPACK framework for the preparation of science teachers is proven through its components and linking them explicitly to science (content), pedagogy, and technology in a meaningful and realistic context.

Based on the characteristics of the TPASK-approached lecture program and the description of the TPASK program, the researchers then developed lecture tools in the form of RPS courses based on the TPASK approach along with other lecture tools in the form of lecture contracts, teaching materials, Student Worksheets (LKM).

The results of expert and practitioner assessments related to the feasibility of the developed product indicate that the TPASK-C approach along with the science teaching materials developed are by the eligibility criteria for the lecture program because they are considered very feasible by experts and practitioners to obtain an average validity score of 46 in the very feasible category, both from experts and practitioners. The science teaching material as a component of the lecture program is also considered very feasible with an average score of 88.6 from experts and 84 from practitioners.

The effectiveness of the lecture program on the self-efficacy of science teacher candidates

Self-efficacy descriptive data were obtained before and after the treatment was carried out. Data is the student's answer to the self-efficacy scale carried out before and after the implementation of the lecture program with the TPASK approach. The self-efficacy is descriptive as shown in Table 2.

Table 2. Results of the Analysis Description of Self-efficacy

Class	Aspect	N	Minimum	Maximum	$\overline{X}$	*Std. Deviation*	*N-gain*
A	*Pretest*	25	74	100	91,92	12,06	0,14
	Postest	25	75	110	96,68	9,75	
B	*Pretest*	34	55	113	93,74	11,54	0,18
	Postest	34	85	119	99,38	7,77	

Table 2 shows that the mean posttest score is higher than the mean pretest score in both classes A and B, with a low increase indicated by an N-gain of less than 0.3, both in class A and class B.

To test the advanced statistical analysis in a parametric manner, a prerequisite test is carried out in the form of a normality test and a homogeneity test. The homogeneity test results show that the significance value of the homogeneity test for self-efficacy data is 0.206 (> 0.05), then H0 is accepted, which means that the data comes from a population that has a homogeneous variance. For the K-S significance value on the pretest and posttest data normality test, self-efficacy was greater than 0.05 (data normally distributed). Then furthermore, self-efficacy data were analyzed using paired t-tests.

The results of the paired t-test score of self-efficacy obtained a p-value (2-tailed) of 0.022 <0.05 (class A) and 0.007 <0.05 (class B), so H0 is accepted, which means that there is a significant difference in self-efficacy between before and after the lecture program with the TPASK-C approach. The paired t-test results are shown in Table 3.

Table 3. Results of the Paired t-test Self-efficacy

Paired	*Paired Differences*					t	df	*Sig.* (2-*tailed*)
	$\overline{X}$	***Std. Deviation***	***Std. Error Mean***	***95% Confidence Interval of the Difference***				
				Lower	***Upper***			
Pretest-Posttest A	-4,76	9,68	1,94	-8,76	-0,76	-2,46	24	0,022
Pretest-Posttest B	-5,64	11,40	1,95	-9,62	-1,67	-2,89	33	0,007

Table 3 shows that there is a significant difference between the results of the pretest and posttest self-efficacy data in the two classes. Lecture programs with the TPASK approach can develop self-efficacy because the use of context in learning certainly provides motivation for students that learning these subjects has benefits and uses in everyday life to foster student self-efficacy as science teacher candidates. Student self-efficacy can develop while taking the TPASK-approached lecture program. This is because there is a positive learning environment that encourages the growth of motivation and is quite challenging so that students feel comfortable and free to express themselves easily. Such environmental conditions can encourage the development of student self-efficacy (Arslan, 2012).

Conclusion

Based on the results and discussion above, it can be concluded that the lecture program with the TPASK approach is declared feasible by experts and practitioners. Also, lecture programs with the TPASK approach are effective for developing teacher candidate self-efficacy. This is indicated by the paired t-test significance value which is smaller than 0.05. Lecture programs with the TPASK approach can create a conducive environment to foster motivation and challenges so that students feel comfortable and feel free to express themselves.

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