

Preservice Science Teachers Teaching Model: Analysis in Education University

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Abstract

The development of preservice science teachers is an essential process in producing professional science teachers. The teaching model used by university needs to be oriented towards the appropriate competence of science teachers. The aim of the study was to analyze the teaching model in several university in Indonesia that generated science teachers. This study was conducted in April 2022 that used qualitative research to obtain information about the teaching model in education university. This research involved science lecturers in six universities in Indonesia. The data was obtained by interview techniques. This study found that the development program of preservice science teachers still were obstacles in several aspects. The aspects were the use of teaching models, teaching steps, preparing lesson plans, advantages of teaching patterns, deficiencies of teaching patterns, obstacles to mastery of the scientific method, and challenges in teaching science teacher candidates. These finding can be used as a model for teaching in universities to develop preservice science teachers.

Keywords: *Preservice, science teacher, university.*

1. Introduction

The development of science and technology demands the urgency of mastering interdisciplinary abilities and skills in the 21st century. The development of holistic science knowledge skills is a matter of substance, considering that the integration of science material includes aspects not only of science content (physics, chemistry, biology) but also its relation to technology, design or engineering design, which describes the basic knowledge to solve problems that arise in society. In this case, a science teacher needs to be able to present a problem that arises in the community in the classroom and invites students to understand the integrity of the material in the problem as a step in solving the problem. This ability is related to the pedagogic competence and professional competence of teachers.

Education-based universities have an important role in producing professional teachers. To develop a teaching model for preservice science teachers in higher education, an initial analysis of the portrait of the teaching model for preservice science teachers at several education-based universities in Indonesia is needed. The teaching model for preservice science teachers should use a constructivist approach where teachers build knowledge through experiences. Previous research highlighted that the scientific literacy profile of preservice science teachers is still low (Tulus Junanto, etc., 2019). In line with the findings of other research which states that all aspects of scientific literacy of preservice

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science teachers are low (Novike Bela Sumanik, et al, 2021). Based on these research findings, research is encouraged to conduct research to analyze teaching models at universities producing preservice science teachers. This research aims to analyze the teaching models of preservice science teachers at several education-based universities in Indonesia. The results of the analysis are used to explore the needs of universities producing preservice science teachers regarding the teaching models used. Furthermore, the research results can be used to determine teaching models for preservice science teachers.

2. Methods

Research Design

This study uses qualitative descriptive research with explorative survey to obtain information about the teaching model in generating science teachers in six university in Indonesia. The university consist of Yogyakarta State University, Semarang State University, Surabaya State University, Indonesia Education University, Sarjanawiyata Taman Siswa University, Ganesha Education University. The subjects used in this research included lecturers at six education-based universities in Indonesia. Subjects were determined using purposive sampling technique. This technique is based on the consideration that the university has already established cooperation.

This research involved 12 lecturer from 6 universities in Indonesia. Data collection was carried out in April 2021. Data was collected through open interviews electronically via google form (Cresswell, 2012). Data were analyzed through the stages of data reduction, data presentation, and withdrawal conclusion (Milles and Huberman, 2014).

3. Results and Discussion

The following data is the result of interview technique:

Table 1. Data of Teaching Model

University	
	Question 1. What is the teaching model used in courses that develop the teaching competence of prospective science teachers in your study program?
University A	Constructivist, TPACK, theory and practice, delivery of theory then strategy, Pjbl (project based learning), discussion, assignment, case study, presentation, inquiry.
University B	Inquiry, PjBl, STEM
University C	Project based learning and problem based learning
University D	Direct learning and project based learning
University E	Team project or case methods
University F	Simulation, practice, project based learning, collaborative.

Table 2. Data of Teaching Methods

University	
	Question 2. How do you teach the subjects that provide education for prospective science teachers in your study program?
University A	Discussion, PjBl, <ul style="list-style-type: none"> - Analysis of curriculum and materials, analysis of pedagogy and technology, planning and development of tools, simulation of learning and reflection - Combining theory and practice, use of ICT - Discussion, brainstorming, assignment - Multimethods based on case and problem solving according to conditions in the field - Enabling students to search for and develop science content and learning, then discuss and conclude - Equipping students with materials and developing learning tools
University B	Demonstration and experimentation to build knowledge, attitudes and skills
University C	Provide project assignments that are tailored to the material
University D	Problem based learning, project based learning, case study
University E	Team project, case methods
University F	<ul style="list-style-type: none"> - Provide problems and challenges in lectures, group discussions, projects, online and offline - Activate and develop skills

Table 3. Data of Teaching Steps in planning lesson plan

University	
	Question 3: What are the teaching steps in courses that equip the ability to plan science lessons?
University A	Curriculum discussion, device design, microteaching, reflection. Direct instruction, explained procedurally, guided exercise, independent practice. Understand the curriculum content (scope), master knowledge about the topic and the characteristics of the topic.
University B	Scientific demonstration, understanding science content, integrating content, teaching and technology
University C	It begins with a basic competency search, formulating indicators, objectives, reviewing materials, determining models and methods

University D	Team project, case methods, Material experience, problem identification, curriculum analysis, device development and simulation, reflection and follow up plan
University E	Team project, case methods
University F	The Niteni device then switches to the existing method and adds it. Theory, practice, evaluation, revision

Table 4. Data of Model Advantages

University	
	Question 4 : What are the advantages of teaching patterns in courses to provide competencies for prospective science teacher students in the Mr. Mrs. Study Program?
University A	Formation of simple to complex thought patterns. Students master the TPACK paradigm. Integration with technology. Integration between theory and practice. Foster student creativity. Strengthening of concepts, principles that support integrated science. Strengthening in providing understanding of content and processes
University B	Mastery of IT and English language skills
University C	Project and problem based teaching develops self potential
University D	Active student
University E	Learning by doing, contextual, problem-based
UST (Tamansiswa Sarjanawiyata University)	Can share more roles. Strengthen abilities. Strengthening analytical skills, communication skills.

Table 5. Data of Teaching Lack

University	
	Question 5: What are the lacks of the teaching pattern in the course to provide competencies for prospective science teacher students in the Mr. Mrs. Study Program?
University A	- the ability of lecturers to provide feedback is lacking.

	<ul style="list-style-type: none"> - Not all lecturers have innovated on the content and teaching methods in lectures - There needs to be uniformity of thought from the entire teaching team in preparing science teachers - Not maximal in mastering analysis
University B	The pandemic condition makes all learning held online
University C	Student-centered learning patterns require more time and students who are not used to it will be burdened
University D	Small credits
University E	Completeness of supporting facilities and infrastructure, consistency of time management
University F	<p>Not yet bilingual, still minimal application of experimental data analysis</p> <p>The application of a good model is constrained by time both preparation and implementation</p>

Table 6. Data of obstacles in the scientific method

University	
	<p>Question 6:</p> <p>What are the obstacles for prospective science teacher students in mastering the scientific method?</p>
University A	<p>Lack of ability in preparing creative practicums and solutions, lack of in-depth discussion.</p> <p>Most of the practicums are carried out using the cook book model and rarely by inquiry, so scientific methods are not trained.</p> <p>Mastery of measurement methods is sometimes forgotten. Less than optimal during a pandemic, material that trains skills is done online.</p> <p>Obstacles in mastering science and science curriculum content so that students do not understand the core of the topic.</p> <p>Difficulty in analyzing problems</p>
University B	Ability to use scientific measuring tools
University C	Less able to find problems in a phenomenon, lack of reading references in finding hypotheses
University D	Lack of scientific thinking skills
University E	On process design and scientific publication
University F	<p>Data analysis, the relationship between variables, how to formulate questions.</p> <p>It is more difficult to do with more specific materials or topics, because not all science topics are compatible with the scientific method.</p>

Table 7. Data of Challenge in Teaching

University	
	Question 7: What is the biggest challenge in teaching the basic science teacher education program to the Ladies and Gentlemen Study Program?"
University A	The way so that students can master professional competence / mastery of science material optimally with a lot of material coverage. Equipping students to be able to adapt to junior high school science material Develop a learning model that is in accordance with the characteristics of the material and is responsive to the learning that occurs The ability of lecturers to always adapt to IT developments
University B	Sudden curriculum changes
University C	The supporting facilities and infrastructure are not yet optimal in the application of the scientific method
University D	PjBL model implementation
University E	Limitations of knowledge and technology literacy in the learning process Misconceptions of science and time management.
University F	Student perception and concentration during online learning. Character formation to become qualified teacher candidates

Discussion

Based on data obtained from survey, some information was obtained regarding teaching models for preservice science teachers, including using innovative learning strategies, utilizing technology, and integrating service research into lectures. The role of lecturers is very important, namely preparing preservice science teachers by providing knowledge about science content and how to learn it. The applied models are varied, the dominant ones are project-based models and problem-based models. The student learning model is active, by always activating students to find and develop science content and learning which is then discussed in class, and concluded that the lecturer then provides reinforcement and reciprocity.

The science teacher development program includes three main things, namely social development, professional development and personal development (Bell & Gilbert (1966). The objectives of integrated science teaching cover four categories, namely: (1) updating knowledge content knowledge; (2) reforming the conception of science teaching; (3) building relationships with students and (4) increasing collegial interactions (Bing Wei, 2020). Science teacher preparation standards (Standards for Science teacher preparation) include content knowledge, content pedagogy, learning environment, safety, impact of student learning, professional knowledge and skills (NSTA, 2020). In

Indonesia, science teacher teaching programs are directed at four competencies, namely professional competence, pedagogical competence, social competence and personality competence (Permendiknas No. 16 of 2007 concerning Academic Qualification Standards and Teacher Competency).

The teaching program for prospective science teachers is focused on the inquiry model to train higher order thinking skills as 21st century skills (Treagust, Won, Petersen, 2015). Science educators have been challenged to develop approaches to help students become scientifically literate. This is a reform to change the teaching strategy of science teachers to focus on inquiry-based learning (Akarat, 2020).

Professional development activities should use a constructivist approach in which teachers build knowledge through experience (Brand & Moore, 2010; Kimble et al., 2006). This constructivist approach can lead to continuous change in practical learning (Howe & Stubbs, 1997). Margot and Kettler (2019) stated that the need for teachers to be skilled in pedagogy is necessary in directing students to provide authentic problem solving experiences. Science education is important in promoting a culture of scientific thinking and inspiring citizens to use evidence-based reasoning for decision making (European Commission, 2015). Constructivistic learning as an important basis in the approach to the development of science teachers (Bell & Gilbert, 1996). Science teacher teaching programs in Indonesia need to apply knowledge to science teaching through investigation and inquiry (NRC, 1996:72) in Rustaman (2005). One of the main science teacher competencies is to properly design and carry out experiments (Permendiknas No. 16 of 2007 Academic Qualification Standards and Teacher Competencies).

The starting point for preservice teachers needs to be considered in teacher professional development programs. Prospective teachers need to acquire skills in self-confidence, knowledge, and teaching skills towards the inquiry process (Ruis, Cobos, Lopez, 2022).

In planning learning, there are several patterns that are carried out by lecturers at university. The first pattern, through tracking base competence, developing indicators of competency achievement, formulating learning objectives, reviewing learning materials, determining learning models and methods, outlining learning steps according to the model used, determining the media used, determining the evaluation tools used. The second pattern, by applying “device niteni” or recognizing an existing device, then imitates and adds to it. The third pattern, with material experience, problem identification, curriculum analysis, development of learning tools and simulations, reflection and follow up plans.

A prospective science teacher in junior high school is required to have the ability to teach integrated science. Science teachers must master the content being taught and how to teach it or how to teach integrated science. This ability is related to pedagogical knowledge and content, which is known as PCK (Pedagogical Content Knowledge). Mastering material content alone is not enough to teach integrated science well. Various theoretical works (Shulman, 2015; van Driel & Berry, 2010) and large-scale empirical studies (Kunter & Voss, 2011; Schmelzing et al., 2013) have highlighted the importance of teacher professional knowledge for classroom teaching quality and student learning success. Teacher knowledge and the ability of teachers to consider the learning process are key components of professional teacher knowledge (Voss & Kunter, 2011). Thus, prospective science teacher students should have pedagogic and content skills in teaching science (Shulman, 1986; Kind, 2019).

In the scientific method, there are several obstacles experienced by prospective science teacher students, among others, in terms of finding problems from a phenomenon, asking questions, reviewing reference sources, formulating hypotheses, designing experiments and conducting experiments. The experimental design developed by students is still limited to a cook book and less creative.

Other findings show that prospective science teachers have inadequate understanding of inquiry in several aspects (Ozer & Saribas, 2023). Inquiry also has a pedagogical meaning which also refers to the teacher's design of a learning environment that provides opportunities for students to formulate and investigate scientific problems by involving them in inquiry-based activities to develop adequate scientific ideas. As the studies show, teacher candidates have difficulties in transforming understandings about inquiry into their practices (Ozer & Saribas, 2023).

Based on data from the questionnaire, the challenges faced by lecturers in preparing prospective science teacher students include mastery of integrated science content in junior high school science, integration with technology, student awareness to understand the material and skills of teaching practice, equipping the ability to compose learning media, identify the characteristics of the material. There are several shortcomings in teaching patterns to equip prospective science teacher student competencies, among others, the ability of lecturers to provide feedback is lacking, not all lecturers have innovated on content and teaching methods, and the scope of junior high school science material is wide.

Evaluate the curricular beliefs of pre-service teachers are critical in enhancing their pedagogical practice. Studies show that there are three common emphases in science teaching: theoretical concepts, application of scientific knowledge, and development of the scientific process (Bahtaji, 2023). Reflection helps science teacher candidates to start paying attention to the order of teacher educators expect them to do lesson planning. (Karlström & Hamza, 2018).

4. Conclusion and Implications

Teaching model used in courses are constructivistic consist of Inquiry, PjBl, STEM, Project based learning and problem based learning, team project or case methods. the methods used include demonstration, experimentation, project assignments. In compiling a lesson plan, has steps that have a different starting point. The advantages of teaching patterns at university-based education are providing TPACK, problem and project based, developing 21st century skills and contextual. the disadvantages of teaching patterns in courses that provide pedagogic content include lecturer innovation, the same ideas of thinking in teaching teams in preparing prospective teachers, applying good models, student-based learning requires more time. There are obstacles in carrying out the scientific method.

Acknowledgements

We thank the Universitas Negeri Yogyakarta (UNY), Univesitas Sebelas Maret (UNS) research institute for supporting the implementation of this research.

Declaration of interests

The authors declare that they have no personal interests that influenced the work reported in this research.

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