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Preservice Physics Teacher Views on Scientist's Role in Physics Teaching and Learning

Nurul F. Sulaeman[1], Atin Nuryadin[1*], Shelly Efwinda[1], Lambang Subagiyo[1], Syayidah Dinurrohmah[1], Tan[1], Fahrur Rozy Tandra[1], Tomohiro Takebayashi[2,3]

[1]Physics Education Study Program, Faculty of Teacher Training and Education Mulawarman University, Samarinda, Indonesia

[2]Graduate School of Environmental Studies, Nagoya University, Japan

[3]Museum of Natural and Environmental History, Shizuoka, Japan

*atin.nuryadin@fkip.unmul.ac.id

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Abstract

This qualitative study explores how preservice physics teachers think about the role that scientists play in the teaching and learning of physics. Our participants were 33 preservice physics teachers in their first year participating in a scientist partnership program through online meetings. Participants' responses were collected through an essay questionnaire, and the result was analyzed with co-occurrence network analysis. Our research shows that preservice physics teachers have a positive perspective on scientists. The primary role of a scientist is related to a person with sufficient knowledge and opinion about physics. Their role is also related to the experiment and research result. Moreover, their innovation and discovery of new physics-related things also became their central role. After preservice physics teachers interact with scientists, they have higher motivation to learn physics. Our findings suggest that the activity facilitating interaction with professional scientists must be encouraged during the preservice physics teacher program.

Keywords: Learning; Preservice physics teacher; Scientists' role; Teaching

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INTRODUCTION

The gap between Teacher Education Institutions (TEI) and the needs of future generations, with the rapid change in the school curriculum, has become the main discussion globally (Risan, 2020; Zulkarnaen et al., 2023). Preservice physics teacher programs aim to shape technological pedagogical content knowledge (TPACK) (Efwinda & Mannan, 2021; Haryanto et al., 2021). Specifically, in the case of preservice physics teachers, the rapid improvement of science by the scientist rarely catches by the physics education curriculum (Sulaeman et al., 2022).

Scientists play a fundamental role as the experts of their genuine scientific expertise and authority (Gundersen, 2018). A professional scientist has two main responsibilities: commitment to good science and civic responsibility (Mieg, 2022). In their distinct role in science-related courses, the scientist

must be recognized (Kapici & Akçay, 2016) for their work and role as admirable figures in science.

Despite the scientist's duty and his recognition in the science curriculum. Science teachers face challenges as facilitators (Ellerani & Gentile, 2013). Teachers must consider the stages in shaping positive perceptions of students (Qiong, 2017). Concerning education, educational strategy has been merging the context of science with science career and their role in facing scientific problems (Amalia et al., 2023; Drymiotou et al., 2021; Hartini et al., 2022; Kapici & Akçay, 2016). Thus, physics teachers are responsible for students' learning objectives, including how to gain students' interest in science, scientists, and physicists.

The preservice physics teacher program must improve its expertise in physics content and teaching physics. However, additional challenges may be faced by those training to teach physics at the school level as they transition from learning about school physics to teachers at school physics in the future (Winter & Airey, 2022).

This study aims to explore the following two research questions concerning a sample of preservice physics teachers in Indonesia. (1) How do preservice physics teachers perceive the role of scientists? (2) Do the views of the preservice physics teachers on the role of physics change during their interaction with scientists, and if so, in what ways?

METHOD

The study group was an entire cohort of preservice physics teachers (n=33,6 males/27 females) on a one-year undergraduate training course at a state university in Indonesia. Female students dominated the cohort. Instead, we hope that this explorative study will start identifying some crucial points of the preservice physics teacher perspective in the scientist role.

The preservice physics teacher program in Indonesia is a 4-year program. Data was collected at the end of the first-year program. This study conducted guest lectures with a professional scientist for two meetings. After the meetings, students' views were explored by questionnaire and interview. All the questions were developed to clarify the research question and validated through focus group discussion by our research team. The richer and more detailed data from the questionnaire and interviews at the end of the meeting provided the bulk of the text for analysis.

The data collected was divided into two general codes related to research questions 1 (RQ1) and 2 (RQ2). Identification of the trend of students' views was analyzed by co-occurrence networks analysis using KH Coder software. Connections were drawn by linking relevant theories and previous studies to the result.

RESULT AND DISCUSSION

Preservice physics teachers perceive the role of scientists.

From all the responses, the result of the co-occurrence network analysis in Figure 1 helps to clarify the trend of the answers. Altogether, 115 sentences were analyzed by the students. In Figure 1, we can analyze that the main role of a scientist is related to a person with sufficient knowledge and opinion about physics. Their role is also related to the experiment and research result. Moreover, their innovation and discovery of new physics-related things also became their central role. Those keywords showed the highest frequency from students' opinions.

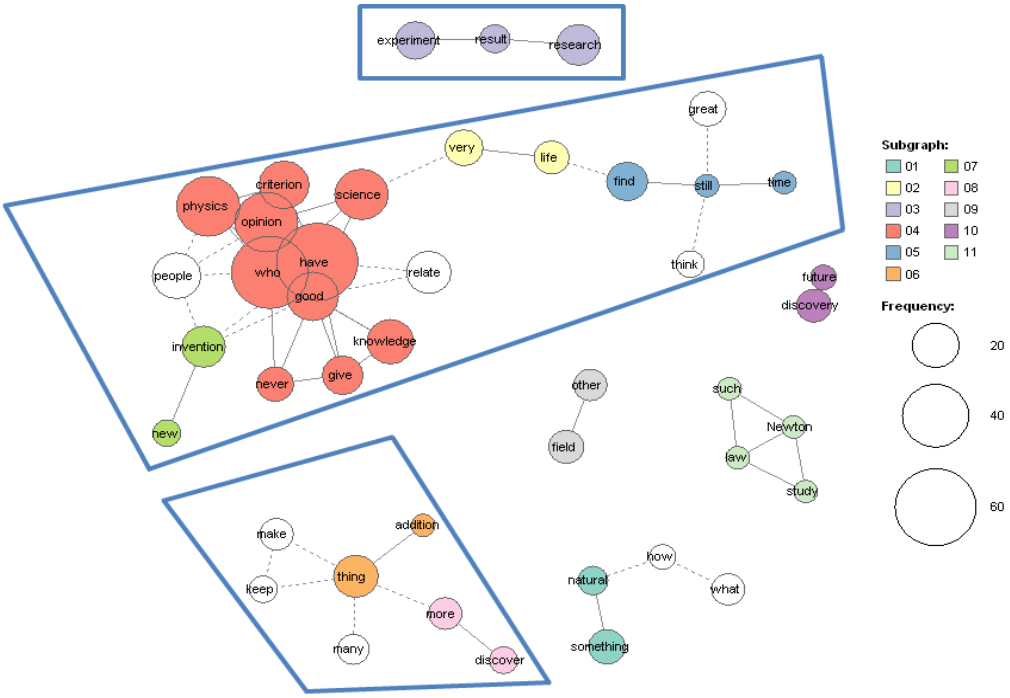

Figure 1 Overview of co-occurrence network analysis

Preservice science teachers' view of the role of scientists was consistent for most of them. Within that view, there was an assumption that being a scientist has the main role in discovering and researching new science-related things.

"In my opinion, physicists have more experience, knowledge, and interest in physics or a subject which they learned deeply for a long time. They have done many experiments……."

[PST 2]

This perception is also in line with the results of previous research by El Takach & Yacoubian (2020), which shows that the perception by teachers and students regarding the role of a scientist is that a scientist plays a role in conducting experiments, where the experimental results can be useful as new knowledge.

Scientists work with data by conducting investigations (D. Anderson & Moeed, 2017), determining goals, planning, collecting, organizing, reducing, representing, and interpreting data (Jin et al., 2023; Sharma & Honan, 2020). Several preservice teachers (for example, PST 29) also stated the role of the scientist in more detail, which is related to how the scientist starts the research to conclude it and even make a new formula, knowledge, or theory.

"……They know very well the basic knowledge of their research and the causes of the things they research until it is published. A physicist usually researched and analyzed the concept, including calculating, investigating how things can happen, and making absolute formulas……"

[PST 29]

A scientist must have social responsibility (Bektaş & Tayauova, 2019; Zhang, 2023). Other preservice science teachers also stated that successful scientists have a conceptual opinion of science and are responsible for it.

"……In my opinion, the criteria of a great physicist or great scientist are ready to accept advice or even a counterargument from other……."

[PST 5]

As expected, preservice science teachers' good view of the scientist's role was found. In general, scientists are

responsible for their fundamental role as the experts of their scientific expertise and authority, such as their findings through research or experiments (Gundersen, 2018; Mieg, 2022). Their responsibility for expertise is built on trust since society trusts that scientific research results are a factual and accurate reflection of their work.

Analysis of the preservice science teacher responses shows the positive statement of scientists. These results are consistent with research by El Takach & Yacoubian (2020), which shows that teachers and their students have a positive attitude toward scientists, and no one has a negative perception that scientists are strange, dangerous people or isolate themselves from society.

The participants appreciate the scientists' work and know this is the scientific process behind the findings. They also know the ethics of being honest in research and responsible for their argument. Their positive statement to scientists was expected since they were familiar with STEM-related (Barry et al., 2022; Blotnicky et al., 2018).

Preservice physics teachers' views on the role of physics change during their interaction with scientists

Based on the result of the co-occurrence network analysis. The responses in Figure 2 showed that their view on the role of physics changes during their interaction with scientists. They stated that interaction with scientists could help them gain the motivation to learn more science, particularly physics, as asserted by PST 4 and 7. These results confirm S. W. Anderson & Libarkin (2016) statement, which states that students' attitudes toward scientists can affect their learning motivation.

"……motivates me that there are so many things to learn from Physics related to our daily lives where it will make it easier for us to do something very useful"
[PST 4]

"…….I can be motivated to continue learning something that is not yet known either related to physics or other sciences"
[PST 7]

This perception is also in line with the results of research by Rushton & Reiss (2019), Fadzil et al. (2019), and Saat et al. (2021), which shows that collaborative activities with scientists can motivate teachers and students to carry out scientific activities that can be useful for solving real-world life problems.

The positive beliefs of teachers and preservice teachers toward science, scientists, and science teaching are important things to develop because their positive beliefs affect the potential of the teachers and preservice teachers to practice constructivist or inquiry activities, especially in teaching (Ngman-wara & Edem, 2016; Uçar et al., 2020). Science has experienced a specialization that continues to grow, whereas, in the 19th century, laboratory and research methods were the main activities in training or schools for scientists and preservice scientists (Hultén, 2016). The media also shows that a scientist works by spending his time in a laboratory; this can also impact people's perceptions of scientists (Ateş et al., 2021).

The positive perceptions that preservice teachers have regarding their favorite scientists can inspire and increase their motivation to study physics more deeply. They highlighted scientist behavior in never giving up and continuing to learn physics, as PST 14 and 17 stated.

"……He motivates me a lot, I like all the stories about him that make me want to know more about physics ……."
[PST 14].

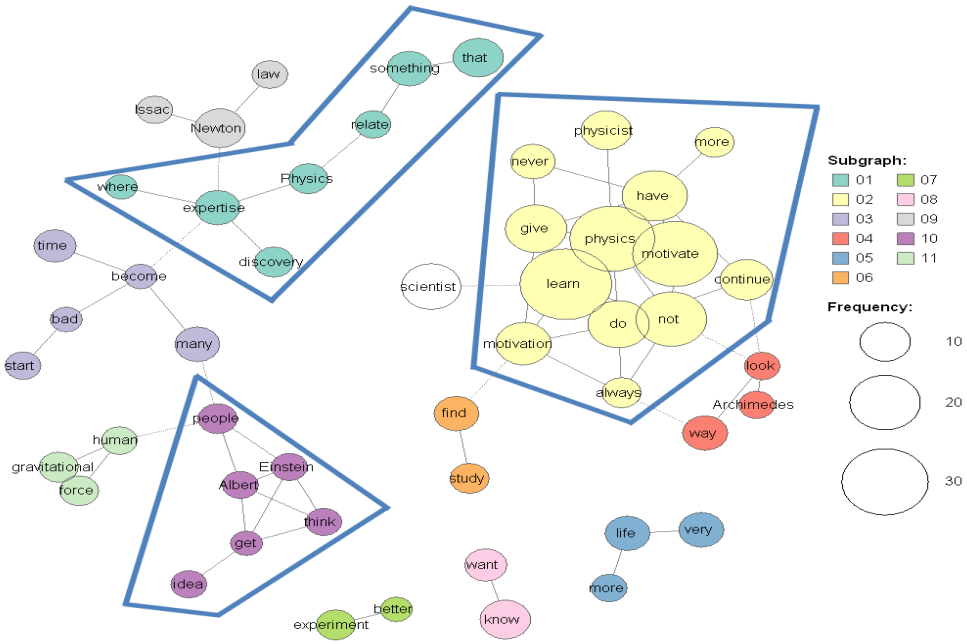

Figure 2 Overview of co-occurrence network analysis

"I was motivated by my favorite physicist to learn more about physics. From his life journey, he never gives up and is passionate about learning things of this nature. He also discovered something very extraordinary."
[PST 17]

Preservice science teachers' positive perceptions of scientists are impacted by their interpretation through science courses or other interactions with scientists (Qiong, 2017; Sade Memişoğlu & Erçelik, 2022; Ucar, 2012). Hence, increasing the frequency of interaction with scientists, both direct and indirect, is needed to gain positive perceptions. Moreover, it is supported by the findings that the stereotype statistically significant differences in student grade level (El Takach & Yacoubian, 2020; Hillman et al., 2014), and their experiences in science activities (Thomson et al., 2019). Especially for teachers as facilitators, simplified personal trainers, or coaches, science class requires motivation from within science and a positive perception of scientists (Bye, 2017; Membiela et al., 2023).

CONCLUSION

From our research, we can conclude that preservice physics teachers have a positive perspective related to scientists. A scientist's main role is to have sufficient knowledge and opinion about physics. Their role is also related to the experiment and research result. Moreover, their innovation and discovery of new physics-related things also became their central role. After preservice physics teachers interact with scientists, they are more motivated to learn physics. Our findings suggest that the activity facilitating interaction with professional scientists must be encouraged during the preservice physics teacher program.

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