Formatif: Jurnal Ilmiah Pendidikan MIPA, March 2024, 14 (1), 69-84
http://dx.doi.org/10.30998/formatif.v14i1.13080
p-ISSN: 2088-351X e-ISSN: 2502-5457
Accredited (S2) by Ministry of Research and Technology of Indonesia No. 148/M/KPT/2020
Available online at https://journal.lppmunindra.ac.id/index.php/Formatif/index

Science Teachers' Teaching Competency: Educational Background versus Teaching Experience

Weni Anissa Putri(*, 1), Ari Widodo[2]
Indonesia University of Education, Bandung

Abstract

Teaching science requires specific competencies that trained teachers in their previous education level. Teachers' educational backgrounds influence the implementation of science learning. Besides, the teaching experience is also an essential factor in determining the quality of science learning. This study aimed to identify how science teachers' educational background influences their way of teaching science. The data was obtained by observing three science teachers from Biology Education, Physics Education, and Biology when teaching the topics of Vibration and Excretory systems. The video recordings were then analyzed by using qualitative analysis software. The software for coding and analysis of video is *Videograph*. The result showed that teachers from Biology Education backgrounds who taught the Vibration topic exceeded the science teachers with Physics Education degrees. According to teaching period and professional development program records, the teacher who had taught for 35 years outperformed the other two teachers. Therefore, science teachers should increase their participation in teacher training to improve science teaching skills.

Keywords: Teaching Competency, Teaching Experience, Educational Background, Professional Development

(*) Corresponding Author:

How to Cite: Putri, W.A. Widodo, A. (2024). Science teachers' teaching competency: educational background versus teaching experience. *Formatif: Jurnal Ilmiah Pendidikan MIPA,* 14(1), 69-84. http://dx.doi.org/10.30998/formatif.v14i1.13080

INTRODUCTION

Science teachers in middle school can come from various educational backgrounds, such as Biology, Physics, or Chemistry. Consequently, it impacts science contents that tend to be taught from a discipline-specific point of view rather than integrated science. Thus, it is difficult for teachers to combine those disciplines (Priyatma et al., 2019; Septiana et al., 2018). Most science teachers in middle schools have degrees in biology education at 60% and Physics Education at 25% (Kemendikbud, 2022). Science teachers find it challenging to integrate science because teachers from physics, chemistry, and biology backgrounds do not know how to teach science with the integrated model. However, there are often several obstacles in classroom management because of teachers' different backgrounds and experiences (Waluyo & Naparin; A., 2016).

When implementing science learning, teachers must master the material and use learning media and methods (Priyatma et al., 2019). Teachers can teach science using an inquiry approach to achieve learning objectives and train students with scientific skills (DiBiase & McDonald, 2015; Doyan et al., 2019; Saharuddin & Wahab, 2019; Satria, 2013). However, many science teachers have not yet applied inquiry in science classrooms to train students' science process skills, mainly because of limited lesson hours (DiBiase & McDonald, 2015). Thus, professional development for science teachers is needed for more

practical knowledge on implementing inquiry-based science learning to its best potential (Ngaisah et al., 2018).

Based on the science secondary teacher competency test (UKG), the results from Pangkalpinang in 2020 were 63.08 (Kemendikbud, 2022). One of the reasons is that teachers lack teaching experiences, such as teaching periods and involvement in professional development (PD) activities arranged by the government and private institutions (Hanuscin et al., 2021; Jiang, 2015). PD activities can increase pedagogical knowledge, improve teachers' understanding of science learning strategies (Berry & van Driel, 2013; Hanuscin et al., 2021), and increase teachers' confidence (Dijkema et al., 2019; Wilson et al., 2015). The more teachers get involved in various PD activities, the better teaching performance teachers will conduct in actual practices (Earle, 2016; Fadilah & Suparwoto, 2016). The schools must also provide the teachers with facilitation to improve their teaching competence (Azuelo et al., 2015; Evagorou, Dillon, et al., 2015). Professional development training for teachers must be carried out on an ongoing basis. Thus, teachers are responsible for teaching science with good quality to achieve efficient professional competence (Azuelo et al., 2015). Teachers can join an academic qualification program to obtain teaching certification to improve science teachers competence. Other programs are workshops, seminars, scientific research forums such as conducting scientific publications on research results or scientific ideas, textbook publications, and science teacher guidelines (Faisal & Martin, 2019). By having more experience in teaching, teachers can develop their pedagogical skills, which helps them find the best way to teach students with different characteristics (Marco-Bujosa et al., 2017). In addition, active participation in educational organizations is vital in shaping the teachers and school staff to become proficient in implementing good quality science learning (Harefa, 2020).

Implementing science learning involves describing learning objectives, determining science content, learning strategies, learning media, and developing assessments (Azuelo et al., 2015). Teachers should have the capability to open the lesson, facilitate students with scientific communication, motivate students, and interact with them to learn science (Dijkema et al., 2019; Fadilah & Suparwoto, 2016). Science teaching competence is the knowledge and skills to act on content and learning processes to solve problems in class. It is also associated with certain activities using science learning standards (Azuelo et al., 2015). Science teaching competencies can be improved through teaching practices that allow teachers to train and improve their observations (Blackmore et al., 2018). Based on curriculum 2013, it explains that science learning is conducted by integrated science. Integrated science adds some aspects, such as attitude, knowledge, and skills. Thus, teachers should be required to integrate knowledge of science content, skills, and attitudes (Insani, 2016; Kemdikbud, 2016; Septiana et al., 2018).

Based on the description above, the article intends to conduct further studies on science teacher competence and educational background. Science teachers from non-natural sciences educational backgrounds can also teach the science class. Teaching experience is also essential (Waluyo & Naparin, A, 2016). This research aimed to identify how science learning conducted by teachers from different experiences and educational backgrounds may differ regarding science learning implementation. How are science learning competencies from teachers with different educational backgrounds and teaching experiences?

METHODS

This research used a quantitative descriptive method. The researchers observed three science teachers with different educational backgrounds and experiences in teaching science. This research was conducted from March 2022 until April 2022. The science contents were Vibration and excretory systems.

Table 1. Teachers' Educational Background and Experience

Teacher	Major	Training program	Certification	Organization	Scientific research forum	Period of teaching
Teacher A	Biology Education	✓	✓	✓	✓	35 years
Teacher B	Physics education	✓	x	x	x	Seven years
Teacher C	Biology	✓	x	x	x	Two years

Table 1 shows Teacher A has conducted classroom action research training and 2013 curriculum training, MGMP as Teacher Forum training about learning approach, LPTK (*Lembaga Pendidikan Tenaga Keguruan*) training, PPPPTK (*Pusat Pengembangan dan Pemberdayaan Pendidik dan Tenaga Kependidikan*) training on science learning methods. Teacher A participates in organizational activities, such as the PGRI (*Persatuan Guru Republik Indonesia*) program and seminars. Meanwhile, Teacher B attended the 2013 curriculum training, which included making lesson plans and analyzing core and essential competencies. Teacher C has attended science learning training held by a private institution regarding the competence of teachers to meet the new paradigm curriculum and learning models. Teacher C has also participated in academic programs, arranging teaching hours according to the rules and attending class on time.

The researcher collected data through surveys and video recordings. The survey explained teachers' educational background, training programs, organization, teaching period, scientific research forum, and certification. In the first observation, the researcher observed teacher A from a biology education background when he taught physics (60 minutes) in the first week. In the second observation, the researcher observed teacher B from a physics education background when she taught physics lessons (45 minutes) and biology (60 minutes), which took two times in the second week. In the third observation, the researcher observed a teacher from a biology background when he taught biology lessons (60 minutes) in the third week. The researcher observed the science learning process from physics education, biology education, and biology teachers when they teach biology and physics in class. The researcher recorded teachers' classroom practices via video recording (Azuelo et al., 2015). Teacher A is from SMP A and teaches physics in eighth grade; Teacher B is from SMP B and teaches physics and biology in eighth grade; and Teacher C is from SMP C and teaches biology in eighth grade. *Videography is a multimedia player that analyzes classroom or learning process recordings* that can be played and evaluated. The software enables the construction of observation and rating scales to analyze the video content. The coding can take synchronously while the video runs and can be segmented as time intervals or refer to what happens. Data is graphically presented on the screen and can be transferred or exported for statistical calculations to SPSS statistics. Then, the researchers get the percentage of science teaching competencies from 3 teachers. The indicators of science teaching competency are facilitating

constructivist learning environment analysis, facilitating students' scientific problem-solving competence, facilitating students' communication competence, teaching science inquiry, and connecting science to everyday life. Video recordings can make it easier for researchers to watch the learning process and minimize missed video parts (Mufida & Widodo, 2021). The results of Teacher B and Teacher C used the lecturing method, and Teacher A used practical work—the instrument adapted from teacher competency in competency-focused science teaching (Kang et al., 2020). The indicators can be seen in Table 1.

Table 1. The science teaching competency

No	Indicators
1	Facilitating a constructivist learning environment
2	Facilitating student's scientific problem-solving competence
3	Facilitate student's communication competence.
4	Teaching science inquiry
5	Connection of Science to Everyday Life

RESULTS & DISCUSSION

Science Teaching competency consists of five indicators: 1) Ability to create a constructivist learning environment; 2) Ability to facilitate students' scientific problem-solving competence; 3) Ability to facilitate students' scientific communication competence; 4) Science Teaching Performance Competence (Teaching science inquiry); 5) The connection of science to daily life (Kang et al., 2020). The sub-indicators of facilitating a constructivist learning environment are facilitating students to construct their knowledge and explanation, flexibly facilitating students in unexpected class atmospheres, explaining science concepts systematically while considering students' abilities, and facilitating students' critical thinking. Table 3 shows teachers' ability to create a constructivist learning environment by teachers A, B, and C that taught the Vibration and Excretory System.

Table 3. Facilitating a Constructivist Learning Environment

Science teaching competency	Teacher A teaches Vibration	Teacher B teaches Vibration	Teacher C teaches Excretory System	Teacher B teaches Excretory System
Ability to create a constructivist learning environment	46.37%	18.9%	31.2%	24.1%

Table 3 shows that Teacher B did not teach the excretory system, and Teacher C did not teach vibration because it is only focused on how physics and biology background teach physics and biology. This measurement was obtained through a rubric, analyzed through a Videograph, and then converted into SPSS. Teacher A could create a constructivist environment through hands-on activity in learning physics about Vibration and encourage students to think about scientific concepts and construct an explanation through questions and answers between 4 groups, and each group has four students. The question is, how can vibration make sound? Students explored ideas and found oscillatory

motion in the pendulum. Teacher A was enthusiastic about creating meaningful science learning so that they could participate actively. Teacher A's classroom was exemplary because he provided more opportunities for students to use tools such as a stand, rope, and pendulum in experiments, and they actively did simple pendulum experiments (Ahmad et al., 2015; Santi, 2015; Satria & Sari, 2018; Sugrah, 2020; Supriyati, 2015). Teacher A taught Vibration using the worksheet as the learning media, while Teachers B and C explained the Vibration and Excretory System on primary and general concepts. Science teachers should provide facilities for students to independently carry out the learning process, complete tasks, obtain information, and connect it with their prior knowledge (Prins et al., 2016; Satria & Sari, 2018).

Teacher B's major was physics. Students in this class were bored because the content of excretory systems in invertebrates was too advanced for the middle school level. Thus, Teacher B should comprehend more about the scope of excretory system concepts for lower secondary students. However, Teacher B could handle bored students. He asked students to play mimic gesture games while learning. A psychological relationship between teacher and student leads to the desire to enjoy learning. Students can feel a sense of pleasure without pressure or coercion, so they tend to pay more attention to the lessons (Sulthon, 2017).

Teacher B is categorized as low on creating a good learning environment when teaching Vibration and Excretory Systems. Teacher B had not yet had experience managing the class using constructivist learning, which has many benefits for students, such as exploring ideas, explaining scientific phenomena, and actively participating in science learning. Teachers B and C also did not implement various learning steps for students to think creatively. The lack of various learning activities causes students to be unmotivated to learn independently (Berry & van Driel, 2013). Teachers B and C should use the learning method to develop student's thinking skills, requiring students to build their thoughts through active peer interaction. The learning approach with constructivism applies students' previously known knowledge and develops it in their environment. The constructivist emphasizes students' role in compiling their knowledge or thinking through activities (Setialesmana, 2016). Teachers should also be facilitators who create a supportive learning environment to build students' knowledge and develop collaboration skills (Sugrah, 2020).

Teacher A had the most extended teaching period and attended several professional development programs in managing science learning with teacher B. Teacher A attended extensive training from the Teacher Forum on the science learning approach. Therefore, Teacher A had comprehended the constructivist approach to learning. Teachers who are given training can improve their teaching competence (Evagorou, Dillon, et al., 2015; Lee et al., 2016; Sugrah, 2020). Training can also help teachers improve teaching skills, such as designing and implementing teaching materials, monitoring student progress, directing student activities, and implementing adequate time in teaching (Azuelo et al., 2015). Teacher B and Teacher C rarely joined the science learning approach training. Thus, they can create a constructive environment by applying experience, knowledge, and interaction from professional development programs (Zukmadini et al., 2021).

Table 4. Facilitating Student's Scientific Problem-Solving Competence

Science teaching competency	Teacher A teaches Vibration	Teacher B teaches Vibration	Teacher C teaches an excretory system.	Teacher B teaches an excretory system.
Ability to facilitate students' scientific problem-solving competence	45.75%	0%	0%	0%

Table 4 was obtained through a rubric analyzed through a Videograph and then converted into SPSS. Sub-indicators of facilitating students' scientific problem-solving competence are the ability to provide opportunities for students to find problems and the purpose of inquiry and to provide opportunities for students to reflect on the inquiry process. Teacher A facilitated students' problem-solving competencies more than Teacher B and Teacher C. Teacher B and Teacher C got 0% because of a lack of identifying problems, analyzing answers, and finding the best solution that trigger students' critical thinking. Teacher A guided students to interpret and elaborate and instructed them to think critically about Vibration. After that, students analyzed and solved problems about pendulum vibration and collected facts that students knew and did not know before about pendulums. In the end, Teacher A asked fundamental questions (What are the examples of vibration?) and problem-based questions after experimenting. Problem-solving competency includes all aspects of knowledge: memorization, understanding, application, analysis, synthesis, and evaluation (Ramdhan, 2020).

Teacher B and Teacher C got lower results on problem-solving skills than Teacher A. This was caused by the lecturing method, which was not optimal for improving students' problem-solving skills. Another factor was that Teachers B and C used textbooks and soft files as learning media and only emphasized mastery of concepts. Teachers should choose the appropriate learning media and method to help students solve problems in learning Vibration and Excretion Systems. The experimental method can support students' problem-solving competence (Ramdhan, 2020; Suhendri, 2015). The teachers should be familiar with appropriate learning methods for students to analyze problem-solving and strengthen participation in government and private institutions' training activities, organizations, and programs (Budiarti et al., 2016).

Teachers B and C carried out additional training activities, such as unique and short training organized by PPPPTK and LPTK, as alternative strategies to improve teacher professionalism. Short courses at LPTKs or other educational institutions were intended to practice and improve teacher competence in several abilities, such as conducting classroom action research to solve problems, arranging scientific papers, and evaluating science learning (Hoesny & Darmayanti, 2021). School science training equips teachers to train the students with the scientific process and critical thinking skills, participate in problem-based learning activities and experimental activities to obtain data, and discuss with other students to conclude (Dijkema et al., 2019; Hinduan et al., 2009). Teachers B and C should join seminars and scientific forums. This kind of activity upgrades teachers' pedagogical and scientific knowledge. Many scientific forums invite teachers and lecturers to present research reports. Therefore, they can communicate and get new ideas for quality learning (Hanuscin et al., 2021; Hoesny & Darmayanti, 2021).

Table 5. Facilitate Student's Communication Competence

Science teaching competency	Teacher A teaches Vibration	Teacher B teaches Vibration	Teacher C teaches Excretory System	Teacher B teaches Excretory System
Ability to facilitate students' scientific communication competence	82.3%	33.7%	27.7%	18%

The indicators are the ability to communicate students' scientific knowledge through language and scientific representation and facilitate interaction and verbal communication of students with teachers and other students. This data was obtained through a rubric, analyzed through a Videograph, and then converted into SPSS. Table 5 shows that Teacher A guided students in learning Vibration to communicate scientific findings with their peers. Teacher A provided scientific representations to students regarding verbal (expressing opinions) and visuals (tables and pictures) on worksheets through practical group activities that described concepts and processes about pendulum vibration observation. Students can express something as a concept, improving their problem-solving skills and applying these representations in various forms (Arif & Muthoharoh, 2021). Teacher B got low in teaching the excretory system because Teacher B did not provide opportunities for students to argue and present the results of learning the excretory system.

One of the indicators of scientific communication is that the teacher provides opportunities for students to interact or communicate by getting information, conveying information orally, and writing through scientific activities (Ika, 2018). For example, Teacher A can provide opportunities for students to discuss problems that were instructed in the worksheet to solve together. This allows students to interact more actively and communicate their creative ideas to solve problems and work in group discussions (Budiarti et al., 2016). Students, as partners, effectively develop verbal communication skills (Wati et al., 2019). Teacher A can provide opportunities for students to communicate by asking questions to the teacher, classifying, interpreting, compiling data, discussing the results of laboratory activities in compiling and writing reports systematically, then presenting the results of discussions systematically and making conclusions. Students conduct laboratory inquiry activities to improve oral and written scientific communications (Ika, 2018).

Teachers A, B, and C used image representation to teach Vibration and Excretory Systems. Teacher A used a mind map, Teacher B showed the urination process via presentation, and Teacher C drew a pendulum representation on the whiteboard. Science concepts are abstract and complex. Thus, an appropriate visual representation is required to make it easier for students to understand the concept, especially the excretory system and vibration (Inaltekin & Goksu, 2019). Using image representations is more accessible than other types of representation (Asiska et al., 2021). However, students had difficulty reading, interpreting, and understanding graph information because of a lack of mathematical representation (Nurlaelah et al., 2020).

Teachers B and C are lower in applying mathematical representations in conveying concepts. Teacher C only showed symbol representation (picture). Meanwhile, Teacher B used image representation in the excretory system topic. Various image representations are found in Biology. Scientific representation is a student's ability to present the concepts of graphics, tables, and mathematical equations in other forms. Students must comprehend

scientific representation skills in learning (Anderson et al., 2013). They use scientific representations to find solutions to scientific problems (Evagorou, Erduran, et al., 2015). If the concepts contain a scientific representation, science learning, especially Physics, will be easier to understand. It is crucial to be mastered by students to determine successful science learning (Asiska et al., 2021).

Regarding oral scientific communication, Teacher B and Teacher C are categorized as low because the learning methods used by Teacher B and Teacher C do not involve students in the scientific communication process. Therefore, it is necessary to have facilities and media that support learning with variations in learning methods to improve students' scientific communication (Nana & Pramono, 2019). Teacher A provides students with the tools to develop their presentations, give clear statements to the audience effectively, and listen to others' responses.

Teachers B and C need professional development training in scientific communication so that students can increase their thinking and gain new knowledge (Derlina & Nst, 2016). Teachers B and C can apply the learning material presented in the lesson, including representations such as tables and graphs. Another alternative way is joining social activities, seminars, training, meetings, research, organizations, and teaching practice programs held by the government or non-government that have specific standards for teaching and learning to be achieved (Azuelo et al., 2015). Teaching practice allows participants to practice and refine what they have observed and learned to build their communication skills and competencies (Blackmore et al., 2018; Dijkema et al., 2019).

Table 6. Teaching Science Inquiry

Science teaching competency	Teacher A teaches Vibration	Teacher B teaches Vibration	Teacher C teaches an excretory system.	Teacher B teaches an excretory system.
Ability to teach science inquiry	86.6%	0.375%	0%	0%

Teaching science inquiry provide appropriate opportunities for students to think logically based on scientific evidence, provide the right opportunity for students to observe and explore something with a scientific attitude and curiosity, provide appropriate opportunities for students to carry out independent scientific investigations, provide appropriate opportunities for students to experience different types of exploration, such as experimentation, investigation, and discussion, provide opportunities for students to use scientific terms and representations (graphs, tables, figures, etc.) effectively, provide opportunities for students to exchange ideas and opinions and understand each other about science, provide for students to work together in solving inquiry problems and provide appropriate opportunities for students to understand scientific and technological information presented in various media such as broadcasting and the internet as well as evaluate scientific objectivity and validity. Table 6 was obtained through a rubric, analyzed through Videograph, and then converted into SPSS. Table 6 illustrates that Teacher A explained the topic and learning objectives and conveyed an overview of learning activities regarding the vibration lesson. Afterward, teacher A encouraged students to formulate answers, investigate, and determine what information could be obtained from the experiment. Teacher A facilitated inquiry activity using laboratory tools (pendulum, stands, stopwatch, and rope) to obtain, analyze, interpret, and communicate results. Teacher A asked some questions about investigation activities, such as (what did you find on the pendulum with different strings? and How many minutes does the pendulum move?) and

the students found the information from the inquiry activity. In addition, it provided opportunities for students to exchange opinions on inquiry activities in learning Vibration and think of proving the answers according to the findings (Winanto & Makahube, 2016). At the end of the lesson, students presented and concluded the experimental findings regarding the pendulum. Then, they evaluated and reflected on the inquiry activities (pendulum experiment) with other groups. This inquiry activity is significant for practicing students' competencies (Rohmi et al., 2020). Science learning is directed at inquiry activities in that students gain knowledge about surrounding phenomena to improve their ability to think, work, and have a scientific attitude in communicating knowledge (Minawati et al., 2014). Teachers A and B got 0% in science teaching inquiry because they did not provide students to observe, carry out independent scientific investigations, and appropriate opportunities for students to experiment and discuss. Teacher B gets 0.375% in teaching science inquiry because students are given opportunities to use scientific terms and representations (graphs, tables, figures, and vibration and waves concepts.

Teacher A fostered students' inquiry competence to think critically and curiously, cooperate, and respond to information in inquiry activities. Students are skilled or familiar with experimental equipment, such as pendulum, standee, stopwatch, and rope. The students achieve learning goals by showing science process skills (Azizah, 2018; Sutrio et al., 2020; Warpaatun, 2019). This situation affects students' enthusiasm during learning. The inquiry-based learning process involves students directly conducting experiments related to the lessons (Jerrim et al., 2020). Then, they feel more interested in learning because the method makes it easier for students to understand (Nunaki et al., 2019). Teachers B and C are lower in facilitating and instructing students in inquiry. The teacher's role is critical in guiding and involving students in conducting inquiry activities (Rohmi et al., 2020). Teacher B and Teacher C used the lecturing method. The lecturing method made students passive because they only listened to the information given by the teacher (Tomkin et al., 2019). Thus, Teachers B and C should have experience and conduct experiments that allow students to discover their concepts and knowledge.

Teacher A implemented inquiry activities facilitated by schools' programs, national institutions such as the Ministry of Education and Culture, and other private institutions. This training can be integrated by improving the concepts and skills (Zukmadini et al., 2021). Teaching competency differed from Teacher B and Teacher C in teaching physics and biology concepts because they did not have training activities about inquiry learning. Teacher training aims to determine teachers' competency in science teaching, provide excellence in student performance in conducting inquiries, develop teaching materials, and train students related to projects in science investigations (Dijkema et al., 2019; Evagorou, Dillon.

Table 7. Connection of Science to Everyday Life

Science teaching competency	Teacher A teaches Vibration	Teacher B teaches Vibration	Teacher C teaches Excretory System	Teacher B teaches Excretory System
Ability to teach connection of science in everyday life	20.4%	0.1%	4.3%	0.8%

The connection of science to everyday life relates to providing appropriate opportunities for students to understand scientific and technological information presented

in various media such as broadcasting and the internet, as well as evaluate scientific objectivity and validity, provide opportunities for students to select, analyze, and organize various information related to scientific phenomena and solve scientific problems, provide opportunities for students to be interested in social issues related to science and make decisions, provide the right opportunity for students to create a class atmosphere that is happy in learning science and the benefits of science and provide opportunities for students to explore ethical issues related to science and technology. Table 7 shows that Teacher A taught science lessons that integrated students' real-world situations and encouraged students to connect their knowledge based on facts and phenomena with its application in the laboratory. This is in line with students' ability to apply knowledge to everyday life, such as clock, wrecking ball, bowling ball, and ballistic pendulum, where students can understand scientific thinking in integrating knowledge and natural phenomena, apply science concepts, laws, and theories to explain various natural phenomena, explain the application of scientific laws in technology, mainly that can be found in everyday life (Nursa'adah et al., 2021; Syaodih et al., 2021; Winanto & Makahube, 2016). One aspect of science in daily life is that Teacher A provided opportunities for students to conduct experiments, investigations, and discussions during learning. The discussion, observation, and experiments on natural phenomena allow students to think, ask questions, and discuss with their friends (Azuelo et al., 2015; Purnomowati, 2016).

Teachers B and C did not integrate the theories of scientific concepts and phenomena in everyday life. Teachers C and B only explained the concepts and daily-life explanations in the opening session and lack of laboratory activity. Teacher C explained examples of vibrating objects and how they vibrate. Teacher B explained examples of excretory system organs (skin, pancreas, and kidney) and excretory system diseases. Teacher C explained the biological content related to the product, diseases, and the impact of consuming food and drink on the excretory system. Teachers B and C should teach theories or concepts to explain facts or phenomena that students often find in everyday life, both phenomena and laboratory. Science is defined as a way to try and find the things, attitudes, and skills that enable individuals to solve problems through scientific processes related to everyday life (Nursa'adah et al., 2021; Yaswinda et al., 2018).

Training activities, workshops, and programs from the government, such as the Teacher Forum and other institutions, can help teachers improve their knowledge and skills in implementing daily activity-oriented learning and teachers' science learning competencies (Zukmadini et al., 2021). Other programs, such as seminars, activities from scientific organizations, and forums, can provide an integrated analysis of science learning and daily life based on the current curriculum (Dijkema et al., 2019; Prihastuty et al., 2021). Another activity is the academic qualification program as a teacher facilitator in providing feedback on the other teacher's performances (Nursa'adah et al., 2021). Besides understanding theory to explain the facts, teachers must also comprehend theories to predict. In addition, teaching staff should assist science teachers in implementing science learning in everyday life (Nursa'adah et al., 2021).

The weakness of this study was that it only examined teacher A from a physics education background who taught vibration with 35 years of teaching experience, while teacher C from a physics education background taught vibration and excretory systems and had five years of teaching experience and teacher B from a biology background taught excretory systems and had three years of teaching experience. For further research, science teaching competencies can be added based on teaching background and experience (from 5 to 30 years) from science, biology, physics, and chemistry education backgrounds. Teachers with more extended teaching experience have higher science teaching competence, even though the teacher is from a biology background. Teachers have more

than 15 years of teaching experience and various ways to overcome challenges and obstacles in learning. Teachers do not experience obstacles regarding the content component because they already have confidence in conveying material/concepts to students. The teacher understands students' concepts by equipping themselves to make material summaries and learning from the media and other sources (Zuhaida & Yustiana, 2023).

CONCLUSION

Teachers with non-linear educational backgrounds have better science teaching competencies than teachers with linear backgrounds. Science teaching competencies facilitate constructivist learning, problem-solving competence, communication competence, inquiry activity, and science in everyday life. Teachers have a lot of teaching experience from trainings organized by the government and national institutions such as LPMP (*Lembaga Penjaminan Mutu Pendidikan*), MGMP (teacher forum), and LPTK (*Lembaga Pendidikan Tenaga Keguruan*). Teachers from linear educational backgrounds have low-quality science learning in the lesson because they rarely join training experience. Those science teachers are expected to participate in training to improve science teaching competencies, such as increasing the concept mastery of science teachers. A professional teacher should facilitate the learning process. Teachers can apply and implement the skills taught in the training program with the students.

REFERENCES

Ahmad, C. N. C., Ching, W. C., Yahaya, A., & Abdullah, M. F. N. L. (2015). Relationship between constructivist learning environments and educational facility in science classrooms. *Procedia - Social and Behavioral Sciences*, *191*(1), 1952–1957. https://doi.org/10.1016/j.sbspro.2015.04.672

Anderson, T. R., Schonborn, K. J., Plessis, L., Gupthar, A. S., & Hull, T. L. (2013). Multiple representations in biological education. *Multiple Representations in Biological Education, Series: Models and Modeling in Science Education*, *7*(19), 19–38. https://doi.org/10.1007/978-94-007-4192-8

Arif, S., & Muthoharoh, A. (2021). Pengembangan media pembelajaran berbasis powtoon dalam meningkatkan kemampuan representasi IPA di tengah pandemi covid 19. *Jurnal IPA & Pembelajaran IPA*, *5*(1), 112–124. https://doi.org/10.24815/jipi.v5i1.19779

Asiska, A. D. W., Mahardika, I. K., & Bektiarso, S. (2021). Analisis kemampuan representasi gambar dan matematis materi gerak lurus pada siswa SMA di Bondowoso. *Jurnal Pembelajaran Fisika*, *10*(3), 90–97. https://doi.org/10.19184/jpf.v10i3.25324

Azizah, A. (2018). Penerapan model pembelajaran inkuiri untuk meningkatkan hasil belajar ipa siswa kelas V Sekolah Dasar. *Primary: Jurnal Pendidikan Guru Sekolah Dasar*, *7*(1), 106–118. https://doi.org/10.33578/jpfkip.v7i1.5358

Azuelo, A. G., Sariana, L. G., & Manual, A. (2015). Science teachers' teaching competencies and their training experience in classroom pedagogical approaches. *Liceo Journal of Higher Education Research*, *11*(1), 1–15. https://doi.org/10.7828/ljher.v11i1.886

Berry, A., & van Driel, J. H. (2013). Teaching about teaching science: aims, strategies, and backgrounds of science teacher educators. *Journal of Teacher Education*, *64*(2), 117–128. https://doi.org/10.1177/0022487112466266

Blackmore, K., Howard, C., & Kington, A. (2018). Trainee teachers' experience of primary science teaching and the perceived impact on their developing professional identity. *European Journal of Teacher Education*, *41*(4), 529–548. https://doi.org/10.1080/02619768.2018.1462330

Budiarti, S., Nuswowati, M., & Cahyono, E. (2016). Guided inquiry berbantuan e-modul untuk meningkatkan keterampilan berpikir kritis. *Journal of Innovative Science Education*, *1*(1), 1–9.

Derlina, & Nst, L. A. (2016). Efek penggunaan model pembelajaran inquiry training berbantuan media visual dan kreativitas creativity-assisted inquiry learning model on students ' science process skills. *Jurnal Cakrawala Pendidikan*, *15*(2), 153–163.

DiBiase, W., & McDonald, J. R. (2015). Science teacher attitudes toward inquiry-based teaching and learning. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *88*(2), 29–38. https://doi.org/10.1080/00098655.2014.987717

Dijkema, S., Doolaard, S., Ritzema, E. S., & Bosker, R. J. (2019). Ready for take-off? The relation between teaching behavior and teaching experience of Dutch beginning primary school teachers with different educational backgrounds. *Teaching and Teacher Education*, *86*(19), 1–13. https://doi.org/10.1016/j.tate.2019.102914

Doyan, A., Susilawati, S., Bahri, S., Muhlis, M., & Artayasa, I. P. (2019). Pelatihan pemantapan konsep materi fisika dan pengukuran bagi guru IPA di SMPN 9 Mataram. *Jurnal Pengabdian Magister Pendidikan IPA*, *2*(2), 1–9. https://doi.org/10.29303/jpmpi.v2i1.333

Earle, S. (2016). The challenge of balancing fundamental principles in teacher assessment. *The Journal of Emergent Science*, *12*(17), 41–47.

Evagorou, M., Dillon, J., Viiri, J., & Albe, V. (2015). Pre-service science teacher preparation in Europe: comparing pre-service teacher preparation programs in England, France, Finland and Cyprus. *Journal of Science Teacher Education*, *26*(1), 99–115. https://doi.org/10.1007/s10972-015-9421-8

Evagorou, M., Erduran, S., & Mäntylä, T. (2015). The role of visual representations in scientific practices: from conceptual understanding and knowledge generation to 'seeing' how science works. *International Journal of STEM Education*, *2*(1), 1–13. https://doi.org/10.1186/s40594-015-0024-x

Fadilah, N. U., & Suparwoto, S. (2016). Keterlaksanaan pembelajaran fisika implementasi kurikulum 2013 berdasarkan latar belakang akademik guru di MAN DIY. *Jurnal Inovasi Pendidikan IPA*, *2*(1), 76–90. https://doi.org/10.21831/jipi.v2i1.8380

Faisal, & Martin, S. N. (2019). Science education in Indonesia: past, present, and future. *Asia-Pacific Science Education*, *5*(1), 1–29. https://doi.org/10.1186/s41029-019-0032-0

Hanuscin, D., Donovan, D., Acevedo-Gutiérrez, A., Borda, E., DeBari, S., Melton, J., Le, T., Morrison, W., & Ronca, R. (2021). Supporting the professional development of science teacher educators through shadowing. *International Journal of Science and Mathematics Education*, *19*(1), 145–165. https://doi.org/10.1007/s10763-021-10154-5

Harefa, D. (2020). Pengaruh antara motivasi kerja guru IPA dan displin dengan prestasi kerja. *Aksara: Jurnal Ilmu Pendidikan Nonformal*, *6*(3), 225–240. https://doi.org/10.37905/aksara.6.3.225-240.2020

Hinduan, A. A., Trisnamansyah, S., & Rusli, A. (2009). Pelatihan Keterampilan proses ilmiah berbasis organisasi belajar bagi guru Sekolah Dasar. *Paedagogia*, *12*(1), 10–21.

Hoesny, M. U., & Darmayanti. (2021). Permasalahan dan solusi untuk meningkatkan kompetensi dan kualitas guru: Sebuah kajian pustaka. *Scholaria : Jurnal Pendidikan Dan Kebudayaan*, *11*(2), 123–132. https://ejournal.uksw.edu/scholaria/article/view/3595

Ika, Y. E. (2018). Pembelajaran berbasis laboratorium IPA untuk melatih keterampilan komunikasi ilmiah siswa SMP kelas VII. *JIPFRI (Jurnal Inovasi Pendidikan Fisika Dan Riset Ilmiah)*, *2*(2), 101–113. https://doi.org/10.30599/jipfri.v2i2.338

Inaltekin, T., & Goksu, V. (2019). Research on visual learning representations of primary and secondary science textbooks in Turkey. *International Journal of Progressive Education*, *15*(6), 51–65. https://doi.org/10.29329/ijpe.2019.215.4

Insani, M. D. (2016). Studi pendahuluan identifikasi kesulitan dalam pembelajaran pada guru IPA SMP se-Kota Malang. *Jurnal Pendidikan Biologi*, *7*(2), 81–93. http://journal2.um.ac.id/index.php/jpb/article/view/723

Jerrim, J., Oliver, M., & Sims, S. (2020). Erratum: the relationship between inquiry-based teaching and students' achievement. New evidence from a longitudinal PISA study in England (Learning and Instruction (2019) 61 (35–44), (S095947521830361X), (10.1016/j.learninstruc.2018.12.004)). *Learning and Instruction*, *10*(16), 1–10.

Jiang, F. (2015). Elementary teachers' professional background, science knowledge, science teaching practices, and students' science achievement: Path analysis. *Conference: Annual Conference of American Educational Research Association*, *1*(1), 1–20.

Kang, N. H., Kang, H., Maeng, S., Park, J., & Jeong, E. (2020). Teacher competency in competency-focused science teaching in the South Korean context: teacher self-assessment instrument development and application. *Journal of Asia-Pacific Science Education*, *6*(2), 480–513. https://doi.org/10.1163/23641177-bja10012

Kemdikbud. (2016). *Peraturan Menteri Pendidikan Dan Kebudayaan Nomor 37 Tahun 2018*.

Kemendikbud. (2022). *Neraca Pendidikan Daerah (NPD)*. https://npd.kemdikbud.go.id/?appid=ukg

Lee, Y. C., Lau, K., & Yip, V. W. Y. (2016). Blended learning for building student-teachers' capacity to learn and teach science-related interdisciplinary subjects. *Asian Association of Open Universities Journal*, *11*(2), 166–181. https://doi.org/10.1108/aaouj-09-2016-0029

Marco-Bujosa, L. M., McNeill, K. L., González-Howard, M., & Loper, S. (2017). An exploration of teacher learning from an educative reform-oriented science curriculum: case studies of teacher curriculum use. *Journal of Research in Science Teaching*, *54*(2), 141–168. https://doi.org/10.1002/tea.21340

Minawati, Z., Haryani, S., & Pamelasari, S. D. (2014). Pengembangan lembar kerja siswa ipa terpadu berbasis inkuiri terbimbing pada tema sistem kahidupan dalam tumbuhan untuk smp kelas VIII. *USEJ - Unnes Science Education Journal*, *3*(3), 587–592.

Mufida, A. Al, & Widodo, A. (2021). Analisis kedalaman dan keterkaitan antar konsep pada pembelajaran IPA di masa pandemi. *Jurnal Inovasi Pendidikan IPA*, *7*(2), 116–127. https://doi.org/10.21831/jipi.v7i2.40887

Nana, N., & Pramono, H. (2019). Upaya peningkatan kemampuan kognitif dan komunikasi ilmiah siswa kelas X MIA 1 SMA Negeri 1 Ciamis menggunakan model pembelajaran inquiry. *Diffraction*, *1*(1), 1–10.

Ngaisah, F., Ramli, M., Karyanto, P., Nasri, N. F., & Halim, L. (2018). Science teachers' practical knowledge of inquiry-based learning. *Journal of Turkish Science Education*, *15*(Special Issue), 87–96. https://doi.org/10.12973/tused.10260a

Nunaki, J. H., Patiung, Y., Kandowangko, N. Y., Nusantari, E., & Damopolii, I. (2019). The validity and students' response toward coordination system teaching material-oriented guided inquiry. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *9*(1), 59–70. https://doi.org/10.30998/formatif.v9i1.2884

Nurlaelah, I., Widodo, A., Redjeki, S., & Rahman, T. (2020). Analisis kemampuan komunikasi ilmiah peserta didik pada kegiatan kelompok ilmiah remaja berbasis riset terintegrasi keterampilan proses sains. *Quagga: Jurnal Pendidikan Dan Biologi*, *12*(2), 194. https://doi.org/10.25134/quagga.v12i2.2899

Nursa'adah, E., Sundaryono, A., & Karyadi, B. (2021). Penguatan aspek-aspek nature of science and technology dalam pembelajaran bagi MGMP IPA Kabupaten Kaur Provinsi Bengkulu. *Jurnal Warta LPM*, *24*(4), 593–602.

Prihastuty, R., Nuzulia, S., Muhammad, A. H., & ... (2021). Peningkatan kompetensi guru dalam mengidentifikasi kepribadian siswa Madrasah Aliyah di Kabupaten Tegal. *Budimas : Jurnal Pengabdian Masyarakat*, *03*(02), 465–472.

Prins, G. T., Bulte, A. M. W., & Pilot, A. (2016). An Activity-based instructional framework for transforming authentic modeling practices into meaningful contexts for learning in science education. *Science Education*, *100*(6), 1092–1123. https://doi.org/10.1002/sce.21247

Priyatma, B., Sikumbang, D., & Marpaung, R. R. T. (2019). Analisis Kendala pendidik ipa terpadu di SMP Swasta. *Jurnal Bioterdidik*, *7*(5), 44–56. http://digilib.unila.ac.id/56830/

Purnomowati, Y. L. (2016). Upaya meningkatkan hasil belajar, aktivitas dan sikap pada materi getaran, gelombang dan bunyi, melalui metode diskusi, observasi, dan eksperimen. *Jurnal Pendidikan Fisika*, *4*(1), 36–48. https://doi.org/10.24127/jpf.v4i1.400

Ramdhan, B. (2020). Profil kemampuan memecahkan masalah siswa sekolah menengah pertama (SMP) Negeri pada materi sistem ekskresi profile of problem solving skills of junior high school. *Didaktika Biologi: Jurnal Penelitian Pendidikan Biologi*, *4*(1), 19–26.

Rohmi, P., Islam, U., Sunan, N., & Yogyakarta, K. (2020). Peningkatan domain kompetensi dan pengetahuan siswamelalui penerapan levels of inquirydalam pembelajaran IPA terpadu. *Edu Sains: Jurnal Pendidikan Sains & Matematika*, *1*(1), 1–10. https://doi.org/10.15408/es.v9i1.1979

Saharuddin, S., & Wahab, M. (2019). Analisis kesulitan dalam pemebelajaran ipa di SMP Negeri Limboro. *Jurnal IPA Terpadu*, *2*(2), 75–83. https://doi.org/10.35580/ipaterpadu.v2i2.11148

Santi, J. (2015). Penerapan pendekatan konstruktivisme untuk meningkatkan hasil belajar siswa pada pokok bahasan tumbuhan hijau di kelas V SDN 3 Tolitoli. *Jurnal Kreatif Tadulako*, *4*(3), 57–71.

Satria, E. (2013). Peningkatan proses dan hasil belajar kognitif pembelajaran IPA peserta didik dengan pendekatan rational inquiry di kelas III SD pembangunan air tawar UNP Padang. *Jurnal CERDAS Proklamator*, *1*(1), 31–43.

Satria, E., & Sari, S. G. (2018). Penggunaan alat peraga dan KIT IPA oleh guru dalam pembelajaran di beberapa Sekolah Dasar di Kecamatan Padang Utara dan Nanggalo Kota Padang. *Ikraith-Humaniora*, *2*(2), 1–8. https://journals.upi-yai.ac.id/index.php/ikraith-humaniora/article/view/109/44

Septiana, N., Rohmadi, M., Nasir, M., Nastiti, L. R., Usmiyatun, U., & Riswanto, R. (2018). Kesulitan guru Ipa SMP/MTS mengajarkan Ipa terpadu di Kalimantan Tengah. *Edu Sains: Jurnal Pendidikan Sains & Matematika*, *6*(1), 1–11. https://doi.org/10.23971/eds.v6i1.716

Setialesmana, D. (2016). Pengaruh penggunaan pendekatan konstruktivisme terhadap kemampuan berpikir kritis matematik mahasiswa. *Jurnal Penelitian Pendidikan Dan Pengajaran Matematika*, *2*(2), 99–106.

Sugrah, N. U. (2020). Implementasi teori belajar konstruktivisme dalam pembelajaran sains. *Humanika*, *19*(2), 121–138. https://doi.org/10.21831/hum.v19i2.29274

Suhendri, H. (2015). Pengaruh metode pembelajaran problem solving terhadap hasil belajar matematika ditinjau dari kemandirian belajar. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *3*(2), 105–114. https://doi.org/10.30998/formatif.v3i2.117

Sulthon, S. (2017). Pembelajaran IPA yang efektif dan menyenangkan bagi siswa MI. *ELEMENTARY: Islamic Teacher Journal*, *4*(1), 1–17. https://doi.org/10.21043/elementary.v4i1.1969

Supriyati. (2015). Pembelajaran sains untuk anak SD/MI dengan pendekatan saintifik. *ELEMENTARY: Islamic Teacher Journal*, *1*(2), 45–51.

Sutrio, S., Sahidu, H., Harjono, A., Gunada, I. W., & Hikmawati, H. (2020). Pelatihan pembelajaran IPA berbasis inkuiri berbantuan KIT bagi guru-guru SD di Kota Mataram. *Jurnal Pengabdian Masyarakat Sains Indonesia*, *2*(2), 147–153. https://doi.org/10.29303/jpmsi.v2i2.80

Syaodih, E., Kurniawati, L., Handayani, H., & Setiawan, D. (2021). Pelatihan sains kreatif pada guru pendidikan anak usia dini. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*, *5*(2), 1854–1859. https://doi.org/10.31004/obsesi.v5i2.771

Tomkin, J. H., Beilstein, S. O., Morphew, J. W., & Herman, G. L. (2019). Evidence that communities of practice are associated with active learning in large STEM lectures. *International Journal of STEM Education*, *6*(1), 1–15. https://doi.org/10.1186/s40594-018-0154-z

Waluyo, E., & Naparin, A, S. A. (2016). Hubungan latar belakang pendidikan guru IPA SMPN dengan kemampuan mengelola kelas di Kabupaten Hulu Sungai Selatan. *Prosiding Seminar Nasional Pendidikan IPA*, *1*(45), 113–120. http://jbse.ulm.ac.id/index.php/PMPIPA/article/view/31

Warpaatun, W. (2019). Metode Penemuan (Inquiry) untuk meningkatkan pemahaman siswa dalam mata pelajaran matematika. *Jurnal Edutrained : Jurnal Pendidikan Dan Pelatihan*, *3*(2), 177–188. https://doi.org/10.37730/edutrained.v3i2.12

Wati, Maulidia, I., & Supeno. (2019). Keterampilan komunikasi siswa kelas VII SMPN 2 Jember dalam pembelajaran IPA dengan model problem based learning pada materi kalor dan perubahannya. *Jurnal Pembelajaran Fisika*, *8*(4), 275–280.

Wilson, R. E., Bradbury, L. U., & McGlasson, M. A. (2015). Integrating service-learning pedagogy for preservice elementary teachers' science identity development. *Journal of Science Teacher Education*, *26*(3), 319–340. https://doi.org/10.1007/s10972-015-9425-4

Winanto, A., & Makahube, D. (2016). Implementasi strategi pembelajaran inkuiri untuk meningkatkan motivasi dan hasil belajar IPA siswa kelas 5 SD Negeri Kutowinangun 11 Kota Salatiga. *Scholaria : Jurnal Pendidikan Dan Kebudayaan*, *6*(2), 119–138. https://doi.org/10.24246/j.scholaria.2016.v6.i2.p119-138

Yaswinda, Y. (2018). Pengembangan bahan pembelajaran sains berbasis multisensori ekologi bagi guru Paud Kecamatan Tilatang Kamang Kabupaten Agam. *Yaa Bunayya : Jurnal Pendidikan Anak Usia Dini*, *2*(2), 13–22.

Zuhaida, A., & Yustiana, Y. R. (2023). Tantangan guru dalam mengajar IPA: Studi kasus guru Sekolah Dasar. *Jurnal Kajian, Penelitian Dan Pengembangan Kependidikan*, *6356*(3), 226–231.

Zukmadini, A. Y., Karyadi, B., & Rochman, S. (2021). Peningkatan kompetensi guru melalui workshop model integrasi terpadu literasi sains dan pendidikan karakter dalam pembelajaran IPA. *Publikasi Pendidikan*, *11*(2), 107–116. https://doi.org/10.26858/publikan.v11i2.18378