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Teacher survey of Science Practices Learning (SPL) in elementary schools after participating in the teacher professional programs

Winarto[a], Dwi Hesty Kristyaningrum[b], Asri Widowati[a], Fine Reffiane[c,*]

[a] *Department of Science Education Study Program, Faculty of Mathematics and Natural Science, Yogyakarta State University, Yogyakarta 55198, Indonesia*
[b] *Department of Mathematics Education, Faculty of Educational Sciences, Peradaban University, Brebes 52276, Indonesia*
[c] *Department Pendidikan Profesi Guru, Faculty of Postgraduate, Universitas PGRI Semarang 50232, Indonesia*

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Abstract

This paper was aimed at finding an instrument to measure science practices learning of elementary school teacher after participating in teacher professional programs. The method of the study was a survey method. The respondents of this study were elementary school teachers in the province of Central Java, totaling 578 teachers at elementary school level. This research employed a science learning practice questionnaire. The instrument was confirmed by expert judgement and empirical measurement. The Data were analyzed through descriptive statistics by calculating the percentage and level of achievement of science learning practices carried out by the teacher. The instrument was examined by implementing Exploratory Factor Analysis (EFA). The results of the reliability test which were based on the results of Cronbach's alpha score were .91. Dimensions EI, EE, SDC, SD learning science practices are good category. The EPK dimension for elementary school teachers is in the moderate category. The SD teacher's IT dimension is in a very good category. The conclusion of this study is that student learning activities designed by teachers following the professional program focus on investigation, modeling and explanation, scientific discourse, connecting with daily life activities, and discussions. The implication of this research is that teacher capacity building programs have an impact on the quality of science learning in elementary schools. It is very important for the government, regional heads, and school principals and teachers to organize teacher improvement programs, especially research-based science learning.

* Corresponding author.
E-mail address: finereffiane@upgris.ac.id (F. Reffiane).

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Introduction

Natural Science literally can be referred to as the science of studying events that occur in nature, both animate and inanimate objects along with their characteristics, symptoms and phenomena (Sujana, 2013). Natural Science is a science that has been tested for truth through scientific methods so that Science is a process of inquiry (Widowati, 2017). A professional science teacher expects to realize more emphasis on the learning process. Learning that gives opportunities for students to learn by searching, finding, concluding, and communicating a range of knowledge, values and experience students need through activities learning that actively engages students (Aji & Pujiastuti, 2022). Sayekti (2016) stated that science learning allows students to get experiences through learning activities, such as reading, discussing, conducting experiments, making summaries, and observing natural phenomena to make learners more involved in their learning process. Additionally, learning should be done by using inquiry (Wiyanto, 2005). Science learning which is based on scientific method processes of discovery, questioning, presentation, application and transformation of scientific knowledge trains individual problem solving (Aksoy, 2005). Teachers can ask students to carry out independent research activities, or engage in divergent thinking training in science process skills (Sternberg, 2003). Students are encouraged to develop science through scientific observation, classifying, asking questions, forming hypotheses, planning trials, measuring, using equipment, and making conclusions from empirical data (Cheng, 2011).

Science learning standards include (1) inquiry-based learning, (2) guiding and facilitating learning, (3) assessment, (4) developing an environment for learning, (5) forming learning communities, (6) planning and developing learning in schools (The National Science Education Standards, 1996). Science learning requires teachers who can bring investigative tasks by giving questions, building hypotheses, anticipating results, outlining practices, investigating data, and making conclusions (National Research Council, 2013). Science learning can help students develop conceptual understanding and the ability to investigate (make questions, answer scientific questions), be able to communicate and justify findings, products which are needed to build productive citizens (Davis, 2003). The learning implemented by the Indonesian Ministry of Education is a scientific approach with project based learning (PjBL), problem based learning (PBL), or discovery learning. The selection of the learning model is left to teachers by adjusting to the characteristics of teaching materials (Hidayatul et al., 2020). Therefore, the teacher's ability to carry out inquiry-based science learning needs to be reviewed to improve the quality of science learning.

Literature Review

Teachers need to be trained in applying strategies of inquiry teaching through involving them in inquiry activities and upgrading their knowledge regarding the concepts of science lessons that they deliver in the class (McBride et al., 2004). Teachers need to develop the pedagogical competences needed to effectively implement inquiry teaching and the science concepts, namely, pedagogical knowledge for investigating and recognizing the science concepts (Abd-El Khalick et al., 2004). How science is taught will depend on a teacher's understanding concerning the relation between the nature of science and the ability to establish a link between these concepts to everyday life (Kasanda et al., 2005). Experimental activities in science learning which are related to daily activities support the achievement of mastery of concepts for students (Hofstein & Kesner, 2006). Previous research conducted by Agustina and Apko (2021) found that teachers believe in the importance of experiment-based science learning. Gasong (2006) learning practicum methods makes learning more directed at experimental learning based on concrete experiences, discussions with friends, which will then generate new ideas and concepts. Sulaeman (2016) has not yet mapped the inquiry abilities of science teachers in Indonesia which can be used as a benchmark for teacher education and training program development programs in improving their ability to conduct learning in the classroom. Because classrooms are based on NGSS (Next Generation Science Standards) (and more recently inquiry research), they must move towards the investigative learning process, which involves learners in promoting meaning construction and critical thinking (Zimmerman, 2007). Nevertheless, Sarjono (2000) asserted that scientific inquiry at primary schools is hardly ever implemented in the learning process. Information transfer activities are a more common approach carried out in the classroom, which results in low and temporary learning outcome. Traditional activities including transfer activities are used widely in mathematics and science classes in many countries (Hiebert et al., 2003).

Lamb et al. (2011) mentioned some aspects contributing to successful learning in science lessons, one of which is the teacher. Learning activities which focus only on transferring knowledge means students just know the information. (Silk et al., 2009). The teacher has a vital role to bring the information knowledge into challenging and interesting classroom activities (Ambusaidi & Al-Balushi, 2012). Teachers also encounter some challenges, for instance, the readiness of learning facilities which are less supportive, and the implementation of learning strategies that have not been effective. The difficulties experienced by teachers are triggers contributing to unsuccessful learning activities and making it difficult for students to understand science lessons (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2010). Lukum (2015) mentioned that teachers often make lesson plans which are not related to the nature of the students causing them to misunderstand the lesson; the children's psychological aspect is often ignored from the beginning until the end of the lesson. Furthermore, this learning process decreases the meaningfulness of science learning for the students. Raharja and Retnowati, (2013) reported that some teachers do not know how to apply various media, approaches, and learning resources. Moreover, teachers do not give chances for students to be more involved in the learning activities like the curiosity to explore the topic of the science lessons. Science learning tends to be done with a teacher centered approach. Students listen to a teacher lecturing and are not involved as active participants in learning (Nurdiyanti & Suryanto, 2010). Based on the Regional Education Balance (REB) Indonesia, Teacher Competency Test (TCT), which measures professional and pedagogical competence, both aspects are still below average, where the average for professional is 53.40 and pedagogical is 48.82 (Wardhana, 2020). Teachers still use the old pattern of science learning, namely, a one-way learning process dominated by the teacher. It can be said that such science teacher is not acceptable and cannot be said to be a professional science teacher (Witarsa, 2011).

The Indonesian government carries out teacher capacity building programs such as: (1) In-house training, (2) Internship programs, (3) School partnership, (4) Distance learning, (5) Tiered training and special training, (6) Short courses in educational institutions, (7) Internal coaching by schools, and (8) further studies (Pangestika & Alfarisa, 2015). One of the improvement programs consistently carried out by the government is the Teacher Profession Programs. A teacher can get an educator certificate by following the Professional Education Program (PEP) managed by the government to be placed in one of the universities. This program is arranged for the preparation for the educational and non-educational undergraduates who have the interest and talent to become teachers in order to fully master teacher competencies in accordance with educational standards. Teachers who participate in PEP are expected to experience increased professionalism as educators. The results of research on improving the performance of science teachers after participating in PEP were conducted by Suparwoto et al. (2011) Science teachers at senior and junior high school levels were in the good and very good categories, as was their pedagogical competence. Kesuma and Fatimah (2021) researched improving teacher skills in carrying out learning and assessment after participating in PEP. Teacher Professional Education (PEP) has a positive and significant influence on teacher performance (Rahman, 2014). Guspiati (2020) found that the level of professional competence of all those certified had met the standards of professional learning competence in terms of planning, implementation and evaluation of learning. The results of previous research examined teacher performance after participating in PEP, not specifically discussing the quality of implementing science learning. Research reveals science learning practices have novelty, namely, revealing the ability of teachers who take PEP in applying science learning in elementary institutions. The results of this study provide information about improving teacher teaching practices after attending PEP. The results of this study are to determine the impact of PEP followed by teachers. Therefore, examining teachers' Science Practice Learning (SPL) is crucial to examine the extent of knowledge and practice. Survey instruments are applied widely to capture instructional practices because of their practicality in administration (Desimone et al., 2002; Dorph et al., 2011). This research aims to survey practical science in learning according to Hayes and Trexler (2016). Measuring SPL is important to determine the level of knowledge and practice (Dorph et al., 2011). What are the steps taken to compile SPL measurement instruments, and what is the level of SPL of science teachers in elementary schools after participating in PEP? The purpose of this research is to produce instruments and determine the ability of teachers to carry out science practice learning after attending PEP.

In science learning practices, according to Hayes and Trexler (2016), the learning process can be separated into five aspects, namely, (1) empirical investigation, (2) evaluation and explanation, (3) science discourse and communication, (4) involving prior knowledge, (5) traditional instructions. Every aspect is explained in detail as follows: (1) Empirical Investigation (EI): This aspect emphasizes investigating procedure: giving questions, deciding what should be investigated, exploring phenomena, planning practices, and conducting and describing of data; (2) Evaluation and Explanation (EE): This aspect focuses on designing, evaluating, and reasoning: making description, assessing appropriateness based on data, fitting models, and critiquing ideas; (3) Science Discourse and Communication (SDC): Providing chances for students in scientific discourse which nurtures them into scientific language and practices; (4) Engaging Prior Knowledge (EPK):Bridging students' prior knowledge, daily life, and science practices to connect between science epistemologies and their experiments; (5) Traditional Instruction (IT): Teaching students through teacher-centered approaches, such as teacher's talk, demonstrations, worksheets, and textbook exercise.

Methodology

To measure the extent of teachers of practices in science lesson, a quantitative approach was employed. A descriptive survey was applied as the method of the study. Salaria (2012) stated that descriptive surveys related to nowadays phenomena including beliefs, processes, relationships, practices, conditions, or trends are always referred to as "descriptive survey" studies. This paper applied a questionnaire instrument of the dimensions of science learning practice according to Hayes and Trexler (2016). There are five dimensions of science learning practice, namely, (1) empirical investigation, (2) evaluation and explanation, (3) science discourse and communication, (4) involving prior knowledge, (5) traditional instructions. Then, the SIP surveyed the science teachers to test the validity and reliability of the instrument. The result of the validity test reduced 13 of 31 items in the questionnaire, which became 18 items after evaluation. The Exploratory Factor Analysis (EFA) approach was applied to test the instrument and five factor extractions were obtained. The Result of the reliability test showed the Cronbach alpha score of 0.91 classified into good category. The questionnaire given online through survey was applied through the service of google form. This survey was shared via Gmail services, Facebook, and WhatsApp. The data obtained were analyzed using descriptive statistics.

Participants

The survey was held at primary schools in the region of Central Java yang telah mengikuti program PEP. The subjects of the study were 578 primary school teachers involving 147 male teachers and 431 female teachers. The sampling technique chosen was purposive sampling. Purposive sampling is a sampling technique with certain considerations (Sugiyono, 2016). Purposive sampling was chosen because it was to measure the practices in science lessons of elementary school teachers who participated in PEP.

Data Collection

The questionnaire of science practical learning adopted from Hayes and Trexler (2016), including 18 items, was measured to test its' validity. This validity test was given to 78 teachers of science. Exploratory Factor Analysis (EFA) was employed to measure the validity factor of the five subscales. Norusis (1993) states that to validate the characteristics of the data prior in the data set for factor extraction, the two tests recommended are the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity (BTS). Both are suitable for EFA and are applied to the data prior to factor extraction to ensure both tests show the data satisfaction of the psychometric criteria in determining the factor analysis. Additionally, the EFA examined item-total correlations and Cronbach's alpha internal consistency coefficient.

Table 1 KMO and the value of BTS

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.890
Bartlett's Test of Sphericity	Approx. Chi-Square	2068.698
	df	406
	P	.000

The result of the measure of sampling adequacy (KMO MSA) was 0.890 with the significance value of .000. The score of 0.89, which is higher than 0.5, is classified as good category according to Norusis' criteria (1993). In Table 2, there are 18 components of total variance, which explains that there are 18 components brought in the factor analysis, which has 5 factors acquiring eigenvalues higher than 1 (>1). The data display the fitness between the number of factors and the number of estimated indicators.

The Cronbach's alpha coefficient was applied to test the reliability of the instrument. For the instrument items, the internal consistency results for each subscale were 0.917. Furthermore, the factor correlation results were strong and highly positive between all subscales. Reliability values are presented in Table 3.

Table 2 Total variance explained value

Component	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.734	37.411	37.411	6.734	37.411	37.411
2	1.888	10.488	47.898	1.888	10.488	47.898
3	1.262	7.009	54.907	1.262	7.009	54.907
4	1.093	6.075	60.982	1.093	6.075	60.982
5	1.057	5.873	66.856	1.057	5.873	66.856
6	0.775	4.308	71.163			
7	0.758	4.213	75.376			
8	0.586	3.257	78.633			
9	0.534	2.967	81.601			
10	0.524	2.913	84.514			
11	0.509	2.829	87.343			
12	0.437	2.427	89.770			
13	0.391	2.173	91.943			
14	0.351	1.951	93.894			
15	0.303	1.682	95.576			
16	0.283	1.572	97.148			
17	0.270	1.499	98.647			
18	0.244	1.353	100.000			

Table 3 Reliability value

Cronbach's Alpha	*N* of Items
.917	23

Data Analysis

The questionnaire was made in an online platform, which was google form service, to survey the subjects of the study. The questionnaire consists of 18 items using a five-option Likert scale with five response choices, including "1 = never," "2 = ever," "3 = seldom," "4 = often," and "5 = very often using email service, Facebook, and WhatsApp platform. The data were analyzed by applying descriptive statistics analysis. The results were transformed and categorized into five categories. Azwar (2011) made the standard of each category by comparing the ideal average score (X_i) and the ideal standard deviation score (SBi) as a basis. The details of the classification regarding the science teachers are displayed in Table 4.

Table 4 SPL category

No	Interval Score	Category
1	X > Xi + 1,5 Sbi	Very Good
2	Xi + Sbi < X < Xi + 1,5 Sbi	Good
3	Xi – 0,5 Sbi < X < Xi + Sbi	Enough
4	Xi – 1,5 Sbi < X < Xi - 0,5 Sbi	Bad
5	X < Xi - 1,5 Sbi	Very Bad

Results and Discussion

The results obtained showed that information dimensions of EL, EE, SDC, EPK were in the good category, and TI was classified into very good category. Teachers' SIP are presented in Table 5 and Table 6.

The research results obtained that the instrument for measuring SST consists of 18 items, which were developed based on the Hayes and Trexler (2016) instrument models. SPL instrument has fulfilled validity with Principal Component Analysis (PCA) approach as exploratory approach. The score of KMO MSA 0.89 is categorized good based on Kaiser rule, in which: KMO MSA ≥ 0.90 is very good, ≥ 0.80 is good, ≥ 0.70 is fair, ≥ 0.50 is poor, and < 0.50 is unacceptable. BTS score reaches Chi Square 2068.69 with freedom degree 406 with significance .000, which means correlation matrix is not identity matrix so that factor analysis can be applied. SPL is conceptually in accordance with five estimated factors theory. The score of Rotated Component Matrix for 18 components is > 0.3. The component will be deleted if its factor content rotation is less than 0.30 (< 0.30) and more than -0.30 (> -0.30). The internal consistency scores for each subscale 0.917 for the survey items are quite high. For scales used in research, the level of an acceptable Cronbach's alpha coefficient is suggested as 0.70. The instrument has met the criteria of a good measuring instrument (Subali et al., 2018).

Table 5 Percentage of achievement of science learning practice

Indicators	Questionnaire Items	Achievement (%)
Empirical Investigation (EI)	Student makes question or prediction for proof.	55.7
	Student identifies question from natural phenomenon.	67.2
	Student chooses variable for investigation.	50.2
	Student designs design experiment without teacher's help.	32.2
	Student makes observation notes.	68.8
	Student collects quantitative or qualitative data.	56.3
	Student presents data in diagrams or chart.	42.0
	Student analyzes the data using calculation.	60.7
	Student presents procedures, data and conclusions in front of class formally and informally.	66.7
Traditional Instruction (IT)	Student reads science book or material taught in class	88.7
	Student synthesizes information from various sources (media, internet, books).	69.0
Evaluation and Explanation (EE)	Student models concrete objects to explain some phenomena (for example solar system model/DNA model/other models).	47.1
	Student uses models to predict results.	38.7
Science Discourse and Communication (SDC)	Student gives explanation to an idea presented.	55.9
	Student gives critical opinion to other students accompanied scientific explanation.	40.1
Engaging Prior Knowledge (EPK)	Student gives proof to conclude or explain some phenomenon.	45.5
	Student considers/accepts alternative explanation from self alone or with another student.	50.7
	Student makes argument to support or reject some conclusion.	37.0
Average		54.45

Table 6 Level of SIP elementary school teachers

Gender	SIP dimensions				
	EL	EE	SDC	EPK	IT
Man	4.0	4.0	3.9	4.1	4.5
Woman	4.0	4.1	4.0	4.0	4.5
Average	4.0	4.1	3.9	4.1	4.5
Level	Good	Good	Good	good	Very good

SPL conducted by elementary school science teachers who have participated in PEP achieved 54.45 percent. Teachers are able to learn science in their classes that trains students in empirical inquiry, (2) evaluation and explanation, (3) science discourse and communication, (4) involve prior knowledge, (5) traditional instruction. Science learning by the teacher is in accordance with the learning standards set by investigative activities, training process skills, practicing communication, reflection, criticizing, and evaluating. Evaluation and explanation aspects are less than optimal achievements. The IT aspect is highest because of the tendency to learn from books or other teaching materials. Investigation and communication activities are better than evaluation and explanation activities. These findings indicate that the activity of reading books is dominated by students. Science learning activities are in accordance with their essence, namely, investigation/inquiry. Inquiry must be understood and implemented by science teachers (Akgul, 2006).

Learning science with inquiry will train students to think critically, think reasoning, and other scientific skills so that their learning objectives are achieved. The teachers and students often implemented the activities including scientific investigation activities in science lessons. The learning process in the curriculum should focus on student and class inquiry, not on memorizing and presenting facts (Cymer, 2007). Inquiry investigation gives students chances to experience the feeling, knowing, and understanding the benefits of learning science lessons (Duschl & Osbone, 2002). The basis for teachers in implementing inquiry learning is their understanding regarding science as inquiry and learning as inquiry (Anderson, 2002). This learning process provides reasoning and thinking skills for students reforming and modifying the theories and concepts concerning social and natural knowledge (Zimmerman, 2005). It improves scientific completion including experiments, verification of judgement, and conclusion that are carried out to reach scientific understanding or conceptual reformation (Zimmerman, 2007).

Learners experience some difficulty in constructing arguments and connecting evidence to claims (Jime ́nez-Aleixandre & Erduran, 2007). As a result, teachers involved in students' explanation and evaluation task lower the students' cognitive activity by giving them detail instruction (Smith, 2000; Tekkumru et al., 2015). Teachers who wish to require the improvement on students' cognitive engagement change into guided explanation and evaluation tasks, improving students' scientific skills in science classes (Kuhn, 2015; Richmond & Striley, 1996). Dunbar and Fugelsang (2004) stated that the ability to adapt to rapid changes is highly dependent on thinking skill and decision making including analyzing, reasoning, and synthesizing information. Problems that are complex with different fundamental issues require learners to practice skills of scientific reasoning, like thinking, understanding, and criticizing (Rebich & Gautier, 2005). Evaluation and explanation of teaching practices are often applied by the teacher and learners.

Communication activities in learning science have been carried out by students and teachers. Communication skills are crucial in delivering science (Noviyanti, 2013). The performance tasks and structured instructional are two necessary components in enhancing scientific communication (Levi, 2009). Students' scientific communication skills can be maximized through practices with science object or students' demonstration (Kulsum & Nugroho, 2014). Scientists tried to find some solutions in problems of the study, described the steps of conducting data, analyzed the obtained data, and wrote the conclusion by using scientific communication language. They are required to communicate findings and ideas properly to the students (Levi, 2009).

The teachers and students' concerning the connection between practices of prior knowledge and real-life experiences are brought into classroom practices. Gunstone (1995) states that good science learning is learning that involves students in an integrating process, namely, connecting what is being learned with what students already know and believe. In this context, teachers can use a number of strategies to increase access to students' prior knowledge and relate it to new knowledge. Teachers and students' perception often experience the dimensions of traditional teaching. The learning process of science lessons is based on the connection between learning material and learning process, that results in direct instruction to understand learners' knowledge of principles and scientific ideas (Zimmerman, 2007). Nevertheless, the approaches of traditional teaching and inquiry should be done altogether; studies have conveyed that lecturing or teacher-centered instruction has only a little preparation in helping the generative knowledge of the students (McGinn & Roth, 1999).

This study results of SPL in science classes practices were classified as good category. The science learning practices face problems in learning process. Furthermore, (Anderson, 2002) states that dilemmas and obstacles are categorized into three categories, which are the cultural, political, and technical category. The technical category involves the inability to apply the learning process constructively, limited assessment, limited commitment difficulties in group assignment, obstacles to change the role for new teachers, obstacles to change the role for new students, and the lack of practices through training. The dimension of politics involves limited resources, lack of training, different standard for fairness and justice, parental support.

The teachers' readiness is the key problem in science classes. Yulaelawati (2000) states that the problems and issues in science education in Indonesia are that science teachers are less competent, unable to apply scientific knowledge in science learning. Raharja and Retnowati (2013) reported that the teachers were not capable of implementing some aspects including the application of different approaches, the media resources for learning process, which mean the lack of capability to create students' interaction and engagement in learning activities, such as engaging learners to search for additional reading sources related to the content of the learning process. Moreover, concerning the knowledge of pedagogic content and science, referring to the initial competency score held by the Ministry of Education and Culture in 2011, such described that a great number of science teachers have very low scores. Anderson (2002) divided the problems into three categories, namely, cultural problems, political problems, and technical problems. The political problems involve the lack of sufficient teacher training, limited resources, parental support, and different views on fairness and justice. The technical problems involve the teachers' inability to teach constructively, lack of sufficient assessments, lack of commitment, obstacles in implementing of new teachers' role, obstacles in implementing students' role, obstacles in group task, and limited teacher training practices. Syamsuri (2010) found that although the government has attempted to solve the problems mentioned by enhancing the teachers' quality through training, upgrading, and some workshops for weeks, in fact, the teachers still implemented the traditional approaches in learning classes. The implication of this research is that teacher capacity building programs have an impact on the quality of science learning in elementary schools. It is very important for the government, regional heads, and school principals and teachers to organize teacher improvement programs, especially research-based science learning.

Conclusion and Recomendation

The results of the current research on science teachers' perceptions of SIP Elementary teachers fall into the good category. Science teachers' dimensions of El, EE, SDC, EPK, and SDC were classified into good category standard. The IT dimensions of the teachers were categorized into very good category standard. The perceptions of science teachers on their learning practices were categorized as good category standard. Based on research results, the recommendation of this research is that the teacher improvement program through in-service education can increase the level of teacher professionalism so that the more teachers receive the program, the more professional they will be.

Conflict of Interests

The authors declare that there is no conflict of interest.

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