Received : 16 November 2021
Revised : 24 December 2021
Accepted : 26 December 2021
Online : 28 December 2021
Published: 30 December 2021

DOI: doi.org/10.21009/1.07206

Learning Designing for Establishment Physics Content and Teacher Pedagogic Aspects Through Lesson Study-based In-House Training

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Abstract

Mastering physics content is essential for physics teachers to carry out the learning process in the classroom. After mastering good physics content, teachers must also master the teaching competencies contained in pedagogical competencies. This study aims to demonstrate efforts to increase teachers' mastery of physics content and pedagogic competence. The pedagogic aspect refers to the teacher's ability to prepare practical instructions in a Cookbook Laboratory, Inquiry Laboratory, Problem-Solving Laboratory, and Higher Order Thinking Laboratory. The method used is in-house training based on lesson study. There are three stages of activities carried out, including Plan, Do, and See. Data were collected using observation sheets, interview guidelines, performance instruments, and tests. The study results show that the professional competence of teachers who are members of the Science Teacher Deliberation (MGMP) in one province in West Java has increased, especially concerning materials competencies practiced. In addition, the pedagogical competence of the teachers who are members of the Science MGMP has increased, especially concerning the mastery of organizing science practicums oriented to developing the 21st-century skills of students.

Keywords: in house training, physics content, community service

INTRODUCTION

According to Permendiknas No. 16 of 2007, a teacher must possess two essential competencies: professional competence and pedagogic competence (Umasugi 2014). Professional competencies that a professional teacher must have namely: 1) Mastering the material, structure, concept and scientific mindset that supports the subjects being taught, 2) Mastering Standard and Basic Competencies subjects being taught, 3) Developing learning materials that are taught creatively, 4) sustainably develop professionalism by taking reflective actions, and 5) Utilizing ICT to communicate and develop themselves (Selvi 2010; Kulshrestha & Pandey 2013). Meanwhile, the pedagogic competencies that teachers must possess are: 1) Mastering the character of students from the physical, moral, social, cultural, emotional, and intellectual aspects, 2) Mastering learning theory and educational learning principles, 3) Developing a curriculum that related to the subject being taught, 4) Organizing educational learning, 5) Utilizing ICT for learning purposes, 6) Facilitating the development of the potential of students to actualize their various potentials, 7) Communicating effectively, empathically, and politely, 8) Conducting assessments and evaluation of learning processes and outcomes, 9) Utilizing the results of assessments and evaluations for the benefit of learning and 10) Taking reflective actions to improve the quality of learning (Nousiainen, Kangas, Rikala & Vesisenaho 2018; Rusilowati & Wahyudi 2020).

Both of these competencies absolutely must be possessed by teachers who teach science to their students. It cannot be lame or one-sided. A teacher who is strong in content mastery but not robust in pedagogic mastery will not help facilitate students' learning. On the other hand, a teacher who is strong in pedagogy but weak in the mastery of teaching materials will be even more tragic because his knowledge can be wrong. If this happens, the student will not gain enlightenment but go astray.

According to the 2013 curriculum, learning in physics must use the scientific method, which contains five components: observing, asking, exploring, concluding and communicating. (Sudjito, Keliat & Hastuti 2018; Suyanto 2018). Scientists build physical science, which is part of science through a process that begins with observing natural phenomena, followed by empirical investigations, and ends with conclusions that usually produce concepts, laws, principles, or even theories. It is very appropriate if physics learning uses the scientific method because it is also built using the scientific method. Learning physics using scientific methods will provide students with the knowledge and form scientific attitudes and practice skills. (Junipisa 2019; Novianti & Rajab 2020).

The characteristics of science learning consist of products, processes and scientific attitudes. Learning Natural Sciences (IPA) is a product with much knowledge, including laws, postulates, principles, facts, concepts, theories and mathematical equations (Mason & Singh 2016). Science as a process includes research activities that involve observing, measuring, formulating hypotheses and manipulating variables (Mundilarto 2002). The scientific method must be based on a scientific attitude such as being honest, objective, open, and disciplined. Science is learning in schools that must be based on a scientific attitude to produce appropriate products.

The ability of teachers to teach science is essential because teachers who have limited multiple representation abilities will not be able to provide a holistic and appropriate learning experience. After all, students have different skills in constructing their knowledge (pppf 2020). Students must observe, investigate, and analyze experiments and everyday events (Sugiyarti, Sunarno & Aminah 2015). Students are also expected to master the ability to think critically, logically, analytically, creatively, act independently, communicate, and have a spirit of responsibility (Wagensberg 2014). In addition to studying theory, students are expected to conduct research and master problem-solving skills.

Efforts to realize better learning intensify problem-solving skills (Sambada 2012). Some of the efforts of educators to practice this ability are by using a variety of learning methods and the latest research (Yanni 2018). Educators do the form of giving problems by providing assessments. Mariyaningsih and Hidayati (2018) stated that providing tests and assessing student performance also improves learning and guides learning. Unfortunately, the situation in the field has not been very encouraging, based on the results of research conducted showing that the competence of teachers in mastering physics teaching materials and preparing lesson plans (RPP) is following the 2013 curriculum, namely: using learning that uses the scientific method on average is still relatively low (Arifah, Ibda & Furroyda 2021; Sumartini 2021). Most of them still do not have a deep understanding of physics content (teaching material), even some of them experience misunderstandings and misconceptions. Even in the preparation of the lesson plans, they know the components of the scientific method, which are often referred to as 5M, but understand well what it means to observe, ask questions, explore, and so on. This situation is suspected of having something to do with the habits they have been doing in planning and implementing physics learning which tends to be informational using the lecture method.

The low ability of teachers to package physics learning using the scientific method is thought to have something to do with the lack of debriefing in terms of pedagogic content using the scientific method when they attend teacher candidate education in LPTKs. This assumption is reinforced by the results of a survey on the ability to master content and pedagogic content using the scientific method on prospective teacher students who show that their ability to make lesson plans using the scientific method is, on average, still relatively low.

In addition, much debriefing mainly focuses on making learning resources, and it is still sporadic to conduct training to develop learning activities in the laboratory through making practicum modules. Therefore, this article will discuss efforts to improve teachers' physics and pedagogical competence in making practicum modules: the Cookbook Laboratory, Inquiry Laboratory, Problem Solving Laboratory, and Higher Order Thinking Laboratory.

METHODS

This research followed a lesson study pattern consisting of Plan, Do, and See activities (Subadi, Murtiyasa, Sutama, Sutopo & Muhroj 2016). Forty teachers participated in this study which came from the group of subject teachers (MGMP) in one of the districts in West Java. Researchers collected the data in the study with observation sheets, performance assessments, interview guidelines, and teacher ability tests. Data analysis was carried out by referring to four levels: reaction, learning, behavior and results. Explicitly, the four levels of data analysis are listed in TABLE 1.

TABLE 1. Data Collection and Measurement Process

Level of Evaluation	Description	Data Collecting
1. Reaction	Measuring participants' responses and levels of satisfaction with the implementation of lesson study-based in-house training	Questionnaire and interview
2. Learning	Measuring the level of participants' understanding of the material presented during in-house training based on lesson study	Performance assessment
3. Behavior	Measuring changes in participant behavior as a result of implementing the results of in-house training based on lesson study	Interview and observation sheet
4. Results	Measuring the success of lesson study-based in-house training related to increasing both the capacity and competence of participants regarding the making of various practical instructions	Test and Assessment Product

RESULTS AND DISCUSSION

Evaluation design of in-house training for content strengthening and pedagogic content based on the 2013 curriculum with a lesson study pattern for physics teachers. The four levels are described in detail as follows:

Level 1: Reaction Evaluation

The reaction evaluation aimed to find out the participants' opinions regarding the in-house training program to strengthen content and pedagogic content based on the 2013 curriculum with a lesson study pattern for physics teachers. In addition, reaction evaluation was used to measure participants' satisfaction with the training. Based on the open questionnaire given, there are the following responses:

Experimental Model

The in-house training for content strengthening and pedagogic content stated that the Higher Order Thinking Laboratory (HOT-Lab) is the best practicum guide model in training and developing higher-order thinking skills. This result shows that the participants have understood and felt the benefits of applying the HOT-Lab model, which can train and develop higher-order thinking skills. Participants agreed that the laboratory cookbook could describe and support students' learning, and experimental techniques do not teach students' thinking skills. These findings indicate that the teacher has realized the shortcomings of the laboratory cookbook model that they applied when doing a practicum (Malik, Setiawan, Suhandi, Permanasari & Sulasman 2018; Imaduddin & Hidayah 2019). Participants stated that the inquiry laboratory practicum guide strengthened their understanding of the content. In general, participants still had difficulties formulating guiding questions related to methods and analysis. Participants stated that a practical problem-solving laboratory could practice critical and creative thinking skills. Participants still find it challenging to create real-world problems; creativity and innovation are needed. Teachers in real-world problems can relate the content studied to phenomena in everyday life and the application of the content in technology (Imaduddin & Hidayah 2019; Bakri, Kusuma & Permana 2021).

This result is expected to motivate teachers to apply the laboratory cookbook and other practicum models to train and improve higher-order thinking skills. The results are in line with the curricula goals, where teachers must be able to train and develop the 4C skills (critical, creative, communication and collaboration) of students.

Experimental Activities

The in-house training on content strengthening and pedagogic content stated that the various practicum activities were oriented towards experimenting skills, understanding concepts, critical thinking, creative and problem-solving. These results change some teachers' mindsets so far who think that practicum is just a waste of time because the practicum takes a long time to prepare before carrying out the practicum. Also, less effective because the learning atmosphere is not conducive. Practicum is only to verify prior knowledge because they assume a dichotomy between learning in the classroom and practicum in the laboratory. Learning objectives in the laboratory are different from learning objectives in the school; lack of training and developing students' higher-order thinking skills.

Participants are less trained in using Information and Communication Technology (ICT). These findings indicate that teachers still think that students can only carry out practical activities with fundamental tools found in schools; for example, using KIT media is limited in number. Teachers need to receive training and debriefing on using virtual laboratories in experimenting (Nuryantini, Fajriah, Zakwandi & Nuryadin 2020). Both natural and virtual laboratories can be used during practicum and have advantages and disadvantages. The choice between the two depends on the learning objectives; the content taught, teachers' professional competence, and the facilities and infrastructure available. Virtual laboratories can use offline and online simulations such as PhET, Lab Exchange, Physics Toolbox Suites and Tracker (Nuryantini, Zakwandi & Ariayuda 2021).

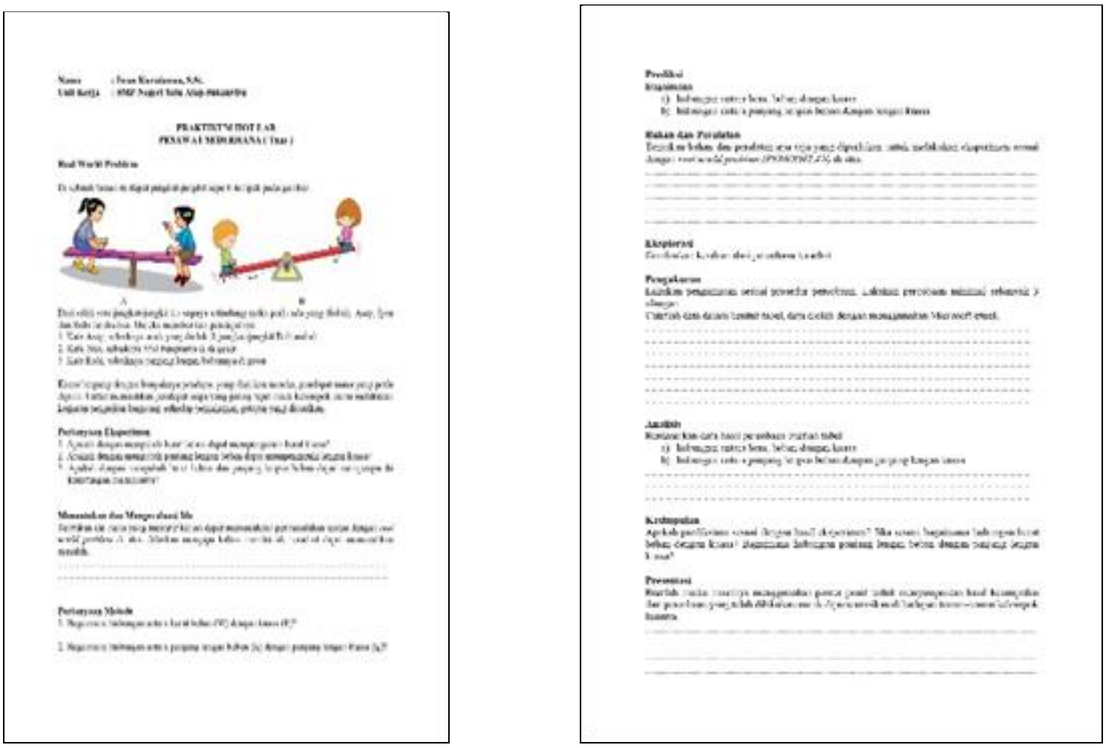
Training Various Practicum Instructions

Participants in the in-house training to strengthen content and pedagogic content stated that the teacher efficiently carried out the training activities to make various practical instructions. These results indicate that the teacher has understood that practicum activities can be energized and integrated with learning. There is no longer a separation between practicum and education, which has been many complaints by teachers who stated that it is challenging to manage time between practicum and learning (Holmes & Wieman 2018; Malik, Setiawan, Suhandi, Permanasari & Sulasman 2018; Bakri, Kusuma & Permana 2021). In addition, the burden of teaching is heavy, which requires delivering material following the demands of the curriculum and other administrative activities that take up much time so that many teachers do not carry out practicum. Curriculum demands indicate that students must construct their knowledge. Therefore, students must be active in learning, and teachers must facilitate this. Investigations through practicum can facilitate and build students' knowledge construction (Solihan, Astra & Budi 2018).

Participants in the in-house training for strengthening content and pedagogic content were enthusiastic and active in participating in workshops and implementing various practical instructions in four representative regions of the Science MGMP. Each participant hopes to continue the in-house training activities to strengthen content and pedagogic content.

Level 2: Learning Evaluation

The learning evaluation aims to determine how participants understand the in-house training material to strengthen the content and pedagogical content delivered and assess its effect on increasing participants' knowledge, skills, and attitudes about something learned in training. Evaluation data was obtained by determining various practical instructions made by participants. The evaluation technique used is a performance assessment. In addition, they were using tests to measure the ability of participants to understand the content and pedagogics. After participants have finished in-house training, the test is carried out to strengthen content and pedagogic content. The questions are structured to cover all the range of the training material



(page 1) (page 2)

FIGURE 1. The Performance Assessment Results of Participant

The performance assessment results related to the making of practical instructions, as shown in FIGURE 1, show that participants experienced an increase in their ability to design various practical instructions. Most of the participants have understood the characteristics and each stage in the practical manual model. Only a few participants did not understand several steps in each practicum guide. The final question stage in the laboratory cookbook practicum guide is where there are still misconceptions. Participants make questions not to strengthen the material/content that is practiced but are still stuck in making questions using mathematical equations. Participants had difficulty preparing guiding questions related to methods and analysis in the inquiry laboratory practicum guide. Compiling a real-world problem is difficult for participants to collect a problem-solving laboratory practicum guide. Likewise, at the stage of compiling HOT-Lab practicum instructions, participants had difficulty making alternative answers that were not trivial. In addition, participants had trouble at the step of determining and evaluating ideas. This is because participants have to create problems that are real-world problems. The issues that students must solve have several characteristics, namely: familiar with everyday life; objective; load motivation; there are limitations in terms of problem-solving; there are alternative answer choices; the solution to the problem is not trivial, but requires analysis; analysis is not mathematical; solutions can only be tested through experimental activities; apply the basic concepts or principles of physics; requires two or more steps in terms of problem-solving (Dörner & Funke 2017; Reynolds, Altmann & Allen 2021).

Based on the posttest results, most participants understand the medium category in understanding practical instructions. Participants who understand the high category are more petite than participants in the low category. Participants' understanding of the cookbook practicum instructions included high criteria. This finding is because participants are accustomed to using cookbook practicum instructions when practicum in the laboratory. Participants understand the medium category related to the problem-solving laboratory and Higher Order Thinking Laboratory (HOT-Lab) practical instructions. This result shows a positive thing, considering that most participants do not know about the two models of practicum instructions. Participants assumed that the problem-solving laboratory and Higher Order Thinking Laboratory (HOT-Lab) practical instructions could only be implemented by students at the tertiary level. Participants understand the low category in general knowledge (nature, objectives, characteristics and competencies) regarding laboratory activities.

The practicum model can be used as a new learning method to improve students' higher-order thinking skills. In addition, the teacher can also implement various practicum models for research activities and scientific publications. Teachers can use various practicum models to write classroom action research and papers published in scientific journals, which are helpful for promotion and class.

Level 3: Behavior

The purpose of the behavior is to discover changes in participants' behavior after attending in-house training to strengthen content and pedagogic content. These behavioral changes include aspects of knowledge, skills, and attitudes resulting from the training program so that they are expected to be applied in daily behavior (Dörner & Funke 2017; Reynolds, Altmann & Allen 2021).

The results of interviews with several teachers who represent each area of the Science MGMP obtained some information including: professional competence related to science content and pedagogic content, especially Physics participants increased; participants understand the characteristics and spirit of learning physics conducting investigations through practical activities; Physics learning is carried out by not only explaining the material by means of lectures or reducing mathematical equations; add insight and knowledge related to the characteristics of various practical instructions; participants can choose and determine practicum instructions in accordance with the characteristics of teaching materials, student development, and the availability of infrastructure and professional competence of teachers; changing the teacher's mind sheet so far that says practicum and learning are two separate things and are dichotomous; Classroom learning objectives can be integrated with practicum objectives in the laboratory.

Participants stated that in-house training activities to strengthen content and pedagogic content were beneficial. They are motivated to implement various practical instructions in learning physics in their respective schools. They also expect this activity to be sustainable. Teachers can continue this activity by forming online discussions such as making WhatsApp group discussions (WAGD). WAGD can be used even though the internet network is low and the costs required are also relatively cheap so that the use of WA in discussion activities is not constrained by the network and is approved by all members (Farhan et al. 2021).

Level 4: Result

The results aim to examine the impact of in-house training content strengthening and pedagogic content on participants. The target of the implementation of the training program is the tangible results that will be felt by the trainees, namely an increase in content and pedagogic content abilities, especially in designing, designing, implementing, and evaluating various practical instructions. We should also remember that teacher pedagogical readiness is as important as technology readiness for teachers to integrate technology to serve more advanced teaching goals (Li et al. 2019).

The teacher's application of various practical instructions can be used as a new learning method to improve students' understanding of concepts, experimentation skills, and higher-order thinking skills. In addition, the application of various practical instructions can be used as research activities and scientific publications. In in-house training to strengthen content and pedagogic content, participants can implement various practical instructions for writing classroom action research and papers published in journals. These activities are beneficial for adding credit when applying for promotions and classes.

CONCLUSION

Based on the results, it can be concluded that the professional competence of teachers who are members of the Science MGMP increased, primarily related to the material competencies that can be put into practice. In addition, the pedagogical competence of the teachers who are members of the Science MGMP has increased, especially concerning the mastery of organizing science practicums that are oriented to developing 21st-century students' skills.

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