



Research Article

© 2023 Haenilah et al.
This is an open access article licensed under the Creative Commons
Attribution-NonCommercial 4.0 International License
(<https://creativecommons.org/licenses/by-nc/4.0/>)

Received: 5 July 2023 / Accepted: 24 August 2023 / Published: 5 September 2023

Scientific Method-Based Pedagogical Competence Reflection for Improving Teacher Professionalism

Een Yayah Haenilah¹

Ridwan²

Hasan Hariri^{*}

¹Faculty of Teacher Training and Education,
Universitas Lampung,
Indonesia

²SMP Negeri 3 Way Pengubuan,
Lampung Tengah,
Indonesia

^{*}Corresponding Author

DOI: <https://doi.org/10.36941/jesr-2023-0136>

Abstract

This study investigated the effect of scientific method-based pedagogical competence reflection (SMBPCR) to improve teacher professionalism in Bandar Lampung schools, in Indonesia. This study used a quasi-experiment with pretest-posttest experimental designs on three groups of teachers carried out over six months. Purposive sampling was used to recruit 18 teachers as samples with three criteria: Bachelor of Education degree in Primary Teacher Education, primary classroom teachers, and three groups of teaching experiences. Data were analyzed using the nonparametric test with two related samples. Results showed that there is an average increase from 2.49 to 3.54 statistically therefore the SMBPCR could improve teacher professionalism significantly.

Keywords: pedagogical competence, reflection, professionalism, scientific method, teacher

1. Introduction

Teacher professionalism is essential. That is why efforts to increase teacher professionalism have become serious programs worldwide, including in Indonesia. Teacher professionalism will lead to the quality of the nation. There are findings from many studies that demonstrate teacher professionalism (Chowdhary, 2015; du Plessis et al., 2014; Haenilah, 2013a; Lopes & Cunha, 2017; Suci & Mata, 2011). Several models of teacher professional development have been studied, one of the most popular ones is Lesson Study. This model has become increasingly popular as a platform for teacher learning and the development of professional learning communities in schools worldwide (e.g., Hong Kong, Indonesia, Singapore, Vietnam), the United States, and Europe (e.g., Norway, Sweden, the UK) (Fägerlind & Saha, 2016; GoH, 2015).

Indonesia, with a total of 3,133,638 teachers in 250,000 schools (Ministry of Education and Culture (Data, 2017; Saito et al., 2006), has tried using various conventional models of increasing teacher pedagogic competence such as Lesson Study (Saito et al., 2006), Dual-Mode (Widodo & Riandi, 2013), Scaffolding (Rahman et al., 2015), Community-Based Teachers (Harjanto et al., 2018), and Certification Program Lecturers (Kusumawardhani, 2017). Even so far, the Government of Indonesia has made various efforts such as in-service training, education, and training (basic and advanced levels), and short training (crash courses), which are organized by teacher professional organizations. Specifically, the implementation of Scientific Method-Based Pedagogical Competence Reflection has never been applied to teachers for in-service training activities. Previously, Scientific Method-Based Pedagogical Competence Reflection has implemented in elementary school teacher education students with the result that Scientific Method-Based Pedagogical Competence Reflection was able to improve pedagogical competence which was reflected in students in learning teaching practice (Haenilah, 2013a).

However, the efforts have not worked well in making teachers self-reliant to improve their professionalism. Teacher competence test results are still low. For example, the results of the Teacher Competency Test (Uji Kompetensi Guru or UKG) in 2015 for pedagogical competence with an average score of 48.94 was below that of the nationally targeted (55). That is, this average score is below the minimum competence standard of 55 out of 100 targeted by the Indonesian Government (Destiana & Utami, 2017). These results have become academicians' concern because pedagogical competence is a significant basis of teacher professionalism (Chowdhary, 2015; Darling-Hammond, 2012; Liakopoulou, 2011). The low average score teacher qualification needs to be paid attention to for improvement because Indonesia still has 15,59% of educators (teachers and principals) who have not completed undergraduate degrees as required. It makes the student's learning achievement in Indonesia lower than that of their counterparts in other countries (Gurria, 2016). Additionally, in terms of student achievement, the test results from the Program for International Student Assessment (PISA) published by the Organization for Economic Cooperation and Development (OECD) showed that the average scores of such subjects as math, reading, and science were 375, 396, and 382 respectively below those of OECD for these three subjects (494, 496, and 501).

In 2015, OECD revealed that Indonesian students performed below their fellows in other countries because their teachers were not equipped with the expertise to help them develop their potency (Gurria, 2016; Kementerian Pendidikan dan Kebudayaan (MoEC), 2017). In addition to the teacher's insufficient expertise, the General Director of the Teacher Training Institute (Lembaga Pendidikan Tenaga Kependidikan, or LPTK) reported that only seven out of 34 provinces in Indonesia obtained average scores slightly above the minimum competency standard of 55 in the teacher competency test in 2015. These seven provinces with the obtained average scores are as follows: DI Yogyakarta (62.58), Central Java (59.10), Jakarta (58.44), East Java (56.73), Bali (56.13), Bangka Belitung (55.13) and West Java (55.06). Teachers from Lampung Province obtained an average score of 49.72. It is lower than the nationally targeted minimum score (Destiana & Utami, 2017).

In Indonesian schools, many teachers' competence improvement pedagogical competence programs through regular in-service training crash courses organized by the Indonesian Government and teachers' organizations, but the programs are still unsuccessful. Indonesia needs an effective model for improving teacher professionalism to have and to put into practice by teachers. This study offers a solution to guide teachers in ways to enhance their pedagogical competence over time to lead to teacher professionalism improvement: scientific method-based pedagogical competence reflection (SMBPCR). Some experts suggest that the scientific method can be one of the models of self-reflection in improving pedagogical competence through scientific ways of thinking (Keesing-Styles, 2003; Pollard & Collins, 2005; Swennen, 2009).

This study assumes that efforts to increase teacher professionalism depend on the teacher's interests. However, improvements must be made as part of the teacher's needs and be carried out continuously. Reflection on scientific method-based pedagogical competencies is carried out using an integrated self-reflection program to increase teacher professionalism (Haenilah, 2013a; Singh &

Mabasa, 2015; Taylor, 2014). Therefore, these efforts need to be facilitated with a model that allows teachers to do it continuously, systematically, independently, and sustainably. The government and teachers' organizations can use the SMBPR model to help teachers learn and improve their professionalism.

This study investigates the effect of SMBPCR in improving teachers' professionalism. The results of this study give feedback to the government, particularly the central government, on how to improve teacher professionalism continuously, systematically, independently, and sustainably based on the steps of the scientific method so that improving teacher professionalism will no longer be mainly dependent on government policy.

2. Theoretical Framework

Current teacher professionalism describes a pattern of educational reforms that lead to efforts to develop teacher standards to strengthen the development of a performance culture. The desired work culture of improvement and accountability will impact teacher autonomy to increase their knowledge and professional judgment (Sachs, 2016).

The implementation of teacher professionalism and accountability is embedded in the policies and practices of the education system and schools (Sachs, 2016). This system reflects the core competencies that demand professional teachers to design, implement, and evaluate learning (Shulman, 1986) and is reflected in the lesson plan. This competence is called pedagogic competence and is also defined as how prospective teachers can familiarize themselves with three aspects of competence (knowledge, attitudes, and skills) to improve learning to achieve learning goals for competency development (Apelgren & Giertz, 2010).

The lesson plan is a guideline for implementing and evaluating the success of learning. It consists of educational goals, organized educational experiences, and evaluation (Tyler, 2013). However, teachers prepare lesson plans to use as a guide to measuring student success and have not used teachers to reflect on their success.

Meanwhile, this study used lesson plans as the basis for developing scientific method-based pedagogic competency guidelines, which were developed by incorporating one component of additional education: the goal of improving teacher teaching. Thus, RPP serves as a measure of the success of teachers and students.

Scientific method-based pedagogical competence reflection (SMBPCR) is a self-reflective effort to develop teacher professionalism. The SMBPCR is based on the assumption that pedagogical competence is a sub-competency of overall competence, but its existence becomes the core of the overall capability of the teachers. Pedagogical competence becomes the spearhead of professionalism because its implementation is directly related to all other competencies. Pedagogical competence is described as the ability and willingness to implement the attitudes, knowledge, and skills that support learning regularly by planned objectives (Haenilah, 2013a; Jones, 2015; Taylor, 2014).

Pedagogical competence can reflect the level of teacher professionalism because this competence can combine all the other three types of competencies: academic, social, and personality. Such competencies as a whole can be reflected by the quality of the development of the learning process as well as the attitudes and actions that can be used as a model that leads to the success of student learning (Roig Vila et al., 2015). Pedagogical competence is not something static, but something that one never completes. Showing the ability and the will to apply a way of working that supports student learning means continuously taking in new knowledge, learning from new experiences, and developing professionally and pedagogically. Pedagogical competence means continuously evaluating one's pedagogical practice in light of what research and proven experiences have shown to best promote student learning (Apelgren & Giertz, 2010; Haenilah, 2013a).

The real target of SMBPCR is not just the activity of transferring knowledge but also the ability in designing, implementing, and evaluating learning. This involves the ability to acquire knowledge, attitudes, and skills as a bridge between the curriculum and the students so that learning on purpose

can be realized. In terms of teacher professionalism standards, pedagogical competence is not only built on the knowledge that will be taught to the students but also on their knowledge to develop their profession or academic content. Pedagogical competence is also required to be able to internalize the aspects of the academic content with the aspects of pedagogical content into a real action that can allow all students to achieve their learning goals (Yee Lai & Wah Priscilla Lo-Fu, 2013) as shown in Figure 1.

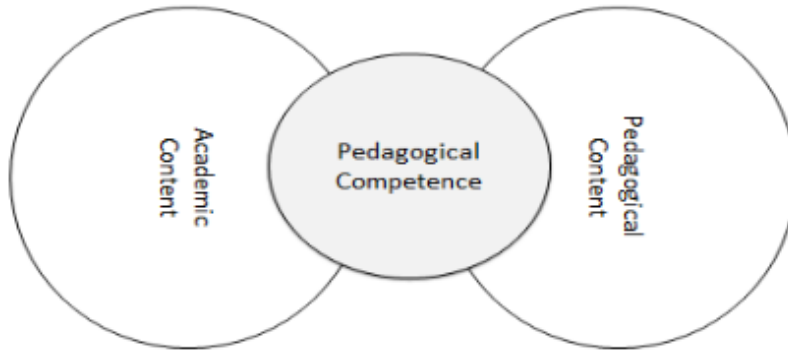


Figure 1: Pedagogical competence position

Source: Data analysis of this article

The teachers are required to know academic content in the form of facts, concepts, principles, laws, and theory, both on the content to be taught and on the usefulness to establish their identity as an educator. The content becomes meaningful when formulated proportionally to the classroom learning situation (Borko & Livingston, 1989). In addition, some researchers argue that the transformation of teaching knowledge must occur in teaching practice because this transformation process is related to the planning and design of learning, evaluation, and reflection activities (Leikin & Zazkis, 2010; Shulman, 2013). The curriculum structure illustrates that teaching does not just convey information from teacher to students but it also includes activities and actions to be done. This indicates that teachers should have pedagogical content knowledgeability which becomes the main capital in presenting fun learning for students (Shulman, 2013).

Increasing pedagogical competence on an ongoing basis becomes an essential requirement for teachers to improve their professionalism which leads to student success in learning. Teachers have unlimited opportunities to improve their teaching skills to be effective, and the most appropriate effort is by reflection (Laverick, 2017). The evolution of reflection in learning as well as an educational effort for teachers can be traced back to the thought of Dewey (1929) who used the idea of scientific methods to scaffold people to think and learn by learning by doing. Dewey made a tremendous impact on education and how teachers used reflection as a scaffold to enhance their learning experience and professionalism. Reflection is an effort to divert the subject in mind and to give serious and factual considerations to enable people to act in a programmed way. Reflective efforts involve the consideration of being active, persistent, and careful (Lupinski et al., 2012).

The scientific method in the professional development of teachers should be an ongoing process, which begins with the activity of self-reflection. In essence, human nature is naturally curious, so humans are always questioning the things they see or hear, and develop ideas (hypotheses) about why. The best hypothesis leads to a prediction that can be tested in various ways, including making further observations about their teaching abilities. Haenilah (2013a) suggests five stages of such activity: 1) finding the problem, 2) formulating the problem, 3) determining alternative solutions to the problem, 4) developing ideas to solve the problem, and 5) designing solutions to the

problem. The fifth step must be planned on the next teachers' lesson plan, as the achievement of increasing teacher professionalism. Teachers come to professional development opportunities with different backgrounds, confidence, and motivation (Whitworth & Chiu, 2015). Therefore, teaching is not a routine job, but an effort to improve professionalism, so there must be programmed efforts in addition to realizing student learning outcomes as well as the achievement of the ability of teachers themselves.

3. Methods

3.1 Research design and subjects

This study used a one-semester quasi-experimental design with a pre-post design experiment with the three groups of teachers representing three categories of teachers' years of teaching experience. The subjects of this study are 36 public primary school teachers in Bandar Lampung City.

Purposive sampling was used to recruit 18 out of 36 teachers from 18 out of the 36 public primary school teachers in Bandar Lampung City, meeting three criteria:

- (1) Teachers held Bachelor of Education degrees in Primary Teacher Education (Pendidikan Guru Sekolah Dasar or PGSD). This is as required by Law No. 14 of 2005 about teachers and lecturers.
- (2) Teachers were primary classroom teachers. These teachers taught in a class-teacher system, where the same teacher taught several subjects such as science, social studies, Indonesian citizenship education, and mathematics in one class.
- (3) Teachers were from three groups of teaching experiences: ≤ 5 years, 6 -10 years, and > 10 years. Each group consisted of six classroom teachers, assigned to teach different six grades (from first to sixth-grade students). 18 teachers in three categories of teaching experience: (a) ≤ 5 years (comprising 6 teachers), (b) 6 - 10 years (comprising 6 teachers), and (c) > 10 years (comprising 6 teachers).

3.2 The Components of the SMBPCR and the methods of intervention

Researchers utilized SMBPCR components as shown in Table 1 with the use mentorship method as shown in Figure 2.



Figure 2: The Cycle of Mentorship

The method used was mentorship programs where researchers provide guidance and support to those seeking to enhance their skills.

3.3 Procedure

1. Observe: The mentor comes to the class where the teacher (mentee) is teaching and the mentor records important events during the lesson
2. Reflect: The mentor uses the SMBPCR assessment instrument with the teacher to reflect on the learning that has been carried out.
3. Improve lesson plans: Mentors and mentees (teachers) improve lesson plans and add reflection points using the SMBPCR instrument.
4. Develop a new lesson plan for the next teaching.

3.4 Data collection

The data were collected using two instruments: a scoring guide and a self-reflection form. The former was used to assess teachers' ability to plan and teach before the treatment was given. This way enabled the teachers to know their teaching accomplishments. The latter is a scientific approach as a guide for the professional development of their next teaching activity. The self-reflection form used the format of pedagogical competence reflection based on the scientific method (see Table 1). This form was used to assess teacher pedagogical competence as the treatment.

Data collection was carried out in two stages: first, before using the format of a scientific-based pedagogical ability reflection, and second, after using the format of a scientific-based pedagogical ability reflection. Collecting data in the first stage of this study used documents in the form of a lesson plan used as the scoring guide to identifying teachers' ability to plan and teach before the treatment was given. During this stage, the teachers identify their problems in planning and/or in learning implementation. The identified problems were then preceded by the second stage.

In the second stage, the teachers used the problems in the first stage as one of the next lesson plan components to be achieved as teaching achievement. However, conventionally, such problems were not previously included in a lesson plan. In other words, normally, the lesson plan includes only student learning achievement, not teacher teaching achievement. This is a breakthrough in this model of improving teacher professionalism through SMBPCR in this study.

In other words, the second stage of data collection was combined with the steps of professional development based on the scientific approach by including the problems identified in the first stage. Collecting data from the three target groups was conducted six times: three times to get the data without treatment and three times to get the data during the treatment. The steps and objects of SMBPCR are outlined in Table 1.

Table 1: Format for assessment of SMBPCR

No	Steps of Reflection Based on Scientific Method	Pedagogical Competence Assessment (Score: 1-5)											
		Learning Plan				Learning Implementation			Learning Evaluation				
		Formulating the indicator	Determining the media	Determining the learning method	Developing the scenario	Formulating the evaluation	Using the media	Using the method	Steps of learning	Conducting the evaluation	Using the learning tools (media)	Using the way of learning	Reaching the target
1	Identifying Problems												
2	Formulating the Problems												
3	Selecting Alternative Solutions to the Problems												
4	Defining Ideas to Solve the Problems												
5	Planning to Solve the Problems												

Source: Haenilah (2013b)

Table 1 shows the format used to assess teacher pedagogical competence reflection based on scientific methods. Pedagogical competence based on the steps of the scientific approach was assessed using three stages of learning: plan, implementation, and evaluation. First, the learning plan, which became the target of pedagogical competence in this study, consisted of five aspects: 1) formulating the indicators, 2) determining the media, 3) determining the method, 4) developing the learning scenarios, and 5) formulating the evaluation. Second, the learning implementation included four aspects: 1) using the media, 2) using the method, 3) carrying out the steps of learning, and 4) conducting the evaluations. Last, learning evaluation included three aspects: 1) using evaluation tools, 2) using the evaluation method, and 3) reaching the target. The steps of the reflection-based scientific method are: 1) identifying problems, 2) formulating the problem, 3) selecting alternative solutions to the problem, 4) defining ideas to solve the problem, and 5) planning to solve the problem.

3.5 Data analysis

The obtained data were then analyzed using the nonparametric test, that is the Wilcoxon signed-rank test with two related samples. These analyses generated the tables of mean rank values and absolute Z-values at a significance level of (α) 0.05. The Wilcoxon signed-rank test was used to compare the scores before treatment with those after treatment from the same teachers and to assess any change in the scores (Statistics, 2018).

4. Results and Discussion

This study investigated the effect of scientific method-based pedagogical competence reflection (SMBPCR) to improve teacher professionalism in Bandar Lampung City schools, in Indonesia. The results of the data analyses are shown in Table 2.

Table 2: Average scores of teachers' pedagogical competence before treatment and after treatment

Years of Teaching Experience	The Average Scores of Pedagogical Competence		Gain	Z	Asymp. Sig. (2-tailed)
	Before the Treatment	After the Treatment			
≤ 5 years	2.48	3.59	1.11	-2.215(a)	0.028
6 – 10 years	2.46	3.51	1.05	-2.208(a)	0.028
> 10 years	2.54	3.53	0.99	-2.376(a)	0.018

Source: Data analysis of this study

Table 2 shows the average scores resulting from data analyses using the Wilcoxon signed-rank test. The results are presented based on the three groups of years of teaching experience, average scores of pedagogical competence, and Z values. This was used to meet the objective of this study in general and in detail.

In general, the data analyses show results that the effect of SMBPCR to improve teacher professionalism is significant. The average scores of pedagogical competencies of teachers resulted from the data of three times of teaching before using the scientific-based method reflection program and after using the scientific-based method program. The analyses generated the tables of mean rank values and absolute Z-values at a significance (α) level of < 0.05.

In detail, the results of the data analyses are presented below. This presentation is not limited to results by the objective of this study, but it also discusses the problems that emerge in each group.

a. Teachers with ≤ 5 years of teaching experience

Before the reflections using a scientific method, the average score of pedagogical competence of the six teachers was 2.48, and the average score after the treatment of reflection by using a scientific

method was 3.59. The average increase (gain) from the initial ability to the post ability was 1.11. Based on these scores, then the statistical test was conducted using the Wilcoxon signed-rank test, the obtained value of Z was -2.214 with a significance level (α) of $0.028 < 0.05$. Using SMBPCR resulted in a significant increase in the pedagogical competence score of teachers with a teaching experience of fewer than five years. This indicates that, for teachers with ≤ 5 years of teaching experience, the data analyses show results that the effect of SMBPCR to improve teacher professionalism is significant.

b. Teachers with 6-10 years of teaching experience

Before the reflections using a scientific method, the average score of pedagogical competence of the six teachers was 2.46, and the average score after the treatment of reflection by using a scientific method was 3.51. The average increase (gain) from the initial ability to the post ability is 1.05. Based on these scores, the statistical test was conducted using the Wilcoxon signed-rank test, the obtained value of Z was -2.208 with a significance level (α) of $0.028 < 0.05$. There is a significant increase in the pedagogical competence score of teachers with a teaching experience of 5-10 years. This indicates that, for teachers with 6-10 years of teaching experience, the data analyses show results that the effect of SMBPCR to improve teacher professionalism is significant.

c. Teachers with over 10 years of teaching experience

Before the reflections using a scientific method, the average score of pedagogical competence of the six teachers was 2.54, and the average score after the treatment of reflection by using a scientific method was 3.53. The average increase (gain) from the initial ability to the post ability was 0.99. Based on these scores, the statistical test was conducted using the Wilcoxon signed-rank test, the obtained value of Z was -2.376 with a significance level (α) of $0.018 < 0.05$. There is a significant increase in the pedagogical competence score of teachers with a teaching experience of over 10 years. This indicates that, for teachers with over 10 years of teaching experience, the data analyses show results that the effect of SMBPCR to improve teacher professionalism is significant.

In conclusion, the score increased statistically for teachers with tenure of < 5 from 2.48 to 3.59, assignments of 5-10 increased from 2.46 to 3.51, and works of > 10 years increased from 2.54 to 3.53. In aggregate, there is an average increase from 2.49 to 3.54 statistically.

Not only did this study focus on investigating how pedagogical competence reflection improves teacher professionalism, but it also identified the problems that emerged in each group for solutions. Despite being grouped into three by years of teaching experience, the teachers did the same efforts to increase their professionalism by using the scientific method of pedagogical competence reflection through the following steps: 1) identifying problems, 2) formulating the problems, 3) selecting alternative solutions to the problems, 4) defining ideas to solve the problems, and 5) planning to solve the problems. As previously mentioned, pedagogical competence based on the steps of the scientific method was assessed using three stages of learning: plan, implementation, and evaluation. Each group faced the problems in these steps as presented below.

Generally, the dominant tendency of the problems that emerged faced by all groups is in the stages of the learning plan and learning evaluation. From the curriculum documents for public schools in Indonesia, it is clear that the design process is considered an important aspect of a wide variety of subjects. Plan, implementation, and evaluation are three integral components. Not only do teachers facilitate the acquisition of new concepts and knowledge for students, but also the ability to produce teacher-professional actions has been programmed, so that actions are identified, passed, acted upon, or even solved (Lee & Takahashi, 2011; Ozogul et al., 2008; Potgieter, 2013).

Specifically, the problem that appeared dominant in the group of over 10 years of working experience was almost equal to the group of 6-10 years of working experience in the planning of learning in the aspects of determining the learning method and developing the scenario. As for the group with less than five years of working experience in learning plans, particularly in the aspect of formulating the indicators.

Although there were differences in certain stages of learning, all groups were able to follow through the steps which were guided by the scientific method. The scenario of the learning and teaching process is a description of the teachers' professionalism in implementing their pedagogical

abilities. This is the most important life skill. Learning is a process and an outcome. Understanding learning as a process can increase the effectiveness of teachers and students. Students who understand learning can master the content consciously; while, teachers who understand learning can intentionally convey knowledge in a way that makes it easier for students to learn (Thien, 2003).

However, by looking at the scores of professionalism improvement from the results of these reflection efforts, it seems that the highest score occurred in teachers with less than 10 years of teaching experience, while the lowest improvement occurred in the group of teachers with more than 10 years of teaching experience. The success of the reflection efforts of scientific-based methods is also supported by the evidence of teachers' ability in the form of scores obtained through documentary evidence of observation guidelines for the teaching and reflection program, as shown in Figure 2.

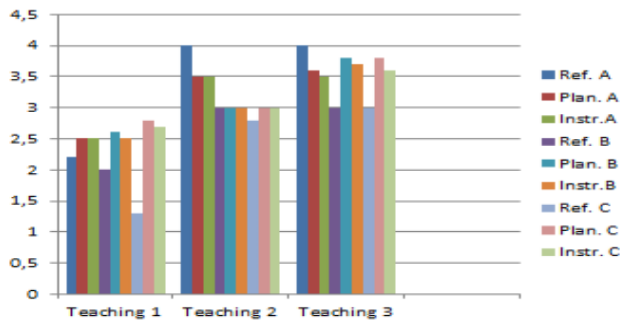


Figure 3: Average score of reflection, planning, and instruction by teachers of group A (≤ 5 years), B (6-10 years), and C (> 10 years) Source: Data analysis of this study

Figure 2 shows the results of teachers' reflections on each round. The data resulted from the competence development activity based on the efforts of reflection using the scientific method. Interestingly, the reflection efforts obtained during the learning process were developed using the reflection program that could be followed by an increasing the score of the ability in formulating the lesson plan (planning) and the score of learning implementation ability in pedagogical competence. This condition occurred in all teachers of the three groups of teaching experiences: ≤ 5 years, 6-10 years, and more than 10 years. The scores of pedagogical competence during the use of the reflection program are shown in Table 3.

Table 3: The score of pedagogical competence during the use of the reflection program

Years of teaching experience	Pedagogical Competence Scores								
	1 st Teaching			2 nd Teaching			3 rd Teaching		
	Ref.	Plan.	Impl.	Ref.	Plan.	Impl.	Ref.	Plan.	Impl.
≤ 5 years	2,2	2,5	2,5	4,0	3,5	3,5	4,0	3,6	3,5
6 – 10 years	2,0	2,6	2,5	3,0	3,0	3,0	3,0	3,8	3,7
> 10 years	1,3	2,8	2,7	2,8	3,0	3,0	3,0	3,8	3,6

Source: Data analysis of this study

Note: Ref. = Reflective, Plan. = Planning, Impl. = Implementing

Table 3 shows that in the first teaching, the value of the reflection process and mastery of the pedagogical competence was still a concern. This study revealed that reflective ability based on scientific methods plays a very important role in developing good pedagogical competence both in planning and implementing learning.

In the first teaching, we found that teachers with a teaching experience of fewer than 5 years show a better ability to reflect their pedagogical competence than those with a teaching experience of more than 5 years. As a result, the former showed better significant improvement in pedagogical competence than the latter.

Whereas, teachers with a teaching experience of more than 5 years show their reflection ability in their teaching in the second and third cycles. In these last two cycles, the teachers of the three groups (teachers with teaching experiences of less than 5 years, 5-10 years, and more than 10 years) have shown their reflective abilities as a basis for improving their pedagogical competence.

These findings may indicate that the better the teachers have the reflective ability, the better the teachers improve their pedagogical competence. In turn, teachers' reflective ability will improve the other three teacher competencies (social, personal, and professional). Accordingly, the teachers will improve their professionalism. As a result, the teacher's reflective ability will be able to actively motivate students to involve in learning (Rana & Culbreath, 2019).

However, along with the preparation of the reflection programs to follow up the problems in the second and the third teaching, the problems gradually diminish and the mastery of pedagogical competence gradually increases. When visually depicted, the relation between the problems of competence and the improved competence can be seen in Figure 3.

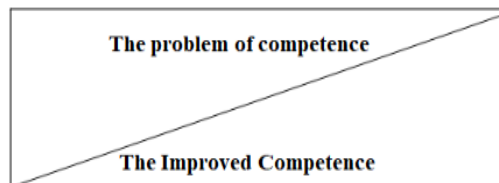


Figure 3: Relation of the problems of competence with improved competence
Source: Data analysis of this study

Figure 3 shows the decreasing problems faced by teachers turned out to be accompanied by the increase of their pedagogical competence mastery gradually over time. Besides, the things that make this effort successful are the increasing scores of pedagogical competence mastery achieved without fluctuation because the scores obtained were based on the efforts programmed and guided by systematic measures. Therefore, follow-up of teacher professional development can be structured and organized in different ways, and for different reasons. Here, based on the findings, SMBPCR could be used as an effective alternative to improve teacher professionalism.

Although much research has investigated the impact of professional development on teacher change, little research exists that explicitly links professional development to student outcomes (Desimone, 2009; Kennedy, 2016). Existing literature indicates that when characteristics of effective professional development are present, student achievement can be improved (Buczynski & Hansen, 2010; Chaaban & Abu-Tineh, 2017; Desimone, 2009; Johnson et al., 2007). In essence, teacher reflection applies to students. Reflection of teacher behavior toward students is how teachers perceive their students, and they treat their students differently (Johnson et al., 2007). However, no research previously used the scientific method to improve teacher professionalism through reflection. This study has closed this gap.

These findings are little known in the literature, particularly in an Indonesian school context. Therefore, this is an initial paper that could be further investigated in any other setting associated with teacher professionalism. This is important to help improve education quality in general, particularly in Indonesian schools.

5. Conclusion

This study investigated the effect of scientific method-based pedagogical competence reflection (SMBPCR) to improve teacher professionalism in Bandar Lampung City schools, in Indonesia. In general, the data analyses show results that the effect of SMBPCR to improve teacher professionalism is significant.

These findings suggest that SMBPCR can help develop teacher professionalism. The main outcome of this study is a program of reflection-based scientific approach which can be used to help teachers to do self-reflection guided by the steps of the scientific approach so that the follow-up of teacher professional development can be systematically programmed and the outcomes are measurable. The findings also may particularly help the Indonesian Government through its Education Quality Assurance Agency to encourage the teachers to achieve the standard of competencies of those targeted by the Government. To make it into practice, one essential thing is that in every lesson plan, teachers need to include not only indicators of learning achievement for students but also indicators of achievement of teaching improvement for teachers. This way can help teachers gradually improve their pedagogical competence effectively. Pedagogical competence reflects complete professionalism because it can simultaneously illustrate mastery of academic content, attitudes, and even social aspects.

These findings are little known in the literature, particularly in an Indonesian school context. Therefore, this is an initial scratch that could be further investigated in any other setting associated with teacher professionalism. This is important to help improve education quality in general, particularly in Indonesian schools.

5.1 Implications for teacher professional development

In the last decade, the Indonesian Government has set policies regarding the standards of competencies that must be mastered by teachers. Law Number 20 of the Year 2003 on the National Education System confirms that teaching is a professional job that must be mastered by teachers. To put it in practice, the conditions must be fulfilled to master the four competencies: pedagogical, personality, social, and professional. The four competencies are expected to be mastered and performed by teachers as a requirement for the effectiveness of classroom teaching.

In particular, pedagogical competence is the core of the four competencies because when teachers can develop pedagogical competence, then they will help improve the other three competencies. Reflective efforts guided by the steps of the scientific approach in improving pedagogical competence can be a guideline for teachers in developing their professionalism independently, responsibly, and measurably, so they can anticipate the outcomes of teaching (Giaino-Ballard, 2010; Haenilah, 2013a; Minott, 2010). To put it into practice, therefore, every lesson plan designed by teachers should not only contain components that are the target of student learning, but it also must add one component to the indicator of the lesson plan, that is, teacher pedagogical improvement as a result of reflective efforts. By doing this, teachers can help themselves gradually improve their pedagogical competence effectively. Pedagogical competence improvement will possibly help improve the other three teacher competencies because pedagogical competence is believed to be the core among the four competencies.

The findings of this study provide theoretical, practical, and policy contributions. Theoretically, the findings of this study contribute to adding knowledge to teacher pedagogical reflections based on a scientific method.

Practically, the findings of this study contribute to educators, particularly teachers, in terms of practical learning using a scientific method not only to improve student learning but also teacher pedagogical competence. The scientific method was previously used for student learning only but now is also applied to teacher learning. Therefore, teachers can gradually improve their professionalism scientifically and independently over time through pedagogical competence

reflection based on scientific methods.

Teachers should develop a design with an additional component, that is, the teacher achievement targets based on their previous teaching weaknesses/es or problems to be resolved in their lesson plan not only for student learning but also for teacher learning by applying systematic steps based on scientific methods for their professional improvement. Every problem or weakness the teachers encounter in their teaching ought to be included in every lesson plan.

Principals should be able to ensure that their teachers can depend on themselves to improve their professionalism. More importantly, principals should directly supervise their teachers' learning process to make sure that the learning process works effectively not only focusing on student learning but also on teacher learning. This will result in a gradual improvement of teacher professionalism systematically when applied findings of this study. To make this happen, it is important to build trust in the relationship between stakeholders (e.g., principals, teachers, principal supervisors, and district leaders) (Haenilah et al., 2020).

Further research could be that researchers would investigate school settings in other districts in Indonesia with mixed method research, particularly by including in-depth interviews to obtain data that cannot be obtained using the quantitative method only.

In terms of policy contribution, the findings of this study contribute to education offices in Indonesia, particularly in Lampung, to consider these findings used as a basis for their policy to improve student learning and teacher professionalism. Teacher professionalism may potentially significantly by improving its status "to be an appealing, high-prestige profession" (Haenilah et al., 2020).

6. Recommendation

Mentorship Program: It is feasible to carry out mentorship programs since experienced teachers usually supervise peer teachers, and the supervision program by experienced teachers would be the more significant result by utilizing SMBPCR's syntax and instrument.

7. Declaration of Conflicting Interests

The authors declared no potential conflicts of interest regarding the research, authorship, and/or publication of this paper.

8. Funding

The authors received financial support for the research, authorship, and/or publication of this article.

9. Limitation

1. In this investigation, quasi-experimental is employed, potentially introducing limitations due to the absence of a randomization design.
2. The further author has the opportunity to enhance the exposition regarding the measurement instruments employed for evaluating teacher professionalism pre and post-intervention, including any conceivable constraints inherent.
3. This research utilizes 18 educators for further research that could be applied to a larger one to get robust generalization.

References

Apelgren, K., & Giertz, B. (2010). Pedagogical competence: A key to pedagogical development and quality in higher education. *A Swedish perspective on pedagogical competence*, 25-40.

- Borko, H., & Livingston, C. (1989). Cognition and improvisation: Differences in mathematics instruction by expert and novice teachers. *American educational research journal*, 26(4), 473-498.
- Buczynski, S., & Hansen, C. B. (2010). Impact of professional development on teacher practice: Uncovering connections. *Teaching and teacher education*, 26(3), 599-607.
- Chaaban, Y., & Abu-Tineh, A. (2017). Instructional coaches' perceptions of professional development: An exploration of the Qatari school-based support program. *International Journal of Mentoring and Coaching in Education*.
- Chowdhary, B. (2015). *Reflective pedagogical practices in an era of standards based reform: What do teachers do? An examination of science teachers' communities and their contribution to the facilitation of professional growth through authentic reflection*. State University of New York at Buffalo.
- Darling-Hammond, L. (2012). *Powerful teacher education: Lessons from exemplary programs*. John Wiley & Sons.
- Data, P. (2017). Ikhtisar data pendidikan dan kebudayaan tahun 2017/18 [revisi].
- Desimone, L. M. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. *Educational researcher*, 38(3), 181-199.
- Destiana, B., & Utami, P. (2017). Urgensi kompetensi pedagogik guru vokasional pada pembelajaran abad 21. *Elinvo (Electronics, Informatics, and Vocational Education)*, 2(2), 211-222.
- Dewey, J. (1929). *Impressions of Soviet Russia and the Revolutionary World: Mexico--China--Turkey* (Vol. 10). New York: New Republic.
- du Plessis, A. E., Gillies, R. M., & Carroll, A. (2014). Out-of-field teaching and professional development: A transnational investigation across Australia and South Africa. *International Journal of Educational Research*, 66, 90-102.
- Fägerlind, I., & Saha, L. J. (2016). *Education and national development: A comparative perspective*. Elsevier.
- Gaimeo-Ballard, C. (2010). *Key reflective teaching strategies used by education faculty in NCATE-accredited universities*. ERIC.
- GoH, C. C. (2015). Successes and challenges in the continuing education of teachers. *Teacher Development: Dimensions & Perspectives*, 9.
- Gurria, A. (2016). PISA 2015 results in focus. *PISA in Focus*(67), 1.
- Haenilah, E. Y. (2013a). The development of a reflective practical teaching model for Improving pedagogical competence of undergraduate students in elementary school teacher education program. *Asia-Pacific Collaborative Education Journal*, 9(1), 41-52.
- Haenilah, E. Y. (2013b). *Pengembangan Model Pembelajaran Praktik Mengajar Reflektif (MP2MR) untuk Meningkatkan Kompetensi Pedagogik Mahasiswa S1 Pendidikan Guru Sekolah Dasar (PGSD) Universitas Pendidikan Indonesia*].
- Haenilah, E. Y., Surahman, M., & Sukamto, I. (2020). Efektivitas Pembelajaran Interdisipliner Pada Pembelajaran IPA Di PGSD.
- Harjanto, I., Lie, A., Wihardini, D., Pryor, L., & Wilson, M. (2018). Community-based teacher professional development in remote areas in Indonesia. *Journal of Education for tEaching*, 44(2), 212-231.
- Johnson, C. C., Kahle, J. B., & Fargo, J. D. (2007). A study of the effect of sustained, whole-school professional development on student achievement in science. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, 44(6), 775-786.
- Jones, A. G. (2015). *The relationship between elementary teachers' years of experience and their self-perceived pedagogical competence in Alabama elementary schools*. Liberty University.
- Keesing-Styles, L. (2003). The relationship between critical pedagogy and assessment in teacher education.
- Kennedy, M. M. (2016). How does professional development improve teaching? *Review of educational research*, 86(4), 945-980.
- Kusumawardhani, P. N. (2017). Does teacher certification program lead to better quality teachers? Evidence from Indonesia. *Education Economics*, 25(6), 590-618.
- Lee, Y.-A., & Takahashi, A. (2011). Lesson plans and the contingency of classroom interactions. *Human Studies*, 34, 209-227.
- Leikin, R., & Zazkis, R. (2010). *Learning through teaching mathematics: Development of teachers' knowledge and expertise in practice* (Vol. 5). Springer Science & Business Media.
- Liakopoulou, M. (2011). Teachers' pedagogical competence as a prerequisite for entering the profession. *European Journal of Education*, 46(4), 474-488.
- Lopes, J. B., & Cunha, A. E. (2017). Self-directed professional development to improve effective teaching: Key points for a model. *Teaching and teacher education*, 68, 262-274.
- Lupinski, K., Jenkins, P., Beard, A., & Jones, L. (2012). Reflective Practice in Teacher Education Programs at a HBCU. *Educational Foundations*, 26, 81-92.

- Minott, M. A. (2010). Reflective teaching as self-directed professional development: building practical or work-related knowledge. *Professional development in education*, 36(1-2), 325-338.
- Ozogul, G., Olina, Z., & Sullivan, H. (2008). Teacher, self and peer evaluation of lesson plans written by preservice teachers. *Educational Technology Research and Development*, 56, 181-201.
- Pollard, A., & Collins, J. (2005). *Reflective teaching*. A&C Black.
- Potgieter, C. (2013). Teaching practice trends regarding the teaching of the design process within a South African context: a situation analysis. *International journal of technology and design education*, 23, 953-968.
- Rahman, B., Abdurrahman, A., Kadaryanto, B., & Rusminto, N. E. (2015). Teacher-based scaffolding as a teacher professional development program in Indonesia. *Australian Journal of Teacher Education*, 40(11), 4.
- Roig Vila, R., Mengual Andrés, S., & Quinto Medrano, P. (2015). Primary teachers' technological, pedagogical and content knowledge. *Comunicar*, 2015, vol. 45, num. 23, p. 145-149.
- Sachs, J. (2016). Teacher professionalism: Why are we still talking about it? *Teachers and teaching*, 22(4), 413-425.
- Saito, E., Harun, I., Kuboki, I., & Tachibana, H. (2006). Indonesian lesson study in practice: Case study of Indonesian mathematics and science teacher education project. *Journal of in-service education*, 32(2), 171-184.
- Shulman, L. S. (2013). Those who understand: Knowledge growth in teaching. *Journal of Education*, 193(3), 1-11.
- Singh, S. K., & Mabasa, L. T. (2015). Using student-teachers' reflections in the improvement of a teaching practice programme at the University of Limpopo: part 1. *South African Journal of Higher Education*, 29(3), 168-182.
- Statistics, L. (2018). Wilcoxon signed rank test in SPSS statistics-procedure, output and interpretation of output using a relevant example. In.
- Suciu, A. I., & Mata, L. (2011). Pedagogical competences—the key to efficient education. *International online journal of educational sciences*, 3(2), 411-423.
- Swennen, A. (2009). Epilogue: Enhancing the profession of teacher educator. Dalam: Swennen, A. & van der Klink, M.(Editors). *Becoming a teacher educator. Theory and practice for teacher educators*.(hal. 219-225). In: Amsterdam: Springer Science+ Business Media.
- Taylor, T. (2014). *Changing Pedagogy for Modern Learners—Lessons from an Educator's Journey of Self-Reflection*. *Journal of Educational Technology & Society*, 17(1), 79-88.
- Thien, S. J. (2003). A teaching–learning trinity: Foundation to my teaching philosophy. *Journal of Natural Resources and Life Sciences Education*, 32(1), 87-92.
- Tyler, R. W. (2013). *Basic principles of curriculum and instruction*. University of Chicago press.
- Whitworth, B. A., & Chiu, J. L. (2015). Professional development and teacher change: The missing leadership link. *Journal of science teacher education*, 26(2), 121-137.
- Widodo, A., & Riandi. (2013). Dual-mode teacher professional development: challenges and re-visioning future TPD in Indonesia. *Teacher development*, 17(3), 380-392.
- Yee Lai, M., & Wah Priscilla Lo-Fu, Y. (2013). Incorporating learning study in a teacher education program in Hong Kong: a case study. *International Journal for Lesson and Learning Studies*, 2(1), 72-89.