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The Development of Teacher Leadership Assessment Instruments in Learning Physics

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Abstract: Teacher leadership is directly related to the development of high-quality learning in schools that focus on improving education based on the principles of professional collaboration. Physics is a part of natural science which has unique characteristics. Some physics material is abstract, so some students need help to learn. Teacher leadership in physics learning is required to improve the quality of physics learning. This study aims to develop instrument teacher leadership in learning physics. It is a research and development design. The research instrument was a questionnaire of 4 types, namely a questionnaire filled out by physics teachers, school principals, physics teacher colleagues, and students. Data were analyzed using factor analysis. All questionnaires filled the valid aspects by expert judgment. The questionnaires filled by physics teachers, principals, and fellow physics teachers comprised 45 items, 45 items, and 44 items, respectively. Only questionnaires filled by students not only fulfill validation by expert judgment but also fulfill empirical validation and reliability of 0.864 with reliable criteria for as many as 39 items. The study's implication is to produce an instrument to measure the quality of prospective physics teachers who can improve the quality of learning physics.

Keywords: *assessment instruments; teacher leadership; physics learning; valid; reliabel*

A. INTRODUCTION

The Industrial Revolution 4.0 is an era of technological development that requires people to be smart in utilizing it. Various conveniences are obtained from technology that helps various smooth community activities. However, RI 4.0 also raises various challenges, some of which actually come from the ease of RI 4.0. One of the problems that is currently rampant in the scope of students is addiction to online gaming which has an impact on wasteful behavior, the emergence of addictive effects, real life becomes messy, makes people isolated from the surrounding environment, disrupts health, irregular eating and sleeping

patterns, and is susceptible to disease (Noya & Salamo, 2021). This is only one of the problems resulting from the misuse of technology that can have a wide impact on the next generation of the nation, even though there are many other problems.

Education is one of the hopes of the community to prepare the nation's successors who are able to conquer the demands of RI 4.0. The era of the industrial revolution 4.0 demands an education system that can lead to a better human civilization by optimizing the nation's generation with 4C (critical thinking, creativity, communication, and collaboration) abilities (Eko Risdianto, 2019)). Teachers as the frontline of education have an important role in determining the quality of human resources through leadership, especially in learning activities. The teacher's leadership spirit is also very necessary to know the uniqueness of individual students as well as their competence capacity so that they can focus on students to grow and develop with their achievements. The results of Amiranti (2013) show that teacher leadership in the learning process has a positive and significant effect on student participation by 37%.

Teacher leadership is directly related to the development of high-quality learning in schools and contributes to improving the quality of education. Teacher leadership focuses on improving learning based on the principles of professional collaboration. So, teacher leadership is not a formalized state or responsibility in doing tasks, but it is empowering teachers in developing teams to improve the quality of teaching and learning activities (Harris & Muijs, 2002). Harrison & Killion (2007) state that in their leadership, teachers have 10 roles: resource person, learning expert, curriculum expert, learning supporter, facilitator, mentor, school leader, coach, change agent and learner. However, the most important of these ten roles is the role of the teacher as a learner. Through this role, teachers are expected to implement various innovative learning models, demonstrate lifelong learning, and apply what they learn for student achievement. Good and Brophy's findings (Jones & Jones, 2001, p. 3) show that teachers who are involved in the classroom in the process of developing and maintaining the learning environment tend to be more successful than teachers who place themselves as authority figures in their teaching. Teacher success can be seen from the improvement of students' abilities resulting from the learning that is carried out. Research (Rhoton & McLean, 2008, p. 45) involving 750 physics, biology, and chemistry teachers and 50 principals showed that the ability of students taught by teachers who participated in teacher leadership development programs increased compared to students taught by teachers who did not participate in the program. These studies show that teacher leadership is very important to improve the quality of education.

Physics is the most basic branch of science that studies the behavior and structure of matter. This means that physics contains creative activities that in many aspects resemble other creative activities. One important aspect of science is observation and observing events, which

includes planning and conducting experiments. However, observation and experimentation require imagination, as a scientist will never fit anything into a description of what they observe. (Giancoli, 2011; Kirkpatrick, L. D. ; Francis, 2010). Thus, a scientist must decide what is relevant in their observations and experiments. Rustaman (2008) adds that the scientific process is not only limited to data collection, but also sharpens mental processes and manipulative skills. The above discussion shows that physics discusses concepts that are partly abstract so that it is difficult for students to understand. Therefore, many physics teachers strive for learning by making learning media (Rivai et al., 2021; Rizaldi et al., 2020; Verdian et al., 2021). However, learning media is not enough. Teachers must also have the ability to lead physics learning in accordance with the characteristics of physics so that it is easily understood by students. Scheider (1980) recommends 27 steps teachers in teaching physics with regard to the characteristics of physics learning, five of which are: 1) do not teach words alone in learning, 2) encourage students to form a useful imagination for themselves; 3) teach the numbers that form accuracy (do not use a calculator); 4) recognize and respect the level of student differences; 5) sometimes present concrete examples and parables with graphical relationships to satisfy student curiosity. Observing the five steps shows that physics learning requires specific ways for teachers to lead physics learning according to the characteristics of physics. That is, teacher leadership is important to teach physics.

So far there is no standardized instrument to measure teacher leadership in teaching physics. This instrument is very important to measure the ability of teachers in teaching physics to support the improvement of the quality of physics learning as well as providing knowledge related to the theory that underlies the development of appropriate technology. This research aims to produce an instrument to measure teacher leadership in physics learning. It is hoped that the results of the study can contribute to improving the quality of physics learning.

B. MATERIALS AND METHODS

The design is research and development with eight steps: (1) determining instruments specifications, (2) compiling the instruments, (3) determining the measurement scale, (4) determining the scoring system, (5) examining, (6) doing limited experiment, (7) analyzing instruments, and (8) assembling instruments. the data were collected by using questionnaires. The questionnaire is one of three instruments to measure teacher leadership. The other instruments are documentation sheet, observation sheet, and interview guideline. Due to the scope of the discussion, this article will only discuss the development of the questionnaire instrument. The questionnaire will be filled in by four different groups of respondents, namely physics teachers, principals, fellow teachers, and students. Data analysis was carried out by conducting validation (content and construct) and reliability tests. Expert judgment analyzed the content. Construct validation was analyzed through

analysis of factors while the reliability was observed from the alpha Cronbanch value. Construct validation and reliability tests were only applied to the questionnaire to be filled out by students due to time constraints and bureaucratic difficulties. The instrument analysis was conducted by employing SPSS 25 software for windows. The respondents were an expert in the field of physics education, an expert in the field of educational evaluation, as well as 115 grade X students in one of the Vocational High Schools in Wonosobo Regency, Central Java.

C. RESULT AND DISCUSSION

1. Determining Instrument Specifications (Step 1)

The study aims to develop an instrument to measure teacher leadership in physics learning. The questionnaire is one of the instruments used to measure teacher leadership. There are three other instruments, namely documentation sheet, observation sheet, and interview guideline. Due to the scope of the discussion, this article will only discuss the development of the questionnaire instrument which is intended to be filled in by different respondents, namely physics teachers, principals, fellow teachers, and students. The instrument was developed from various theories and relevant research studies as follows.

Harris & Muijs (2002) divide teacher leadership into three activities. The first is leadership towards other teachers. For example, being a mentor, coach, or leader in a team-related activity. Second is leadership in a team tasked with developing learning and teaching. The third is leadership in classroom learning to implement effective learning. In practice, the three teacher leadership activities above cannot be separated. Harrison & Killion (2007) state that there are 10 teacher leadership roles: resource person, learning expert, curriculum expert, learning supporter, facilitator, mentor, school leader, coach, change agent, and learner. Good and Brophy's findings (Jones & Jones, 2001) show that teachers who are involved in the classroom in the process of developing and maintaining the learning environment tend to be more successful than teachers who place themselves as authority figures in their teaching. Rhoton & McLean (2008) research confirms that teachers who participated in a teacher leadership development program in science were able to improve students' abilities higher than teachers who did not participate in the program.

This study will only examine the ability of teachers to lead physics learning in the classroom. The selection of physics is because physics is a science that partly studies abstract concepts, such as electricity and magnetism. Therefore, tricks are needed for teachers in teaching it. Scheider (1980) mentions 27 things that are recommended for physics teachers in teaching physics, namely: 1) do not teach words alone in learning, 2) encourage students to form a useful imagination for themselves; 3) teach the

numbers that form accuracy (do not use a calculator); 4) recognize and respect the level of student differences; 5) sometimes present concrete examples and parables with graphical relationships to satisfy student curiosity; 6) trying to find analogous connections between the abstract (from natural phenomena that cannot be investigated directly) and real facts in nature; 7) using demonstrations and laboratory activities to shape imagination and crystallization of knowledge; 8) being careful and honest in making observations in the laboratory; 9) choosing demonstrator materials to shape relevant imagination. 10) teach the nature of inquiry by teaching science facts that are in accordance with the laws of nature; 11) use the opening sentence of learning by linking previous learning; 12) encourage students to ask questions; 13) dominate class discussions at the limits of seriousness; 14) make warm and comfortable communication with students; 15) tactfully answer student questions that intend to undermine the authority of the teacher; 16) answer "don't know" or "I'm wrong" if it doesn't know and is wrong; 17) convey the history of science as necessary to motivate students to learn but do not give the impression that science is the best field; 18) convey the history of science only as necessary to honor scientists for their discoveries; 19) give an understanding of the difference between pure and noble science and non-science to form thoughtful students; 20) be a leader but not a master; 21) respect and appreciate students; 22) interact with students in a kind and thoughtful manner; 23) be flexible in action but obey the rules; 24) be serious but not boring (sometimes it is also necessary to be funny as necessary); 25) make working principles as a rule; 26) judge objectively from both the teacher and student sides; 27) communicate the life mission clearly to others. So, there is one thing that is very prominent needed by a physics teacher in leading learning, namely inviting and directing the imagination of students through demonstration, laboratory, and modeling activities to equip students with knowledge, attitudes, and skills. This is closely related to the characteristics of physics learning materials which are partly related to abstract things. Chodakowski (2009) in his dissertation stated that a teacher needs to include the imagination process in planning and teaching that will be done. These are the various theories and results of previous research that underlie the preparation of instruments to measure teacher leadership in physics learning.

2. Compiling The Instruments (Step 2)

The in-depth theoretical study was then developed into an instrument grid which contained several components, each component was described in several sub-components. As for each sub-component will be described again into several indicators as shown in Table 1. A questionnaire consists of 45

items that will be filled by physics teachers and principals, 44 filled by college teachers, and 43 filled by students will fill the questionnaire.

3. Choosing a Measurement Scale (Step 3) and Scoring (Step 4)

Questionnaire items are arranged using a Likert scale in the range of 1 to 4, namely 1 = strongly agree, 2 = agree, 3 = disagree, 4 = strongly disagree.

4. Examining (Step 5)

The examining instrument aims to find out the quality of questions or statements based on indicators by expert judgment. The preparation of instrument frameworks and indicators will be tested by two experts, each of whom has expertise in the field of physics learning and learning evaluation to fulfill the requirements of instrument validation in terms of material content (content validity). The construct validity is done by asking for expert judgment to provide input or suggestions on the instrument that has been prepared. After conducting several stages of validation tests and improvements according to expert advice, finally a questionnaire instrument was determined that had met content and construct validity.

5. Doing Limited Experiment (Step 6)

Empirical validation was only carried out on questionnaires filled in by students and was not carried out on questionnaires filled in by physics teachers, principals, and fellow physics teachers due to bureaucratic difficulties and longer time needed considering the adequacy of the number of respondents. The pilot test was conducted on grade X students of one of the vocational schools in Wonosobo Regency, Central Java. Empirical validation was obtained using factor analysis technique to see how much correlation between one factor and other factors as variable formers. If a strong enough correlation is found between the forming factors, the factor is declared as a variable shaper, as well as providing information that the item fulfills empirical validation.

6. Analyzing Instruments (Step 7)

A total of 115 students have filled out the physics teacher leadership ability questionnaire. The data was then analyzed using factor analysis with the help of SPSS version 25. The adequacy of the sample shows the Chi-square value in the Bartlett test of 1862,225 with degrees of freedom 903 and p-values less than 0.000. That is, the sample size of 115 used is sufficient. It is corroborated by the Kaiser Meyer Olkin measure of adequacy sampling (KMO) of 0.695 greater than 0.5.

The analysis was continued to find out the validity of items. The anti-image correlation (AIC) in Table 2 shows the variables that are feasible to use in carrying out factor analysis. It can be seen from the value of a Measure of Sampling Adequacy (MSA) by “a” code. MSA values above 0.50 indicate items are feasible to use factor analysis (Hair et al., 2010). This also shows that the items fulfill the valid aspect.

Table 2 Anti-Image Correlation

Item	Anti-image Correlation	Description
1	0,687	Valid
2	0.702	Valid
3	0,627	Valid
4	0,659	Valid
5	0,677	Valid
6	0,645	Valid
7	0,452	Tidak valid
8	0,457	Tidak valid
9	0,535	Valid
10	0,529	Valid
11	0,816	Valid
12	0,437	Tidak valid
13	0,769	Valid
14	0,521	Valid
15	0,729	Valid
16	0,744	Valid
17	0,552	Valid
18	0,505	Valid
19	0,753	Valid
20	0,790	Valid
21	0,660	Valid
22	0,658	Valid
23	0,670	Valid
24	0,533	Valid
25	0,817	Valid
26	0,702	Valid
27	0,698	Valid
28	0,851	Valid
29	0,782	Valid
30	0,686	Valid
31	0,804	Valid
32	0,633	Valid
33	0,776	Valid
34	0,790	Valid
35	0,720	Valid
36	0,649	Valid
37	0,646	Valid
38	0,799	Valid
39	0,691	Valid
40	0,627	Valid
41	0,758	Valid
42	0,714	Valid
43	0,450	Tidak valid

Table 2 is known that the four invalid items if removed will not eliminate the indicators in the teacher leadership sub-component. This means that the meaning of the teacher leadership indicators is still maintained. With this consideration, items 7, 8, 12, and 34 which were declared invalid were removed, so that the total valid instrument was only 39. The 39 items were then continued with the reliability test through the Cronbanch alpha formula using the SPSS 25 program showing a reliability coefficient value of 0.864. According to (Widoyoko, 2009, p. 165), the instrument is said to be reliable if it has an alpha coefficient value of at least 0.7. This means that the instrument in the form of a questionnaire to find out the teacher's ability to develop leadership in learning filled by students is declared reliable (steady).

7. Concluding (Step 8)

Based on the results of expert judgment and EFA (Explanatory Factor Analysis), a valid and reliable instrument is established to measure teacher leadership through the learning physics. Table 3 is an example of a questionnaire filled out by students and has been declared to fill the valid and reliable aspects.

D. CONCLUSION

The research successfully produced an instrument to measure teacher leadership that meets the valid and reliable aspects. Questionnaires filled out by physics teachers, principals, fellow physics teachers, and students meet the valid aspects by expert judgment. The questionnaires filled by physics teachers, principals, fellow physics teachers consisted of 45 items, 45 items, and 44 items respectively. Only questionnaires filled by students not only fulfill validation by expert judgment, but also

fulfill empirical validation and reliability of 0.864 with raliabel criteria as many as 39 items.

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Table 1
The Framework of Teacher Leadership Instruments (Questionnaire) in the Learning Physics

Component/ Subcomponent	Indicators	Number of quessionaire item		
		Physics teacher/ School principle	Physics teacer colleagues	Students
Determine the direction				
1. Formulate a vision	1. Having a vision of life	1	1	1
	2. Dare the to communicate the vision of life to others	2	2	2
2. Describe the big picture of the material to be studied	1. Open learning by lingking previous learning	3	-	3
	2. Explain the big picture of the material to be studied	4	3	4
3. Determine learning strategies	1. Determine learning strategies according to student characteristics	5	4	5
	2. Determine relevant teaching materials	6	5	6
	3. Determine appropriate learning resources	7	6	7
	4. Be able to determine a logical time allocation	8	7	8
	5. Be able to determine the appropriate form of assessment and evaluation	9	8	9
	6. Be able to determine the follow-up of the evaluation that has been carried out	10	9	10
Directing Students				
1. Discuss the learning objectives to be achieve	1. Be able to compile learning tool (syllabus, lesson plans, evaluating sheet) in according with the objectives to be achieved	11	10	-
	2. Be able to convey learning objection based on lesson plans clearly.	12	11	-
	3. Be able to directing student to achieve the learning objectives	13	12	11
2. Form a clear commitment between teacher and students regarding learning activities.	1. Make a agreement with students in learning activities	14	13	12
	2. Be consistent with the decisions that have been taken	15	14	13
	3. Give sanction to students who break the agreement	16	15	14
	4. Flexible in acting, but obey the rules	17	16	15
	5. Make the working principle as a rule	18	17	16
	6. Assess objectively	19	18	17
3. Building a team and a	1. Direct students in forming a solid team	20	19	18

good cooperation between students and teacher; between students and students.	2. Direct students to work together with group members	21	20	19
	3. Build the food communication with students individually or groups	22	21	20
	4. Dominate class discussion on the limits of seriousness	23	22	21
	5. Be the leader but not the master Menjadi pemimpin tetapi bukan tuan	24	23	22
	6. Provide easy access for student to communicate	25	24	23
Motivating and inspiring				
1. Inspire	1. Provide an example in form of discipline	26	25	24
	2. Set an example in speech	27	26	25
	3. Set an example in attitude and action	28	27	26
	4. Carry out learning that is able to arouse students' curiosity	29	28	27
	5. Gave concrete examples in life	30	29	28
	6. Present the history of physics ad need to motivate	31	30	29
2. Give encouragement during the learning process	1. Enthusiasm in conveying learning	32	31	30
	2. Encouraging student to enthusiasm in learning and life	33	32	31
	3. Provide rewards for students who are active in learning (ask or answer)	34	33	32
	4. Creating fun learning	35	34	33
	5. Able to provide appropriate solutions to problems that arise	36	35	34
3. Empowering students according to their potential	1. Recognizing and respecting student differences	37	36	35
	2. Giving assignment according to the potential of students	38	37	36
	3. Encouraging the perfection of students achievement within the limits of student abilities	39	38	37
4. Fulfill unsatisfied needs	1. Serious but not boring	40	39	38
	2. Finding things that seem analogous to abstract relationships and real fact that exist in nature	41	40	39
	3. Using demonstration or laboratory activities to form imagination and concentration	42	41	40
	4. Teaches the nature of investigation by teaching scientific facts in accordance with natural laws	43	42	41
	5. Encourage students to form useful fantasies for themselves through repetition of students' own words	44	43	42

	6. Teach the number that make up accuracy so that students are able to make useful fantasies	45	44	43

Table 3. Questionnaire to measure teacher leadership to be completed by students

No	Statement	4	3	2	1
1	Teachers have a vision in teaching physics, such as: wanting to make physics liked by students, making physics learning interesting for students to follow.				
2	The teachers communicate the vision of teaching physics to students, such as learning physics is interesting to follow.				
3	The teacher opens the lesson by linking the previous lesson.				
4	The teacher is able to explain the detailed description of the material to be delivered				
5	The method used by the teacher in teaching physics is in accordance with the students' abilities.				
6	The teachers are able to determine the material in accordance with the student's ability to learn.				
7	The teachers have the ability to determine the appropriate assessment method (such as assessing students when doing practicum is different from learning without practicum activities).				
8	The teachers provide enrichment for students who have reached KKM / learning completeness and remedial for students who have not reached KKM / learning completeness according to student abilities				
9	Teachers are able to direct students' understanding so that students easily understand the material.				
10	The teachers have a consistent attitude and answers to students' questions				
11	The teachers sanction students who violate the agreement.				
12	Teachers are able to manage the class to remain conducive for students to learn.				
13	The teachers make work principles as a rule, such as the principles of working in a laboratory that must be orderly, careful, and maintain work safety				
14	The teachers are able to assess objectively				
15	The teachers are able to divide students into several groups fairly based on students' abilities				
16	The teachers are able to motivate each group to be solid in working together.				
17	The teachers are able and friendly to answer students' questions both individually and in groups				
18	The teachers lead the discussion within certain limits, such as limiting the discussion material, mediating disputes that occur during the discussion, and providing solutions if there is a deadlock.				
19	The teachers are able to lead students in learning without coercion.				
20	The teacher does not limit the place and space for students who want to ask questions.				
21	Teachers are able to set an example in the form of discipline, such as coming in on time.				
22	Teachers are able to set an example in terms of speech, such as not saying bad words.				

23	Teachers are able to set an example in behavior and actions, such as respecting students who ask questions, reprimanding students who are wrong gently				
24	The lessons delivered by the teachers are able to raise students' curiosity in learning.				
25	Teachers are able to provide concrete examples that exist in the life of the students.				
26	Teachers are able to motivate students in learning, one of which is through stories of the persistence of a physics figure or other figures in discovering theories or solving problems.				
27	Teachers are enthusiastic in delivering lessons				
28	Teachers are able to encourage students to be enthusiastic in learning and life.				
29	Teachers provide rewards for students who are active in learning (asking and answering)				
30	The teacherr are able to create physics learning that makes students comfortable to learn				
31	Teachers are able to provide appropriate solutions to problems that arise, for example answering student questions, asking for time to find answers if they cannot answer, or connecting with other people who can answer the question.				
32	The teachers recognize and respect student differences				
33	Teachers give assignments according to students' potential.				
34	Teachers are able to encourage the perfection of student achievement within the limits of student abilities				
35	Teachers take learning seriously but are not boring				
36	The teachers are able to find things that appear analogous to abstract relationships and real facts that exist in nature.				
37	The teachers use demonstrations/laboratory activities to build imagination and concentration.				
38	The teachers are able to teach the nature of inquiry by teaching science facts that are in accordance with natural laws, such as the characteristic of heat-conducting objects is that heat can pass through easily. Conversely, objects that are difficult to conduct heat are difficult to pass heat through.				
39	The teachers encourage students to understand the material through their own words				