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Implementation of Participatory Training Model to Develop Teachers' Ability to Design Formative Assessment Instruments in Science Learning

Muslim[1*], Nuryani Y. Rustaman[2], Parsaoran Siahaan[1], Winny Liliawati[1], Ridwan Efendi[1]

[1]Physics Education Study Program, Department of Physics Education, Indonesia University of Education, Setiabudi Street No. 229 Bandung 40154, Indonesia
[2]Biology Education Study Program, Department of Biology Education, Indonesia University of Education, Setiabudi Street No. 229 Bandung 40154, Indonesia

*Email: muslim@upi.edu.

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Abstract. Formative assessment is an essential aspect of learning. Facts in the field show that there still needs to be more teachers who conduct formative assessments during the learning process. The assessment that carries out assesses the final results of learning through summative. This study aims to analyze the ability of science teachers to design formative assessment instruments in science teaching through the implementation of the participatory training model. The research method used is descriptive research with a quantitative approach. The research subjects were 30 junior high school science teachers in Sumedang Regency. Data collection instruments are formative assessment product sheets made by teachers and questionnaires. Data analysis techniques include data reduction, presentation, and conclusion drawing. The results showed that the ability of teachers to design formative instrument assessments was categorized as good. Teachers can create formative instrument assessments integrated into science learning in a varied manner. Teachers' responses to the strengthening and mentoring.
Keywords: participatory training model, teachers' ability, formative assessment instruments, science learning

Introduction

Assessment is obtaining data or information from the learning process and providing feedback to teachers or learners (Stiggins, 2002). The nature of assessment in learning is an activity to reveal the process and results of education. The application of assessment can be made through various ways and using different assessment tools to obtain information about the extent of learner learning outcomes or the achievement of learner competencies. Assessment is an integral part of the learning process. Assessment activities in learning must be designed in such a way as to measure and provide information about the achievement of learner competencies obtained during the learning process.

Assessment must be based on the learning objectives and have certainty of success criteria. Success criteria relate to the learning process carried out by students, learning activities carried out by teachers, and the learning program as a whole (Schildkampa et al., 2020). To obtain results that can describe the actual situation, an assessment can be carried out throughout the learning activities to motivate and develop students' learning activities, monitor teachers' teaching abilities, and support the interest in improving learning programs (Ganajová et al., 2021). Many techniques can be used to collect information about learners' learning processes and outcomes through formative and summative assessments to measure cognitive, affective, and psychomotor competencies (Pylbour, 2015).

The primary purpose of formative assessment is to support and improve learning by assessing understanding and providing feedback (Van der Kleij et al., 2015). The process of assessment, feedback, and improvement is formative and purposeful. The term "assessment for learning" is often used for formative. In contrast, conventional assessment is used summatively after learning to earn points, grades, or rankings; to pass or fail; and as an extrinsic motivator. Applying formative assessment in learning is essential to assess learners' cognitive abilities, attitudes, and skills.

Several researchers (Doric et al., 2021; Pylbour, 2015) have pointed out the importance of formative assessment that can affect learners' cognitive aspects. Formative assessment is an essential aspect of learning, including continuous assessment and providing detailed information about learning achievement (Doric et al., 2021). In line with what Wagner and Vaterlaus said (Sofianto et al., 2016), formative assessment has several benefits, namely monitoring student learning, determining learning objectives and performance differences, and verifying students' cognitive abilities. The importance of implementing formative assessment is also stated by Plybour (2015), that formative assessment allows teachers to determine learners' understanding during learning. Empirical evidence from Black and Wiliam's literature review shows that using formative assessment, including some techniques, benefits all groups of learners, especially in helping learner performance (Stiggins, 2002). Some research evidence suggests that formative assessment can also be beneficial in developing learners' motivation and attitude toward learning (Ismail et al., 2022; Ganajová et al., 2021).

Based on the results of observations, facts in the field found that there still needs to be more teachers at various levels of education who conduct formative assessments during the learning process. The assessment that is often carried out only measures the final results of learning (summative assessment). Even if teachers give homework, the results are only checked and assessed without feedback. The teacher does not detect learners who have not understood the material during the learning process because the assessment is only applied at the end of learning. This fact is reinforced by an initial study conducted in the form of interviews with several science teachers in the field. The results of the study showed that only 25% of teachers conducted formative assessments in the form of quizzes and feedback. The implementation was not done in each basic competency but only occasionally in one semester. Then 25% of teachers provide formative assessment only in the form of assignments on each basic competency by providing feedback, and 75% of teachers provide assignments without feedback. Research results (Bulunuz et al., 2014) show a gap between learning and teaching in the classroom. The fundamental problem occurs when assessment is not integrated into the learning process and cannot improve students' conceptual understanding.

Therefore, by applying formative assessment in the science learning process, teachers can determine students' achievement in understanding concepts and overcome students' incomprehension in learning concepts (McCallum & Milner, 2021). Bransford et al. (1999) stated the importance of using various formative assessment techniques in learning because they have benefits, namely: (1) activate thinking and involve learners in learning, (2) challenge ideas and encourage learners' curiosity, (3) help learners in understanding concepts and argumentation, (4) encourage learners to ask questions and provide thoughtful responses, (5) help learners can apply scientific ideas to new situations, (6) help learners develop self assessment and peer assessment skills, (7) encourage continuous reflection in the learning process, and (8) evaluate the effectiveness of learning.

Some formative instrument assessment techniques that can be used in science learning (Keeley, 2016; Keeley et al., 2007) include: (1) Familiar Phenomenon Probes: two-level questions consisting of a selected response and a justification for the selected response to help learners elicit ideas about a familiar phenomenon; (2) Interest Scale: using a chart with a marked scale to lead learners to place Post-it notes on a low to large scale to indicate their level of interest in the topic being studied; (3) Friendly talk probes: two-level questions consisting of a selected response section followed by a justification, (4) Commit and toss: an anonymous technique used to speed-read different ideas that learners have in class; (5). A & D statements: learners use A & D statements to analyze a series of "fact or fiction" statements; (6) P-E-O probes (predict, explain, observe): present a phenomenon or situation that leads learners to make a prediction or select a prediction from a set of preferred responses that match their thinking; (7) Concept card mapping: build concept maps by leading learners to create linkages between concept cards that illustrate relationships between concepts; (8) Refutations: used to check learners' declarative and procedural knowledge; (9) Scienties' ideas comparison: learners are given a summary sheet of scientists' ideas related to the topic they have learned and compare with their ideas; (10) Thought experiment: provides an engaging way for learners to activate their thinking and apply their ideas in new situations; (11) Muddiest point: provides a metacognitive opportunity for learners to note the part of the lesson that is most difficult or confusing for them; and (12) I used to think . . . , but now I know: asking learners to compare orally or in writing their ideas at the beginning of the learning with the ideas they have after the learning. In this study, only 7 of the 12 techniques proposed by Keeley (2016) were discussed as developed by the trainees.

A participatory training model implements teachers' ability to design formative assessment instruments. This training model emphasizes the learning process during training. Learning activities in training are built based on the active participation of teachers in all aspects of training activities, from planning and implementing to assessing learning activities in training. Efforts made by trainers, in principle, are more emphasized on motivation and involving participant activities. This study aims to identify teachers' ability to design formative assessment instruments through the implementation of participatory training models and teachers' responses to training activities.

Methods

The method used was descriptive research with a quantitative approach through training with a participatory training model and intensive assistance in designing formative assessment instruments. The research subjects were 30 junior high school science teachers in Sumedang Regency. Data collection techniques used product assessment, observation sheets, and questionnaires to obtain data on the ability of teachers to design formative assessment instruments in science learning. The training materials include deepening the nature of science learning, science learning assessment, and formative assessment techniques. The implementation of the knowledge gained during the training was followed up by practical mentoring. The mentoring is carried out through a cyclical process, including the planning (plan), design (design), and reflection (see) stages. The planning stage was conducted through a discussion of formative assessment tools and refined through Focus Group Discussion (FGD). At the implementation stage, each science teacher designed formative assessment instruments in the classroom according to the subject schedule in their respective schools. Observers conducted observations of the implementation. Observations were conducted to determine the effectiveness of teacher learning and formative assessment instruments. Observations are more directed at the activities of formative assessment techniques used by teachers. The results of these observations were discussed at the reflection stage to make improvements. Teachers' responses to the strengthening and mentoring.

Implementing the participatory training model to develop formative assessment techniques was evaluated based on increased science teachers' knowledge and understanding of formative assessment techniques. Analysis was conducted on the product of science teachers' formative assessment instruments and science teachers' responses to the implementation of the participatory training model. The evaluation was conducted through FGD to formulate a follow-up policy for developing the quality of formative assessment instruments in the form of a science teacher competency improvement model that can be applied in all schools where science teachers are active in MGMP. Visually, the implementation flow of the participatory training model for formative assessment instruments for science teachers is presented in Figure 1.

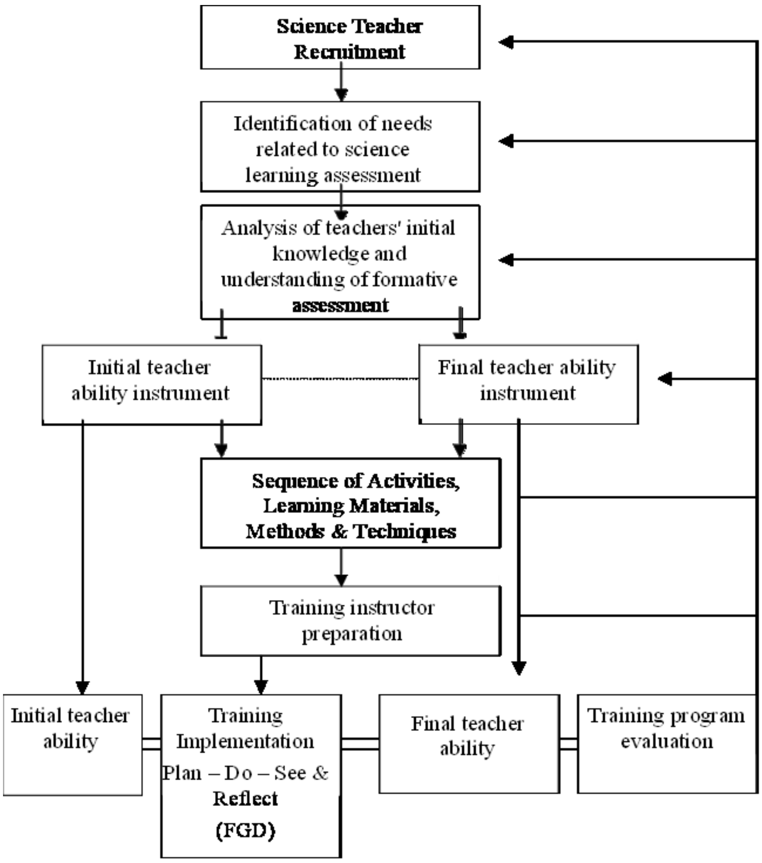

Figure 1. Flowchart of the implementation of the participatory training model of design formative instrument assessment

The data collection instruments in this study were formative assessment product sheets designed by science teachers and questionnaires of science teachers' responses to strengthening and mentoring activities for formative instrument assessments. The assessment rubric uses analytic scoring that can pinpoint areas of weakness and provide meaningful feedback. Data analysis techniques include data reduction, presentation, and conclusion drawing. Data analysis on the ability of teachers to design formative instrument assessments was carried out by converting the scores obtained into value intervals and categories, as shown in Table 1.

Table 1. Categories of Ability to Design Formative instrument Assessments

Value Interval	Kategori
90 < value ≤ 100	Very Good
80 < value ≤ 90	Good
70 < value ≤ 80	Fair
60 < value ≤ 70	Deficient
value ≤ 60	Very Poor

Data analysis of teachers' responses to the strengthening and mentoring activities for formative instrument assessment was processed as percentages. The percentage value of teacher responses was determined using equation 1.

$$PR(\%) = \frac{JSR}{SI} X\ 100\% \qquad (1)$$

PR (%) is the percentage value of the response, and JSR is the number of scores/average of teachers giving responses. SI is the ideal score or maximum score in response. To interpret the percentage of teacher responses, criteria were used, as shown in Table 2.

Table 2. Percentage Categories of Respondents' Responses

Percentage	Criteria
≤80 - 100	Very Good
≤ 60 - < 80	Good
≤ 40 - < 60	Fair
≤ 20 - < 40	Deficient
0 - < 20	Very Poor

(Source: Riduwan, 2018)

Results and Discussion

Science Teachers' Ability to Design Formative instrument Assessments

The results of data analysis before the implementation of strengthening and mentoring become the basis for recommendations for strengthening and mentoring activities related to the ability to design formative instrument assessments for science teachers. After the strengthening and mentoring activities took place, data on the ability of teachers to design formative instrument assessments and teacher responses to the implementation of strengthening and mentoring were obtained. The results of the analysis of the ability of science teachers to design formative instrument assessments based on the of formative instrument assessment design products are presented in Table 3.

Table 3. Science teachers' ability to design formative instrument assessments

Value Interval	Frequency	Percentage	Category
90 < value ≤ 100	7	23,3	Very Good
80 < value ≤ 90	23	76,7	Good
Total	30	100	
Average Value	88,2		Good

Table 3 shows that the average score of the ability of science teachers to design formative instrument assessments in total is 88.2, with a good category. This acquisition shows that, in general, teachers can have good abilities in designing formative instrument assessments integrated into science learning. This finding is in line with the results of research (Furtak et al., 2016) on the ability of science teachers to design, implement, and reflect on formative assessment in the science teacher learning community in schools, which shows that on average, the ability of teachers to improve on four abilities, namely designing formative assessment tasks, asking questions to get students thinking, interpreting students' ideas, and providing feedback that advances students' thinking after the research (Atmaja et al., 2021).

Formative assessment positively impacts learners' academic performance and the professional development of science teachers (Sabel et al., 2016). Various formative instrument assessment techniques designed by teachers and integrated into science learning through strengthening and mentoring activities are: (1) familiar phenomenon probes, (2) interest scale, (3) commit and toss, (4) p-e-o probes (predict, explain, observe), (5) refutations, (6) thought experiment, and (7) muddiest point. The results of the analysis of the ability of science teachers to design formative instrument assessments based on various assessment techniques are presented in Figure 2.

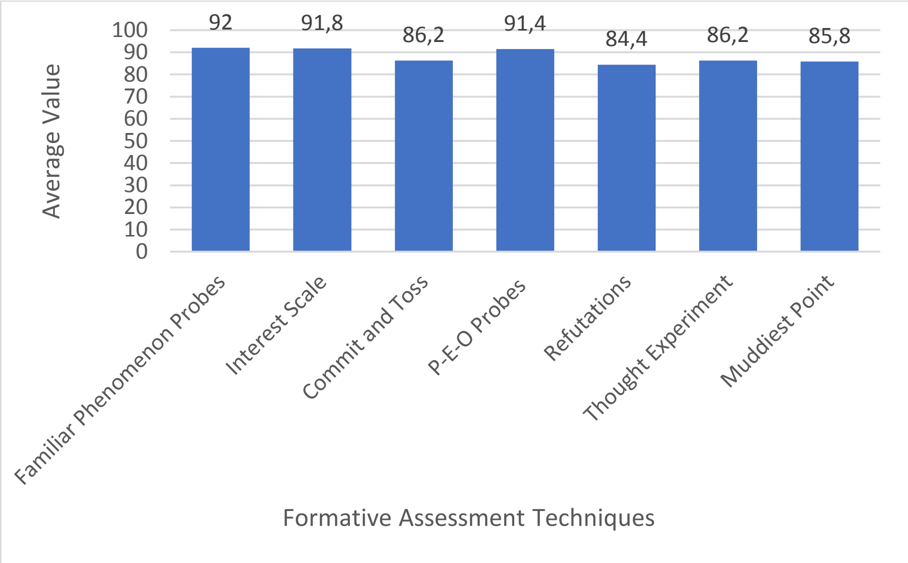

Figure 2. Teachers' ability to design various formative assessment techniques

Based on Figure 1, it is known that the achievement of ability of science teachers in designing formative assessment instruments made is categorized as very good in the familiar phenomenon probes, interest scale, and p-e-o probes techniques and is categorized as good in the commit and toss technique, probes (predict, explain, observe), refutations, thought experiment, and muddiest. The highest achievement was in the Familiar Phenomenon Probes technique with an excellent category, and the lowest was in the Refutations technique with a good category. These results show that teachers can design formative assessment instrument techniques that are integrated into science learning well. The highest achievement of science teachers' ability to design formative instrument assessments in the Familiar Phenomenon Probes technique with a very good category indicates that teachers have been able to apply knowledge of real contexts/situations (real work situations) that are following the real lives of students. The formative instrument assessment design is authentic, with enough information/data for learners to apply their knowledge and initiate ideas. Keeley (2011) reveals that presenting phenomena relevant to science concepts in each scientific investigation on formative assessments will provide insight into learners' thinking and preconceived ideas. Scientific inquiry helps learners clarify the content being discussed and builds an understanding of learners' general ideas in science.

The achievement of science teachers' ability to design formative instrument assessments is lowest in the Refutations technique but still in the excellent category. This achievement indicates that teachers still have difficulty developing the Refutations type formative assessment technique because it requires evidence and justification. In argumentation, a refutation is a reason against a premise, argument, or conclusion. A refutation is an argument with the purpose of questioning. Refutation can effectively correct false ideas, even for strongly supported misconceptions (Ferrero et al., 2020).

Teachers' Responses to Strengthening and Mentoring Activities on Formative instrument Assessment

The teacher response data analyzed included responses to (1) material coverage, (2) material depth, (3) material sequence, (4) time allocation, (5) material adequacy, (6) service quality, and (7) material application. The results of the data analysis of teachers' responses to the strengthening and mentoring activities for formative instrument assessment are generally presented in Figure 3.

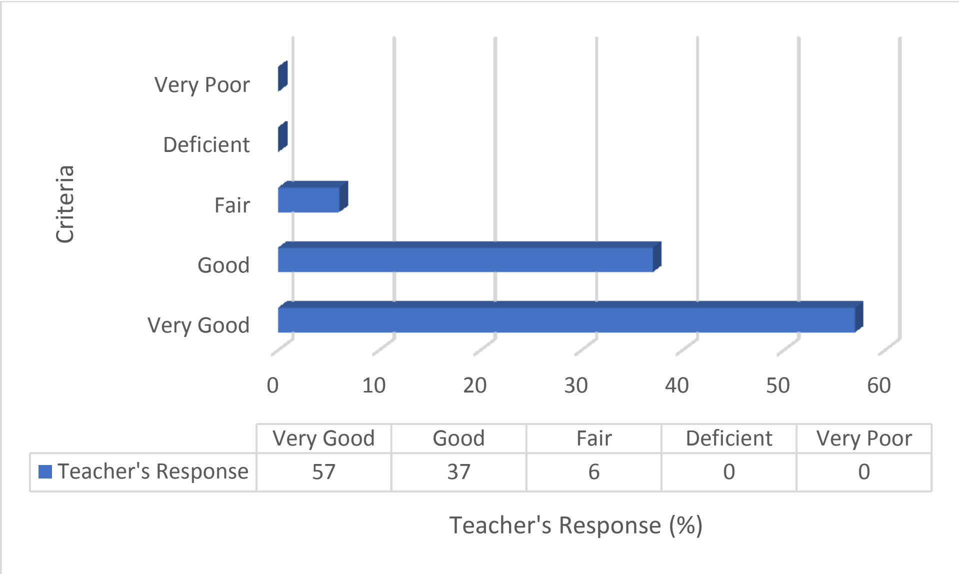

Figure 3. Teacher responses to formative instrument assessment strengthening and mentoring activities

Based on Figure 3, it is known that 57% of teachers gave very good and 37% good responses to the application of participatory training models that can train the ability to design formative assessment instruments. Good reactions from teachers indicate that the training conducted has been able to help teachers overcome difficulties in creating formative assessment instruments while fostering creativity and creative thinking in developing formative assessment instruments (Sari et al., 2020). Some teacher responses after attending the training on making formative assessment instruments include: (1) the materials and instruments are complete, (2) they provide valuable information, (3) the materials are explicit, engaging, and significantly related to the application of science learning in schools, (4) the order of the materials is correct and sequential, (5) the time allocation is perfect, (6) it is very constructive for teachers in developing formative assessments that are integrated into science learning, (7) the material is in-depth, and the sequence is systematic, (8) the discussion of the material is excellent, (9) the material is broader and follows the development of the curriculum, (10) the presentation of examples is more motivating and inspiring for participants in applying the material in daily learning, (11) the quality of service is very good, and (12) more often hold science training.

Science teachers' development of formative assessment varied regarding time, follow-up, and teaching practices. Teachers' implementation of formative assessment in the classroom can support students to reflect on inquiry during learning, discuss concepts, and provide time for further exploration or explicit modeling of science skills (Earle, 2021). Formative assessment provides feedback to improve student performance by matching learning objectives and learning practices. The results of the study (Kariri et al., 2022) showed that science teachers who use formative assessment techniques need more preparation in developing instruments. Research conducted by Siswaningsih et al. (2020) on applying formative assessment using feedback clues in science learning shows that most students can do self-assessment well. Students feel satisfied and benefit from the feedback provided by using the self-assessment rubric. The development of formative assessment instruments can help teachers provide feedback to students.

Conclusion

Teachers' ability to design formative assessment instruments by applying the participatory training model is overall categorized as good. Teachers can create various productive assessment instrument techniques, such as familiar phenomenon probes, interest scale, commit and toss, p-e-o probes (predict, explain, observe), refutations, thought experiments, and muddiest points, which are integrated into science learning. Teachers' responses to applying the participatory training model of formative assessment instruments are excellent.

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