Formative Assessment on Science Learning to Improve the Quality of Learning in Curriculum Merdeka

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Abstract: Formative assessment is a learning assessment whose target is formative and aims to evaluate the learning process. In reality, there are still many teachers who have not implemented formative assessment optimally in science learning. Formative assessments conducted in the middle, end, or throughout learning aim to determine student progress while providing quick feedback to teachers, for example regarding student understanding of the material. This study aims to find out the things that educators need to prepare and how they carry it out. The research method used a descriptive method with a qualitative approach, through distributing questionnaires and interviews. The target respondents were elementary school teachers who teach grade VI students. The data that has been collected is then processed using a Likert scale. The results showed that what needs to be prepared by teachers to conduct formative assessment in science subjects is a clear understanding of concepts, and prepare the three stages of formative assessment carefully. Based on the results of the questionnaire, teachers are still not optimal in the information-gathering and action-taking stages. Ways that can be done to implement formative assessment in improving the quality of learning, can be started from the preparation of the right learning module.

Keywords: Curriculum merdeka; Elementary school; Formative assessment; Learning assessment; Learning modules

Introduction

Merdeka Curriculum is a curriculum with diverse intracurricular learning so that students have the opportunity to explore concepts and strengthen competencies more optimally. In this curriculum, teachers have the flexibility to choose teaching tools tailored to the learning needs and interests of students. Broadly speaking, the Merdeka Curriculum provides flexibility for educators to create quality learning that suits the needs and learning environment of students. The curriculum, which is expected to be a solution to the complicated problems of education in Indonesia provides challenges for elementary school residents. One of the challenges faced is that educators are still confused about finding references to develop student's talents and characters, which requires a lot of time (Barr,

2018). This can take a long time, making teachers confused because they are behind in the material. Moreover, teachers find it difficult to implement the learning evaluation function as an integral part of learning.

Learning assessment is an important component that schools often overlook in achieving curriculum goals. The type of assessment that can be used in an independent learning curriculum is formative assessment. Formative assessment is a learning assessment that targets formative and aims to monitor, develop, and evaluate learning processes and learning outcomes (Schildkamp et al., 2020). Through this assessment, regular and continuous feedback can also be obtained (Ismail et al., 2022). In the independent curriculum, formative assessment can be carried out at the beginning of learning, mid-learning, end of learning,

or throughout the learning process (Andersson & Palm, 2017). The assessment conducted at the beginning of learning aims to provide information to teachers about students' readiness to learn the subject matter and their readiness to achieve learning objectives. The results of this assessment are not reported in the report card. Meanwhile, formative assessments conducted in the middle, end, or throughout learning aim to determine student progress while providing quick feedback to teachers, for example regarding student understanding of the material (Adinda et al., 2021).

Natural Sciences (IPA) or science is one of the subjects that must be studied in elementary school. The definition of science according to Anharuddin et al. (2023), is 'science (IPA) is rational and objective knowledge about the universe and its contents'. Based on this statement, it is explained that science learning prioritizes a learning process. In short, science learning is the study of living things, and non-living things, and the relationship between the two. Scientific explanations in learning still tend to reveal concepts to students. One solution to overcome this problem is to apply formative assessment in science learning (Pals et al., 2023). Formative assessment can be used to measure student learning outcomes. As for science learning, it emphasizes the delivery of science concepts and the presentation of the application of concepts to everyday life problems (Darling-Hammond et al., 2020). This also refers to the objectives of learning science in elementary school, namely developing curiosity and a positive attitude towards science, technology, and society, developing process skills to investigate the surrounding nature, solve problems and make decisions, developing knowledge and understanding of science concepts that will be useful and can be applied in everyday life.

The benefits of formative assessment for students are evaluating independent learning performance, building knowledge, identifying personal weaknesses and strengths during the learning process, and improving abilities (Xu et al., 2023). This assessment can make students value the learning process more than just focusing on results (Leite et al., 2022). For teachers, this assessment has several uses, namely as a means of monitoring student learning, ensuring student progress, and checking the extent of student understanding during teaching and learning. Therefore, formative assessment can estimate the success of the learning program given to students and facilitate teachers in planning learning topics. In fact, according to the Ministry of Education and Culture's Learning and Assessment Guidelines, formative assessment is prioritized over summative assessment. This is because formative assessment focuses more on the development of student competencies rather than the final result. Teachers must recognize formative assessment as a

separate activity from summative assessment and integrate it into regular classroom instruction and student involvement, to fully utilize it (Broadbent et al., 2018).

Even the effectiveness of formative assessment to improve learning quality has been widely reviewed in international research. According to Chen et al. (2020), formative assessment can provide students with opportunities to develop SRL (Self Regulated Learning) in each individual. Kuo et al. (2023) added, students' learning ability increases through 3 phases, namely forward-thinking, performance or volitional control, and self-reflection. Each of these phases can be passed with formative assessment as a definite means. In the research of Yusop et al. (2022), it was found that the formative assessment carried out on Optical Equipment material with the integration of the science approach gave positive results in improving student learning outcomes. The concept understanding of experimental class students has an average score of 77.22 and the control class is 67.50. This means that the average value of the experimental class is greater than the control class. In addition, the use of portfolios by elementary school students helps them estimate their abilities during learning, while teacher support for students such as scaffolding helps skill strategy planning and self-reflection (Dominguez & Svihla, 2023).

Facts in the field, there are still many teachers who have not implemented formative assessment optimally in the learning process. This also happens in science subjects where the teacher should invite students to practice the theory, but only convey material through lectures and end with giving questions, such as conventional methods. According to Näsström et al. (2021), some of the reasons why teachers do not use formative assessment are the lack of study time to produce products that suit students' learning needs, lagging behind material because they only focus on student abilities, lack of materials to make innovations, and teacher readiness in facing an independent curriculum. Many strategies can be used to implement formative assessment, so there is no reason for teachers to lack time to learn or materials to create.

Some examples of strategies that are easy to do include quizzes, student self-assessments, and student presentations. In addition, formative assessment conducted by teachers sometimes does not refer to learning objectives. According to the observation of Reynders et al. (2020), the preparation of assessment rubrics to measure skill aspects has not referred to learning objectives. Often teachers are still misperceived when adopting the concept of formative assessment in science subjects. This is evidenced through research by Muslim et al. (2023) that only 56% of elementary, junior high, and high school teachers in Wonosobo understand

the concept of formative assessment. In addition, some teachers even feel reluctant to conduct formative assessments due to the large number of students and limited tools. According to Fischer et al. (2024), formative assessment is not a tool to determine student learning outcomes, but a practice that is closer to approaches and strategies with a wider range of processes. Formative assessment is also useful to clarify the learning objectives that have been designed by educators (Van Der Steen et al., 2023). The implementation of formative assessment often only focuses on measuring knowledge (cognitive aspects), and neglects affective and psychomotor aspects, as the three aspects should run in balance. Therefore, formative assessment can be a fundamental process that needs to be implemented continuously during learning to improve skills for the achievement of educational goals and objectives. Research Objectives to implement science formative assessment in independent curriculum; how to implement science formative assessment to improve the quality of learning in independent curriculum.

Method

Research Design

The research method used is a descriptive method with a qualitative approach. Descriptive research is conducted to describe a situation systematically, factually, and accurately about certain phenomena. Furthermore, the selection of a qualitative approach is useful to produce a study of the phenomenon that is more comprehensive, and the results of this study cannot be generalized. In addition, primary data will be collected through a survey method using an instrument in the form of a questionnaire for each respondent. The questionnaire aims to find out the form of formative assessment implementation that has been carried out by teachers, and the feedback provided. The respondents selected were determined through the quota sampling technique. Quota sampling is a technique for determining a sample from a population that has certain characteristics until the desired number (quota).

Respondent

The respondents in this study were public primary school teachers in Surakarta City. The respondents consisted of 30 teachers who taught grade VI. Teachers who teach grade VI are believed to have more teaching hours and have faced a variety of diverse student characters, so it is hoped that the questionnaire results can be in-depth.

Data Collection

The research was conducted in several public primary schools in Surakarta until the predetermined number of respondents (30 people) was obtained. Questionnaires were only distributed to grade VI teachers according to the initial planning. The question model compiled in the questionnaire refers to several aspects in the form of 3 stages of formative assessment, namely information collection, information interpretation, and, taking action. The stages of formative assessment are used as a reference in the preparation of the instrument so that the results of distributing questionnaires can factually represent teacher performance when implementing formative assessment. The answer to each item is described according to 5 alternative answers with a Likert scale, namely always, often, sometimes, rarely, never. The questionnaire was distributed digitally through Google Forms. Google Forms helps researchers to obtain data practically and flexibly for both parties (researchers and respondents). Another advantage, progress and temporary quick count can be seen every time automatically through the response menu.

Data Analysis

The questionnaire data was analyzed using 2 types of analysis, namely Likert scale analysis and content analysis. In Likert scale analysis, the first step is to determine the score of the answer given by the respondent. The scores used in this questionnaire are Always (5), Often (4), Sometimes (3), Rarely (2), Never (1). Next, calculate the ideal score (criterion) of all items with the formula:

Criterion Score = Scale Value x Amount of Respondents

The last stage of the Likert scale analysis is the percentage value of approval, to find out the number of answers from respondents through the following formula:

$$P = \frac{f}{n}100\%$$

(1)

Description:
P   = Percentage
F   = Frequency of each questionnaire response
N   = Total ideal score
100 = Fixed number

Furthermore, the results of the questions for each aspect were processed using content analysis, to facilitate concluding. Content analysis is a scientific technique that uses documents and texts to infer the phenomenon under study (Bengtsson, 2016). This

technique is carried out with interpretation through the following scale:

Table 1. Category Conversion based on Percentage

Percentage (%)	Category
0-25	Very Low
26-50	Low
51-75	High
76-100	Very High

Validity and Reliability

The validity test in this study used Pearson correlation. This test is done by calculating the correlation between the values obtained from each question. Pearson correlation obtained has a significance value <0.05, then the data obtained is valid, if the sig value. > 0.05 then the data obtained is invalid. The instrument reliability test is carried out by looking at Cronbach's alpha. The variable can be said to be reliable if the Cronbach's alpha value is> 0.70 (Erlinawati & Muslimah, 2021). Reliable instruments are not necessarily valid and valid instruments are not necessarily reliable, so instrument reliability is a requirement for testing instrument validity. The validity test results showed that 30 instrument items were declared valid with Pearson correlation values having sig <0.05. The instrument was also declared reliable with a Cronbach's alpha value of 0.888 (>0.70). Through the calculation of the test results, it can be seen that the instrument used to collect data related to the implementation of formative assessment by elementary school teachers can be distributed.

Result and Discussion

Implementation of Formative Assessment in Science According to Questionnaire Results

Teachers conducting formative assessments often ignore the steps as guidelines for conducting assessments. Teachers are more likely to focus on the selection of instruments, so it is easy to feel confused to develop their creativity. Formative assessment is not just a tool to determine student learning outcomes, but a practice that is closer to approaches and strategies with a wider range of processes (Monteiro et al., 2021). Even in the guidebook, some references can make it easier for teachers to follow formative assessment. One of the basic guidelines is that the stages of formative assessment according to Wang (2023), consist of collecting information, processing and interpreting information, and taking action.

The questionnaire that has been distributed contains these 3 stages as indicators of instrument items. Each indicator is represented by 10 positive statements, with a range of answers according to the Likert scale. The results of the questionnaire distribution show the success rate of each indicator, namely information collection (68.80%), information processing and interpretation (73.30%), and taking action (72.50%). Through these percentages, it can be seen that teachers have carried out formative assessments quite well but not maximized. Moreover, the information collection indicator is still below 70%, while this stage is the first step to conducting formative assessment.
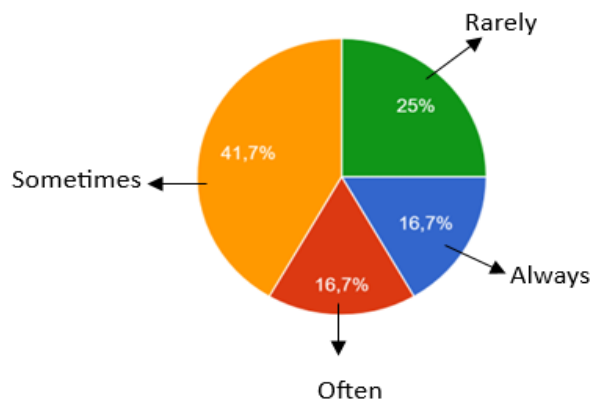

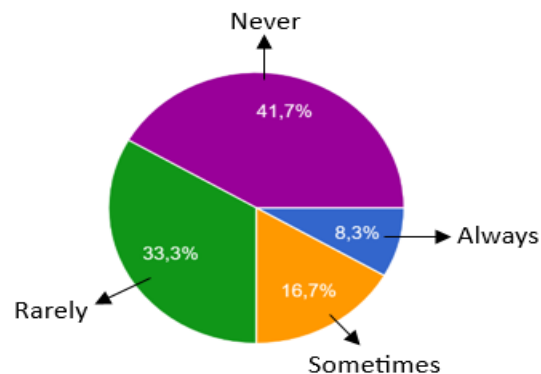**Figure 1.** Percentage of teachers taking the pre-test

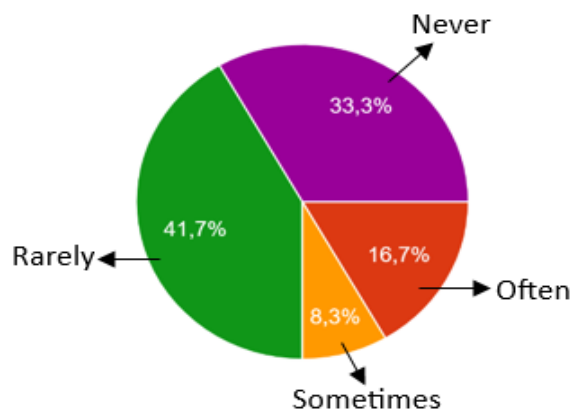**Figure 2.** Percentage of teachers preparing self- and peer-assessment sheets

Figure 3. Percentage of teachers who direct students to make concept maps

In the information gathering indicator, there are 4 things that teachers have not fully implemented. The four things include: conducting a pre-test for students, using tools during observation, compiling self-assessment sheets and peer assessment sheets, and directing students to make concept maps. The reality in the field is that teachers are still inconsistent in conducting pre-tests to determine the extent of student's mastery of concepts. This can be seen in the results of the questionnaire, which stated that 41.70% of respondents did the pre-test only sometimes. The rest rarely do it, and a small proportion have often carried it out (Figure 1). Teachers also rarely (33.30%) design self-assessment sheets and peer assessment sheets to help learners evaluate themselves and their classmates, and most never do so (Figure 2). Teachers should prepare the sheet to involve students in the process of assessing themselves and others as a means of practicing assessment.

According to Hansen et al. (2018), formative assessment is not only a measure of student mastery, but it will be more meaningful if the results of the assessment can be used by students to reflect on themselves. Based on the total number of respondents (30), there was only 1 respondent (8.30%) who always compiled the assessment sheet. The last point that is still less than optimal is the teacher's direction to ask students to make concept maps at the end of the lesson. Concept maps are a form of formative assessment in the form of visual representation. The work of students' concept maps can illustrate the level of understanding of the material, and encourage students to always listen to the teacher (Astiantih & Akfan, 2023). This is also supported by the research of Maker et al. (2020) Concept maps can act as indicators of learning quality and student thinking levels. Facts in the field, the percentage of teachers who often carry out is 16.70%, while 41.70% still rarely do (Figure 3).

The second indicator, namely information interpretation, based on the results of the questionnaire, 3 things have not been achieved optimally, namely: teachers process student development data digitally, teachers present the results of data processing in the form of graphs, teachers conclude the results of the assessment in descriptive form with students. After teachers get student development data, it turns out that not all teacher's process the data digitally. As many as 30.80% of respondents still sometimes do it, there are 23.1% who rarely do it, and teachers who often process only 23.10% (Figure 4). Data processing is a basic step for data interpretation. Data processing will also be more accurate if done formally with a structured method through the help of digital instruments (Chirumalla, 2021). Educators still carry out data processing with spontaneity according to their understanding.

Furthermore, teachers also rarely (50%) present the results of data processing in the form of graphs or tables (Figure 5). Although some have done it often (16.70%) and always (8.30%).
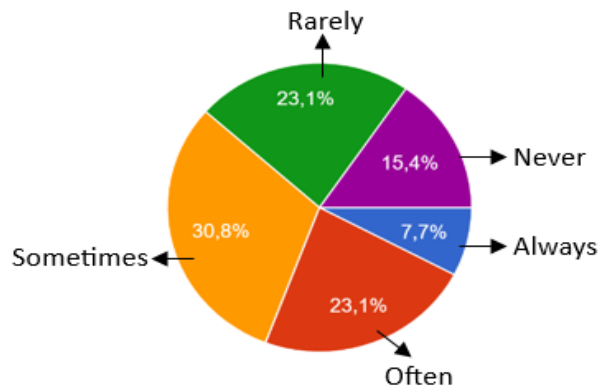

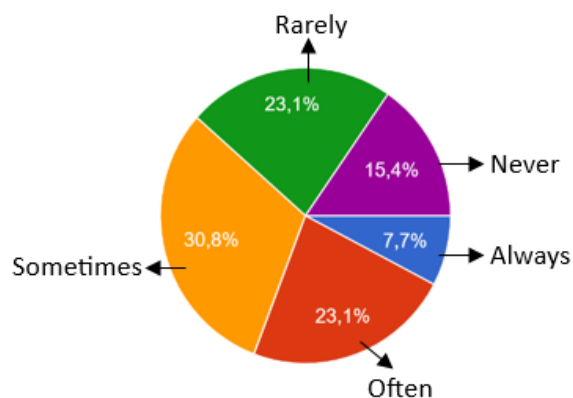**Figure 4.** Percentage of teachers processing student development data digitally

Figure 5. Percentage of teachers presenting data processing results
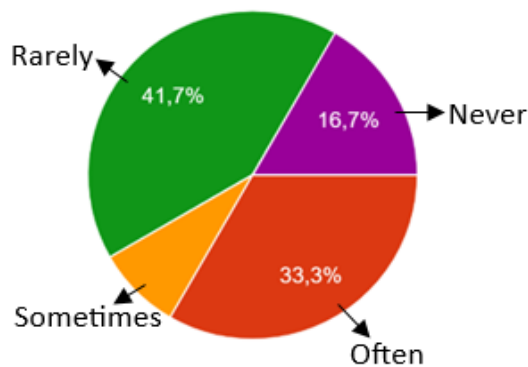

Figure 6. Percentage of teachers summarizing assessment results with students

Presenting data in tabular form is useful for simplifying the presentation of data so that it becomes easier to read and understand as information material. In addition, the number of students in 1 class can be more than 20 people so that the amount of data will be more effective and efficient when presented in the form

of graphs or tables. Educators must master the technique of processing assessment results, to measure student achievement so that later the teacher can find out how far the quality of student mastery of the material is and give its meaning to the results of the learning process. (Amaliyah et al., 2022). The assessment results that have been processed by teachers are rarely (41.70%) concluded together with students to find out specifically the location of the material that students have not mastered and the causes (Figure 6). According to Yan et al. (2022), concluding with students on learning outcomes is not only able to direct students to find out weaknesses and strengths but there is communication that is built. This will make it easier to achieve goals because educational goals will be achieved if the process is communicative (Brinia et al., 2022).

The last indicator is taking action, 4 things have not been fulfilled optimally by educators. These four things include: teachers redesigning the formative assessments used, conducting learning evaluation dialogs with students, tabulating the results of students' progress, and designing tabulation results in the form of mapping. When the assessment results are deemed unsatisfactory, teachers do not always make improvements by designing the formative assessments used. Based on the questionnaire results, 41.70% of teachers sometimes do it 33.30% rarely do it, and even 16.75 never do it (Figure 7). However, there is a possibility that the assessment results are not maximized due to the form of formative assessment that is not on target. This makes students feel difficult and less able to follow. Teachers also rarely (58.30%) dialogue with students to discuss the evaluation of the results of each individual's assessment progress (Figure 8). Dialogue is a way to build closeness and good relationships between teachers and students. Dialogue is also a form of feedback that can be done by teachers so that there is openness and a means of reaching solutions.

Through dialog regarding the evaluation, it is an opportunity for teachers and students to introspect themselves so that the actions that need to be taken are more focused. According to research by Khong et al. (2023), providing feedback has a significant effect on increasing student grades even though some students still do not reach the KKM. Positive feedback will also increase student motivation and learning achievement. Before conducting an evaluation, teachers should tabulate the results of students' progress to review more clearly where errors need to be corrected. However, the facts in the field show that 50% of respondents only tabulate data sometimes (Figure 9). Furthermore, from the tabulation results, it is also rare (41.70%) to find teachers redesigning in the form of mapping (Figure 10). Data mapping has the benefit of knowing quantitatively the results of students' level of understanding. In

addition, data mapping is useful for revealing concept errors and as an evaluation tool (Alic et al., 2022).
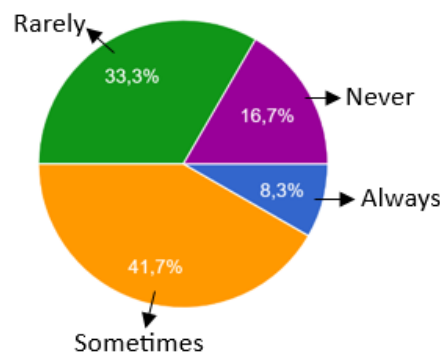

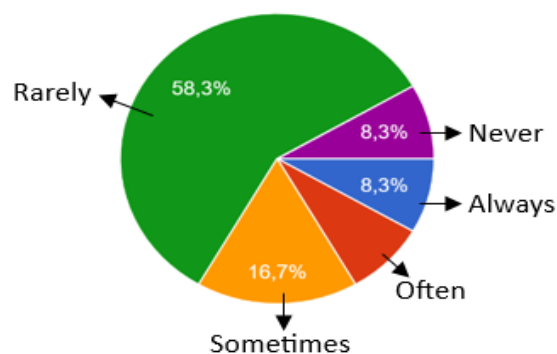**Figure 7.** Percentage of teachers redesigning formative assessments

Figure 8. Percentage of teachers conducting learning evaluation dialogues with students
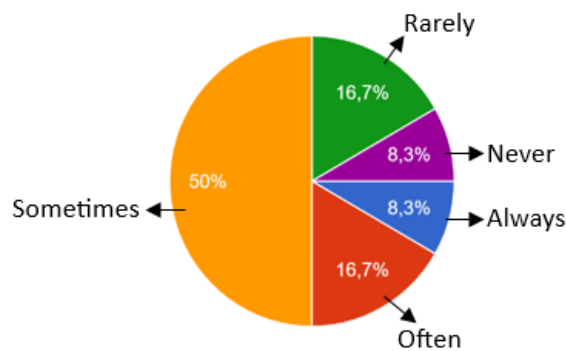

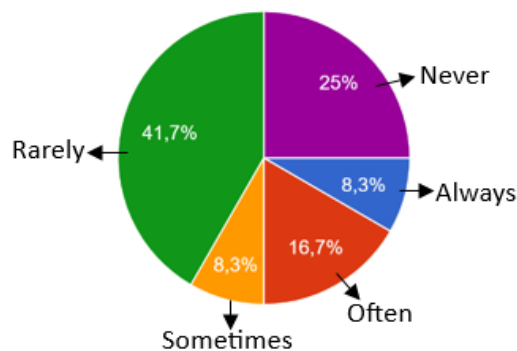**Figure 9.** Percentage of teachers tabulating student progress results

Figure 10. Percentage of teachers mapping the tabulation results

Based on interviews with teachers, in addition to the above problems, the assessment steps taken are still inappropriate. For example, the formative assessment instrument used does not correlate with the learning objectives. Meanwhile, formative assessment aims to see whether the learning process can lead students to achieve learning objectives. Teachers mostly carry out formative assessments with written instruments, such as quizzes, multiple choice, and essays, while not all learning objectives can be achieved with this. Learning objectives that want students to be able to analyze an object are more appropriate when done practically such as presentations. Presentations not only teach courage to students but students are also taught to be accountable for information written on a piece of paper in front of friends and teachers. The presentation method has a positive impact on the level of student participation and learning outcomes have improved well.

Assessment based on paper only encourages children's cognitive aspects but does not train psychomotor and affective aspects. Furthermore, the instrument indicators set by the teacher are also not by the learning objectives. This needs to be improved by redesigning the assessment, which in reality is still rarely done by educators. According to Swiecki et al. (2022) Many of the assessments used today do not match what students need and are contrary to how the brain works. This results in a less meaningful learning process. Redesigning learning assessments by the objectives is also one of the stages to achieve deep understanding. In addition, not every teacher prepares an assessment rubric as a basis for processing the information that has been collected. Many teachers think that assessment rubrics are the same as scoring guidelines, so teachers only make scoring guidelines. An assessment rubric is a more comprehensive tool. It does not only contain assessment scores but can measure student performance based on specific descriptions that describe student abilities in an aspect.

Implementation of Formative Assessment in Science Based on Learning Modules

The quality of the implementation of formative assessment carried out by elementary school teachers can be seen through the content of the teaching module. Teaching modules are teaching materials that are systematically arranged into a single unit of learning material with language that is easy to understand and to be studied by students independently or with the guidance of educators. Teaching module components consist of at least learning objectives, learning activities, and assessment plans. Teachers are also given the freedom to develop components in teaching modules according to the learning context and student needs. A quality teaching module for formative assessment

should be relevant, contextual, and challenging. This means that the teaching module is related to the context of learning outcomes and knowledge, and fosters students' interest in learning actively in the learning process (Harris & Clayton, 2019). The figure below is an example of a form of formative assessment in the form of a self-assessment sheet in the teaching module for Natural Science Subjects with Plant Breeding material (Figure 11).

The self-assessment sheet used is less relevant to the material being taught because it is still general. Each assessment point listed does not encourage students to evaluate their performance when learning the material. Especially in points 9, 10, and 11 which have nothing to do with plant breeding material. It is a must that every school student respects and appreciates their teachers and parents. Therefore, these two points are not crucial things that can encourage students to fulfill learning competencies. Yan et al. (2023), argue that there is a positive relationship between student learning outcomes and self-assessment because self-assessment contributes to habits of mind, one of which is critical thinking. This kind of self-assessment sheet cannot be used by educators to identify students' strengths and weaknesses. Self-assessment not only assesses attitudes, but the development of mastery of knowledge, and skills. According to Power et al. (2023), self-assessment and peer assessment are important attributes of formative assessment. Appropriately, the assessment sheet contains statement points related to students' ability to distinguish between vegetative and generative plant reproduction and their processes.

Figure 11. Example of teaching module 1

A comprehensive teaching module should contain an assessment grid. The assessment grid is the basic framework used for the preparation of questions in evaluating the education and learning process. It is also useful so that the items designed do not deviate from the topic of discussion. The following is an example of a

quality teaching module, seen from the suitability of the form of assessment with learning objectives, and equipped with an assessment grid (Figure 12). The teaching module is related to the material of the Five Human Senses. Broadly speaking, in the learning objectives, students are expected to be able to mention body parts and their respective functions. The teacher has prepared an assessment grid that contains indicators of each learning objective, complete with the form of the questions. Each question presented has clear instructions and is accompanied by additional information so that students do not just automatically choose the answer question. Teaching modules with this form are an appropriate implementation of formative assessment to encourage students to better understand the material rather than just memorize the material. Through the quality of student answers later, the teacher will know specifically where the weaknesses of each student are. Petropoulos et al. (2022) added, a question grid that is carefully and conceptually made will guarantee that teachers can measure student mastery of learning in a relevant and representative manner.

Figure 12. Teaching module example 2

It is also not uncommon for teachers to design questions for formative assessment in the form of multiple choice, as listed in the module below (Figure 13). The module is a 4th-grade elementary school module with material on Written and Unwritten Rules. In the exam questions, 2 questions review a villager's activity about unwritten regulations and find the benefits of regulations from the picture presented. The questions presented to students are not thoroughly related to the learning objectives. Students are expected to be able to categorize forms of written and unwritten rules and conclude the impact of violations. This form of assessment does not encourage students to think critically, because in multiple-choice questions the correct answer is obvious. According to the results of Murphy et al. (2023), the use of essay formative tests in the learning process can provide higher learning

outcomes than the use of multiple choice formative tests, especially for students with low learning independence.

Students are taught from an early age that the most appropriate answer is the one with a positive connotation. Of the four answer choices, a, b, c, and d usually 1 of them has a positive connotation, thus leading students to choose that point. This makes students only guess the answer without experiencing a long thinking process (Mundelsee & Jurkowski, 2021). In addition, the form of multiple choice questions is more appropriate for summative assessment, not formative. Multiple-choice questions are a form of objective test for which answers have been provided and are usually used to measure students' abilities about knowledge and definitions (Mahdi, 2024). Therefore, this form of question is more suitable for carrying out summative assessment as an evaluation at the end of learning that can measure learning achievement by students.
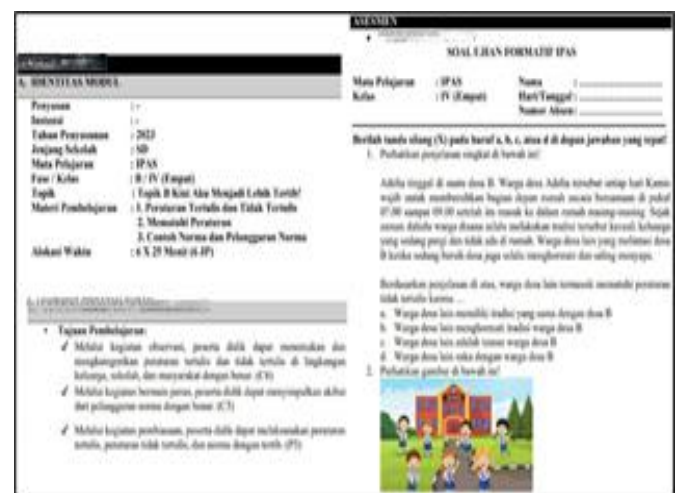

Figure 13. Example of teaching module 3

Conclusion

What need to be prepared by teachers to conduct formative assessment is a clear understanding of the concept and careful preparation of the three stages of formative assessment. The three stages consist of collecting information, processing and interpreting information, and taking action. Based on the results of the study, teachers are still not optimal in the information-gathering and action-taking stages. In the information-gathering stage, it can be seen that teachers only occasionally conduct pre-tests, most teachers never compile self-assessment sheets, and teachers rarely direct students to make concept maps. At the action-taking stage, teachers do not consistently redesign formative assessments, teachers rarely conduct evaluation dialogs with students, teachers only sometimes tabulate the results of student progress, and rarely map the tabulated results. Feedback is also an

important process in the implementation of assessment. Science subjects that emphasize the scientific method to solve problems around, them should be assessed in the form of practicum more improved. Students not only master the theory but can also be applied in real terms to master the field of science taught. Ways that can be done to implement formative assessment of science in improving the quality of learning, can be started from the preparation of the right teaching module. Teaching modules must be tailored to the learning objectives that have been set. Important components in it such as items and self-assessment sheets in reality are still often wrong. These components should contain crucial things to encourage students to meet learning competencies. Therefore, an assessment grid is needed as a basic framework for preparing questions. Through this assessment, it is hoped that student reasoning in the field of science can be trained and spur rational thinking.

Conflicts of Interest
The authors declare no conflict of interest.

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