MICESHI Proceeding
Available online at: https://ojs.unimal.ac.id/mijeshi/MICESHI
Vol. 1, No. 1, Januari 2024

LITERATURE STUDY: DYNAMIC ASSESSMENT IN MATHEMATICS

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ABSTRACT
The aim of this paper is to collect sufficient information about dynamic assessment in mathematics. The method in this paper is a literature study that collects several studies or writings to answer dynamic assessment in mathematics. Mathematics Dynamic Assessment (MDA) is a method teachers can use to help students understand mathematics practically and flexibly applied in the mathematics curriculum. MDA integrates four research-effective assessment approaches in mathematics: 1) Determining student interests for the purpose of embedding instruction in meaningful and authentic contexts: 2) CRA assessment, 3) error pattern analysis, and 4) flexible mathematics interviewing. Four features of MDA: Interaction: Dynamic assessment often involves face-to-face interaction between students and teachers; Assessors offer support and assistance to help students solve math problems. Feedback: During dynamic assessment, students receive immediate feedback on their answers or help students understand mistakes and learn from their mistakes. Adaptability: Dynamic assessment can be adapted to students' skills to help understand certain concepts so as to provide support and motivation. Problem Solving Ability: Dynamic assessments often focus on students' ability to solve problems rather than simply evaluating their mathematical abilities.

Keywords: Mathematica, Dynamic Assessment, Mathematics

1. INTRODUCTION

Mathematics is an important discipline in education, and a deep understanding of mathematical concepts is the key to student success in this field. Assessment is an integral part of the educational process, and in recent years, there has been increasing attention to more dynamic approaches to assessment in mathematics. Dynamic assessment is an approach that aims to better understand students' progress in mathematics, rather than simply measuring their ability to memorize facts or answer test questions. This assessment involves continuous observation of students' thinking processes, the use of formative feedback, and an emphasis on conceptual understanding and problem-solving abilities.

According to Bavali, M., Yamini, M., & Sadighi, F (2011) that *dynamic assessment* is an approach to assessment that focuses on the learning process and individual development. The concept of *dynamic assessment* was first introduced by Lev Vygotsky, a famous Russian psychologist in the field of developmental and educational psychology. Vygotsky played a key role in developing the idea of the zone of real development (*Zone of Proximal Development* , ZPD). This concept refers to the range of an individual's abilities within which they can successfully complete a task with the help of another, more experienced person or appropriate instruction. Meanwhile, according to Teo, A. K (2012) *Dynamic assessment* is a way to identify and understand a person's ZPD by involving interaction between the examiner (or educator) and the individual being assessed. The examiner not only measures the individual's current abilities, but also seeks to see how far the individual can develop through guidance or assistance. So, the concept of *dynamic assessment* was first developed by Lev Vygotsky as part of his framework for thinking about cognitive development and education. This concept has subsequently become the basis for many assessment approaches that focus on individual understanding and development. According to Khaghaninejad (2015) said that *Dynamic*

assessment is a powerful tool in exploring individual potential and helping them achieve higher levels of understanding and achievement through guidance and in-depth social interaction. This approach reflects Vygotsky's view of learning as a process that occurs through interaction and socialization, as well as increasing individual abilities through support and guidance.

Dynamic assessment according to Lev Vygotsky is an assessment approach that focuses on individual understanding and development in the learning context. Vygotsky introduced this concept as part of his theory of the Zone *of Proximal Development* (ZPD), which is one of the core concepts in his theory of cognitive development. The following are several key points about *dynamic assessment* according to Vygotsky in Daneshfar. S. and Moharami. M (2018) (a) **Zone of Real Development (ZPD):** Vygotsky argued that every individual has a ZPD, which is the range of abilities within which a person can successfully complete a task with help or support. ZPD is the distance between an individual's actual abilities and his or her maximum potential. *Dynamic assessment* is designed to identify and understand a person's ZPD. (b) **Social Interaction** : Alsaadi (2021) said that *Dynamic assessment* emphasizes the importance of social interaction in learning. This process involves interaction between the examiner or educator and the individual being assessed. The examiner not only measures the individual's current abilities, but also provides assistance, hints, or questions designed to help the individual overcome tasks or problems that may be beyond his or her abilities if left unaided. (c) **Development Through Guidance** : *Dynamic assessment* seeks to identify individual development potential by involving them in dynamic assessment activities, Poehner E. _ Matthew (2008) . This process provides an overview of the extent to which an individual can develop through guidance or educational intervention. (d) **The Important Role of Scaffolding** : *Scaffolding* is an important concept in *dynamic assessment* . It refers to the support or framework provided by examiners or educators to help individuals solve complex tasks, Shabani, K., Khatib, M., Tabataba'i Uinversity, A., & Ebadi, S. (2010) . *Scaffolding* can gradually be adjusted to individual abilities so that they can become more independent in completing the task. (e) **Changes in Assessment** : *Dynamic assessment* recognizes that assessment does not have to be static. On the contrary, assessment can be an active learning tool and help individuals achieve their potential, (Leung C onstant, 2007) . (f) **The Importance of Learning Context** : *Dynamic assessment* considers the specific learning context. This means that dynamic assessment can be adjusted to the material or learning objectives being studied, Hidri, S and R oud, (2020) . (g) **Focus on Understanding** : *Dynamic assessment* focuses more on the individual's understanding and ability to solve problems rather than on measuring the final result that is right or wrong. Atkinsol, L. (2001).

According to Prastami, HB, & Kartono, K. (2023). Dynamic assessment in mathematics aims to (1) better understand students' abilities in formulating mathematical problem solving strategies. (2) providing ongoing feedback that helps students improve their understanding of mathematical concepts. (3) Increasing student involvement in their own learning and assessment processes. (4) Create an inclusive learning environment, support student development, and encourage deeper understanding of concepts. Dynamic assessment in mathematics is an approach that aims to measure students' understanding and mastery of mathematical concepts continuously and in depth. This approach focuses on understanding concepts and their application in various contexts, not just on memorizing formulas or algorithms. Dynamic assessments also provide students with opportunities to think critically, solve problems, and communicate their understanding effectively

Dynamic assessment also has the potential to improve mathematics teaching, because teachers can better identify student needs and difficulties, and design lessons accordingly. In the context of this article, I will explore the use of mathematical concepts in schools. This paper will analyze how this approach can improve students' understanding of mathematical

concepts and provide insight into effective ways of implementing dynamic assessment of mathematics teaching. It is hoped that this paper can contribute to the development of mathematics pedagogy and help create a better learning environment for students to master mathematics subjects better.

2. RESEARCH METHODS

The method for writing this article is a literature study of research results that have been published in national journals. Literature study is a series of activities related to methods of collecting library data, reading and taking notes, and managing research materials. Another definition of literature study is looking for theoretical references that are relevant to the case or problem found. These references can be searched from books, journals, research report articles, and sites on the internet. The output of this literature study is the collection of references that are relevant to the formulation of the problem. The results of the research examined are regarding dynamic assessment of mathematics The results of the literature study will be presented in the form of a description that will make it easier for readers to understand the effectiveness of using dynamic assessment in mathematics.

3. RESULTS

Approaches to Dynamic Assessment

Dynamic assessment approaches in mathematics can be categorized into four parts. This approach can be directed within students. and the approach in question can be seen below.

Determines student interests for the purpose of embedding instruction in a meaningful and authentic context

Determining student interests for the purpose of embedding instruction in a meaningful and authentic context is a learning strategy that aims to make course material more relevant and interesting for students. By understanding students' interests and preferences, teachers can design more engaging and relevant learning experiences, Harackiewicz, Smith, & Priniski (2016). The following are examples and further understanding:

a. Mathematics in Personal Finance: A mathematics teacher can determine a student's interest in personal finance. For example, if most students have an interest in investing or managing their own money, teachers can design lessons that involve math concepts such as interest, investing, or budget planning.
b. Literature in Everyday Life: A literature teacher can determine a student's interest in certain films or music. Teachers can choose literary works related to those interests and analyze them together.
c. Natural Science in Ecology: If students are interested in environmental issues or nature conservation, natural science teachers can design research projects that involve understanding natural science concepts such as the water cycle or food chains in the context of local ecology.

By determining student interests and integrating them into learning, teachers can create more interesting, relevant and meaningful learning experiences for students. This can increase student engagement and allow them to see the connections between what they learn at school and their everyday lives. In mathematics, determining student interests for the purpose of embedding instruction in a meaningful and authentic context can be very effective. The following is a concrete example of Mathematical Modeling in Music Event Planning

a) Situation: A mathematics teacher wants to teach mathematical modeling concepts to students in an intermediate level class. After talking with students, he found that many of

them had an interest in music and wanted to learn more about how mathematics could be used in a musical context.

b) Instruction that is embedded in a meaningful and authentic context: Rhythm Analysis: Teachers can begin by discussing mathematical concepts related to musical rhythm, such as counting beats in various time signatures (for example, 4/4, 3/4, or 6/8). Students can identify rhythm patterns in their favorite songs and count the beats in specific lines.

c) Sound Frequency: Teachers can discuss the concept of frequency in a musical context. Students can understand how frequency relates to pitch and low pitch in musical instruments. They can calculate sound frequencies based on wavelengths and learn about the relationships between notes in a musical scale.

d) Modeling Musical Volume: Teachers can ask students to model musical volume using mathematical concepts. They can compare volumes in decibels (dB) for various musical instruments and understand how changes in volume can be represented mathematically.

e) Concert Performance Chart: Teachers can invite students to plan a music concert. Students can create graphs that show how ticket sales develop over time and how concert revenues relate to production costs. It will integrate mathematical concepts such as graphs, percentages, and comparisons.

4. DISCUSSION

CRA Assessment

CRA (Concrete-Representational-Abstract) assessment is an approach to learning mathematics that is used to help students understand and master mathematical concepts better, Minarti, ED, & Wahyudin. (2019) . This approach breaks learning into three stages: concrete stage, representational stage, and abstract stage. The following is the definition and example of using the CRA Assessment approach:

a. Concrete Stage (*Concrete*): At this stage, students are introduced to mathematical concepts through real and concrete experiences. They use physical objects, manipulatives, or physical activities to understand the concept. Example in Mathematics: Concept: Addition. A teacher teaches addition to first grade students using physical manipulatives such as wooden blocks or marbles. The teacher asks students to add some marbles to the basket. Students then count how many marbles they have added by moving the marbles one by one and absorbing the process. If the teacher wants to teach adding fractions, he or she can provide pieces of paper that represent fractions, such as 1/2, 1/4, and 1/8. Students can physically arrange these pieces and see how fractions are used in real situations, such as dividing a cake.

b. Representational Stage : After understanding the concept concretely, students are then invited to illustrate the concept using visual representations, such as pictures, diagrams, or mathematical models . Once students have a concrete understanding of addition, the teacher illustrates the addition operation using pictures or cards showing the objects being added. Teachers also use the plus sign (+) as a symbolic representation of addition. Once they understand adding fractions concretely, students can transfer their understanding to visual representations, such as pie charts or number lines, to visualize the operation of adding fractions.

c. Abstract Stage (*Abstract*): After having a strong understanding through the concrete and representational stages, students then move their understanding to the abstract stage, where they work with mathematical symbols, formulas, and mathematical operations formally. Once students have a strong understanding of addition in concrete and representational form, they then practice addition abstractly, namely by using numbers and mathematical formulas. For example, they learn to add numbers such as 3 + 4 = 7. After understanding the addition of

fractions in concrete and representational form, students can then write addition operations in the form of mathematical symbols, such as 1/2 + 1/4 = 3/4.

The CRA approach allows students to build a strong understanding of mathematical concepts before they actually enter the formal mathematical operations stage. This helps students understand the meaning of mathematics in more depth and prevents merely mechanical understanding. CRA (*Concrete-Representational-Abstract)* assessment is an approach in teaching mathematics that aims to help students understand mathematical concepts in depth through three sequential stages: concrete, representational, and abstract, Nugroho, SA, & Jailani, J. (2019) . This approach is designed to allow students to build a strong understanding of mathematical concepts by starting with concrete experiences and experiencing visual representations before moving on to more abstract mathematical concepts.

Error Pattern Analysis

With this approach, students have a strong foundation to master more complex mathematical concepts. Error pattern analysis is the process of observing and recording errors made by students when they work on mathematical problems, (Lai, 2012). This includes identifying the types of errors, their causes, and recurring error patterns. In this analysis, errors are considered a valuable source of information about students' understanding of mathematical concepts. For example, a mathematics teacher teaches students about decimal multiplication operations. After giving several exercises, the teacher realized that many students made mistakes in multiplying decimal numbers. The following are examples of error patterns that may be encountered and their analysis:

a. Mistakes in Multiplying Decimals: Many students make the mistake of putting a decimal point in the product without considering the number of decimal digits in both factors. For example, they might multiply 0.25 by 0.3 and produce 0075 as the answer. This error may occur because students do not understand how to determine the position of the decimal point in the decimal product. Teachers can provide additional exercises that focus more on this concept and ask students to visualize multiplication with a decimal point representation.
b. Digit Grouping Errors: Some students may have difficulty separating decimal digits from whole digits when multiplying. They may mix up decimal digits and whole digits when doing calculations. Analysis: This error may occur because students do not understand the importance of separating decimal digits from whole digits. Teachers can use manipulatives or visual representations to help students understand these concepts better.
c. Errors in Rounding: Students may also make errors in rounding decimal multiplication results. They may not know how many decimal digits to include in the answer. Analysis: This error may occur because students do not have sufficient understanding of the rounding rules in decimal multiplication. Teachers can provide special training regarding rounding in decimal multiplication.

Flexible Mathematics Interview

Dynamic assessment in mathematics often involves flexible mathematics interviews. This is an evaluation method that allows teachers to interact directly with students to understand their understanding of mathematical concepts. The following is an example and explanation of a flexible mathematics interview in the context of dynamic mathematics assessment. Flexible mathematics interviews are a dynamic assessment approach in which teachers interact with students face-to-face or in small groups to explore their mathematical understanding, Ginburg Herbert (2009). The main goal is to explore students' understanding in more depth, identify their thinking patterns, and gain insight into how students deal with

certain mathematical problems. Suppose a teacher wants to assess students' understanding of the concept of adding fractions. He decided to conduct a flexible mathematics interview with a student. Here is an example of how such an interview might go:

Teacher :"Hi, Rama, we will talk about adding fractions today. Let's look at the first question. If you have 1/3 of a cake and you add it with another 1/4 of a cake, how will you add them?"
Rama : "Hmm, I think I just need to add the numerator, so 1 + 1 is 2."
Teacher : "Good, you have done the first step correctly. Now, what about the denominator?"
Student : "Oh yes, the denominator must remain 3 because that is the denominator of the first fraction."
Teacher : "You are absolutely right. So, how do you add up now?"
Student : "So, 1/3 + 1/4 = 2/3."
Teacher : "Great, you really understand it! Now, what if we want to add another 1/3 to it?"
Student : "Hmm, I think I just need to add the numerator again, so 2 + 1 is 3."
Teacher : "Good, you have understood it well. Now, try to convey to me in words, what you have learned about adding fractions."
Student : "Adding fractions involves adding the numerators if the denominators are the same. If the denominators are different, we need to find the common denominator first."

Characteristics of Mathematics Dynamic Assessment

Interaction

Understanding and explanation of Interaction: Dynamic assessment often involves face-to-face interaction between students and teachers; assessors offer support and assistance to help students solve math problems. Interaction in the context of dynamic assessment in mathematics refers to the face-to-face relationship between students and teachers or assessors during the assessment process. This is an important aspect of this approach, where the assessor actively interacts with students as they complete the math assignment or problem. The aim is to (a) understand students' thinking and understanding in more depth, (b) provide support, and (c) help students overcome difficulties they may encounter in the problem-solving process. For **Understanding Student Thinking** : During the interaction, the assessor attempts to gain a better understanding of the student's thinking. This involves asking questions, listening to students' answers, and observing the steps taken by students as they work on math problems. By understanding students' thinking, assessors can identify thinking patterns that may influence their understanding of mathematical concepts. **Providing Support** : During the interaction, the assessor can also provide support to the student. This support can take the form of guidance, positive feedback, or hints that help students continue in completing their math assignments. This helps students feel supported and can increase their confidence in solving math problems. **Identifying Difficulties** : This interaction also allows the assessor to identify difficulties that the student may be experiencing. By asking relevant questions and observing student actions, assessors can identify where students may be experiencing difficulties or concepts that may be confusing them. This allows the assessor to design appropriate assistance or adjustments. Formative Assessment: These interactions can also serve as a form of formative assessment, where the assessor uses information obtained during the interaction to guide further instruction. If the assessor realizes that a group of students is having difficulty with a particular concept, he or she can plan appropriate additional learning to help students overcome those difficulties. Measuring Deep Understanding: Through these interactions, assessors can measure student understanding in more depth than just measuring the final results.

Feedback

Definition and explanation of Feedback: During dynamic assessments, students receive immediate feedback on their answers or help students understand mistakes and learn from them. In the context of dynamic assessment, feedback is the process of providing direct feedback to students regarding their answers or performance during learning or when working on mathematics assignments. The purpose of feedback is (a) to help students understand the concepts being studied, (b) to identify errors, and (c) to enable them to learn from their mistakes, (Leung C onstant, 2007) . **Helps Understand Concepts** : Feedback in dynamic assessments is used to help students understand the math concepts being studied. When students answer questions or solve math problems, the teacher or assessor provides feedback that explains the concept more clearly. Feedback can take the form of additional explanations, examples, or illustrations that help students absorb the concept. **Identifying Mistakes** : Feedback is also used to identify possible mistakes made by students. This includes conceptual or computational errors that may interfere with their understanding. **Correcting Wrong Understanding** : Feedback aims to help students correct wrong understanding. If students give inaccurate answers or do not understand mathematical concepts correctly, feedback will help them to understand better and change their incorrect understanding.

Adaptive capabilities

Adaptive capabilities in dynamic assessment aim to create a more effective and relevant learning experience for each student, helping them understand mathematical concepts better, and reach their maximum potential. It also promotes an inclusive approach that recognizes that each student has unique needs in mathematics learning. Adaptive capabilities in the context of dynamic assessment refer to the ability of assessors or teachers to adapt their approach, teaching, or evaluation to individual student abilities and needs. This means teachers or assessors can identify where each student is in their understanding of a particular math concept and design appropriate learning strategies to help them understand that concept . Here is a further explanation of adaptive capabilities in dynamic assessment:

Identification of Student Abilities : Adaptive abilities begin with recognizing the individual student's level of understanding of the mathematical concepts being studied. Teachers or assessors will use various assessment tools, such as observation, formative tests, or interviews, to measure student abilities. **Student Grouping** : After identifying the students' level of understanding, the teacher or assessor can group students based on their abilities. This can involve forming groups that are homogeneous in terms of ability, so that students with similar levels of understanding can work together. **Needs-Based Teaching** : Adaptive capabilities allow teachers or assessors to design instruction that fits students' needs. **Individual Support** : Students who have difficulties may be given more intensive individual support. This could be extra tutoring, personal guidance, or other help tailored to their needs. **Motivation:** Adaptive capabilities also enable teachers or assessors to provide appropriate motivation. **Continuous Evaluation** : Teachers or assessors continuously monitor student progress and conduct ongoing evaluations.

Problem Solving Abilities in Dynamic Assessment

Problem-solving abilities in dynamic assessment refer to the emphasis on students' ability to apply the mathematical concepts they learn to solve real problems or unstructured situations. This means that dynamic assessment not only evaluates students' understanding of mathematical formulas or theories, but also the extent to which students can use that knowledge in a meaningful context. The goal of problem-solving abilities in dynamic assessment is **to measure deep understanding** : problem-solving abilities enable a deeper

assessment of students' understanding of mathematical concepts. **Measuring Practical Ability** : The main goal of mathematics is to provide practical tools for solving problems in everyday life and work contexts. **Encourages Critical Thinking** : Problem solving requires critical and analytical thinking. In dynamic assessment, the goal is to encourage students to think more deeply about problems, formulate strategies, and evaluate their solutions. **Measuring Transferability** : Problem-solving ability measures the extent to which students can transfer mathematical knowledge and skills from one context to another. **Identifying Skills that Need Improvement** : With a focus on problem solving, dynamic assessments also help teachers identify specific skills or concepts that students may need to improve. **Develop Life Skills** : Problem solving ability is a very valuable skill in everyday life and in various fields of work.

a. Dynamic Assessment Rubrics in Mathematics

Dynamic assessment rubrics can be described as follows: **Assessment Rubrics** : Books and journals can include clear and structured assessment rubrics to assist teachers in evaluating student understanding. This rubric covers various aspects, such as understanding concepts, problem solving, and mathematical communication. **Portfolio**: Dynamic assessment often involves collecting a student's portfolio containing examples of their work over a certain period of time. This portfolio can include various types of math assignments, such as word problems, projects, or problem solving. **Open Questions**: Teachers can use them in dynamic assessments to dig deeper into student understanding by asking open questions that encourage critical thinking and in-depth problem solving. **Classroom Discussion**: Mathematics journals often include research on the use of classroom discussion as a dynamic assessment tool. Discussions can help students talk about their understanding and explain their thinking processes. **Formative Assessment**: Dynamic assessment is often closely related to formative assessment, which refers to the use of information obtained from an assessment to direct subsequent learning. This may include adapting instruction based on student needs. **Contextual Problem Solving**: Books and journals can discuss the importance of evaluating students' ability to apply mathematical concepts in real-world contexts or different problem situations. **Student Engagement**: Dynamic assessment may also include evaluation of student engagement in the learning process, such as participation in discussions, collaboration with peers, and active problem solving.

5. CONCLUSION

Mathematics Dynamic Assessment (MDA) is a method teachers can use to help students understand mathematics practically and flexibly applied in the mathematics curriculum. MDA integrates four research-effective assessment approaches in mathematics: 1) Determining student interests for the purpose of embedding instruction in meaningful and authentic contexts: 2) CRA assessment, 3) error pattern analysis, and 4) flexible mathematics interviewing. Four features of MDA: Interaction: Dynamic assessment often involves face-to-face interaction between students and teachers; Assessors offer support and assistance to help students solve math problems. Feedback: During dynamic assessment, students receive immediate feedback on their answers or help students understand mistakes and learn from their mistakes. Adaptability: Dynamic assessment can be adapted to students' skills to help understand certain concepts so as to provide support and motivation. Problem Solving Ability: Dynamic assessments often focus on students' ability to solve problems rather than simply evaluating their mathematical abilities.

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