Proceeding of ICMR 6(1), 123-130 DOI: https://doi.org/10.32672/picmr.v6i1.760

Differentiated Learning Assisted by Angle Meter to Improve Students' Creative Mathematical Thinking Ability on Trigonometry

Yuverni Selvy[1*]

[1]SMA Negeri 1 Lhokseumawe, Aceh, Indonesia

*Corresponding Author: yuverniselvy1@gmail.com

Abstract. *Teachers as learning facilitators cannot avoid the diversity of students that occurs in a class, especially in deciding what strategies should be used in learning. As time progresses, today's teachers are required to be innovative, and creative in choosing and developing learning methods. Based on the 2023 Aceh education report card, the numeracy score was below standard, especially in the geometry domain at SMAN 1 Lhokseumawe with a score of 57.84. Numeracy abilities are closely related to creative thinking abilities. Efforts to improve creative thinking abilities mean that teachers must organize learning strategies to meet students' diverse learning needs with differentiated learning. The purpose of writing the paper is to determine the increase in students' mathematical creative thinking abilities with differentiated learning. The indicators of creative mathematical thinking abilities tested are fluency, flexibility and elaboration. The methodology of this research is descriptive with a sample of class X students at SMAN 1 Lhokseumawe learning trigonometry are elevation and depression in class be concluded that the students' mathematical creative thinking abilities as a group were at 90.375 and individually at 89. The learning process of angle meter-assisted differentiation helps students connect graphical, algebraic, and numerical representations and brings up critical, creative, communicative and collaborative attitudes in accordance with 21st-century skills.*

Keywords: *differentiation, creative thinking, elevation*

1. Introduction

Each student is a unique individual who has characteristics that are different from other individuals. That is why, when students go to school and are placed in the same class, of course, there are students with a variety of characteristics, be it diversity of interests, learning styles, backgrounds, or diversity of students' abilities in receiving information on the subject matter being taught (Sudarmin, 2019). Teachers as learning facilitators cannot avoid the diversity of students that occurs in a class, especially in deciding what strategies should be used in learning. As time progresses, today's teachers are required to be innovative, and creative in choosing and developing learning methods (Pozas, 2021). The aim is to ensure that the learning carried out is effective, meets students' learning needs, and maximizes students' learning potential.

Student success in learning can be seen from the student's ability to learn independently so that the results of the learning carried out are knowledge that they have mastered (Siburian et al., 2019). Therefore, in the learning process, it is necessary to use approaches or methods to foster creative thinking abilities. This ability is one of the characteristics desired in the world of work (Maharani, 2014). These characteristics include having self-confidence, having achievement motivation, having expertise in the field of technology, mastering analytical and creative thinking skills, and mastering interpersonal skills such as the ability to work together and negotiate. These aspects are often encountered in the mathematics teaching and learning process because mathematics

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has many abstract concepts that require creative thinking. Creative thinking abilities include proficiency/fluency, flexibility, originality, and elaboration.

To improve students' creative thinking abilities, teachers must be able to differentiate learning instructions in the classroom. Every student has differences in terms of abilities, interests, cultural background and learning styles. One learning strategy that can meet the learning needs of students with diverse abilities is differentiated teaching, which was coined by Tomlinson (2001). The reality on the ground is that students who are affected by learning during the COVID-19 pandemic, experience a lot of learning loss so the effectiveness of the curriculum in special conditions further strengthens the importance of changing the design and implementation strategy of the curriculum in a more comprehensive manner.

Currently, differentiated learning is in the spotlight in the world of education which is based on the diversity of student potential. This is reinforced by Murtala's et al. (2023) research that differentiated learning can maximize learning, especially in geometry material. Ditasona's research results (2017) show that the increase in mathematical problem-solving abilities of students who take part in differentiation learning is better than students who take conventional learning.

Digital differentiated learning contains activity content, lesson plans, activity processes, and final results, products, that can be modified and set more flexibly and transparently. According to Hasanah et al. (2023), information technology is a tool that can help adapt teaching to students' learning styles, interests and readiness, giving teachers the possibility to use tools, methods and means to adapt them to content, activities and processes. Teachers use tools that are close to students, namely gadgets that they often use.

Learning Differentiate is a teacher's effort to adapt the learning to meet students' individual learning needs. According to Tomlinson (2001) in a class which implements learning differentiation, a teacher makes an effort which consistently respond to student learning needs. Carrying out differentiated learning does not mean that teachers have to teach with 32 methods which is different from teaching 32 students. No also means that the teacher must multiply amount questions for students which faster work compared to others. Differentiated learning also doesn't mean teachers have to group which clever with which clever and which not enough with which not enough.no also give tasks which different for every child. Learning differentiation is not a chaotic learning process, *in* which the teacher then has to make several lesson plans at once, in where teacher must run to there here for help si a, si b or si c in timewhich simultaneously.

Tomlinson (2001), in his book titled ‘How to Differentiate Instructions in Mixed Ability Classroom’, conveys that we can see students' learning needs, most No based on 3 aspects viz

1) Learning Readiness
   Readiness Study (readiness) is the capacity to learn the material, draft, ornew skills. an assignment that takes into account the student's level of readiness willtake students out of their comfort zone and give them a challenge, however with environment study which appropriate and support which adequate, they still can master the new material or skills. There are many ways to differentiate learning readiness. Tomlinson (2001) said that designinglearning is similar to using the equalizer buttons on a stereo or player CD.
2) Student Interest
   Interest is a mental state that produces a directed response to something situation or

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object certain which pleasant and gives satisfaction self. Tomlinson (2001), says that objective learning which is based on interest, helps students realize that there is a match between school and love they alone to learn; demonstrate connectedness between all learning; using skills or ideas known to students as a bridge tolearn ideas or skills that are unfamiliar or new to them, and improve motivation student for study. Several methods can be used by the teacher for interesting interest students among them are creating situation learning that interesting attention student (for example withhumour, creating surprises, etc.); creating context learning that links with the interest of individual students; communicating mark benefit from what which studied students, creating learning opportunities where students can solve the problem (problem-based learning).

3) Student Learning Profile

Profile study refers to ways how we as individuals most good study. objective of notice needs study student based on profile study is to provide opportunities for students to learn naturally and efficiently. As teachers, we sometimes inadvertently tend to choose styles of learning that suit our learning style. Even though we know every child has their learning profile. Having awareness of this is very important for teachers can vary the method and their teaching approaches. Profile study student related with lots factor. Following This are several including:

a) Preferences for the learning environment, in the form of influence culture for example relax - structured, quiet type - expressive, personal - impersonal and preferential style Study. Learning style is how students select, acquire, process, and remember information new. By general style study, there are three, that is (1) visual: a study with see (for example material which forms pictures, diagrams, power points, notes, concept maps, graphic organizers, etc); (2) auditory: learn by hearing (e.g. listening to explanations teacher, read aloud, listen to opinions while discussing, listening to music); (3) kinesthetic: study while do (for example while move, carry out activities hands-on, etc.). remembering that our students have different learning styles, teachers can combine them.

b) Preference-based on intelligence compound (multiple intelligence*):* The theory about multiple intelligence explains that humans have eight different intelligences that reflect the different ways we interact with the world. Intelligence is visual-spatial, musical, bodily-kinesthetic, interpersonal, intrapersonal, verbal-linguistic, naturalist, logic-mathematics.

According to Andini (2016), differentiation learning uses various approaches (multiple approaches) in terms of content, processes and products. The three elements mentioned above will be modified and adapted based on the assessment carried out according to the student's level of readiness, interests and learning profile. There are 3 important elements for differentiation, including (1) Content, content relates to what students will know, understand and will learn in learning. In this case, the teacher will modify how each student will study a topic of learning material, (2) Process, the process is the way students get information or how they learn. In another sense, the process is a student's activity in gaining knowledge, understanding and skills based on the content to be studied. Learning activities will be said to be effective if they are based on the level of knowledge, understanding and skills of students, (3) Products and products are evidence of what students have learned and understood in learning and then demonstrate or apply

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what they have understood. This form of demonstration is in the form of a product that will change students from "consumers of knowledge to producers with knowledge". In the context of this research, researchers designed learning on the topic of preliterate humans based on 3 (three) important elements in a differentiated approach, considering students' needs.

Based on factor analysis, Handayani et al. (2021) found traits that are indicators of creative thinking abilities, namely: (1) Fluency is the ability to provide various responses, and fluency is generally related to the ability to generate alternatives at the moment. required. (2) Flexibility is the ability to propose various kinds of solutions or approaches to problems. Flexibility relates to the ability to make variations on one idea and the ability to find new ways. (3) Originality is the ability to generate ideas in ways that are original and not cliche. Authenticity is related to the ability to provide a non-typical/unique response that is different from what other people usually do. (4) Elaboration is the ability to describe something in more detail. It can be said that elaboration is the addition of details or information to an existing idea. (5) Redefinition is the ability to review an issue based on a perspective that is different from what is already known by many people.

Increasingly sophisticated technology means we can easily measure angles just with an angle calculating application, namely the angle meter application. This application has a quite attractive appearance, with quite clear angle indicator numbers. Students can find the save recordings option in this application, where this feature can save measurement results files in the form of charts or lists.

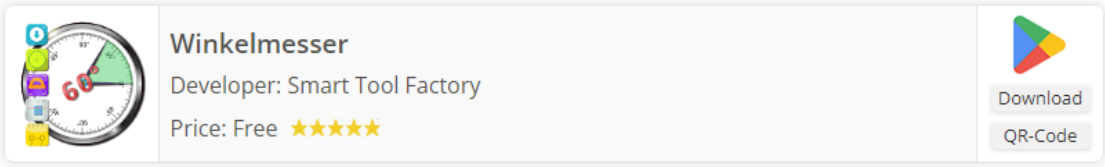

Figure 1. Angle Meter Application

Learning is carried out in accordance with the learning process plan that has been designed and students are given worksheets that they must discuss. During the learning process, teachers accommodate students who have visual, auditory and kinesthetic learning styles by conducting learning in the classroom and outside the classroom. At this stage, the teacher carries out differentiated learning with the help of an angle meter using a problem-based learning (PBL) model with the following syntax:

Table 1. Problem-Based Learning (PBL) Phase

PHASE-PHASE	TEACHER CONDUCT
PHASE 1 Student orientation to problems	The teacher explains the learning objectives, explains the logistics required, and motivates students to engage in selected problem-solving activities.
PHASE 2 Organizing students to study	The teacher helps students define and organize learning tasks related to the problem.
PHASE 3 Guiding individual and group investigations	Teachers encourage students to collect appropriate information, carry out experiments, obtain explanations and solve problems.
PHASE 4 Develop and present work results	Teachers assist students in planning and preparing appropriate work such as reports, videos, and models and help them share assignments with their friends.

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PHASE-PHASE	TEACHER CONDUCT
PHASE 5 Analyze and evaluate the problem-solving process	Teachers help students to reflect on or evaluate their investigations and the processes they use.

2. Method

This research is a good practice of differentiated learning to improve students' creative thinking skills with the application of an angle meter as a tool to help calculate angles in trigonometry material during two meetings using a problem-based learning model aimed at students being able to measure elevation and depth angles correctly and using comparisons. trigonometry to solve contextual problems involving angles of elevation and angles of depression. Learning was carried out in class X-9 at SMAN 1 Lhokseumawe. The number of students involved was 36 people who were divided into 8 groups. Each group counts tall objects around the school. The instruments in this research are student worksheets and tests at the end of learning to measure students' mathematical creative thinking abilities which can be seen in the assessment rubric in Table 2.

Table 2. Assessment Rubric of Mathematical Creative Thinking Abilities

No. Question	Criteria	Weight	Scale				Score
			1	2	3	4	
1-3	Fluency (sparks many answers)	3	Students provide 1 answer with the correct solution and procedure	Students provide 2 answers with the correct solutions and procedures	Students gave 3 answers with correct solutions and incorrect procedures	Students give 3 answers with correct solutions and correct procedures	12
4	Flexibility (answer questions in a variety of ways)	4	Students solve problems with 1 variation and the solution is not correct	Students solve the problem with 1 variation and the correct solution	Students solve problems with 2 different variations and the results are less precise	Students solve problems with 2 different variations and get the correct results	16
5	Elaboration (make another way based on the information provided)	4	Students solve problems in other ways and the solutions are less precise	Students solve the problem in another way and the solution is correct	Students solve problems in 2 different ways and the results are not accurate	Students solved the problem in 2 different ways and the results were correct	16

3. Results and Discussions

Learning trigonometry aims to solve right triangle problems involving trigonometric comparisons and their applications. Part of the material uses elevation/depression angles to calculate the height of objects (objects). From classroom

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learning, teachers will find children who do not understand the concept of trigonometric comparisons, so the teacher facilitates them with book sources, videos or short direct explanations. However, students who are already in the advanced category, will not have difficulty understanding the content they will study. This process is an element of content differentiation. According to Handayani et al. (2021), indicators of mathematical creative thinking ability consist of 5 indicators, but in this best practice, researchers took the indicators: 1) fluency; 2) flexibility; and 3) elaboration. These three indicators are represented in three activities on the worksheet. Based on the mathematical creative thinking ability rubric (table), the assessment of student work results on the worksheet can be seen in the table.

Table 3 Assessment of Student Results on Worksheet

No.	Group	Activity Value Weighting			Total
		1 (12)	2 (16)	3 (16)	
1.	Group 1	12	12	16	91
2.	Group 2	12	16	16	100
3.	Group 3	9	16	12	84
4.	Group 4	12	12	16	91
5.	Group 5	12	16	12	91
6.	Group 6	9	16	16	93
7.	Group 7	12	12	12	82
8.	Group 8	12	16	12	91
		Average			90,375

Table 3 above shows that the average student worksheet result is 90,375 and the student test is 89, both are above the minimum completeness in mathematics subject which is 77 for class X, so the average score is in the very good predicate. Differentiation learning with the help of an angle meter can improve students' creative mathematical thinking abilities even though there are findings in the worksheet results, namely that there are still groups who experience difficulties with the elaboration indicator, namely finding new ways to solve problems. This is because students are not used to non-routine questions and lack numerical literacy. One of the prerequisites for realizing 21st-century life skills is students' literacy skills so that technology-assisted differentiated learning solutions can be applied to other materials.

Differentiation learning using angle meters in groups leads students to think creatively. One of the indicators of mathematical creative thinking ability is fluency, which is the ability to provide responses that give rise to alternatives when needed. Students can respond well to the problems given on the worksheet. and discuss to determine the height of the object (object) they will choose. In this activity, each group has different tasks, so the process of collecting the data/information required is different. This stage is an element of process differentiation.

The results of student work on worksheet number 5 show students' ability to come up with various kinds of problem solutions, this is flexibility regarding variations in determining new/different ways of solving problems. In worksheet number 4, students are asked to describe in detail the problem-solving process using existing content from the teacher such as book sources, learning videos related to elevation/depression angles as well as direct explanations. Each group explains differently according to the height of the object they measure, this ability is called elaboration.

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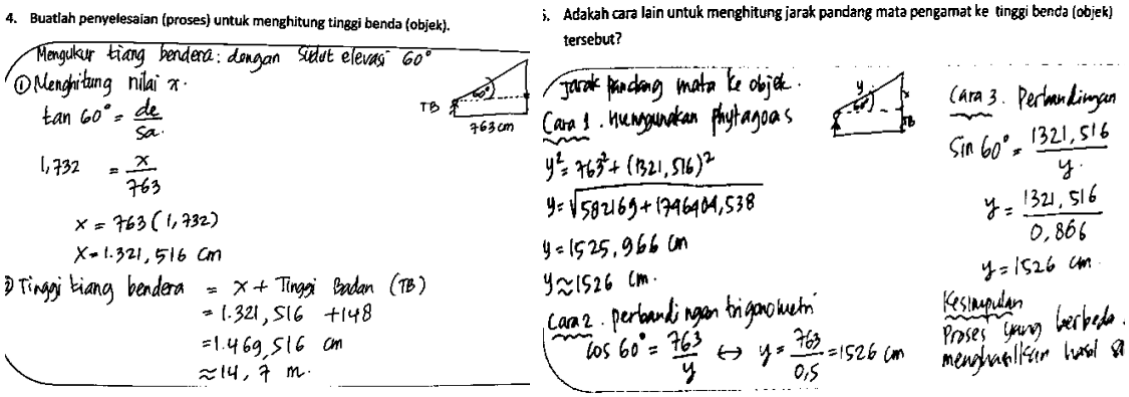
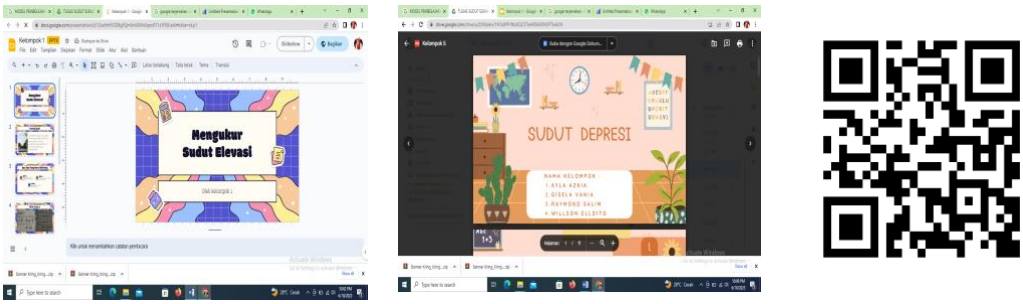


(a) (b)

Figure 2. One of The Student Worksheet Results (a. Number 4; b. Number 5)

At the evaluation stage, students are given the freedom to present the results of their discussions in the form of cardboard, PowerPoint, Canva, or video where each choice has the same value because the teacher assesses it from the worksheet assessment rubric. The results obtained by 1 group used PowerPoint, 7 groups used Canva and 1 group used video so there was an element of product differentiation in this activity. At the stage of analyzing and evaluating the problem-solving process, students are given 6-7 minutes to present the results of their discussion. The teacher uses the wheel of names to randomize which group will present first. The use of the wheel of names adds excitement to learning because students are curious about which group will advance first. Students submit their assignments on Drive (in the form of PPT or PDF), if they cannot submit via Drive then students can send them via WhatsApp. They collect their assignments according to what they like. For those who make videos, they can be uploaded to YouTube (Figure 3).



(a) (b) (c)

Figure 3. Differentiation Product Resulting from Group Discussions (a. PowerPoint; b. File PDF; c. Video Barcode)

This positive student response can be seen from several words in the reflection given on the Mentimeter application, starting from feelings, opinions and interest in the learning. Students feel happy with the learning that has taken place. The positive response obtained in differentiated learning helps teachers in teaching-learning material because each learning activity is written in detail and completely. The use of an angle meter, wheel of names and Mentimeter can attract students' interest in learning because the use of technology available on students' gadgets makes them faster in calculating elevation/depression angles so that they can solve contextual problems using trigonometry material.

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Angle meter-assisted differentiation learning is an update because it can accommodate the needs of all students in the class with varying student learning styles. The use of technology such as angle meters makes students interested in participating in every learning activity, especially when students retrieve data/information on worksheets, they immediately move to feel it themselves so that these activities can be stored in long-term memory, making learning mathematics fun.

4. Conclusions

Based on the learning activities that have been carried out, the following conclusions are obtained (1) Process differentiated learning assisted angle-meter helps students connect graphical, algebraic, and numerical representations and brings up critical, creative, communicative and collaborative attitudes in accordance with the 21st century skills that everyone must have. student. The use of technology such as angle meter, wheel of name and meter makes learning mathematics exciting and fun. (2) Differentiated learning assisted angle-meter can improve students' mathematical creative thinking abilities with scores of 90, 375 for group worksheets and 89 marks for individuals.

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