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Development of a HOTS-Based Mathematical Abstraction Ability Instrument in Trigonometry Using Riau Islands Province Culture

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Abstract
The lack of available assessment tools that effectively measure students' ability to think abstractly in mathematics, particularly in trigonometry. Additionally, there is a need to incorporate local culture into the assessment instrument to make the content more relatable and relevant to students in Riau Islands Province. This study is a development study using the Define, Design, and Develop processes from the 4D development model that have been converted to 3D. 3 doctoral lecturers in mathematics education subsequently validate the instruments produced; they are modified in response to their feedback and recommendations. A team of 17 teachers and instructors of high school mathematics validated the results, followed by panelists' validation. The content Validity Ratio (CVR) index value on the panelist's validation of 25 items is greater equals to 0.765. The instrument has been tested on 20th-grade 10th high school students. The results show that the instrument can be used on a large scale, and the instrument with the cultural context of the Riau Islands Province enables students to break down complex problems into simpler components, identify relevant variables, and establish connections between them.

Keywords: Higher-Order Thinking Skills (HOTS); instrument development; mathematical abstraction ability

I. Introduction

Learning and innovation, life and work skills, information, media, and technology are the three basic foundations for 21st-century skills (OECD, 2018; Scott, 2017; Silber-Varod et al., 2019). The domain of higher-order thinking skills is another name for such a skill (Ghanizadeh et al., 2020). Given the demand for these abilities, taking the level of students' higher-order thinking skills (HOTS) seriously is important.

Instead of only remembering, restating, or referencing information, HOTS is a cognitive skill that encompasses deeper knowledge and involves the abilities to analyze (C4), evaluate (C5), and create (C6) (Anderson et al., 2001; Brookhart, 2010; Phil et al., 2022). According to the 2018 Program for International Student Assessment (OECD, 2019), education in Indonesia ranks last regarding higher-order thinking skills (HOTS), including literacy and numeracy, essential for daily life. Scientific competence is ranked 70 out of 78 countries, reading competence is 72 out of 77, and competency scores in mathematics are ranked 72 out of 78. In the past 10 to 15 years, the value of this ability has stayed constant. These results were derived from the test results of the "Progress in International Literacy Study (PIRLS)" and the "Trends in International Mathematics and Science Study (TIMSS)." The majority of Indonesian

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students need to possess strong higher-order thinking skills.

Continuous evaluation of educational performance is required for teachers to enhance students' HOTS skills. The standard of learning activities and academic success are inextricably linked. The talents of the students are evaluated in order to evaluate educational performance. Assessment is learning about a person's abilities based on their traits (Phil et al., 2022). Teachers need assessments to identify student skills and support learning evaluation. This is because educational activities aim to improve students' abilities. Learning activities and academic achievement will be impacted by the quality of the assessment (Phil et al., 2022; Putri et al., 2021).

Assessment is a crucial component of education. For many years, educators have highlighted the significance of gauging pupils' capacity for mathematical thinking. Using a HOTS thinking skills evaluation is one method to accomplish this. Creating HOTS problem instruments is crucial for assessing how learners use critical thinking, logical reasoning, reflective thinking, metacognition, and creative thinking in mathematics. (Ocy, 2021; Phil et al., 2022; Suhady, Roza, & Maimunah, 2020;Tanujaya, 2016). Consequently, it is essential to have an assessment tool for mathematical subject matter based on the HOTS principle.

One area of math that students find particularly challenging and esoteric compared to other curriculum areas is trigonometry. The claim made by Jatisunda & Nahdi (2019) that trigonometry is a subject that most math students find challenging and that students frequently struggle with its application lends weight to this. Achieving mathematical disciplines like geometry and calculus requires a lot of trigonometry content. Gur (2009) argues that trigonometry is crucial since it is used in various scientific and practical contexts, including geography, navigation, and astronomy measurements.

Students need help applying trigonometry principles to real-world situations, which is one of the key reasons they perform poorly mathematically when studying trigonometry material. In addition, students find it challenging to model real-world trigonometry occurrences mathematically. According to the findings of a brief survey done by Ocy, Rahayu, & Makmuri (2021), students' poor mathematical abilities were brought on by their inability to apply the mathematics they had learned to real-world situations. Therefore, it takes more work to continue assessing and enhancing students' HOTS abilities in trigonometry material since answering difficulties on trigonometry problems and phenomena frequently encountered and applied in real life, which require realistic to abstract notions or vice versa, requires more effort.

Students are required to have the ability to develop ideas from concrete to abstract, commonly known as mathematical abstraction skills, in order to understand trigonometry (Cetin & Dubinsky, 2017; Syarifudin et al., 2021; Yusepa, 2017). Even though mathematical abstraction skills are covered in one part of HOTS abilities, they are critical but frequently overlooked thinking skills in students (Suhady et al., 2020). For example, abstracting, representing, building, and decontextualizing are all examples of mathematical abstraction skills (Fitriani et al., 2018; Hong & Kim, 2016; Kidron & Dreyfus, 2008; Mitchelmore & White, 2007; Pradesh, 2016). Students can build an idea using earlier concepts through mathematical abstraction (Hong & Kim, 2016; Pradesh, 2016). The ability of students to perceive qualities or characteristics, represent, coordinate, and develop to generalize an object or event mathematically was found to be the definition of mathematical abstraction. This makes it intriguing that students must have strong mathematical abstraction abilities to enhance their knowledge and higher-order thinking skills.

Ocy et al. (2021) surveyed by sending questionnaires to 112 high school math teachers in various institutions around the Riau Islands Province in April 2021. Data was accumulated. The capacity to abstract mathematics is the one that needs the most work and attention. That is to say, 79.5% of students have a lower level of modeling—the ability to abstract a problem into a mathematical phrase that can then be solved mathematically. This is consistent with the findings of Hadi, Retnawati, Munadi, Apino, & Wulandari (2018) study, which looked at students' struggles with HOTS problems and discovered that one of the challenges they encountered was having trouble creating mathematical models of their own. According to the findings of the explanation mentioned above, it is imperative to create a HOTS assessment tool on the topic of mathematical abstraction ability in order to gauge students' overall HOTS proficiency.

The contextual aspect of the HOTS evaluation tool is one of its key characteristics (Brookhart, 2010; King et al., 1998). According to Agustin, Ambarawati, & Era Dewi Kartika (2019), a mathematical notion inspired by or based on culture can effectively stimulate students' thinking processes. Mathematics based on cultural traditions might encourage students to become more interested and motivated in mathematics by incorporating the surrounding natural environment (Alfiatin & Oktiningrum, 2019; Hera et al., 2021; Pramesti & Rasmanto, 2021; Yuliani et al., 2022). This is consistent with the ideas of Maimunah, Izzati, & Dwinata's (2019) research findings, which stated that students' interest in mathematics, which is continuing to grow, will make it easier for students to recognize the fact that mathematics is more than a subject learned in a classroom and has real-world applications.

A "culture-based assessment" type prioritizes students' experiences and activities from various cultural backgrounds and incorporates them into the mathematics evaluation process. The term "mathematical activity" refers to any application where mathematics is employed to abstract from real-world experience or vice versa. This includes grouping, counting, measuring, designing tools or structures, making patterns, counting, determining locations, playing, and explaining, among other activities. For instance, Alfiatin & Oktiningrum (2019) developed a HOTS instrument based on East Javanese culture (Nganjuk, Java, Malang, and Madura) to assess students' ability to reason, and Khoriyah & Oktiningrum (2021) used Blitar local culture to create HOTS-style math problems, the findings of this study suggest that a mathematical assessment tool with a local wisdom background can also be an engaging and contextual stimulus because it is closely related to everyday life realities, such as the school environment or the local area, which sparks interest and encourages students to investigate problems further. Using the cultural aspects will give students fresh engagement in the matter. This meets the criterion for HOTS inquiries, which stipulates that HOTS problems must be novel and unfamiliar to students (Brookhart, 2010; Ghanizadeh et al., 2020; Schraw & Robinson, 2011; Supianti et al., 2021).

However, no previous research has attempted to uncover an evaluation tool in the form of an assessment instrument by incorporating aspects of local culture, such as the culture of the Riau Islands Province, as a contextual stimulus in light of the urgency of the importance of measuring students' HOTS-based mathematical abstraction abilities in depth. Therefore, this study was conducted to explore: 1) how is the content validity of the HOTS instrument for trigonometry comparison material on the aspect of mathematical abstraction ability following the cultural context of the Riau Islands Province; and 2) what are the results of developing the HOTS instrument for trigonometry comparison material on the aspect of mathematical abstraction ability following the cultural context of the Riau Islands Province. The findings of this study are crucial for the growth of mathematics learning in Indonesia, as it represents the skills needed in the twenty-first Century.

II. Research Method

This research is a development study that produces a product, namely a HOTS-based trigonometry instrument with Riau Islands culture, to assess students' mathematical abstraction abilities. HOTS items include three cognitive levels, namely, analyze (C4), evaluate (C5), and create (C6) (Aisjah & Tajunnisa, 2018; Magdalena et al., 2020). At the same time, abilities include the level of mathematical abstraction, namely perceptual abstraction, internalization, Interiorization, and the second level of Interiorization (Hong & Kim, 2016). The research indicators based on Hong & Kim's (2016) research can be seen in Table 1.

Table 1.
Mathematical abstraction ability indicator

Abstraction Level	Indicator
Perceptual Abstraction	Learn the properties of mathematical objects by utilizing physical objects
	Learn about prior experience that relates to the current issue.
Internalization	Representing the conclusions of cognition using mathematical symbols, phrases, or images (such as diagrams, graphs, or other visual representations).
	Able to solve/manipulate problems.
Interiorization	Arranging ideas into new understandings or knowledge by gathering, collating, developing, and coordinating them.
Second Level of Interiorization	Apply new knowledge broadly in various situations.

This study used a 4D model converted to 3D as the development model. S. Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel created the 4D model in 1974 using the processes of Define, Design, Develop, and Disseminate (Sugiyono, 2009). The development process, however, was only completed up until the development stage in this study.

The instruments developed are subsequently put through a content validation process that includes panel and expert assessment. Expert judgment is carried out to examine the instrument in terms of construct accuracy, indicator accuracy, and item accuracy in measuring indicators (Djaali & Muljono, 2008). After receiving feedback from the experts, the researcher made revisions in response to their feedback and recommendations until all of the experts approved of the instrument being constructed.

Three mathematics education experts were consulted to assess the content validity from the viewpoint of the item questions' suitability for the topic of study. This is consistent with Shrotryia & Dhanda's (2019) recommendation that three subject-matter experts be consulted to evaluate an item's content validity. Additionally, Yazdanmehr & Akbari (2015) criteria were used to select the field experts for this study, according to which the experts should have specific experience, such as being a senior lecturer in mathematics education, and they should actively participate in studies that are related to their field, like the management of mathematics learning. This covers elements like matching the content of trigonometry to students' cognitive abilities, the level of challenge of the questions based on the three HOTS levels, the caliber of the questions following Indonesian exam standards, and the consistency of the exams.

The Content Validity Rubric requires experts to show the content validity index for each item (I-CVI). By completing the "Expert Review" column, they can also provide recommendations for improvement or point out any flaws found in each item. I-CVI is calculated by considering the typical conformance level reported by experts. Polit & Beck (2006) suggested utilizing Lynn's criteria (I-CVI = 1 with 3 or 5 experts and a minimum I-CVI of 0.78 for 6 to 10 experts) to calculate the I-CVI. I-CVI were determined in this investigation using the following formula (Polit & Beck, 2006):

$$\text{CVI for item (I} - \text{CVI)} = \frac{\text{Number of agreement}}{\text{number of expert}}$$

All comments made by experts are employed in addition to the critical I-CVI index to refine the items further. This is highly beneficial for enhancing the test instrument's content. The researcher then tested the instrument's contents using a panel test to demonstrate whether the instrument was appropriate. Regarding the test panel, 1 (one) for appropriate and 0 (zero) for improper criteria were used.

While the “Expert Judgement” is a team of specialists made up of lecturers in mathematics education who hold doctorates in mathematics education, “Panelists Validation” is a team of math educators and instructors of high school math. There were 17 participants in the panelist's validation. The panelists reiterated the content validity of the instruments to be utilized in the study. The CVR (Content Validity Ratio), created by Lawshe (1975), is the approach used to analyze the content validity of the panelists' evaluation. Using areas of competence in mathematics and evaluation, this method gauges how much the panelists agree on the significance of each instrument item.

The researcher then used the CVR (Content Validity Ratio) to calculate the assessment outcomes after the panelists had evaluated the instrument. The Lawshe CVR formula is as follows (Lawshe, 1975).

$$CVR = \frac{M_P - \frac{M}{2}}{\frac{M}{2}} = \frac{2M_P}{M} - 1$$

Information:

M_p = the number of experts who stated that it was appropriate

M = the number of experts who validate

The probable CVR values fall within the range of -1 to 1. The validity value of an item or item increases as the CVR score approaches or equals one and decreases as the CVR number approaches or equals one (near -1 or -1) (Lawshe, 1975).

The research instrument is provided to respondents once it satisfies the requirements of an acceptable or standard instrument. A small-scale test was administered to 20-grade 10th high school students to identify mistakes for further correction. Small-scale trials test newly designed instrument items in a controlled and relatively small setting. This allows us to forecast how the instrument items perform on a larger scale. Before being used on a larger scale, small-scale trials can assist in finding issues and mistakes in instrument items.

III. Results and Discussion

Content Validity by Expert Judgement

The HOTS domain's three cognitive levels—analyzing, evaluating, and creating—were employed in this study to create the instrument items. Expert judgment is a team of specialists made up of lecturers in mathematics education who hold doctorates in mathematics education, assessed and scored each item to confirm its degree of accuracy. The experts who contributed to the assessment are listed in Table 2.

Table 2.
Summary of experts’ background

Expert	Position	Field of Expertise	Institution	Highest Education Level
P1	Senior Lecturer	Mathematics and Sciences Education	State University of Jakarta	Ph.D
P2	Senior Lecturer	Mathematics Education	State University of Jakarta	Dr
P3	Senior Lecturer	Mathematics Education	State University of Jakarta	Dr

The experts were given an instrument and a questionnaire to fill out in order to assess the content validity of each test item after the validator agreed to participate in the study. The I-CVI scores for each test item reviewed by the experts are shown in Table 3.

Table 3.
Content Validity Scores for the Instruments Items

HOTS Level	Mathematical Abstraction Level	Type of Question	Item Number	Number of Experts	Number of Agreement	I-CVI	Status
C5	Internalization	Multiple Choice	1	3	3	1,00	Appropriate
C5	Internalization	Multiple Choice	2	3	3	1,00	Appropriate
C4	Perceptual Abstraction	Multiple Choice	3	3	3	1,00	Appropriate
C4	Perceptual Abstraction	Multiple Choice	4	3	3	1,00	Appropriate
C4	Perceptual Abstraction	Multiple Choice	5	3	1	0,33	Eliminated
C4	Perceptual Abstraction	Multiple Choice	6	3	1	0,33	Eliminated
C5	Internalization	Essay	7	3	3	1,00	Appropriate
C5	Internalization	Multiple Choice	8	3	3	1,00	Appropriate
C5	Internalization	Multiple Choice	9	3	3	1,00	Appropriate
C5	Internalization	Multiple Choice	10	3	3	1,00	Appropriate
C5	Internalization	Multiple Choice	11	3	3	1,00	Appropriate
C5	Internalization	Multiple Choice	12	3	3	1,00	Appropriate
C5	Internalization	Multiple Choice	13	3	0	0	Eliminated
C4	Perceptual Abstraction	Multiple Choice	14	3	3	1,00	Appropriate
C4	Perceptual Abstraction	Multiple Choice	15	3	3	1,00	Appropriate
C6	SecondSecond level of Interiorization	Multiple Choice	16	3	3	1,00	Appropriate
C6	SecondSecond level of Interiorization	Multiple Choice	17	3	3	1,00	Appropriate
C4	Perceptual Abstraction	Essay	18	3	3	1,00	Appropriate
C5	Internalization	Multiple Choice	19	3	1	0,33	Eliminated
C5	Internalization	Multiple Choice	20	3	1	0,33	Eliminated
C4	Perceptual Abstraction	Essay	21	3	3	1,00	Appropriate
C6	SecondSecond level of Interiorization	Essay	22	3	3	1,00	Appropriate
C4	Perceptual Abstraction	Multiple Choice	23	3	3	1,00	Appropriate
C4	Perceptual Abstraction	Multiple Choice	24	3	3	1,00	Appropriate
C5	Interiorization	Multiple Choice	25	3	3	1,00	Appropriate
C6	Interiorization	Multiple Choice	26	3	3	1,00	Appropriate
C5	Internalization	Essay	27	3	3	1,00	Appropriate
C5	Perceptual Abstraction	Essay	28	3	3	1,00	Appropriate
C5	Interiorization	Multiple	29	3	3	1,00	Appropriate

HOTS Level	Mathematical Abstraction Level	Type of Question	Item Number	Number of Experts	Number of Agreement	I-CVI	Status
		Choice					
C5	Interiorization	Multiple Choice	30	3	3	1,00	Appropriate

After determining the content validation index for each item, it can be concluded that not all questions are feasible and acceptable because the I-CVI scores in items 5, 6, 13, 19, and 20 are not 1.00. Since the number of validators, there are 3 experts (P1, P2, and P3), then the value of I-CVI must be equal to 1,00, according to Polit & Beck (2006). The expert judgment's findings led to the elimination some instrument items, including items 5, 6, 13, 19, and 20. The summary in the form of comments and recommendations on the inspection results for instrument improvement can be seen in Table 4.

Table 4.
Expert judgment validation comments and recommendations

Experts	Experts Review
P1, P2	Items 3 and 4 are comparable to items 5 and 6 in context, so those items should be removed or replaced with others with a distinct context. Pay attention to the choice of words and language, and improve the writing on the instrument, especially the writing of mathematical symbols.
P1, P3	The context in point 13 does not apply to the Riau Islands' culture; therefore, the item should be replaced with another context.
P1	Items 19 and 20 do not meet the C4 HOTS level category; items should be corrected or eliminated. It is suggested that the instrument be created from the routine mathematical instruction high school students in Tanjung Pinang regularly experience.

According to (Creswell & Creswell, 2018), field experts' evaluations, comments, and opinions can be used to determine a test's content validity. All suggestions and comments are considered when making changes to the instrument. Table 5 provides a single instance of the enhancements applied to the instrument

Table 5.
A single instance of instrument design

Instrument Qualification Card	
Identity	Cognitive Level: C6
Subject: Mathematics Class/Semester: X/I Material: Trigonometry Comparisons Author: Dwi Rismi Ocy	Basic Competence: Solving contextual problems related to trigonometry comparisons Question Type: Multiple Choice Abstraction level: Second level of Interiorization Indicator: Students can generalize new knowledge in different contexts regarding trigonometry comparisons
Stimulus	

Figure 1. Dragon boat

The Dragon Boat Race has been held since 1922. This event was originally held at sea, but due to various considerations, the race has been held on the Carang River since 2014. In the Carang River, there is a Gugus Bridge which is the icon of the Carang River. The Gugus Bridge is a bridge that crosses the Carang River,

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Instrument Qualification Card

Tanjung Pinang City, Riau Islands, which connects the cities of Tanjung Pinang and Senggarang.

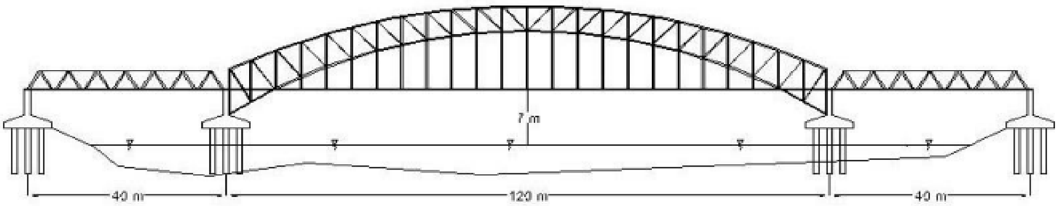

Figure 2. Gugus bridge's structure

The Gugus Bridge spans 200 meters, with a free height of the bridge to the water surface of 7 meters.

The Question Before Revision

A dragon boat with a depression angle of 12° is seen by someone standing above the Gugus Bridge. Six seconds later, the same boat is seen with a depression angle of 45°. Which of the following statements is true if the spectator's height, measured from the eyes, is 150 cm? (Note: tan 12° equals 0.2125)

A. In 6 seconds, the boat has traveled a distance of 40 meters
B. In 6 seconds, the boat has traveled a distance of 30 meters
C. In 6 seconds, the boat only traveled 30 meters
D. In 6 seconds, the boat only traveled 10 meters
E. In 6 seconds, the boat has traveled only 40 meters

Discussion

Look at the following illustration:

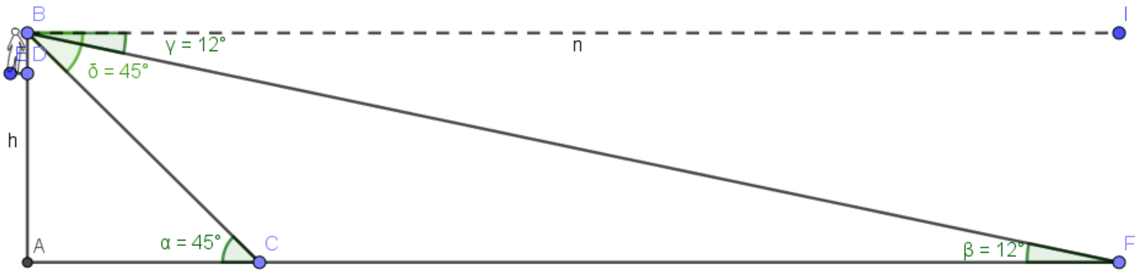

Figure 3. Mathematical illustration of the events

Is known:

- Bridge height = AD = h = 7 meters
- Audience height = BD = 150 cm = 1.5 meters
- Initial depression angle = 12°
- The angle of depression after 6 seconds = 45°

Asked: the distance traveled by boat in 6 seconds (CF distance)?

Answer:

We must first determine the AC distance to determine the CF distance.

Estimate the AC's distance.

$\tan 45° = \frac{AB}{AC}$

$\tan 45° = \frac{AD+BD}{AC}$

$1 = \frac{7+1.5}{AC}$

$AC = 8.5$ meters

Given the distance covered in 6 seconds (CF distance)

$\tan 12° = \frac{AB}{AF}$

$\tan 12° = \frac{AD+BD}{AC+CF}$

$0.2125 = \frac{7+1.5}{8.5+CF}$

$0.2125\,(8.5 + CF) = 8.5$ (multiply both sides by 10000)

$2125(8.5 + CF) = 85000$

Instrument Qualification Card

$8.5 + CF = \frac{85000}{2125}$

$8.5 + CF = 40$

$CF = 40 - 8.5 = 31.5$ meters

Therefore, in 6 seconds, the dragon boat traveled 31.5 meters.

Analyze the answer:

A. For 6 seconds, the boat has traveled a distance of 40 meters (false, because for 6 seconds, the boat only covered a distance of 31.5 m and had not yet reached 40 meters)
B. For 6 seconds, the boat has traveled a distance of 30 meters (correct, because for 6 seconds, the boat traveled 31.5 meters, after having previously traveled 30 meters)
C. In 6 seconds, the boat only traveled 30 m (false, because for 6 seconds, the boat travels a distance of more than 30 meters, which is 31.5 meters)
D. In 6 seconds, the boat only traveled 10 meters (false, because for 6 seconds, the boat travels a distance of more than 10 meters, which is 31.5 meters)
E. In 6 seconds, the boat only traveled 40 meters (false, because for 6 seconds the boat only reached a distance of 31.5 meters. Not reaching 40 meters)

Answer: B

For 6 seconds, the boat has traveled a distance of 30 m (Because in 6 seconds the boat has traveled a distance of 31.5 m, it means that it has traveled a distance of 30 m)

Expert Review:

This question is more suitable for cognitive level C5 but needs to be more complex for the C6 cognitive level and this level of abstraction. By involving elements of other knowledge, such as physics or other sciences, this question will be better and more challenging for students.

The Question After Revision

A person in the crowd who stands approximately 150 cm tall and has a depression angle of 12° watches the dragon boat from the Gugus Bridge. The observer noticed the same boat with a depression angle of 45° six seconds later. How long will it take the dragon boat, going at a constant pace, to get beneath the bridge where the person is standing? (Note: Velocity $(v) = \frac{Displacement(d)}{Time\ (t)}$, and $tan\ 12° = 0.2125$)

A. The boat is under the bridge for 4 seconds
B. The boat is under the bridge at 6 seconds
C. The boat is under the bridge at 8 seconds
D. The boat is under the bridge for 10 seconds
E. The boat is under the bridge at 12 seconds

Discussion

Look at the following illustration:

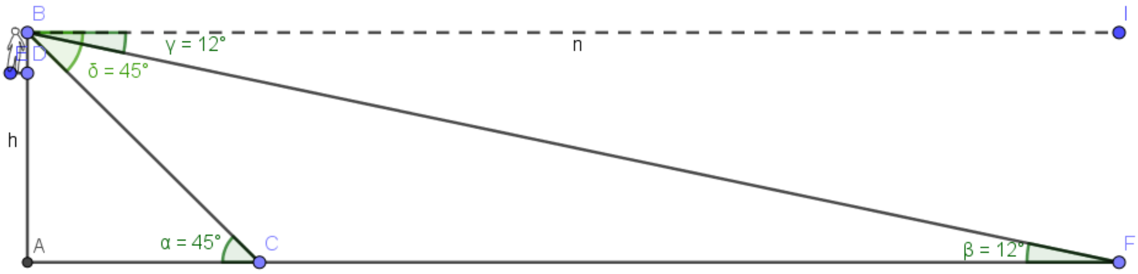

Figure 3. Mathematical illustration of the events

is known:

- Bridge height = AD = h = 7 meters
- Audience height = BD = 150 cm = 1.5 meters
- Initial depression angle = 12°
- The angle of depression after 6 seconds = 45°

Asked: How many seconds will the boat be directly under the bridge where the spectators are standing (at point A)?

Answer:

We must determine the CF distance to determine how many seconds the boat is under the bridge where the

Instrument Qualification Card
audience stands. First, determine the AC distance in order to determine the CF distance. $\tan 45° = \frac{AB}{AC}$ $\tan 45° = \frac{AD+BD}{AC}$ $1 = \frac{7+1.5}{AC}$ $AC = 8.5$ meters The distance covered in 6 seconds (CF distance) $\tan 12° = \frac{AB}{AF}$ $\tan 12° = \frac{AD+BD}{AC+CF}$ $0.2125 = \frac{7+1.5}{8.5+CF}$ $0.2125\ (8.5 + CF) = 8.5$ (multiply both sides by 10000) $2125(8.5 + CF) = 85000$ $8.5 + CF = \frac{85000}{2125}$ $8.5 + CF = 40$ $CF = 40 - 8.5 = 31.5$ meters Therefore, in 6 seconds, the dragon boat traveled 31.5 meters. Next, we will look for the Velocity of the boat using the formula of Velocity. $Velocity\ (v) = \frac{Displacement(d)}{Time\ (t)}$ $v = \frac{31.5\ meters}{6\ seconds}$ $v = 5.25\ m/s$ In the 6th second, the dragon boat has covered a distance of 31.5 meters. When the boat is directly under the bridge, it means the boat has traveled as far as AF. AF distance $= AC + CF = 8.5\ m + 31.5\ m = 40\ m$, with a velocity of $5.25\ m/s$, therefore: $Velocity\ (v) = \frac{Displacement(d)}{Time\ (t)}$ $5.25\ m/s = \frac{40\ meters}{}$ $t = \frac{40\ meters}{5.25\ m/s}$ $t = 7{,}6\ seconds \approx 8\ seconds$ Therefore, at 8 seconds, the boat is beneath the bridge. **Answer**: C The boat is under the bridge at 8 seconds.

The dragon boat race is a traditional water sport with deep cultural roots in the Riau Islands Province of Indonesia. It serves as a local context to showcase and preserve the region's cultural heritage. The race involves teams of paddlers rowing in sync to the beat of a drum, propelling a long and narrow boat through the water. Incorporating the dragon boat race as a local context in educational settings can provide students with a meaningful and engaging way to learn various subjects, including mathematics. One specific area where this connection can be made is trigonometry, particularly when exploring concepts related to Velocity. As seen in Table 5, the questions before the revision did not contain elements of physics. The questions are only designed so that students can analyze changes in the distance of a dragon boat at a certain time by involving trigonometry comparisons.

According to the input and directions from the experts who have reviewed it, the questions on the instrument were modified by adding an element of physics, namely Velocity. Trigonometry has numerous real-world applications, including physics and navigation. By incorporating elements of physics, such as Velocity, into trigonometry lessons using the dragon boat race as a context, students are expected to develop their Higher Order Thinking

Skills (HOTS) in mathematical abstraction abilities. In dragon boat racing, Velocity is crucial in determining how fast a team can propel their boat through the water.

To incorporate Velocity into trigonometry lessons using the dragon boat race as a context, students can explore various mathematical concepts. For example, students can evaluate the distance traveled by a dragon boat and the amount of time it takes to arrive at a specific location by using the concept of trigonometry from various angles, as shown in the instrument design in Table 5. Furthermore, students can apply trigonometric functions to determine how the angle affects the boat's distance and Velocity.

Panelists Validation

The panelists were required to test a total of 25 items. The panelists were required: (1) to determine whether the dimensions chosen are acceptable for assessing the constructs of the variables being assessed and accurately describe the constructs that have been chosen; (2) to determine whether the indicators that have been formulated are the exact descriptions of the dimensions that have been formulated and are suitable for measuring the constructs of the variables to be measured; and (3) to determine whether the items of the instrument made are appropriate for measuring the indicators of the variable to be measured. According to the CVR findings, all 25 items are viable for inclusion in future studies. The CVR ratings are displayed in Table 6 for each item subjected to the panelists' review.

Table 6.
CVR value for the instrumen items

No	HOTS Level	Mathematical Abstraction Level	Item Number	Number of Experts	Number of Agreement	CVR	Criteria
1	C5	Internalization	1	17	17	1,00	Appropriate
2	C5	Internalization	2	17	17	1,00	Appropriate
3	C4	Perceptual abstraction	3	17	16	0,882	Appropriate
4	C4	Perceptual abstraction	4	17	17	1,00	Appropriate
5	C5	Internalization	7	17	17	1,00	Appropriate
6	C5	Internalization	8	17	17	1,00	Appropriate
7	C5	Internalization	9	17	17	1,00	Appropriate
8	C5	Internalization	10	17	16	0,882	Appropriate
9	C5	Internalization	11	17	16	0,882	Appropriate
10	C5	Internalization	12	17	17	1,00	Appropriate
11	C4	Perceptual abstraction	14	17	17	1,00	Appropriate
12	C4	Perceptual abstraction	15	17	16	0,882	Appropriate
13	C6	The second level of Interiorization	16	17	16	0,882	Appropriate
14	C6	The second level of Interiorization	17	17	16	0,882	Appropriate
15	C4	Perceptual abstraction	18	17	17	1,00	Appropriate
16	C4	Perceptual abstraction	21	17	15	0,765	Appropriate
17	C6	The second level of Interiorization	22	17	17	1,00	Appropriate
18	C4	Perceptual abstraction	23	17	17	1,00	Appropriate
19	C4	Perceptual abstraction	24	17	17	1,00	Appropriate
20	C5	Interiorization	25	17	16	0,882	Appropriate
21	C5	Interiorization	26	17	17	1,00	Appropriate
22	C5	Internalization	27	17	16	0,882	Appropriate
23	C4	Perceptual abstraction	28	17	16	0,882	Appropriate

No	HOTS Level	Mathematical Abstraction Level	Item Number	Number of Experts	Number of Agreement	CVR	Criteria
24	C5	Interiorization	29	17	16	0,882	Appropriate
25	C5	Interiorization	30	17	16	0,882	Appropriate

Table 6 demonstrates that the panelists' testing of the 25 items produced positive findings. This is evident from the instrument's CVR value, which is 1,00 or close to 1,00. This shows that each mathematical abstraction indication with the HOTS level to be evaluated complies with the developed instrument. So that the tools that have been created and tested, both in terms of content and structures, can be utilized in the field as a measuring tool for students' propensity for mathematical abstraction for upcoming study.

Small Scale Trials

A small-scale test was conducted on 20-grade 10th high school students in Tanjung Pinang with various educational backgrounds. Each student is given 120 minutes to answer the instrument. The small-scale test results showed that the designed instrument generated enthusiasm and curiosity for students to explore problems in learning trigonometry comparison material more deeply. This is indicated by the emergence of many statements raised by students regarding the solutions to problems that exist in the instrument, such as how an angle can greatly affect many things in mathematics, such as Velocity, volume, area, shape of traditional houses, bridge structures, and many more.

Mathematical abstraction ability is closely linked to problem-solving skills and critical thinking. Since this instrument provides a structured framework for analyzing the problem, exploring different scenarios, and deriving potential solutions, the results show that the instrument enables students to break down complex problems into simpler components, identify relevant variables, and establish connections between them. By abstracting the problem's essential elements, students can create mathematical models that represent the problem accurately. This is demonstrated by 12 out of 20 students receiving scores that exceeded the Criteria for Achieving Learning Objectives (KKTP).

That is why the ability of mathematical abstraction is very important to be mastered by students. The instrument involves identifying common patterns, properties, and relationships among different mathematical objects and using them to develop new theories, solve problems, and make predictions. This instrument proves that mastering mathematical abstraction provides students with a solid foundation in mathematics and equips them with essential skills applicable in various fields.

However, some students needed help to answer questions on the instrument. This is shown by 8 out of 20 students scoring below the Criteria for Achieving Learning Objectives (KKTP). One of the obstacles found is that students need help connecting one mathematical concept with another. Students need help to identify the similarities with other problems in different fields. Some students need help relating trigonometry comparison material with other mathematical concepts such as volume, area, and Pythagoras.

As for the student responses in answering the questions in Table 5, 4 out of 20 students answered the questions correctly. This proves that the instrument that has been developed can function properly. As for 16 out of 20 students who could not answer the questions correctly, this shows the need to improve HOTS abilities in the aspects of students' mathematical abstraction and the need for breakthroughs in the learning process related to trigonometry comparisons. From the results of small-scale tests, it can be concluded that the instrument is ready to be used on a large scale.

Discussions

Mathematics is not just about memorizing formulas and procedures; it is a dynamic field that encourages exploration and discovery. By abstracting specific problems or concepts, students are encouraged to think outside the box and develop novel approaches or solutions. This creative aspect of mathematics allows students to develop strategies and explore alternative methods.

The instruments in this study were specifically designed so that students could develop HOTS abilities in aspects of mathematical abstraction. This ability is crucial in solving complex real-life problems across various domains. This instrument contains various real-life issues closely related to the culture of the Riau Islands Province, such as dragon boat races, traditional houses, musical instruments, and fine arts. Table 5 is only one example of twenty-five problems that have been revised and developed related to trigonometry comparison lessons. This instrument's development involved some cultural and mathematical components. For example, Table 5 contains material on trigonometry comparisons, and the problems developed also contain physics, such as Velocity.

The connection between Velocity and the concept of trigonometry in developing HOTS instruments lies in mathematical abstraction ability. In developing HOTS instruments, the connection between Velocity and trigonometry arises from the need to analyze and solve complex problems. Students can develop their mathematical abstraction ability by understanding the relationship between Velocity and trigonometry by applying abstract concepts to real-world situations.

Mathematical abstraction refers to the ability to identify and understand underlying mathematical structures and concepts, even when presented in different contexts or representations. This is shown in the instrument not only Velocity; other mathematical concepts are also related to this instrument, such as volume, area, distance, and the concept of Pythagoras. The involvement of other mathematical concepts and other sciences that overlap with trigonometry comparison material makes this instrument very challenging for students. As for the influence of the interrelatedness of other mathematical concepts such as volume, area, surface area, and others that exist in the instrument, it demands students to solve complex problems and think critically and creatively in solving problems. However, this instrument also attracts students' attention. This is evidenced by the enthusiasm of students when solving the questions.

The Riau Islands Province in Indonesia is known for its rich cultural heritage. The local culture of the province plays a significant role in shaping various aspects of life, including education. In the context of developing the HOTS instrument on the aspect of mathematical abstraction, understanding the connection between the culture of the Riau Islands Province and the development of this instrument is crucial. One way the culture of the Riau Islands Province can influence the development of HOTS instruments on mathematical abstraction is by incorporating local examples and contexts. This approach helps bridge the gap between abstract mathematical ideas and real-life experiences, making learning more meaningful and engaging for students.

It is important to note that while incorporating local cultural elements into the development of HOTS instruments can enhance students' engagement and understanding, it should be done in a way that does not exclude or disadvantage students from different cultural backgrounds. The instruments should be inclusive and provide opportunities for all students to demonstrate their mathematical thinking and abstraction skills, regardless of their cultural context.

IV. Conclusion

The HOTS instrument on mathematical abstraction ability using Riau Islands Province's cultural norms developed up to 30 items, comprising 6 essay items and 24 multiple choice items. The items developed consist of 4 levels of mathematical abstraction ability: perceptual abstraction, internalization, Interiorization, and second level of Interiorization.

The results of instrument content validity at the expert judgment show that the I-CVI index value is equal to 1.00 for 25 items, and for the other 5 items, the I-CVI value is equal to 0.33. Only 25 questions passed to the next stage, namely the panelist validation stage. The results of instrument content validity at the panelist validation stage can be seen from the index value of the Content Validity Ratio (CVR) score. The CVR value in the panelist test of 25 items is greater than 0.765, meaning that the 25 items developed are valid in content. This study resulted in a HOTS instrument on mathematical abstraction ability using the Riau Islands Province with 25 items proven valid in content and appropriate for use on a large scale.

With HOTS instruments in the aspect of mathematical abstraction that has been reviewed and approved by doctoral lecturers through the expert judgment stage, declared valid in terms of content at the panelist validation stage, and been tested on a small scale, the overall results show that the instrument can be used in a large scale. The instrument enables students to break down complex problems into simpler components, identify relevant variables, and establish connections between them. By incorporating local examples and contexts, aligning with cultural values, and integrating cultural practices related to trigonometry comparison material, the instruments become more relevant, engaging, and meaningful for students. However, ensuring inclusivity and equal opportunities for all students to demonstrate their mathematical abstraction skills is crucial.

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