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TRISAS Media: Bridging Cognitive Styles to Foster Student Engagement in Trigonometric Learning

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Abstract: This research aims to develop and assess the feasibility of the TRISAS media based on the FD-FI cognitive style, which is valid, practical, and effective in enhancing students' engagement in learning trigonometry. The development study employs the ADDIE model, which encompasses the phases of analysis, design, development, implementation, and evaluation. A trial was conducted with 26 students from class X at a vocational school in Sukoharjo, Central Java Province. The research instruments include an expert validation sheet to evaluate validity, a student response questionnaire to assess practicality, and a student learning activity questionnaire to measure the effectiveness of the media. The findings indicate that the TRISAS media meets the criteria of being highly valid based on expert assessments of content and media, very practical according to positive student feedback, and effective in enhancing student learning engagement, although the improvement is categorized as moderate. Therefore, the TRISAS media is deemed suitable as an alternative inclusive learning medium that adapts to the diverse cognitive styles of students in mathematics education.

Keywords: Cognitive style; inclusive; trigomometry.

INTRODUCTION

Inclusive education has emerged as a primary approach to ensure equitable learning access for all students, including those with diverse needs such as disabilities, learning barriers, cultural diversity, and variability in learning styles (Salsabila et al., 2021; Ainscow, 2020). In the contemporary paradigm, inclusive education not only emphasizes the modification of teaching strategies but also involves efforts to eliminate structural barriers, provide access for students with different needs, and implement the principles of Universal Design for Learning (UDL), which prioritize flexibility in representation, action-expression, and engagement in learning (CAST, 2018; Meyer et al., 2014). Nevertheless, the practice of inclusive education in classrooms still faces challenges, particularly in providing learning media that can accommodate the diverse ways in which students receive and process information, including differences in cognitive styles.

Keefe (in Uno, 2006) defines cognitive style as the distinctive way individuals receive, process, and organize information. Messick (in Nasution, 2006) further adds that cognitive style reflects an individual's approach to perceiving, remembering, thinking, problem-solving, and decision-making. In the study of learner variability (Tomlinson, 2017; Venezia & Quinn, 2022), cognitive style is viewed as one dimension of the natural variability among learners that necessitates a flexible learning environment. This research focuses on two types of cognitive styles developed by Witkin et al. (1977), namely field dependent (FD) and field independent (FI).

Individuals classified as Field Dependent (FD) tend to process information in a holistic manner and are significantly influenced by the prevailing context, whereas Field Independent (FI) individuals exhibit a more analytical approach, capable of isolating information elements and reasoning independently (Alifah & Aripin, 2018). FD students require explicit guidance and social support, while FI students are more responsive to independent exploration (Ulandari et al., 2025). Conventional linear and non-adaptive learning media often fail to accommodate these differences, thereby creating learning barriers that contradict the principles of UDL (CAST, 2018; Rose & Dalton, 2009).

Nevertheless, it is crucial to acknowledge that the cognitive style framework, particularly the FD-FI model, has faced criticism in contemporary literature for being perceived as having predictive validity that is not always consistent and for tending to oversimplify the complexities of cognitive processes (Kozhevnikov, 2007; Tinajero & Páramo, 2012). However, such criticism does not negate the practical value of FD-FI within the context of instructional design. The FD-FI model remains pertinent when it is viewed not as a rigid psychological label, nor as an analogy for disability, but rather as a natural cognitive variability that can influence student accessibility and engagement during learning (Florian, 2015; Booth & Ainscow, 2011). Thus, the integration of FD-FI in this research aims to enhance the understanding of how digital media can be designed to align with the diverse ways in which students process information within a broader framework of inclusive education.

Previous research on inclusive learning has predominantly concentrated on the VAK (Visual-Auditory-Kinesthetic) learning styles (Amaliani et al., 2024; Adi et al., 2025), whereas the cognitive style-based FD–FI approach remains relatively underexplored in adaptive media design. However, integrating cognitive styles into media design can enhance the principles of UDL, particularly in providing diverse pathways for representation and expression (Meyer et al., 2014). This is especially pertinent in technology-based mathematics education, where media flexibility can reduce access barriers and increase opportunities for all students to engage optimally.

To address this gap, this research develops TRISAS (Trigonometry Safari with Articulate Storyline), an interactive learning medium designed to accommodate the diverse cognitive styles of FD and FI in trigonometry education for tenth-grade vocational school students. TRISAS offers a structured guide, dominant visuals, and narrative context for FD students, while also providing opportunities for independent exploration, problem-solving activities, and flexible interaction for FI students. By integrating digital technology and UDL principles, TRISAS aims to deliver an inclusive and adaptive learning experience.

The novelty of this research lies in the integration of three key aspects: digital technology, cognitive style-based interactivity, and a socio-emotional approach aimed at enhancing both understanding and engagement The TRISAS media not only presents content flexibly but also facilitates collaboration for FD students and provides exploratory challenges for FI students. Consequently, the objective of this study is to develop TRISAS media focused on trigonometry content, tailored to different cognitive styles, as a learning tool to improve conceptual understanding and student engagement.

METHOD

This research is a development study aimed at producing TRISAS media based on differences in cognitive styles to enhance student engagement in learning. The development model employed is ADDIE, which consists of the stages of Analysis, Design, Development, Implementation, and Evaluation as formulated by Branch (2009). The evaluation of media quality is conducted based on three main criteria: validity, practicality, and effectiveness, in accordance with the guidelines set forth by Nieveen (1999). This study involved 26 students from class X at a Vocational High School in Sukoharjo Regency, selected through purposive sampling techniques. All students had previously studied the material on trigonometric comparisons. The characteristics of the students' cognitive styles were identified using the Group Embedded Figures Test (GEFT). Based on the scoring results from the GEFT, 18 students were identified as having a FD cognitive style, while 8 students exhibited a FI cognitive style. This distribution serves as the foundation for the analysis of differentiated media utilization and the measurement of engagement within each cognitive style group.

Data collection was carried out through interviews, observations, expert validation, and questionnaires. Expert validation involved two media experts and two content experts. The media experts included a lecturer in Mathematics Education from Ahmad Dahlan University and a professional multimedia animator, while the content experts comprised a Mathematics Education lecturer and a mathematics teacher from a vocational high school. The validation tools for both media and content experts consisted of thirteen items each, utilizing a 5-point Likert scale. Student responses were evaluated using a 12-item questionnaire with a 4-point scale to measure practicality. Additionally, student engagement was assessed through a 9-item questionnaire administered both prior to and following the implementation.

In this study, the concept of "inclusive learning" is defined as the media's ability to provide an equitable learning experience for students with both FD and FI cognitive styles. The indicators of inclusivity are analysed by comparing engagement scores and learning outcomes between the two groups. Meanwhile, student engagement in learning is operationalized through the triangulation of three methods: a self-report questionnaire assessing visual, verbal, and written activities behavioural observations during the learning process; and task completion metrics recorded in the TRISAS system, such as completion time, number of attempts, and success rates of steps. This triangulation approach is employed to enhance the validity of the findings and to avoid reliance on a single data source.

The development of TRISAS media through the ADDIE model is conducted using an analytical approach that explicitly integrates the needs of cognitive styles. In the Analysis phase, researchers identify the issues related to low learning engagement and map students' cognitive styles using the GEFT. The Design phase focuses on creating differentiated learning experiences for FD and FI students. The Development phase is realized by implementing distinct adaptive features for both groups. During the Implementation phase, the media is applied in the classroom to observe the responses and usage patterns of FD and FI students. Finally, the Evaluation phase is utilized to assess the quality and effectiveness of the media based on quantitative data, student feedback, and observational results.

The adaptation based on cognitive styles serves as the core innovation of TRISAS. For Field Dependent students, the media offers a guided learning pathway with structured stages, the use of contextual storytelling, emphasis on visual elements, explicit instructions, collaborative activities, and step-by-step guidance. Conversely, for Field Independent students, the media provides the freedom to explore through flexible navigation, analytical challenges, a minimalist display to reduce cognitive load, independent problem-solving activities, and access to in-depth materials such as proofs or mathematical generalizations. This adaptation is realized through differences in the sequence of content, variations in the level of scaffolding, distinct interactive components, and alternative navigation structures within a single media framework.

All research instruments demonstrated good reliability based on the Cronbach's Alpha analysis. The material validation instrument had a reliability of $\alpha = 0.87$, the media validation was $\alpha = 0.85$, the engagement questionnaire was $\alpha = 0.83$, and the practicality questionnaire was $\alpha = 0.81$. Data analysis was conducted using descriptive statistics, gain score analysis according to Hake (1999), and a comparison test between FD and FI students through an independent t-test. The effect size calculation (Cohen's d) was performed to provide a more accurate interpretation of the differences in results with a relatively small sample size. In this study, the validity of the TRISAS media was determined through assessments by media and material experts, consisting of two media experts and two material experts. The first media expert is a lecturer at Ahmad Dahlan University in Yogyakarta, specializing in the development of mathematics learning media, while the second media expert is a freelance animator with expertise in multimedia. Meanwhile, the first material expert is a lecturer in Mathematics Education at Ahmad Dahlan University, and the second material expert is a mathematics teacher at a vocational high school. The validation sheets for the media and material experts each contained thirteen statement items with a five-point scale: Very Good (score 5), Good (score 4), Satisfactory (score 3), Poor (score 2), and Very Poor (score 1). Tables 1 and 2 present the aspects and indicators of the validity instruments assessed by these experts (modified from Zahroh, 2017). Overall, the revised method was developed to reduce repetition, enhance analytical clarity, strengthen the description of the FD-FI differences, and meet academic expectations based on reviewer feedback.

Table 1. Aspects and Indicators of Validity Evaluated by Subject-Matter Experts

No.	Aspect	Indicator
1	Instructional Appropriateness	The alignment of learning media with learning competencies and the developmental levels of students FI and FD
2	Usability	Language that is easily comprehensible and user-friendly learning media for students of FI and FD
3	Completeness	The completeness of the materials and practice questions found within the learning media
4	Clarity	The clarity of the explanation, illustrative images, dialogues and systematic arrangement of materials in learning media

Table 2. Aspects and Indicators of Validity Evaluated by Media Experts

No.	Aspect	Indicator
1	Appropriateness	Accuracy in the selection of learning media based on learning objectives and characteristics of students, as well as accuracy in the selection of material content, dialogue, and image illustrations
2	Navigability and Intuitiveness	Easy to use by FI and FD teachers and students
3	Appearance	Clarity of storyline, animations, and dialogue, as well as clear and uncluttered layouts
4	Communicative	Easy to understand language and easy-to-use learning media for FI and FD students

In the practicality instrument, the student response questionnaire contains 12 positive statements. Each statement item has four options, namely Disagree (score 1), Agree Enough (score 2), Agree (score 3), and Strongly Agree (score 4). Students are asked to choose one of these options according to how they feel based on the statements in each item. The statements on the student response questionnaire are presented in Table 3.

Table 3. Aspects and Indicators of Practicality in the Student Response Questionnaire

No.	Aspect	Indicator
1	Content quality	Easy to understand material. The sound on the picture media is clear. The storyline is clear and easy to understand
2	Enthusiasm for learning and fun	A spirit of learning and a sense of joy arises during the learning process. Displayed media looks new. The media displayed looks attractive. The media used to foster student activeness/active participation
3	Grammar	The dialogue used uses language that is easy to understand
4	Use of illustrations	Images and illustrations displayed according to the material. Images and illustrations are displayed clearly and neatly. The use of colors that match the characteristics of students The illustrations used make students better understand the use of formulas/materials.

The data analysis technique used was quantitative descriptive analysis. The data analyzed were data from the validation sheet instruments of material experts and media experts, student response data, and student activity data. In the analysis of the expert validation sheet, there were steps taken, namely: calculating the average total score for each aspect, calculating the average total validation score (TVS) for all experts, and converting the TVS into qualitative categories by referring to the categorization guidelines according to Widoyoko (2014). The validity criteria for TRISAS media in this study were if the validity category had a minimum valid value. The validity categories in this study are presented in Table 5.

Table 5. Category of Validity in terms of TRISAS Material and Media

No.	Score Interval	Category
1	$TVS > 54{,}6$	Very valid
2	$44{,}2 < TVS \leq 54{,}6$	Valid
3	$33{,}8 < TVS \leq 44{,}2$	Quite valid
4	$23{,}4 < TVS \leq 33{,}8$	Less valid
5	$TVS \leq 23{,}4$	Invalid

In the analysis of the student response questionnaire, there are steps taken, namely: calculating the average total score of each aspect, calculating the average total response score (TRS) for all experts, and converting TRS into qualitative categories by referring to the categorization guidelines according to Widoyoko (2014). The criterion for the practicality of TRISAS media in this study is if the category of practicality has a minimum practical value. The category of practicality in this study is presented in Table 6.

Table 6. Categories of TRISAS Media Practicality

No.	Score Interval	Category
1	$TRS > 40{,}8$	Very practical
2	$33{,}6 < TRS \leq 40{,}8$	Practical
3	$26{,}4 < TRS \leq 33{,}6$	Quite practical
4	$19{,}2 < TRS \leq 26{,}4$	Less practical
5	$TRS \leq 19{,}2$	Not practical

For the analysis of student activity questionnaire data obtained before and after using TRISA media, it was carried out by calculating the average score. Then from the total average, the effectiveness category is obtained. There are four categories of effectiveness as shown in Table 7. Learning media is considered effective if the average total student activity after learning is at least within the interval $2 < \underline{X} \leq 3$ with good category.

Table 7. Categories of TRISAS Media Effectiveness

No.	Score Interval	Category
1	$3 < \underline{X} \leq 4$	Excellent
2	$2 < \underline{X} \leq 3$	Good
3	$1 < \underline{X} \leq 2$	Less good
4	$\underline{X} \leq 1$	Bad

The category of increasing student learning interest results before and after using TRISAS media was calculated using the N-gain formula. The gain score (g) is the result of a comparison between students' activity scores before and after participating in learning. The following equation is formulated to calculate the gain of each student.

$$g = \frac{Skor\ posttest\ -\ Skor\ pretest}{Skor\ maximum\ -\ Skor\ pretest}$$

Furthermore, the average gain value obtained is categorized as in Table 8 (Hake, 1999).

Table 8. Interpretation of Gain Values (g)

No.	Range of g values	Classification
1	$0,7 \le g$	High
2	$0,3 \le g < 0,7$	Currently
3	$g < 0,3$	Low

FINDING AND DISCUSSION

Finding(s)

Analysis Phase

This phase aims to determine the basic problems needed in developing learning media. In this phase, curriculum analysis, material analysis, and analysis of student characteristics as research subjects were carried out. The instruments used for curriculum analysis data, material analysis, and student characteristics analysis are school documents, teacher teaching modules, and interview guide sheets. Curriculum-related interviews were conducted by the researcher with mathematics teachers, students, and principals. The result of the curriculum analysis is that one of the vocational schools in Sukoharjo uses the Independent Curriculum in the learning process. Based on curriculum analysis, it is known that the basic concepts of trigonometry have been learned by students in junior high school, namely related to the recognition of angles, triangle conformation and side calculation using the Pythagorean theorem. Trigonometry is formally taught in Class X of Senior High School as part of phase E. However, in teaching this material to vocational school students, teachers are still constrained and have not provided special media in their learning. Thus, the TRISAS learning media with trigonometric material is new to them.

The results of the interviews conducted with class X students were that 21 students liked visual forms over abstract things and 5 students liked role-playing activities. They also have a high curiosity for new things and find them interesting. Students have differences in cognitive styles which are classified into FI and FD based on the results of cognitive style diagnostic tests. These differences in cognitive styles directly affect the way students process information when they are thinking and completing tasks given by the teacher. On the other hand, students rarely use learning media in mathematics lessons, so if teachers use media in learning, students will feel happy and more excited to be active in learning. Trigonometry material will be presented in the context of stories in the zoo arena as well as integrated assignment quizzes. From the results of curriculum analysis, student character analysis, and material analysis, it is also known that students at schools where TRISAS media is implemented also have the characteristics of liking visual forms rather than abstracts, this is because students have never used learning media with a story context that is integrated with assignment quizzes.

Design Phase

In the design phase, TRISAS media is designed based on the results of analysis ranging from the design of media concepts that are tailored to the needs of students, content design and learning strategies by considering differences in cognitive styles, assessment design, storyboards and media prototypes. In the initial design, TRISAS media displays four features, namely introduction, materials, quizzes, and information as presented in Figure 1 below.

Figure 1. Various Features in TRISAS Media

Translation Figure 1:

Introduction
Material
Quiz
Information

The introduction contains an introduction and retrieval practice in the form of activating prior knowledge before entering the trigonometry material. In this activity, students were asked to look at various pictures in the zoo arena, then classify which images correspond to the shape of the right triangle and which are not right triangles as shown in Figure 2 below.

Figure 2. Content Activating Prior Knowledge in Introductory Features

Translation Figure 2

Before we start learning about trigonometric ratios,

look at the pictures of animals in the zoo below.

Which ones have shapes like a right triangle?

Match the pictures with the correct box.

Right Triangle

Non-Right Triangle

After students classify the pictures that are classified as a group of right triangles and not right triangles, students will get feedback related to the correctness of the students' answers. Furthermore, in the media, an explanation will be given related to the types of sides in a right triangle as a geometric basis for studying angles in trigonometry. The learning material feature instructs students to carefully observe a narrative that describes the conditions and various objects in several cages in the zoo. Next, students will explain the definition of trigonometric comparison, which includes the ratio between sides of a right triangle, including sine, cosine, and tangents. Through visual illustrations presented by the media, the relationship between the angles and sides of the triangle with the context of the objects in the zoo's story is explained. This linkage serves as the foundation for the horizontal mathematical process. Furthermore, the problems related to the relationship between sides and angles are used as the basis for vertical theatricalization, which aims to construct abstractions from the concept of trigonometric comparison as shown in Figure 3 (a). In the material section, students are also given sample questions to bridge theories or abstract formulas with their real application. So that students can transform verbal definitions or mathematical symbols that may still be abstract applicative according to their understanding through the concretization of abstract concepts activities as illustrated in Figure 3 (b).

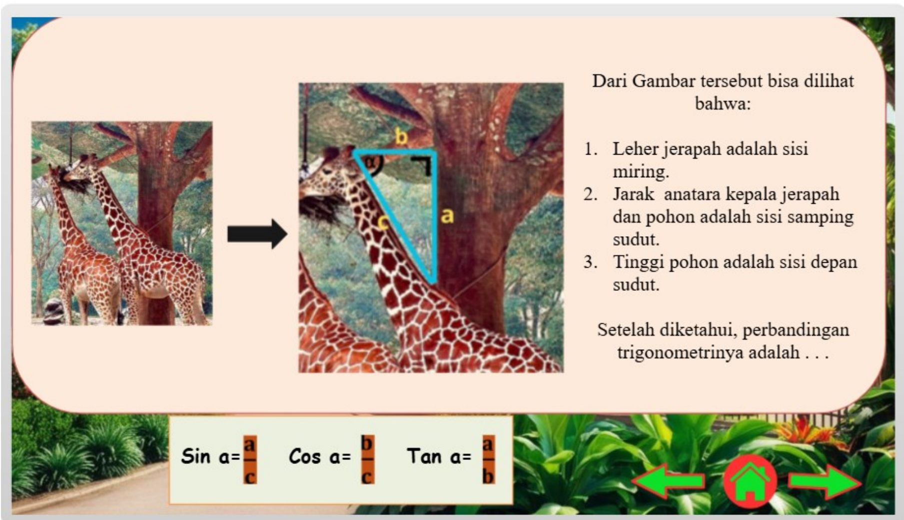

Figure 3 (a). Mathematics on Material Features

Translation Figure 3 (a):

From the picture, it can be seen that:
1. The giraffe's neck is the hypotenuse.
2. The distance between the giraffe's head and the tree is the adjacent side.
3. The height of the tree is the opposite side.

After being identified, the trigonometric ratios are . . .

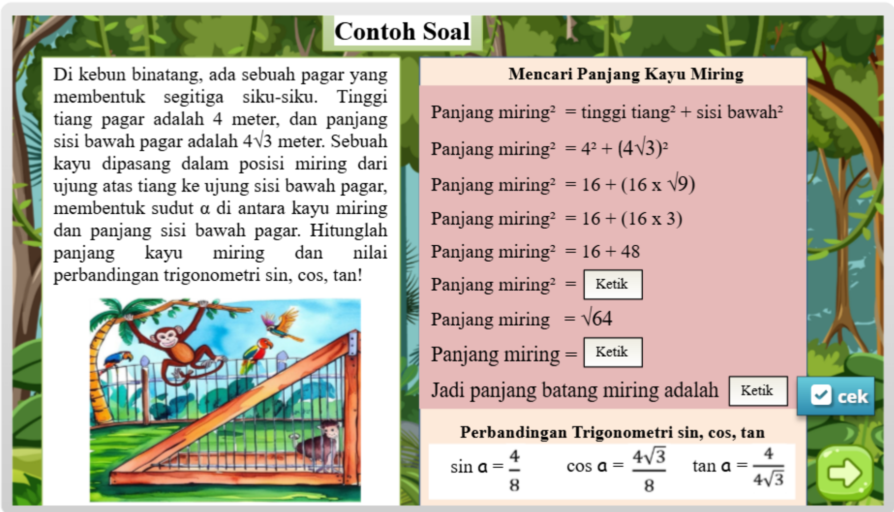

Figure 3 (b). Example Questions on Concretization of Abstract Concepts Activity

Translation Figure 3 (b):

At the zoo, there is a fence forming a right triangle. The height of the fence post is 4 meters, and the length of the base side of the fence is $4\sqrt{3}$ meters. A wooden beam is placed in a slanted position from the top of the post to the end of the base, forming an angle α between the beam and the base of the fence. Find the length of the slanted beam and the values of the trigonometric ratios sin, cos, and tan!

$\text{Slanted Side}^2 = \text{height of post}^2 + \text{base side}^2$

$\text{Slanted Side}^2 = 4^2 + (4\sqrt{3})^2$

$\text{Slanted Side}^2 = 16 + (16 \text{ x} \sqrt{9})$

$\text{Slanted Side}^2 = 16 + (16 \text{ x } 3)$

$\text{Slanted Side}^2 = 16 + 48$

$\text{Slanted Side}^2 =$ Type

$\text{Slantes Side} = \sqrt{64}$

$\text{Slantes Side} =$ Type

So, the length of the slanted beam is Type

In the quiz feature section, the media presents practice questions that students must complete. In this case, students are given the opportunity to apply the theories and formulas they have just learned into concrete situations as a form of consolidation of concepts through quizzes. This exercise activity functions as an ongoing formative assessment instrument for teachers. With quizzes, teachers can monitor student progress in real-time without final grade pressure, so they can provide targeted interventions and support. In addition, the quizzes given can be formative feedback for students because students can make independent diagnoses, while for teachers, the results of student quizzes can be material for evaluating the effectiveness of teaching methods and determining follow-up plans. The example of the quiz display in the TRISAS media design can be seen in Figure 4 below.

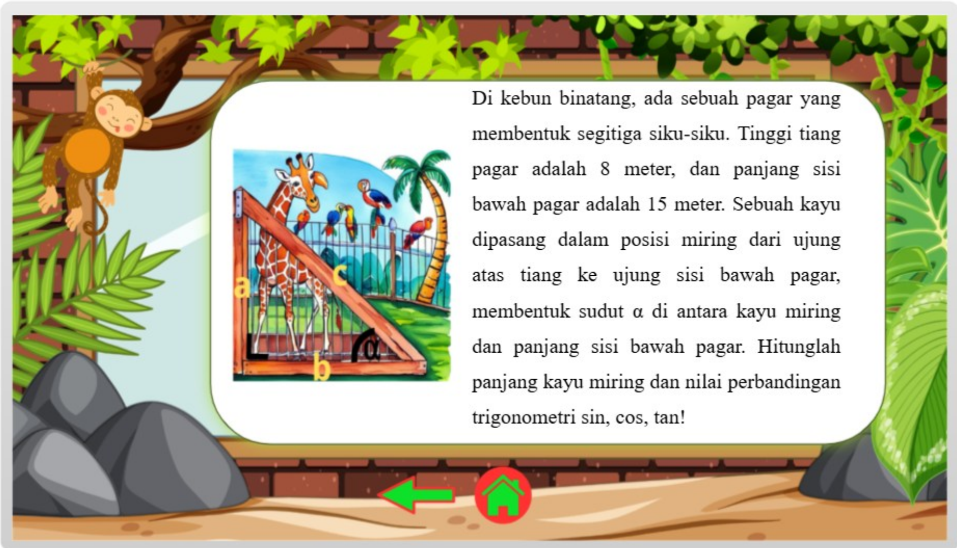

Figure 4. Quiz on TRISAS Media

Translation Figure 4:

At the zoo, there is a fence forming a right triangle. The height of the fence post is 8 meters, and the length of the base side of the fence is 15 meters. A wooden beam is placed in a slanted position from the top of the post to the end of the base side, forming an angle α between the beam and the base side of the fence. Calculate the length of the slanted beam and the values of the trigonometric ratios sin, cos, and tan!

The last feature in the TRISAS media design is information that contains information about icons that are graphic visual representations of a certain function, feature, concept, or action in the TRISAS media interface, as well as navigation buttons related to page movement, flow, or user steps in using the media.

Development Phase

During the development phase, the researchers constructed a prototype in accordance with the established design. To validate its quality, the researchers engaged experts to evaluate the material and media aspects. Subsequently, the researchers refined the initial prototype based on the experts' recommendations, resulting in a revised prototype. At this stage, the assessment results from the media and material expert validators were obtained, as presented in Table 9 and Table 10.

Table 9. Validation Results of the TRISAS Media by Subject Matter Experts

	Aspect	Validator 1	Validator 2	Average	Category
1.	Instructional Appropriateness	53,7	54,2	53,95	Valid
2.	Usability	55,4	56,7	56,05	Very valid
3.	Completeness	52,7	54,2	53,45	Valid
4.	Clarity	55,8	57,2	56,5	Very valid
	The average total validation			54, 99	Very valid

Table 10. Validation Results of TRISAS Media by Media Experts

	Aspect	Validator 1	Validator 2	Average	Category
1.	Appropriateness	55,2	55,6	55,4	Very valid
2.	Navigability and Intuitiveness	56,7	55,3	56	Very valid
3.	Appearance	54,8	55,2	55	Very valid
4.	Communicative	54,6	56,2	55,4	Very valid
	The average total validation			55, 45	Very valid

Table 9 and Table 10 indicate that the TRISAS media received a highly valid assessment from expert validators in both media and content. This suggests that the TRISAS media has satisfied the criteria of material accuracy in the selection of instructional media, based on factors such as instructional appropriateness, usability, completeness, and clarity. In terms of media, the TRISAS media has also satisfied the criteria of appropriateness, navigability and intuitiveness, appearance, and communicative effectiveness. Subsequently, a prototype revision was tested to evaluate the practicality and effectiveness of the TRISAS media during the implementation phase.

Implementation Phase

During the implementation phase, the application of trigonometry learning using TRISAS media was conducted over 5 (five) meetings, with the details of each meeting as follows:

Session 1: The teacher provides an introduction and a retrieval practice that involves activating prior knowledge before delving into the topic of trigonometry.

Session 2: Students observe a contextual story about the zoo, which also includes a visual explanation of the fundamental definitions of trigonometry to assist students in acquiring a visualization of the basic concepts of sinus, cosinus, and tangent from real-life situations.

Session 3:Students are asked to explore the relationship between real-life situations and the concepts of trigonometric comparisons through the activity of transforming horizontal mathematical representations into vertical ones.

Session 4: The instructor provides example problems to bridge the gap between abstract theories or formulas and real-world situations, enabling students to transform verbal definitions or mathematical symbols through the process of concretizing abstract concepts.

Session 5: The teacher provides exercises as a means of consolidating concepts through a quiz.

Following the completion of all learning sessions, students were given a questionnaire to evaluate their responses toward the TRISAS media. The total practicality score of 41.6 indicated that most students responded positively, demonstrating that TRISAS is highly practical for use in learning trigonometric comparisons. In addition to practicality, the implementation phase also evaluated the effectiveness of TRISAS in enhancing student engagement. The average engagement score increased from 3.16 before the learning process to 3.68 afterward, resulting in a gain score of 0.62, which falls within the moderate category. The post-learning engagement score of 3.68 is classified as "Very Good," indicating that the TRISAS media was effective in improving students' learning activities. However, this increase did not reach the high category, which may be attributed to additional factors influencing engagement such as teaching skills, instructional variations applied by the teacher, and the broader learning environment (Agustina, 2015; Rahmadani et al., 2023).

A subgroup analysis based on cognitive styles revealed distinct patterns of engagement between Field Dependent (FD) and Field Independent (FI) students. FD students showed substantial improvements in visual activities (45%) and oral activities (38%), particularly during group discussions and scenario-based tasks supported by storytelling elements and step-by-step guidance. In contrast, FI students demonstrated superior gains in writing activities (42%) and task completion rates (88% compared to 72% for FD students), with their engagement predominantly directed toward exploratory quizzes and analytical problem-solving challenges. Behavioral observation data further confirmed these patterns: FD students spent approximately 65% of their session time interacting with contextualized story elements, while FI students spent around 70% of their time engaging with problem-solving challenges and analytical tasks. Collectively, these findings show that the differentiated instructional pathways embedded in TRISAS guided learning sequences for FD students and exploratory analytical pathways for FI students effectively accommodated the needs of both cognitive styles. Nevertheless, the relatively small sample size requires cautious interpretation of these results.

Evaluation Phase

The evaluation results demonstrate that the TRISAS media effectively bridges cognitive style differences through its inclusive and adaptive design. Although the overall engagement gain score (0.62) falls within the moderate category, this general measure conceals substantial improvements within specific cognitive-style subgroups, thereby supporting the fundamental premise of this study—that adaptive digital media can simultaneously accommodate diverse learning preferences. The triangulation of data through self-report questionnaires, behavioral observations, and task completion metrics strengthens the validity of these effectiveness claims, as findings across multiple methods consistently reveal differentiated yet significant engagement gains for both FD and Field Independent FI students. The operationalization of "inclusive" as providing equivalent learning value across cognitive styles is supported through comparative analyses showing that FD and FI students engaged with different components of the media yet improved meaningfully within their preferred learning dimensions, confirming the media's adaptive capability.

Furthermore, the evaluation indicates that TRISAS successfully operationalizes cognitive-style adaptation through measurable design features. The reliability of the research instruments (α = 0.81–0.87) enhances the credibility of these findings, although the small sample size warrants cautious interpretation. The embedded adaptations structured guidance, contextual narratives, and visual scaffolds for FD students; and exploratory challenges, analytical tasks, and flexible navigation for FI students represent a concrete application of cognitive-style theory in digital learning design. Rather than asserting universal effectiveness, this study posits that TRISAS demonstrates promising adaptive potential for addressing cognitive diversity. The differential engagement patterns align with theoretical expectations: FD students benefited from socially and contextually embedded tasks, while FI students excelled in analytical, self-paced problem-solving activities.

The evaluation phase, conducted continuously from needs analysis through implementation, supports this conclusion by showing that TRISAS through its combination of visual representations, narrative context, and interactive quizzes enhanced student engagement in learning trigonometric comparisons. Consistent with the perspectives of Ahliyanto and Susilo (2025) and Ilma (2025), technology-based learning media that integrate narrative contexts and interactive elements can stimulate active participation in discussions and collaborative group activities. Such media effectively blend visual strengths, compelling storylines, and direct interactivity to support engagement across different cognitive styles. Learning media that incorporates video-based storytelling and embedded tasks aligns with psychological and pedagogical principles that create optimal learning conditions, particularly in challenging subjects such as mathematics. An engaging narrative context shifts students' focus away from anxiety toward active participation, fostering positive emotions that reduce cognitive tension and provide a stable psychological foundation for learning. Likewise, visual storytelling bridges abstract mathematical ideas with concrete representations, enabling students to connect mathematical concepts with enjoyable learning experiences an approach that resonates with active, real-world problem-solving processes free from anxiety (Jusniani & Monariska, 2025; Sinaga, 2024).

Discussion

In this sense, TRISAS offers an inclusive learning alternative by providing multiple "entry points" for diverse cognitive styles. FD learners, who are naturally inclined toward contextual and narrative learning, benefit from cohesive storylines and integrated learning flows that promote understanding through narrative coherence. FI learners, whose strengths lie in analytical reasoning and logical verification, benefit from tasks that provide immediate feedback, logical confirmation, and structured problem-solving challenges embedded within the interactive environment. The interactivity and quiz mechanics satisfy FI students' need for analysis, while the storyline-driven progression maintains FD students' motivation through visible progress, level completion, and narrative-based rewards. This dual accommodation ensures that mathematics is learned not as an isolated subject but as part of a meaningful, contextually grounded experience.

Overall, the findings clearly indicate an increase in student engagement following the implementation of the TRISAS media. Consistent with Januszewski and Molenda (2013), TRISAS provides an innovative alternative that moves beyond traditional face-to-face instruction characterized by closed knowledge and standardized testing. Learning variation contributes strongly to instructional effectiveness, which encompasses positive student expectations, effective classroom management, and appropriate instructional design (Andriyani et al., 2020). Moreover, the integration of learning technology enhances performance by fostering meaningful, goal-oriented learning experiences and deeper conceptual understanding that transcends rote memorization. These principles are aligned with evidence from mathematics education research (Andriyani & Maulana, 2019; Andriyani et al., 2022), which emphasizes the importance of technological integration that supports concrete experiences, meaningful learning, and the connection of mathematical abstractions to real-world contexts. Thus, TRISAS aligns with these principles and demonstrates potential to enhance student performance by increasing engagement.

Despite these promising outcomes, the study has limitations. The moderate n-gain score suggests that other factors such as teacher expertise, instructional variation, and classroom learning environment may also influence engagement and require further investigation. Nonetheless, this study provides evidence that TRISAS positively impacts student engagement and contributes meaningful insights into the development of adaptive, inclusive learning media. The outcomes are expected to inform future research and guide the creation of more responsive, student-centered educational technologies that consider broader environmental and cognitive factors.

CONCLUSION

The TRISAS media developed in this study meets the criteria of validity, practicality, and effectiveness. Its validity is supported by evaluations from two media experts and two content specialists, who categorized the media as highly valid in terms of instructional alignment, usability, completeness, clarity, navigation, presentation, and communication. Its practicality is demonstrated by the overwhelmingly positive responses from students regarding their learning experience with the media. The effectiveness of TRISAS is evidenced by an increase in student engagement, which, although categorized as moderate at the overall level, reveals substantial improvements within specific cognitive-style subgroups. These findings confirm that the adaptive features of TRISAS implemented through differentiated learning paths, tailored content sequencing, and interactive elements aligned with FD and FI cognitive styles form a meaningful contribution to inclusive educational technology and responsive instructional design. However, several limitations should be noted: the small sample size restricts the generalizability of the findings; the moderate gain scores indicate the need for further refinement of the media; and the reliance on self-report measures, despite triangulation with observational and task-based metrics, suggests methodological aspects that can be further strengthened. Future studies are encouraged to examine the longitudinal impact of TRISAS with larger samples, incorporate more objective indicators of learning outcomes, and extend the adaptive framework of this media to other mathematical topics or learning contexts. Nonetheless, the results of this study demonstrate that TRISAS can serve as an inclusive learning alternative capable of accommodating diverse cognitive styles and supporting educators in creating varied and adaptive learning experiences.

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