

# Development of a Trigonometric Wheel to Improve Students' Mathematical Problem-Solving Ability

Kartono\*, Iik Nurhikmayati

Department of Mathematics Education, Faculty of Teacher Training and Education,  
Universitas Majalengka, Indonesia

\*Email: [majakartono967@gmail.com](mailto:majakartono967@gmail.com)

\* corresponding author

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## ABSTRACT

This study aims to develop and evaluate the feasibility of the Trigonometric Wheel manipulative as an interactive learning medium to improve students' mathematical problem-solving ability in trigonometry topics. This research employed the Research and Development (R&D) method using the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation), carried out through the Implementation stage. The research subjects consisted of 30 eleventh-grade students at a public senior high school in Majalengka Regency during the 2024/2025 academic year. The instruments used included expert validation sheets, teacher and student response questionnaires, and a mathematical problem-solving ability test based on Polya's indicators. The results of media expert validation showed an average score of 76.5% (Valid), while material expert validation reached 85.97% (Highly Valid). Teacher and student responses also indicated highly practical categories, with percentages of 90.54% and 88.61%, respectively. As part of the implementation phase, an embedded pre-test and post-test assessment was conducted, revealing an improvement in students' mathematical problem-solving ability with an average N-Gain score of 0.79 (high category). These findings indicate that the Trigonometric Wheel is valid, practical, and shows strong potential as an innovative learning medium that helps students understand trigonometric concepts visually and interactively while enhancing their problem-solving ability.

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## INTRODUCTION

Mathematical problem-solving skills are one of the core competencies that must be developed in mathematics education. Problem-solving enables students to analyze situations, connect concepts, and find solutions using appropriate strategies (Siswanto, 2024). According to Polya in Stacey (2022), problem-solving involves four main stages: understanding the problem, devising a plan, carrying out the plan, and looking back. These stages require students to activate conceptual knowledge, procedural skills, and critical thinking abilities (Chacón-Castro et al., 2023; Yapatang & Polyiem, 2022). Thus, student success in mathematics is not only measured by the memorization of formulas but also by the extent to which they are able to solve problems systematically and logically.

Nevertheless, various studies indicate that students still struggle with solving mathematical problems, particularly in trigonometry. Students tend to struggle with understanding trigonometric ratios (Alfitri et al., 2024), determining the values of special angles (Setiawan, 2023), and applying trigonometric concepts in contextual problems (Syifa & Kurniawati, 2025). The problems that arise include: (1) difficulty understanding the differences in the basic concepts of trigonometric ratios, (2) difficulty performing calculations involving quadrants, (3) low ability to apply problem-solving steps systematically, and (4) low ability to verify and check the results of their work. This indicates that students' difficulties lie not only in conceptual aspects but also in their ability to apply problem-solving steps.

A real problem is also evident among high school students in the local area, where many students are still unable to solve trigonometry problems that require higher-order thinking (Nurmeidina et al., 2020). One factor contributing to this low problem-solving ability is the learning method, which remains monotonous, teacher-centered, and makes minimal use of learning media that support the visualization of concepts (Ahmed et al., 2023). In fact, trigonometry is a subject closely related to the visualization of angles and the relationships between quadrants (Setiawan, 2023). The lack of interactive media makes it difficult for students to connect abstract concepts with real-world representations (Hidayat et al., 2023). Based on a preliminary study conducted at a public senior high school in Majalengka Regency, students' average score on trigonometry problem-solving tasks was found to be below the minimum passing grade, indicating a significant need for intervention through more effective and engaging learning media.

To address this issue, an educational innovation is needed in the form of a Trigonometric Wheel teaching aid designed not only to reinforce conceptual understanding but also to support students' mathematical problem-solving skills. The Trigonometry Wheel helps students visualize special angles, ratio values, and signs in each quadrant interactively. With the help of this tool, students can more easily understand problems, formulate a solution plan, implement the chosen strategy, and verify the accuracy of their answers. This medium also encourages students to actively engage in learning, thereby enhancing their motivation, understanding, and ability to solve mathematical problems.

Several previous studies have developed wheel-based learning media to support the understanding of trigonometric concepts, including the Trigonometry Windmill (Lestari, et al., 2023), Spinning Wheel (Angelina, et al., 2021), Smart Wheel (Kaka, et al., 2022), and TRIGOPOLI (Dewi & Ananda, 2023). The results indicate that wheel-based teaching aids effectively aid in visualizing abstract trigonometric concepts. However, previous studies still have limitations, such as a lack of interactivity, a focus solely on basic

understanding, insufficient consideration of students' learning styles, and evaluations limited to the feasibility of the media.

The novelty of this study lies in addressing a gap not covered by prior research: previous wheel-based media studies (Lestari et al., [2023](#); Angelina et al., [2021](#); Kaka et al., [2022](#); Dewi & Ananda, [2023](#)) focused solely on conceptual understanding and were evaluated only for media feasibility, without measuring their impact on students' mathematical problem-solving ability. This study develops a more interactive and dynamic Trigonometry Wheel that allows students to rotate angles and directly observe changes in trigonometric ratios, while being specifically designed to improve problem-solving ability based on Polya's indicators. The development process utilized the ADDIE model through the Implementation stage, producing a learning medium that is valid, practical, and capable of improving students' mathematical problem-solving ability in trigonometry.

## **METHOD**

This study employed a Research and Development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), though it was limited to the Implementation stage due to constraints in time and scope. This model was chosen because it is capable of producing valid, practical, and effective learning materials (Shakeel et al., [2023](#)). The product developed is a Trigonometric Wheel teaching aid to help students understand the relationship between angles and trigonometric ratios visually and interactively to improve their mathematical problem-solving skills.

This study was conducted at a public high school in Majalengka Regency during the 2024/2025 academic year. The research subjects consisted of 30 students selected through purposive sampling, given that the eleventh-grade class is currently studying trigonometry as part of the regular curriculum. Based on initial classroom observations, trigonometry was identified as the topic with the lowest problem-solving achievement among these students, thus necessitating the development and implementation of an interactive learning medium as an instructional intervention.

Data was collected through observation, interviews, questionnaires, and tests. Observations were used to assess the learning process and student engagement; interviews with teachers explored students' difficulties and responses to the media; validation questionnaires were completed by media experts and subject matter experts to assess content, language, presentation, and graphics; while usability questionnaires were administered to teachers and students to assess the media's ease of use, appeal, and usefulness. The problem-solving ability test was designed based on Polya's indicators:

understanding the problem, formulating a plan, executing the plan, and checking the results (Stacey, 2022).

Validation results were analyzed using a Likert scale, which involves calculating the average score for each evaluation aspect to determine the media's validity level. Validity criteria were categorized as highly valid, valid, moderately valid, less valid, and invalid. Data from the practicality questionnaire were analyzed in a similar manner to determine the level of media usability by teachers and students. Meanwhile, the results of the mathematical problem-solving ability test were analyzed by comparing the achievement of problem-solving indicators before and after the use of the learning media, thereby determining the effectiveness of the developed Trigonometric Wheel teaching aid. Furthermore, validity was calculated using the formula:

$$V = \frac{\text{score obtained}}{\text{maximal score}} \times 100\%$$

After obtaining the expert validation percentage, the validity criteria can be determined using Table 1 (Nabila et al., 2022).

**Table 1.** Product Validity Criteria

Score	Category
$80\% < V \leq 100\%$	Highly Valid
$60\% < V \leq 80\%$	Valid
$40\% < V \leq 60\%$	Moderately Valid
$20\% < V \leq 40\%$	Less Valid
$V \leq 20\%$	Invalid

Next, we can obtain the teacher and student response data by calculating the average score for each indicator, then converting it to a percentage (Nabila et al., 2022) as follows:

$$P = \frac{\sum f}{N} \times 100\%$$

After that, to determine the positive response category from the obtained percentage, Table 2 (Nabila et al., 2022) can be used.

**Tabel 2.** Product Usability Criteria

Score	Category
$80\% < P \leq 100\%$	Highly Practical
$60\% < P \leq 80\%$	Practical
$40\% < P \leq 60\%$	Moderately Practical
$20\% < P \leq 40\%$	Less Practical
$P \leq 20\%$	Not Practical

Next, the improvement of students' mathematical problem-solving ability is determined by calculating the N-Gain value (Wahab et al., [2021](#)).

$$\text{Normal Gain} = \frac{\text{Posttest score} - \text{Pretest score}}{\text{Ideal score} - \text{Pretest score}}$$

After obtaining the N-Gain value, the criteria can be determined using Table 3 (Wahab et al., [2021](#)).

**Table 3.** Product Improvement Criteria

Average	Criteria
$g > 0,7$	High
$0,3 \leq g \leq 0,7$	Moderate
$0 < g < 0,3$	Low
$g \leq 0$	Failed

## RESULTS AND DISCUSSION

### Result

This study aims to develop a learning resource in the form of a Trigonometry Wheel teaching aid that can improve students' mathematical problem-solving skills in trigonometry. In addition to producing the instructional media, this study also aims to assess the feasibility and practicality of the teaching aid so that it can be applied in mathematics instruction in schools. The development process utilized the ADDIE model (Analysis, Design, Development, Implementation, Evaluation); however, this study was limited to the Implementation stage. The following presents the results from the analysis stage.

### Analysis

#### *Content Analysis*

Trigonometry is one of the topics considered difficult by high school students. These difficulties generally stem from understanding trigonometric ratios, special angles, quadrant signs, and the application of trigonometric concepts in solving contextual problems. Students often struggle to determine the values of sine, cosine, and tangent for specific angles, as well as to connect these concepts to real-world problems. Therefore, a learning medium in the form of a visual aid is needed to present the relationship between angles and trigonometric ratios in a visual and concrete manner. The Trigonometric Wheel was selected because it helps students understand changes in trigonometric ratios by directly rotating the wheel.

### *Media Analysis*

Wheel-based teaching aids are considered effective for bridging abstract concepts to make them more tangible. This medium allows students to visualize the relationship between angles and trigonometric values interactively. Thus, the Trigonometric Wheel not only helps students memorize special angles but also encourages them to understand the patterns of relationships between quadrants and the application of trigonometric formulas. Compared to conventional learning media such as blackboards or textbooks, the Trigonometric Wheel provides a more dynamic and contextual learning experience.

### *Analysis of Mathematical Problem-Solving Ability*

Mathematical problem-solving ability are one of the key competencies in mathematics education. According to Polya, these skills encompass four indicators: understanding the problem, formulating a plan, carrying out the plan, and checking the results. In the context of trigonometry, students are expected not only to master basic concepts but also to apply them to solve contextual problems. Through the use of the Trigonometry Wheel, students are expected to more easily understand problems, design solution strategies, perform calculation steps correctly, and verify the accuracy of their results.

### *Student Analysis*

Based on the results of observations and pre-tests, it was found that many high school students struggle with determining the trigonometric values of special angles, understanding signs in quadrants, and connecting these concepts to word problems. Students often merely memorize without understanding the underlying concepts. This results in their limited ability to solve problem-solving questions that require higher-order reasoning. Therefore, students need a learning tool that facilitates a gradual understanding of concepts, starting from concrete visualizations to the application of contextual problems.

### *Student Needs Analysis*

Based on the results of the needs analysis, students require an interactive learning medium that is easy to understand and capable of helping them grasp abstract trigonometric concepts in a simple yet effective manner. The Trigonometric Wheel teaching aid was developed to address these needs, as it is practical, versatile, and capable of actively engaging students in the learning process. With this tool, students can be more motivated to learn and ultimately improve their mathematical problem-solving ability. Several indicators of student needs analysis from Kholikin, et al. (2024) are presented in Table 4.

**Table 4.** Analysis of Student Needs

<b>Need Analysis Indicator</b>	<b>Description</b>
Easy-to-understand learning materials	Students need materials that can present abstract trigonometric concepts in a simpler way, particularly when it comes to understanding ratios in special angles and quadrant signs. Interactive and varied learning media
Interactive and varied learning media	Students need media that can be used directly through spinning-the-wheel activities, thereby encouraging active engagement in the learning process.

## **Design**

The trigonometric wheel is designed with three circles measuring 35 cm, 30 cm, and 16 cm in diameter to facilitate the visualization of trigonometric values. The wheel is made of wood for durability and stability, with a metal axle for smooth rotation. This design ensures that the tool is easy to use for students of varying ability levels and is built to last. The unit circle is the main component of this teaching aid. The unit circle is designed to clearly visualize special angles and trigonometric functions in a way that is easy for students to understand. This unit circle displays special angles from  $0^\circ$  to  $360^\circ$ , with clear markings at each key angle such as  $0^\circ$ ,  $30^\circ$ ,  $45^\circ$ ,  $60^\circ$ ,  $90^\circ$ ,  $120^\circ$ ,  $135^\circ$ ,  $150^\circ$ ,  $180^\circ$ ,  $210^\circ$ ,  $225^\circ$ ,  $240^\circ$ ,  $270^\circ$ ,  $300^\circ$ ,  $315^\circ$ ,  $330^\circ$ , and  $360^\circ$ . This angle division is designed to help students recognize and understand various angles in trigonometry.

Additionally, this tool displays the derivatives of the main trigonometric functions such as sine, cosine, tangent, cosecant, secant, and cotangent. This allows students to understand how trigonometric functions change as the angle changes. By displaying the relationship between the main functions and their derivatives, this tool can help students deepen their understanding of more complex trigonometric concepts. The quadrants of the unit circle are colored differently in each quadrant to make it easier for students to distinguish the position of angles in different quadrants. The contrasting colors in each quadrant make it easier for students to identify and understand the differences in trigonometric function values across quadrants.

## **Development**

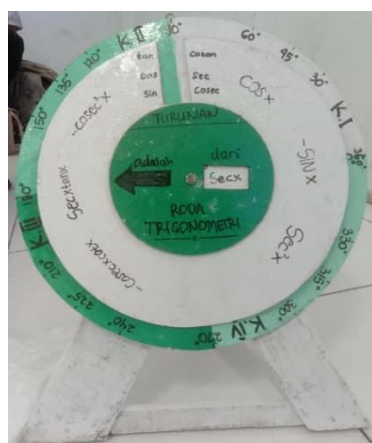
During the development phase, the educational media in the form of the Trigonometric Wheel teaching aid was created based on a previously designed blueprint. The resulting product is a circular wheel featuring quadrant divisions, special angles, and trigonometric functions along with their derivatives. This teaching aid is made of wood and plywood for durability, and is painted green and white to make it more visually appealing and to help students distinguish between its parts.

The Trigonometry Wheel is designed to be rotated as needed for learning. The outer part of the wheel displays angles in a full rotation from  $0^\circ$  to  $360^\circ$ , complete with quadrant

divisions from I to IV. The inner circle lists basic trigonometric functions (sin, cos, tan) and their derivatives (cosec, sec, cotan). Additionally, there are simple derivative guidelines in the center of the wheel, which help students understand the relationship between a function and its derivative. The use of contrasting colors is intended to facilitate the visualization of concepts. For example, the special angles  $0^\circ$ ,  $30^\circ$ ,  $45^\circ$ ,  $60^\circ$ , and  $90^\circ$  are clearly displayed so that students can immediately connect them to the corresponding trigonometric values. The inclusion of quadrants I through IV also helps students remember the sign rules (positive and negative) for each quadrant, which is often a major challenge in learning trigonometry.

In addition, this tool also includes practice features in the form of verbal questions from the teacher as the wheel spins. For example, students are asked to determine the value of  $\sin 150^\circ$  or the derivative of  $\sec x$ . In this way, students can learn actively, interact directly with the tool, and practice solving mathematical problems step by step. This exercise simultaneously trains the indicators of mathematical problem-solving, namely understanding the problem, formulating a plan, implementing the plan, and checking the results of the solution.

This development phase resulted in a final product: a Trigonometry Wheel that is practical for use in learning. This tool is expected to help students understand trigonometric concepts visually and concretely, as well as improve their mathematical problem-solving skills. The following outlines the design development of the Trigonometry Wheel teaching aid.



**Figure 1.** Trigonometry Wheel

An evaluation was conducted with the involvement of media experts to determine the suitability of the “Trigonometry Wheel” teaching aid for learning. This evaluation aimed to ensure that the learning medium meets high standards in terms of presentation, appearance, appropriateness, feasibility, and innovation. Each aspect was assessed to

determine the extent to which the teaching aid can support the students' learning process. The results of the evaluation by the media experts are presented in Table 5.

**Table 5.** Results of Media Expert Validity Assessment

No	Aspect	Percentage	Category
1	Presentation	100%	Highly Valid
2	Appearance	70%	Valid
3	Relevance	62,5%	Valid
4	Feasibility	75%	Valid
5	Inovasi	75%	Valid

Based on the validation results, the Trigonometry Wheel teaching aid achieved an average of 76.5% (Valid category). The presentation aspect received the highest score of 100%, indicating the clarity and appeal of the information. The presentation aspect (70%) and relevance aspect (62.5%) were also valid, but require improvements in visual design and educational relevance. The feasibility and innovation aspects each scored 75%, indicating the presence of interesting novel elements, but further development is still needed. Overall, these results provide important feedback for refinement to make the teaching aid more effective in enhancing students' understanding of trigonometric concepts.

Furthermore, the assessment of the material's feasibility for the "Trigonometry Wheel" teaching aid was conducted by subject matter experts to ensure that the learning content aligns with expected competencies, is relevant to students' needs, and is presented systematically and beneficially for learning. The evaluated assessment aspects include competencies, material presentation, benefits, and completeness. The validation results provided by the subject matter experts are presented in Table 6.

**Table 6.** Results of Content Expert Validity

No	Aspect	Percentage	Category
1	Relevance of the material	87,5%	Highly Valid
2	Accuracy of the material	91,67%	Highly Valid
3	Clarity and systematic organization of the material	75%	Valid
4	Practicality of the material	91,67%	Highly Valid
5	Originality and innovation of content	83%	Highly Valid

The Trigonometry Wheel teaching aid received an average validation score of 85.97%, categorized as Highly Valid. The aspects of content accuracy and practicality received the highest score of 91.67%, indicating an accurate and practical content design. The aspect of material relevance scored 87.5%, indicating that the content is relevant to the learning objectives of trigonometry. Meanwhile, the aspects of material clarity and

organization scored 75% (Valid), suggesting that the presentation should be structured more coherently to maximize student understanding. These validation results confirm that the teaching aid is suitable for use and has the potential to support active learning and enhance students' conceptual understanding.

Subsequently, following the validation by media and content experts, a small-scale pilot test was conducted through teacher feedback to assess ease of use, content relevance, and the effectiveness of the teaching aid in the classroom. This stage aims to ensure that the Trigonometry Wheel truly meets learning needs and provides a clearer, more practical, and meaningful learning experience for students.

**Table 7.** Teachers' Response Results

No	Aspect	Percentage	Category
1	Ease of use	91,67%	Highly Practical
2	Effectiveness in learning	87,5%	Highly Practical
3	Suitability for classroom conditions	83%	Highly Practical
4	Durability and practicality	100%	Highly Practical

Based on the teachers' responses, the Trigonometric Wheel teaching aid received an average score of 90.54% (Highly Practical). The durability and practicality aspect received a perfect score (100%), indicating that this tool is durable, easy to use, and can be used repeatedly without damage. Ease of use was also high (91.67%), indicating that the tool is simple and intuitive. Learning effectiveness scored 87.5% and suitability for classroom conditions 83%, affirming the tool's role in enhancing student understanding while remaining flexible across various learning situations.

In addition to validation by media experts, subject matter experts, and teachers, student responses during the small-scale pilot test also served as a key indicator of the tool's suitability. Student evaluations covered ease of use, clarity of content, effectiveness, engagement, and alignment with their level of understanding, further reinforcing the "Trigonometry Wheel" as an innovative learning tool to support the understanding of trigonometric concepts. The results of student responses to the "Trigonometry Wheel" teaching aid are presented in Table 8.

**Table 8.** Student Response Results

No	Aspect	Percentage	Category
1	Ease of use	90,6%	Highly Practical
2	Clarity of material presentation	89,5%	Highly Practical
3	Effectiveness in learning	87,35%	Highly Practical
4	Relevance and engagement	85%	Highly Practical
5	Alignment with students' level of understanding	90,6%	Highly Practical

The evaluation results indicate that the Trigonometry Wheel teaching aid achieved an average score of 88.61% (Highly Practical). The aspects of ease of use and alignment with students' level of understanding received the highest scores (90.6%), followed by clarity of material (89.5%), effectiveness in learning (87.35%), and student engagement and involvement (85%). These findings confirm that the teaching aid is not only suitable for use but also has great potential to enhance students' understanding and engagement in trigonometry learning, and is therefore recommended as a supplementary tool in the classroom.

### Implementation

To assess the effectiveness of the Trigonometry Wheel teaching aid, a small-scale pilot test was conducted involving five students (S1–S5) who were selected as representatives from the total 30 research subjects. These five students were purposively selected to represent varying ability levels within the class. The results of the data analysis for this implementation phase, calculated using the Gain and N-Gain formulas, are presented in Table 9.

**Table 9.** Results of the Data Analysis for the Implementation

Student	Pretest	Post test	Gain	N-Gain	Criteria
S1	40	90	50	0,83	High
S2	50	100	50	1,00	High
S3	30	80	50	0,71	High
S4	20	75	55	0,69	Moderate
S5	45	85	40	0,73	High

The results of the data analysis show an improvement in student learning outcomes after using the “Trigonometry Wheel” teaching aid. Students' pretest scores ranged from 20 to 50, while posttest scores increased significantly to 75 to 100. The gains achieved by all students ranged from 40 to 55, with N-Gain scores indicating high instructional effectiveness. Four out of five students—S1 (0.83), S2 (1.00), S3 (0.71), and S5 (0.73)—had N-Gain scores in the High category, indicating a very good improvement in understanding. Meanwhile, S4 had an N-Gain score of 0.69, which falls into the Moderate category but is close to reaching the High category. These results indicate that the “Trigonometry Wheel” teaching aid is highly effective in helping students solve mathematical problems, with the majority of students showing significant improvement in their learning outcomes.

## Discussion

The results of the study indicate that the Trigonometry Wheel teaching aid has high feasibility based on validation by media experts (76.5%) and subject matter experts (85.97%), and received very positive responses from teachers (90.54%) and students (88.61%). More importantly, the implementation of this teaching aid demonstrated an improvement in students' mathematical problem-solving skills with an average N-Gain score of 0.79 (high category). Of the five students in the sample, four achieved an N-Gain in the high category (0.71–1.00) and one in the moderate category (0.69). These results indicate that the Trigonometry Wheel is effective in helping students improve their mathematical problem-solving skills in trigonometry.

The effectiveness of this teaching aid can be explained by its alignment with Polya's stages of problem-solving, which include: (1) understanding the problem, (2) planning a strategy, (3) executing the plan, and (4) checking the results (Stacey, [2022](#)). This tool facilitates students' understanding of problems through visual representations of colored angles and quadrants, helps them plan strategies by identifying quadrants and function signs, facilitates calculations and the exploration of relationships among trigonometric functions during implementation, and allows for clear evaluation of answers during the checking stage.

These findings align with the research by Cahyono et al. ([2024](#)), who confirm that manipulative media enhance problem-solving ability through direct interaction with concrete objects. While previous wheel-based studies by Lestari et al. ([2023](#)) and Kaka et al. ([2022](#)) reported positive results in visualizing trigonometric concepts, their evaluations were limited to media feasibility without measuring problem-solving impact. The present study addresses this gap by embedding a pre-test and post-test within the implementation phase, yielding an average N-Gain of 0.79, which demonstrates that the Trigonometric Wheel not only supports conceptual understanding but also meaningfully improves students' problem-solving ability across all four of Polya's indicators.

From a learning theory perspective, the success of the Trigonometry Wheel has a strong theoretical foundation. Constructivist theory emphasizes that knowledge is constructed through direct experience and the manipulation of concrete objects (Do et al., [2023](#)). In this study, students actively construct their understanding of trigonometric concepts by manipulating the wheel, rotating it to observe changes in function values across various angles and quadrants. This hands-on process allows students to construct their own knowledge, rather than merely passively receiving information (Fadiyah et al., [2024](#)). Additionally, the use of visual and manipulative representations supports the principles of multimedia learning, which integrates verbal and visual information for deeper understanding (Mayer & Fiorella, [2025](#)).

This study also reinforces the findings of previous studies emphasizing the effectiveness of manipulative media in supporting problem-solving skills. Deswita (2020) states that media that can be directly manipulated are capable of increasing student engagement when tackling challenging math problems. The findings in this study show a similar pattern, where students who previously scored low on the pretest (20–50) were able to achieve significantly higher posttest scores (75–100). This improvement indicates that the Trigonometry Wheel not only enhances conceptual understanding but also helps students develop systematic and logical thinking skills in solving trigonometry problems.

However, the study's limitations include a small sample size, the absence of a control group, a scope limited to trigonometry, and the lack of measurement of affective aspects. Therefore, future research should involve a larger number of subjects, employ an experimental design with a control group, develop a digital version, expand to other topics, and assess the affective impact on students to ensure the optimal implementation of the Trigonometry Wheel.

## CONCLUSION

This study successfully developed the Trigonometry Wheel as a valid and practical learning medium for improving students' mathematical problem-solving ability in trigonometry through the Implementation stage of the ADDIE model. Media expert validation yielded 76.5% (Valid) and content expert validation reached 85.97% (Highly Valid), while teacher and student responses indicated high practicality at 90.54% and 88.61%, respectively. Furthermore, the embedded assessment conducted during the implementation phase showed a promising improvement in students' problem-solving ability, with an average N-Gain score of 0.79 (high category), suggesting that the medium has strong potential for effectiveness across all four of Polya's indicators. The key contribution of this study lies in filling the gap left by prior wheel-based media research, which had focused only on feasibility without examining the impact on problem-solving ability. By integrating a concrete, rotatable manipulative with Polya's problem-solving framework, this study demonstrates that hands-on visual media can support higher-order mathematical thinking. In practical terms, the Trigonometry Wheel can be adopted by mathematics teachers as a low-cost, reusable instructional aid that actively engages students and makes abstract trigonometric concepts more accessible.

Nevertheless, this study has limitations: it was carried out through the Implementation stage only, the pilot test involved a limited number of students, no control group was employed, and the scope was confined to trigonometry. Future research should complete the full ADDIE cycle including a formal Evaluation stage, involve a larger and more diverse sample, employ a quasi-experimental design with a control group, and

explore the development of a digital version of the Trigonometry Wheel to confirm and extend its applicability more broadly.

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