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Development of Trigonometry's Student Worksheets Based on Microsoft Mathematics Solver for Vocational High Schools in Improving Self-Regulation Dimensions

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ABSTRACT

PISA results show a decline in mathematical literacy scores, indicating the need for teachers to design lessons that support the understanding of mathematical concepts in various contexts and times. Although direct interaction between students and teachers is limited, it is necessary to use learning media that allows students to learn flexibly, whenever needed. The use of student's worksheet combined with Microsoft Mathematic Solver will facilitate students' curiosity to confirm the results of the student's worksheet that have been done self-regulationly which can be accessed anytime and anywhere. The purpose of this study was to determine the validity of the practicality of the Microsoft Mathematics Solver-based student's worksheet on SMK Trigonometry material in increasing the self-regulation dimension in the Self-regulation Curriculum Pancasila Student Profile. This research is a development research that uses a modification of the 4D method. Validators consist of media expert lecturers, and math teachers. The instrument used is the validation sheet for the Microsoft Mathematics Solver-based student's worksheet on SMK Trigonometry material. The data analysis technique used is the average test. The results obtained are the validity score of the Microsoft Mathematics Solver-based student's worksheet on SMK Trigonometry material in increasing the self-regulation dimension in the Self-regulation Curriculum Pancasila Student Profile is 3.5 which is included in the valid category

Keywords: *Student's Worksheet, Microsoft Mathematics Solver, Trigonometry, Self-regulation.*

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INTRODUCTION

Learning in the current self-regulation curriculum is focused on student-centered learning.The existence of student-centered learning gives students the freedom to construct understanding, including the understanding of reading literacy, mathematics literacy, and science literacy.Periodically, these three literacy skills are measured internationally through PISA (Programme for International Student Assessment) conducted by OECD (Organization for Economic Cooperation and Development). In 2022, Indonesia's math literacy improved by 5 positions compared to the 2018 results.However, Indonesia's math literacy score fell 13 points from 2018.

The mathematics literacy score of Indonesian students declined from 379 in 2018 to 366 in 2022 (OECD, 2019, 2023).The decline in mathematical literacy scores indicates that teachers need to design learning in such a way as to facilitate understanding of mathematical concepts that can be done anywhere and anytime.However, the intensity of meetings between students and teachers is limited, so learning media that students can use at any time is needed

The learning media that can and easily used by students is the student's worksheet.This worksheet is more flexible to use in mathematics materials, including trigonometry.The use of student's worksheet in learning affects students in learning basic mathematical concepts (Ummaeroh et al., 2019). The use of student's worksheet combined with Microsoft Mathematic Solver will facilitate students' curiosity to confirm the results of student's worksheet that has been done self-regulationly. Student's worksheet based on Microsoft Mathematic Solver is also needed by students at SMK Budi Luhur, because student learning still depends on the teacher. The ability of SMK Budi Luhur students in trigonometry material still needs to be improved and through the student's worksheet students can carry out learning activities according to the flow and check the results of their learning through Microsoft Mathematic Solver.The use of Microsoft Mathematics Solver can help students in finding solutions to problems (S. D. Handayani et al., 2019). The opportunity for students to check the results of working on problems in the student's worksheet through Microsoft Mathematics Solver, can hone students' self-regulation character. Self-regulation character is one of the dimensions in the Pancasila Student Profile which is currently being sought to be improved through the implementation of the Merdeka Curriculum.

Student's worksheet is a document that is used as a reference for student activities in learning a concept. student's worksheet contains at least eight components, including title, basic competencies to be achieved, estimated completion time, equipment/materials needed to complete the task, summary of information, stages of work steps, tasks that must be carried out, and reports that need to be compiled (Kholifah & Fitrayati, 2013). In this study, the elements of student's worksheet are title, learning outcomes, learning objectives, time allocation, tools and materials, material summary, stages of work steps, tasks to be done, assessment rubric, answer checking, assessment sheet.

The Microsoft Mathematics Solver app is similar software to a calculator, but with more comprehensive features. It presents

solutions to math, chemistry, and physics problems by including steps that help users complete the task easily, quickly, and accurately (Nurdiana & Hasanudin, 2023). The advantage of this Microsoft Mathematics Solver application is that it is easily accessible online using a PC or smartphone. So this application does not need to be installed.

Previous studies have explored the general utility of Microsoft Mathematics in enhancing students' mathematical understanding. For instance, (Rabi et al., 2022) found that using Microsoft Mathematics visualization tools improved students' conceptual understanding and attitudes towards calculus. Similarly, (Susilawati et al., 2021) demonstrated that integrating Microsoft Mathematics into learning activities enhanced students' adaptive reasoning abilities.

While these studies highlight the benefits of Microsoft Mathematics in various educational contexts, this research offers a new contribution by integrating the application specifically into student worksheets aimed at fostering self-regulated learning within the framework of the Pancasila Student Profile in the Independent Curriculum. This approach not only leverages the technological advantages of Microsoft Mathematics Solver but also aligns with national educational goals to develop students' autonomy and lifelong learning skills.

The purpose of national education is to develop the potential of students to become human beings who are faithful and devoted to God Almighty, have noble character, are healthy, knowledgeable, capable, creative, self-regulation, and become democratic and responsible citizens. To realize the goals of national education, the government made the Self-regulation Curriculum which contains character strengthening in the Pancasila Student Profile. Self-regulation is one of the 6 dimensions of the Pancasila student profile. Self-regulation is the attitude or behavior of someone who does not easily rely on help or depend on others (Nova & Widiastuti, 2019). Self-regulation consists of 2 elements, namely self-understanding and the situation at hand (subelements: recognizing personal qualities and interests as well as the challenges faced, developing self-reflection) and self-regulation (subelements: emotion regulation, setting learning, achievement, and self-development goals and strategic plans to deal with them, showing initiative and working self-regulationly). (BSKAP & Kemdikbud, 2022).

This research is a development research of student's worksheet based on Microsoft Mathematics Solver on trigonometry material in SMK. This research has not been done by previous researchers, because previous studies have developed student's worksheets combined with certain learning models (Anggela et al., 2021; S. Handayani & Mandasari, 2018; Pranata et al., 2021). Previous studies have also used Microsoft Mathematics Solver but not combined with other learning media (S. D. Handayani et al., 2019). The purpose of this research is to determine the validity of the Microsoft Mathematics Solver-based student's worksheet on SMK Trigonometry material in increasing the self-regulation dimension in the Merdeka Curriculum Pancasila Student Profile.

The urgency of this development lies in the current decline in Indonesian students' mathematical literacy, as evidenced by the drop in PISA scores from 379 in 2018 to 366 in 2022. One of the contributing factors is the limited interaction time between teachers and

students, especially in vocational schools where learning time is often constrained by practical sessions. Consequently, students require accessible and independent learning tools that support continuous learning outside the classroom. The integration of Microsoft Mathematics Solver into student worksheets aims to address this challenge by providing a flexible, step-by-step digital resource that encourages students to engage actively and regulate their own learning process.

Therefore, the purpose of this research is to determine the validity of student worksheets based on Microsoft Mathematics Solver for trigonometry material in SMK, particularly in enhancing the self-regulation dimension within the framework of the Pancasila Student Profile in the Merdeka Curriculum. This innovation is expected to support the development of independent, digitally literate learners who are capable of managing their learning in line with the demands of 21st-century education.

METHOD

This research is a modified development research that uses the 4D model by Thiagarajan and Semmel, namely: define, design, develop, and disseminate. This research only reached the develop stage. At the Define stage, the researcher conducted several activities to analyze needs and context. First, a curriculum analysis was carried out to review the existing mathematics teaching materials, particularly the trigonometry topics used in vocational high schools (SMK). Then, a student analysis was performed to examine students' initial attitudes toward mathematics and their learning challenges. Task analysis followed, identifying the types of problems students commonly encounter and the competencies targeted. Based on these findings, the learning objectives were formulated to guide the development of the student worksheet.

At the Design stage, the researcher began constructing the framework of the student worksheet by integrating features of the Microsoft Mathematics Solver application. The worksheet was designed to support students in solving trigonometry problems step-by-step with digital assistance. In parallel, a self-regulation scale was also designed to measure students' learning autonomy as aligned with the Pancasila Student Profile in the Independent Curriculum. Both the worksheet and the scale were prepared in draft format for expert evaluation.

At the development stage, researchers validated the Microsoft Mathematics Solver-based student's worksheet on SMK trigonometry material to experts (validators). The validators of this study were 1 lecturer from media experts and material experts, as well as 1 vocational math teacher. If there is a revision from the validator, the researcher will revise according to the direction of the validator. The validity of the Microsoft Mathematics Solver-based student's worksheet on SMK trigonometry material can be seen from the results of expert validation then averaged until it meets the valid criteria.

The instrument of this research is a validation sheet of Microsoft Mathematics Solver-based student's worksheet on SMK trigonometry material. The type of data collected is qualitative data. Qualitative data can be obtained from interviews on the results of the validation of Microsoft Mathematics Solver-based student's

worksheet on trigonometry material for vocational schools. The data collection technique is using a questionnaire.

RESULTS AND DISCUSSION

There are 3 development processes, namely the defining stage, the design stage, and the development stage. In the definition stage, researchers analyzed teaching materials, materials, and tasks used in mathematics subjects, students' initial attitudes in learning mathematics, identified what tasks would be given in learning, formulated learning objectives. Analysis of teaching materials used is to determine the form of teaching materials in the form of student's worksheet. Analysis of the material used, namely trigonometric material in the trigonometric comparison subchapter in class XI. The task analysis used is a question about trigonometric comparison in the form of a description. The problem is related to contextual problems. The initial attitude of students is the positive attitude of students in accepting new materials and media in learning. The learning objectives used in the 2 modules created are 1) Students are able to analyze related trigonometric comparison material, 2) Students are able to solve contextual problems related to trigonometric comparison 3) students can apply trigonometric comparison to find the length of the unknown side of a triangle.

The first student's worksheet for learning objectives “students are able to analyze related trigonometric comparison material” and “Students are able to solve contextual problems related to trigonometric comparison”. the second student's worksheet for learning objectives students can apply trigonometric comparison to find the length of the unknown side of a triangle. Each student's worksheet consists of a cover, learning objectives, time allocation, tools and materials, instructions for use, prerequisites, core activities (containing examples of problems and checking using Microsoft Mathematics Solver and exercise problems that must be completed by students in which there are instructions provided, there are also steps for checking exercise problems using Microsoft Mathematics Solver), and conclusions. Student's worksheet is one of the learning media that can be used to assist students in carrying out learning process activities. There are several things that are considered in making student's worksheet, starting from the cover, material content, and content of the student's worksheet. This is supported by previous research, namely the structure of a good student's worksheet contains (1) title, subject, semester, and place; (2) competencies to be achieved; (3) learning instructions; (4) indicators; (5) supporting information, (6) tasks and work steps; and (7) assessment (Kurnia et al., 2021). The structure of the student's worksheet according to (Wiyono et al., 2020), title, basic competencies to be achieved, completion time, equipment/materials required to complete the task, brief information, work steps.

In the development stage, researchers validated the student's worksheet based on Microsoft Mathematics Solver on SMK trigonometry material to experts (validators). The validators of this study were 1 lecturer from media experts and material experts, as well as 1 vocational math teacher. The validation scores from validators 1 and 2 are shown in Table 1

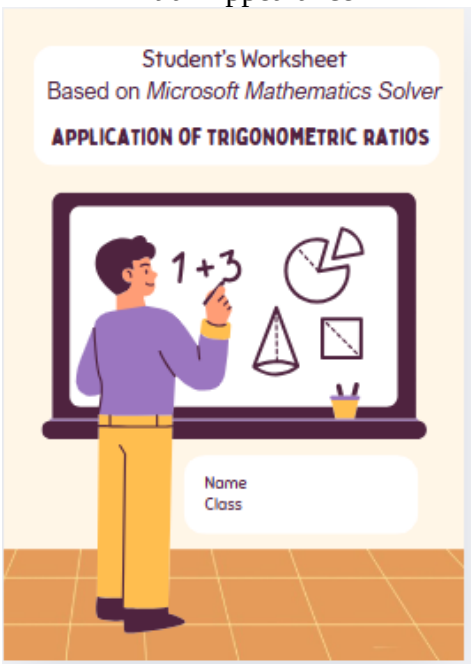
Table 1. Validity Scores from Validators 1 and 2

No	Aspect Item	Val.1 Score	Val.2 Score	Mean
1	A.1	3	4	3,5
2	A.2	3	3	3
3	A.3	4	3	3,5
4	B.1	4	4	4
5	B.2	4	3	3,5
6	B.3	4	3	3,5
7	B.4	4	3	3,5
8	B.5	4	3	3,5
9	C.1	3	4	3,5
10	C.2	4	4	4
11	C.3	4	4	4
12	D.1	4	2	3
13	D.2	4	3	3,5
14	D.3	4	3	3,5
15	D.4	4	3	3,5
16	D.5	4	3	3,5
Average of Validators 1 and 2				3,5

Based on the criteria, the average validity score is 3.5 which is in the valid category. The results of improvements based on the input of validators 1 and 2 are shown below:

1. The cover image should represent a trigonometric figure and the name of the application should be italicized. The cover needs to be improved, it is better if the math image appears according to the student's worksheet material. Initial appearance and final appearance in Figure 1.

Initial Appearance



Final Appearance

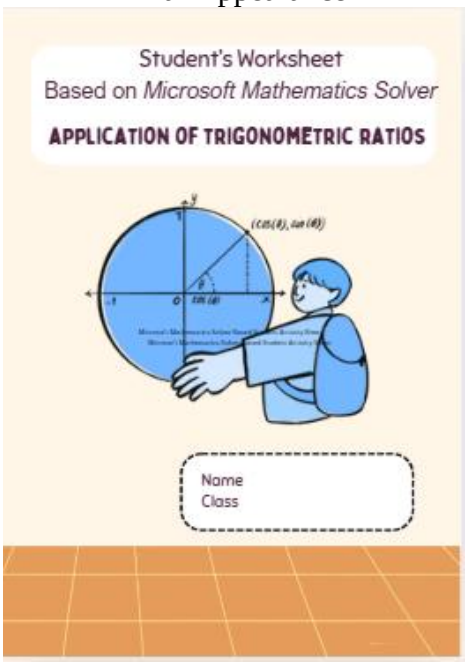
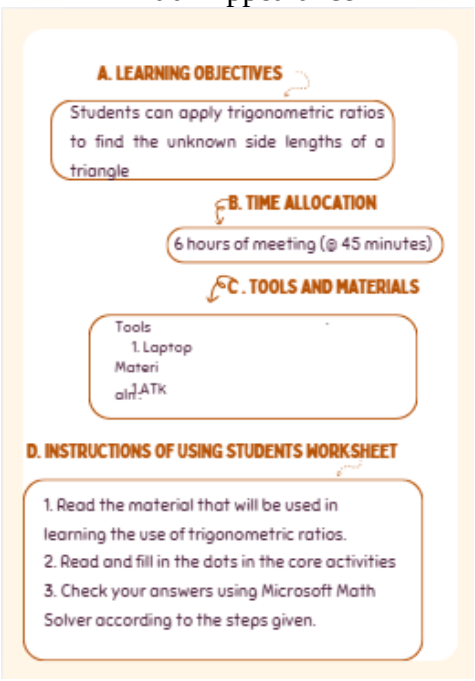


Figure 1. Initial and Final Appearance the Cover

2. Writing less spacing in identity part. Initial appearance and final appearance in Figure 2.

Initial Appearance



Final Appearance

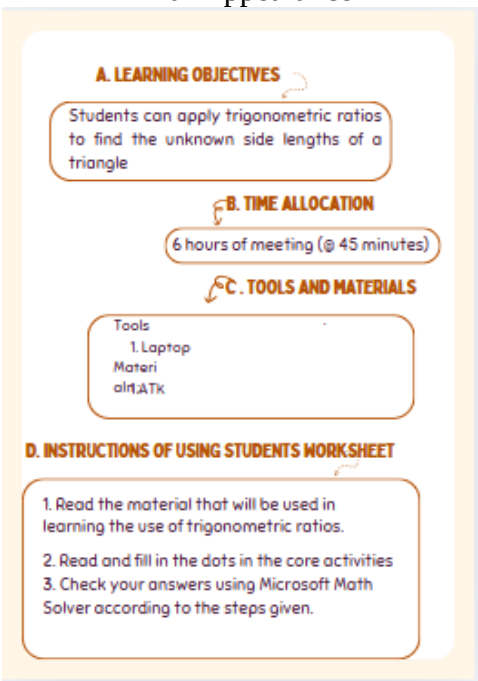
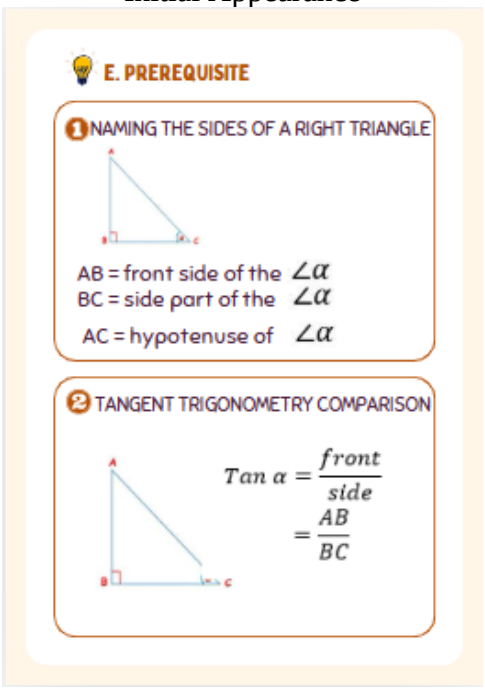


Figure 2. Identity Part

3. It is worth adding for $\sin \alpha$ and $\cos \alpha$. Initial appearance and final appearance in Figure 3.

Initial Appearance



Final Appearance

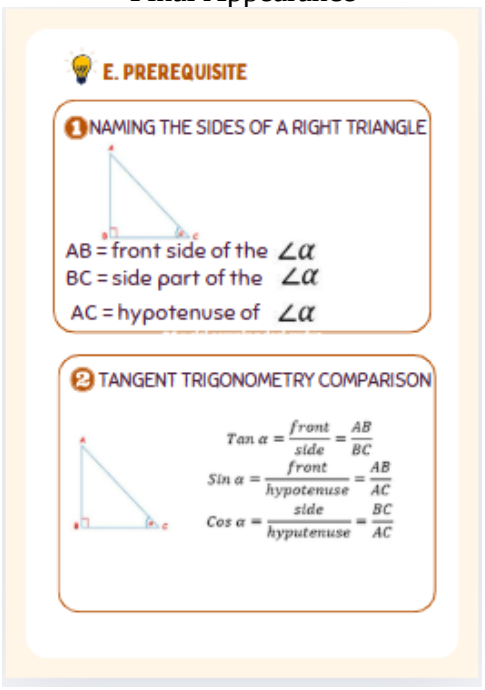
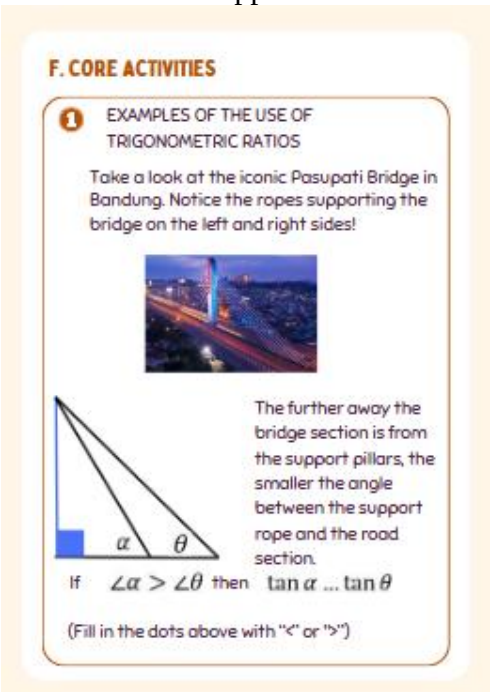


Figure 3. Adding for $\sin \alpha$ and $\cos \alpha$.

4. Adding captions to images. Initial appearance and final appearance in Figure 4.

Initial Appearance



Final Appearance

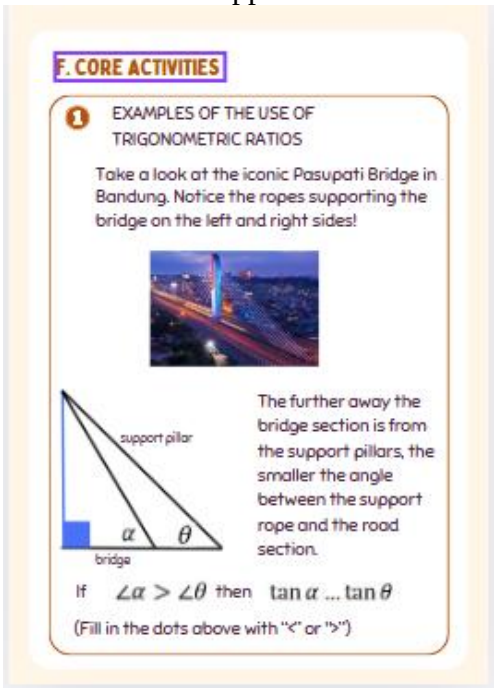
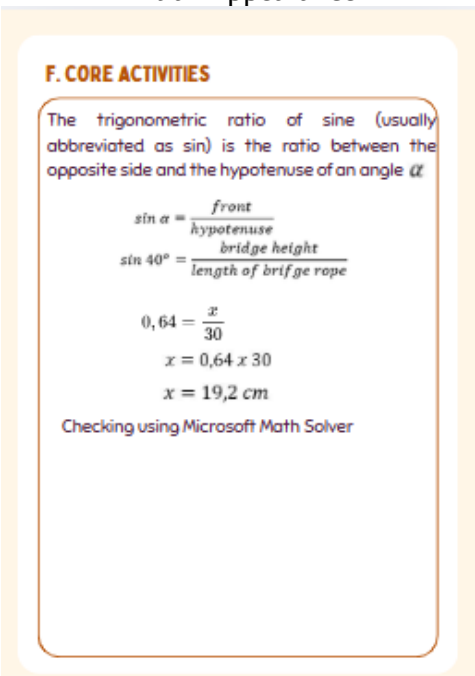


Figure 4. Adding Captions to Images.

5. Adding a conclusion at the end of the example problem. Initial appearance and final appearance in Figure 5.

Initial Appearance



Final Appearance

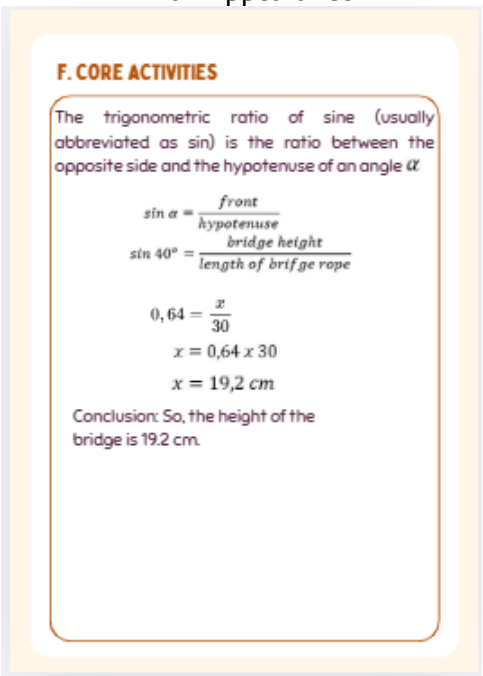
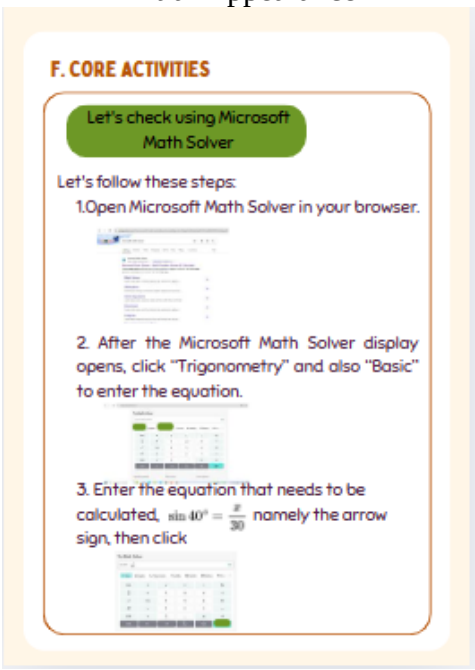


Figure 5. Conclusions

6. The image needs to be enlarged and the clicked part needs to be arrowed. Initial appearance and final appearance in Figure 6.

Initial Appearance



Final Appearance

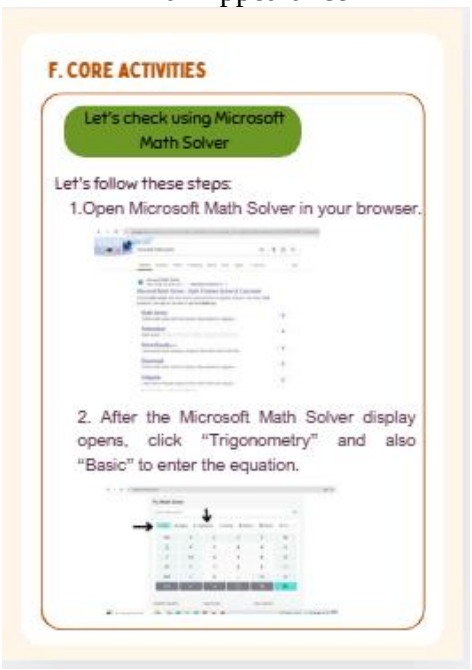
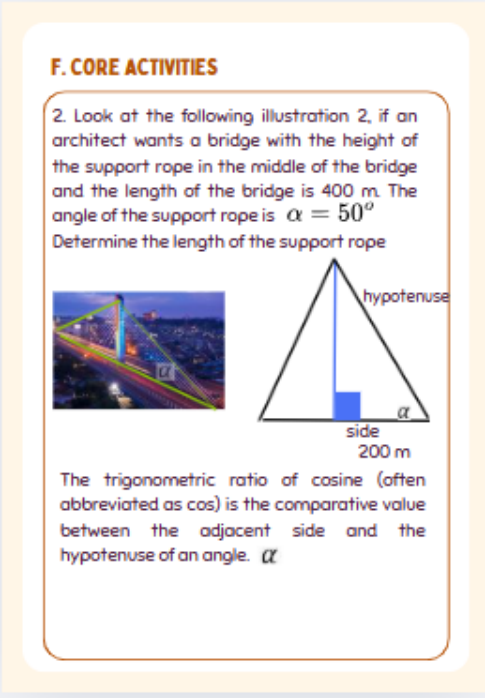


Figure 6. The Image Need to Be Arrowed

7. The illustration needs to be made congruent with the image. Initial appearance and final appearance in Figure 7.

Initial Appearance



Final Appearance

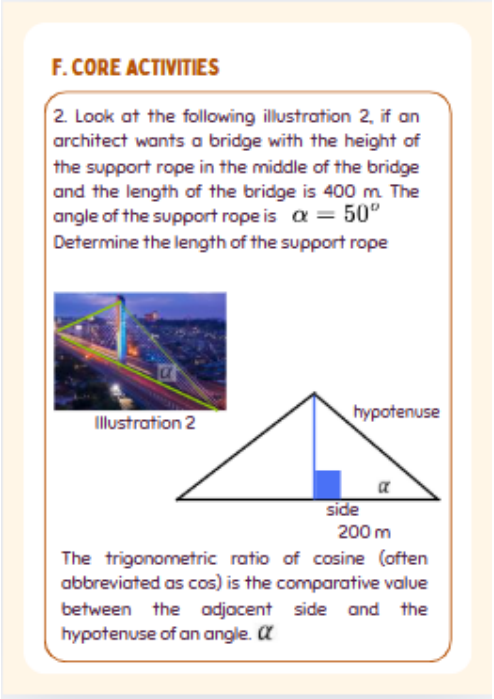


Figure 7. The Congruent Image

8. It is necessary to add a conclusion to the example problem. Initial appearance and final appearance in Figure 8.

Initial Appearance

Example:

Determine the names of the following right triangles!

Solution:

p is the front side of the angle θ

q is the side of the angle θ

r is the hypotenuse

Final Appearance

Example:

Determine the names of the following right triangles!

Solution:

p is the front side of the angle θ

q is the side of the angle θ

r is the hypotenuse

So, p = the front side, q = the side, r = the hypotenuse

Figure 8. The example problem

9. Image identity, image caption. Initial appearance and final appearance in Figure

Initial Appearance

1. **Naming the Sides of a Right Triangle**

- **The front side** is the side that is directly in front of the corner and is abbreviated as **De**.
- **The hypotenuse** is the side that is next to the corner and is abbreviated as **Sa**.
- **The hypotenuse** is the longest side of a right triangle or the one that is in front of the right angle and is abbreviated as **Mi**.

Final Appearance

1. **Naming the Sides of a Right Triangle**

Figure 1. Right triangle

- **The front side** is the side that is directly in front of the corner and is abbreviated as **De**.
- **The hypotenuse** is the side that is next to the corner and is abbreviated as **Sa**.
- **The hypotenuse** is the longest side of a right triangle or the one that is in front of the right angle and is abbreviated as **Mi**.

Figure 9. Image identity

10. The special angle prerequisite is not used in the problem, other prerequisites have not been written yet. Initial appearance and final appearance in Figure 10.

Initial Appearance

PREREQUISITE

Trigonometric Ratios of Special Angles

Trigonometri	0°	30°	45°	60°	90°
Sin	0	$\frac{1}{2}$	$\frac{1}{2}\sqrt{2}$	$\frac{1}{2}\sqrt{3}$	1
Cos	1	$\frac{1}{2}\sqrt{3}$	$\frac{1}{2}\sqrt{2}$	$\frac{1}{2}$	0
Tan	0	$\frac{1}{3}\sqrt{3}$	1	$\sqrt{3}$	–

Final Appearance

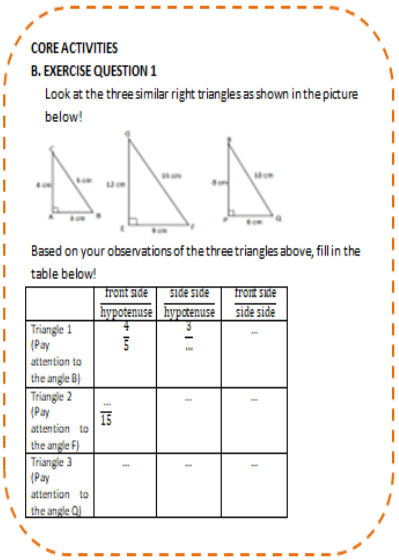
PREREQUISITE

1. A right triangle has one angle that is 90º.
2. A right triangle has two sides that are perpendicular to each other.
3. A right triangle has one hypotenuse.
4. Triangle angle symbols α, β, γ, θ.
5. The symbol < is read as angle

Figure 10. Prerequisite

11. Need to fix spaces (below and above). Initial appearance and final appearance in Figure 11.

Initial Appearance



CORE ACTIVITIES

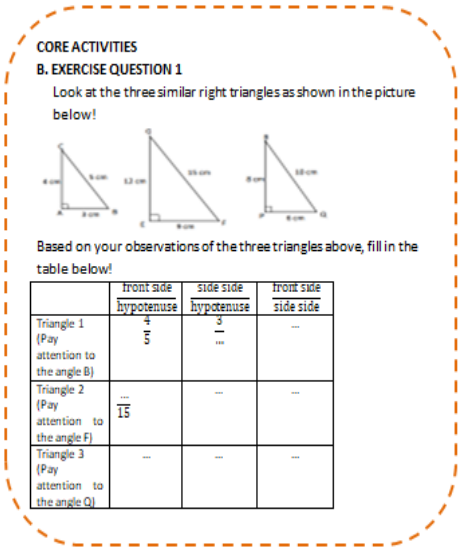
B. EXERCISE QUESTION 1

Look at the three similar right triangles as shown in the picture below!

Based on your observations of the three triangles above, fill in the table below!

	front side / hypotenuse	side side / hypotenuse	front side / side side
Triangle 1 (Pay attention to the angle B)	4/5	3/...	...
Triangle 2 (Pay attention to the angle F)	.../15	...	...
Triangle 3 (Pay attention to the angle Q)	...	...	...

Final Appearance



CORE ACTIVITIES

B. EXERCISE QUESTION 1

Look at the three similar right triangles as shown in the picture below!

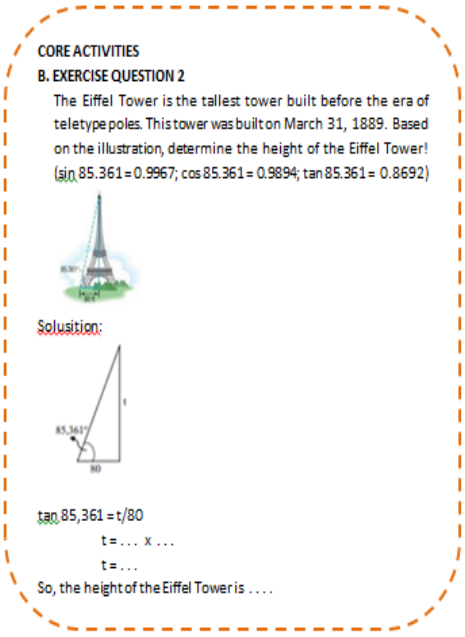
Based on your observations of the three triangles above, fill in the table below!

	front side / hypotenuse	side side / hypotenuse	front side / side side
Triangle 1 (Pay attention to the angle B)	4/5	3/...	...
Triangle 2 (Pay attention to the angle F)	.../15	...	...
Triangle 3 (Pay attention to the angle Q)	...	...	...

Figure 11. Fix Spaces

12. Need to fix a typo word (television). Initial appearance and final appearance in Figure 11.

Initial Appearance



CORE ACTIVITIES

B. EXERCISE QUESTION 2

The Eiffel Tower is the tallest tower built before the era of teletype poles. This tower was built on March 31, 1889. Based on the illustration, determine the height of the Eiffel Tower! (sin 85.361 = 0.9967; cos 85.361 = 0.9894; tan 85.361 = 0.8692)

Solusition:

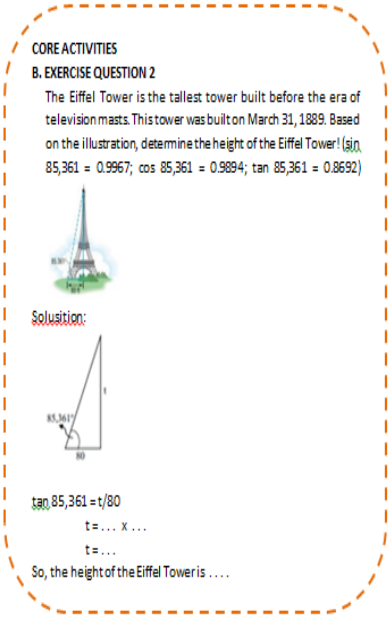
tan 85,361 = t/80

t = ... x ...

t = ...

So, the height of the Eiffel Tower is ....

Final Appearance



CORE ACTIVITIES

B. EXERCISE QUESTION 2

The Eiffel Tower is the tallest tower built before the era of television masts. This tower was built on March 31, 1889. Based on the illustration, determine the height of the Eiffel Tower! (sin 85,361 = 0.9967; cos 85,361 = 0.9894; tan 85,361 = 0.8692)

Solusition:

tan 85,361 = t/80

t = ... x ...

t = ...

So, the height of the Eiffel Tower is ....

Figure 12. Fix a Typo Word

The image on the cover of the student's worksheet would be better if it is related to the material to be given. The cover display provides a marker that the student's worksheet is related to certain material. There is readiness for students to learn both psychologically and physically such as tools and materials that will be used when looking at the student's worksheet cover because the cover clearly shows the subject title and material. The proportions of various characters on the cover must also be in harmony, such as the opinion of (Dimas & Negara, 2022), that the quality of cover design refers to proportion, balance, contrast, rhythm, and unity. About 75% of respondents prefer book covers with attractive illustrations, soft colors, typography that matches the illustrations, and a simple impression when looking at a book (Aisyah & Rinjani, 2023).

In making student's worksheet, the presentation of material does not go directly to the activity or core material, but it is also necessary to provide a review of prerequisite material. Prerequisite material is useful for students to remind them of the concepts that will be used in learning the core material. Understanding this prerequisite material will also affect students' success in learning the core material on the student's worksheet. This is supported by previous research, namely, mastery of prerequisite material is the main factor that becomes a supporting factor for students to understand further material. Mastery of prerequisite material is the main factor that supports students in understanding the next material (Fardiana et al., 2023). In addition to the prerequisite material that needs to be emphasized in making student's worksheet, it is necessary to have a conclusion at the end of each exercise problem as a form of emphasis on the learning activity process. The conclusion provides confirmation of the answers obtained so that students do not feel biased from the results of the learning process (Irmayadi et al., 2020). Understanding of prerequisite knowledge is proven to affect student learning outcomes (Nursalam et al., 2014). Prerequisite knowledge will also have an impact on students' success in solving problems (Nihayah, 2021).

In the core material of the student's worksheet, there are questions that support the learning process by providing questions that are adapted to contextual objects. The illustration cannot be done carelessly, but must be in accordance with the contextual object image. The existence of illustrative images, provides deeper knowledge in utilizing the character of the object (Witabora, 2012). Illustrative images make it clearer for students to understand the images and relate them to mathematical concepts.

Making student's worksheet by integrating technology, for example Microsoft Mathematics Solver can be done to provide a variety of learning and efforts to develop students' abilities. The use of technology in learning can help students visualize abstract mathematical concepts. (Auliya et al., 2020). Microsoft mathematics-assisted teaching materials can increase student motivation (Rizki & Widyastuti, 2019). Some things to consider when integrating technology-based applications in student's worksheets are the need to include detailed steps and images for each step. Need an arrow or circle on the button that is clicked. Students will not experience confusion looking for the clicked area if there is an arrow or circle.

CONCLUSION

The conclusion of this study is that the validity score of the Microsoft Mathematics Solver-based student's worksheet on SMK Trigonometry material in increasing the independent dimension in the Independent Curriculum Pancasila Student Profile is 3.5 which is included in the valid category.

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