



## Journal of Education and Learning Mathematics Research (JELMaR)

Online ISSN : 2715-9787

Print ISSN : 2715-8535

Journal Homepage : <http://jelmar.wisnuwardhana.ac.id/index.php/jelmar/index>

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Nurul Hidayah, Dewi Asmarani & Maryono Maryono

To cite this article Hidayah, N., Asmarani, D., & Maryono, M. (2023). Development of HOTS-Based Student Worksheets on Trigonometry material in Improving Problem Solving Ability. *Journal of Education and Learning Mathematics Research (JELMaR)*, 4(1), 70-78. <https://doi.org/10.37303/jelmar.v4i1.103>

To link this article : <https://doi.org/10.37303/jelmar.v4i1.103>

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#### Publisher

Department of Mathematics Education,  
Faculty of Teacher Training and Education,  
Universitas Wisnuwardhana Malang

# Development of HOTS-Based Student Worksheets on Trigonometry material in Improving Problem Solving Ability

<sup>1</sup>Nurul Hidayah, <sup>2</sup>Dewi Asmarani <sup>3</sup>Maryono

<sup>1</sup>SMKN 3 Boyolangu Tulungagung

<sup>2,3</sup>Program Studi Tadris Matematika, Pascasarjana, UIN Sayyid Ali Rahmatullah Tulungagung, Indonesia

<sup>1</sup>Email: [nurulhidayahspd@gmail.com](mailto:nurulhidayahspd@gmail.com)

<sup>2</sup>Email: [dewiasmarani.iain@gmail.com](mailto:dewiasmarani.iain@gmail.com)

<sup>3</sup>Email: [mario\\_stain@yahoo.com](mailto:mario_stain@yahoo.com)

**Abstract:** One of the impacts of the Covid 19 pandemic is that learning is carried out online so that applications have sprung up to help students solve math problems, as a result students' problem-solving skills are reduced. In addition, the Student Worksheets that has been used so far only contains routine questions, not HOTS questions. For this reason, it is necessary to develop HOTS-based worksheets to improve problem solving abilities. The purpose of this study was to describe the process of developing valid, practical and effective HOTS-based worksheets on Trigonometry material in improving problem solving skills for class X SMKN 3 Boyolangu Tulungagung. This research is research and development called Research and Development (R&D) with the ADDIE development model which includes analysis, design, development, implementation, and evaluation. Sampling used purposive sampling method and the 2 classes selected were Class X Electronics Engineering 4 as the experimental class and Class X Automotive Engineering 4 as the control class. Based on the results of the validator, the responses of educators and students, the results of the research in the form of HOTS-based worksheets on Trigonometry for class X developed using the ADDIE development model were declared valid, practical, effective in improving problem solving skills

**Keyword:** Development, HOTS, Problem Solving Ability, Student Worksheets, Trigonometry

## PRELIMINARY

The 2013 curriculum is designed with various improvements, one of which is an assessment standard, which emphasizes learning outcomes that prioritize higher-order thinking skills, better known as Higher Order Thinking Skills (HOTS) (Dr. I WayanWidana, S.Pd., 2017) in order to be able to compete in the world of work and personal life (Lisda Fitriana Masitoh, 2020). Students' ability to solve HOTS questions is still at a low level, especially during a pandemic.

The pandemic that occurred due to the Covid 19 virus resulted in teaching and learning activities being carried out online (in the network) (Hendayana, 2021). This results in various problems for students, one of which is the ability to solve problems, especially in mathematics, is getting lower. This is because most educators only use the Google form application to make questions, both assignments and tests, in which the form of the questions is multiple choice questions. Online learning also makes applications more widespread (Anugerah Ayu Sendari, 2019) to help students, especially applications to solve math problems. but only answer questions without seeing how to solve the problem so that problem solving abilities become lower.

Problem solving ability is the ability or potential possessed by students in solving problems and applying them in everyday life. (Gunantara1 et al., 2014). Problem solving ability is the ability that students have in understanding problems, planning ways of solving them, carrying out problem solving plans and interpreting or checking the results. This problem-solving ability is also often used in solving problems in vocational schools, because it relates to its application in workshops as happened at SMKN 3 Boyolangu Tulungagung. To see how much problem-solving ability students have, the researcher conducted an initial test

The results of the initial test are that students have not shown an understanding of the problem, because they have not been able to identify the elements that are known, what is asked and other elements that are needed, students have not been able to formulate problems into mathematical models, students have not been able to develop problem-solving strategies (Faturahman, 2015), so they are still not able to come up with what formulas can be used in solving problems, and students are also not able to explain the truth of the answers they get

Based on the facts above, it can be seen that students' problem-solving abilities are still low. For this reason, educators must be able to overcome these problems, one of which is by using HOTS-based Student Worksheets (Purwasil & Fitiyana2, 2020)

The existing Student Worksheets only contains routine questions (Putri, 2018), namely ordinary practice questions that can be solved with procedures learned in class. Questions of this type are widely found in textbooks and are intended only to train students to use the procedures being studied in class. For this reason, it is necessary to develop worksheets that contain non-routine questions, which are more commonly known as HOTS questions. This Student Worksheets is expected to be able to improve students' high-level thinking skills and train students to get used to working on HOTS questions. (Fikin, 2019).

The development of HOTS-based Student Worksheets is not only to find out if it is appropriate or not to be used as teaching materials in learning, but Student Worksheets that is valid, practical and effective for learning. This Student Worksheets is also used to improve students' problemsolving abilities.

The purpose of this study is how the process of developing HOTS-based worksheets on Trigonometry material is valid, practical and effective in improving problem solving skills for class X SMKN 3 Boyolangu Tulungagung.

## **METHOD**

The type of research used by researchers is research and development called Research and Development (R&D) with the Analysis, Design, Development, Implementation, Evaluation (ADDIE) development model which is a procedural model. which is descriptive in showing the steps that must be followed to produce a product. There are five stages in the ADDIE development model, namely (a) Analysis, (b) Design, (c) Development, (d) Implementation and (e) Evaluation. The product produced in this research and development is a HOTS-based Student Worksheet. The products that have been produced are analyzed and tested for their validity, practicality and effectiveness.

## **RESULTS AND DISCUSSION**

### **1. Analysis of Data Validation Results**

The results of this validation data are data validated by two mathematics study program lecturers, namely Dr. Umm Sholihah, S.Pd., M. Si and Dr. Syaiful

Hadi, M. Pd who acts as a material expert as well as a design and media expert who validates the Student Worksheets developed in this study.

a. Data Analysis Results of Expert Validation on HOTS-Based Student Worksheets Development Material on Trigonometry material

**Table 1. Material Expert Validation Results for HOTS-Based Student Worksheets Development in Trigonometry material**

No	Assessment Aspects	Validator Score		Average
		I	II	
1	Content Eligibility	3,1	3,4	3,29
2	Eligibility of Presentation	3	3,3	3,17
3	Language Eligibility	3	3,4	3,2
Overall average:				3,23

Based on the results of the material expert's assessment of HOTS-based Student Worksheets in class X Trigonometry material, the average obtained was 3.23, the average obtained from the development of Student Worksheets was said to be valid.

b. Data Analysis of HOTS-Based Student Worksheets Design and Media Expert Validation Results on Trigonometry material

**Table 2. Results of Validation of Design and Media Experts on the Development of HOTS-Based Student Worksheets on Trigonometry material**

No	Assessment Aspects	Validator Score		Average
		I	II	
1.	Software	3,4	4	3,5
2.	Visual communication	3,3	3,2	3,3
3.	Media characteristics	3	3	3
Overall average:				3,26

Based on the results of the design and media expert's assessment of HOTS-based Student Worksheets on Trigonometry material for class X TE SMKN 3 Boyolangu, the average obtained was 3.26, the average obtained from the development of Student Worksheets was said to be valid.

1. Practicality Data Analysis

The practicality of Student Worksheets data is measured based on data from observations of the implementation of HOTS-based Student Worksheets development on Trigonometry material. The observation questionnaire on the implementation of HOTS-based Student Worksheets on Trigonometry material, which was carried out by 3 (three) observers who are Mathematics educators at SMKN 3 Boyolangu Tulungagung. The three educators are Drs. Pujiono, M. Pd, Eni Sariastuti, S. Pd and Sri Prabandari, S. Pd

**Table 3. Observation Results of the Implementation of HOTS-Based Student Worksheets Development on Trigonometry material**

No	Assessment Aspects	Observer 1	Observer 2	Observer 3	Average
		3rd meeting			

	1	2	3	4	5	6	7	
1. Students have no difficulty in understanding Student Worksheets	3	3	3	3	3	3	3	3
2. Students can adjust the time allocation in the Student	3	3	3	3	4	3	4	3,83
3. Students can carry out the instructions requested in the Student Worksheets	3	3	3	4	4	4	4	3,57
4. Students can fill in all the material fields in Student Worksheets from various sources (package books, internet)	3	3	3	3	3	3	3	3
5. The Competency Test on Student Worksheets is in accordance with the material contained in	4	4	4	4	4	4	4	4
6. Students can complete the competency test on Student Worksheets	3	3	3	3	3	3	3	3
Overall average:								3,4

Based on the results of the observer's assessment of HOTS-based Student Worksheets on Trigonometry material for class X TE 4 SMKN 3 Boyolangu, the average obtained was 3.4, the average obtained from the development of Student Worksheets was said to be practical to use.

### 3. Effectiveness Data Analysis

The effectiveness of Student Worksheets is seen from three aspects, namely the response of educators and students to Student Worksheets and the results of the material mastery test.

#### a. Data Analysis of Results of Validation of Educator's Response Questionnaire Sheets on the Development of HOTS-Based Worksheets on Trigonometry material.

Educator's response questionnaire to HOTS-based Student Worksheets on Trigonometry material conducted by 4 (four) Mathematics educators at SMKN 3 Boyolangu Tulungagung. The four educators are: Drs. Pujiono, M. Pd, Eni Sariastuti, S. Pd, Rahmi Rahayu, S. Pd and Sri Prabandari, S. Pd

**Table 4. Results of the Educator's Response Questionnaire on the Development of HOTS-Based Student Worksheets on Trigonometry material**

No	Assessment Aspects	Average Educator Response Score				Average
		I	II	III	IV	
1	Learning Design	3,57	3,71	3,57	3,71	3,64

2	Operational	3,50	4,0	4,0	4,00	3,88
3	Visual Communication	3,33	3,5	3,67	3,50	3.50
Overall average:						3,67

Based on the results of assessing educator responses to HOTS-based Student Worksheets on Trigonometry material for class X TE SMKN 3 Boyolangu, the average obtained was 3.67, the average obtained from the development of Student Worksheets was said to be used effectively.

b. Data Analysis Results of Student Response Questionnaire Sheet Validation on HOTS-Based Student Worksheets Development on Trigonometry material

The use of this Student Worksheets was carried out 7 meetings so that the student response questionnaire was given at the last meeting.

**Table 5. Questionnaire results of student responses to HOTS-based Student Worksheets on Trigonometry material.**

No.	Statement	Average Score
1	The information in the Student Worksheets is easy for me to understand	3,41
2	Studying with HOTS-based worksheets made me understand Trigonometry material	3,68
3	The presentation of the material in the Student Worksheets is related to examples of everyday life so that I understand more about the material presented	3,59
4	The instructions given in the Student Worksheets are very clear so I can easily understand the steps for using the Student Worksheets	3,38
5	There are no words in the worksheet that confuse me	3,46
6	The pictures on the Student Worksheets match the contents of the material so that it makes it easier for me to understand	3,19
7	The use of letters, font size and spacing is correct so that it makes it easier for me to understand the Student Worksheets	3,00
8	Student Worksheets has a display color that caught my attention	3,00
9	This Student Worksheets motivated me to study Trigonometry material independently	3,05
10	HOTS-based worksheets stimulated me to discuss with friends and ask educators	3,16
11	Presentation of material on Trigonometry can add to my interest in studying the contents of Student Worksheets	3,03
12	I think the overall appearance of the Student Worksheets is interesting	3,14
13	Student Worksheets increases my curiosity in learning Trigonometry material	3,03
14	This Student Worksheets helped me answer the teacher's questions well	3,08
Overall average:		3,23

Based on the results of assessing students' responses to HOTS-based Student Worksheets on Trigonometry material for class X TE SMKN 3 Boyolangu, the average obtained was 3.23, the average obtained from the development of

Student Worksheets was said to be effective in improving problem solving abilities.

In this study, there were two different classes with different treatments. The first class of treatment in class learning uses HOTS-based Student Worksheets which has been developed and is referred to as the experimental class while the other class does not use Student Worksheets which has been developed and is referred to as the control class. The data used is data on the results of the material mastery test. Data from the test results from the 2 classes were then tested, namely the homogeneity test and the t-test.

### 1. Homogeneous Test

The data used for this homogeneous test are the Mid Semester Deuteronomy scores from the two classes. This value is the value obtained by students before getting Trigonometry material. Mid Semester Deuteronomy Scores are used in the Homogeneity Test of class X Electronic Engineering 4 and X Automotive Engineering 4.

In calculating this homogeneous test, the researcher used the SPSS application with the following results.

**Test of Homogeneity of Variances**

		Levene Statistic	df1	df2	Sig.
Kelaseksperimen	Based on Mean	1,828	7	24	,128
	Based on Median	1,138	7	24	,373
	Based on Median and with adjusted df	1,138	7	15,941	,388
	Based on trimmed mean	1,744	7	24	,146

**ANOVA**

Kelaseksperimen					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1302,357	13	100,181	,898	,567
Within Groups	2677,958	24	111,582		
Total	3980,316	37			

Based on the table above, it can be seen from the significant value  $(p) \geq 0.05$  both in the calculation of the Test of Homogeneity of variances and ANOVA so that it can be concluded that the two classes come from populations that have the same (homogeneous) variance..

The material mastery test questions that have been validated are then tested in class X TE 4 with a total of 38 students at the last face-to-face meeting. The Minimum Completeness Criteria value set is 70, so that out of 38 students there are 7 scores that are under the Minimum Completeness Criteria, namely 63, 65, 65, 65, 68, 68, 68, while the others are above or equal to the Completeness Criteria At a minimum. Thus the classical completeness is 81.6%, this means that classically it can be said to be complete and the level of mastery of the material is high, so it can be concluded that the Student Worksheets developed are effectively used in improving problem solving abilities in Trigonometry material.

### 2. Test t-test

The t-test was carried out using post-test data from the experimental class and the control class. Calculation of the t-test, the researchers used the SPSS application with the following results.

**Coefficients<sup>a</sup>**

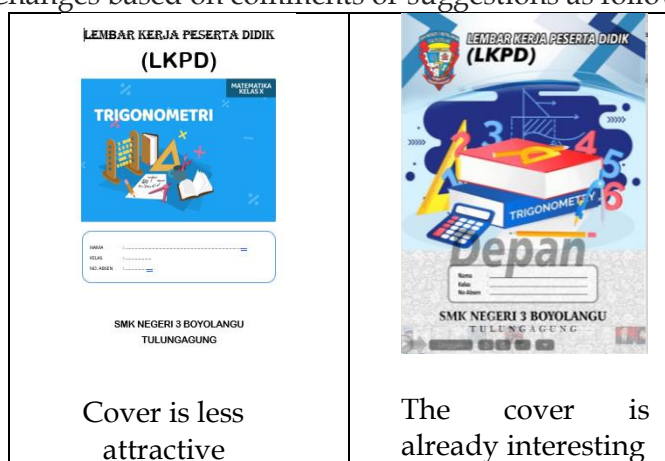
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	64,251	13,031		4,931	,000
	Kelas_Kontrol	,204	,171	,194	1,189	,242

a. Dependent Variable: Kelas\_Eksperimen

Based on the table above, it can be seen at the significance value (2-tailed) = 0.000 < 0.05 so it can be concluded that H0 is rejected and H1 is accepted. Thus there is a significant difference between the learning outcomes of students who apply Student Worksheets based on HOTS and the learning outcomes of students who do not use Student Worksheets. This proves that the use of HOTS-based Student Worksheets in Trigonometry material can effectively improve problem solving abilities in class X students.

### B. Product Revision

The HOTS-based Student Worksheets developed in this study are said to be valid, practical and effective with several revisions. These revisions were made based on comments or suggestions provided by expert subjects and trial subjects. Changes based on comments or suggestions as follows:



### C. Discussion of Development Results

This research begins by analyzing problems in the process of learning mathematics by making observations about the process of learning mathematics, methods and media that are suitable for learning mathematics.

#### 1. Development of HOTS-Based Student Worksheets

The development of HOTS-based Student Worksheets was raised from problems including the results of the PISA which was held on December 3 2019, Indonesia was number 74 out of 79 countries (Edra, 2021). and the existence of the Covid 19 pandemic which has made learning activities carried out online (Hendayana, 2021) so that students' problem solving abilities are reduced, especially in Mathematics lessons. Another impact of the pandemic is the emergence of applications to help students solve math problems. (Ayunda Pininta Kasih, 2021) Based on observations made by researchers, the Student Worksheets that students have used so far are still routine so that students are not used to solving problems. For this reason, HOTS-based Student Worksheets are needed to improve problem solving abilities.



The HOTS-based Student Worksheets development is carried out according to the ADDIE development stage (Cahyadi\*, 2019). The ADDIE stage includes five stages, namely analysis, design, development, implementation and evaluation.

The analysis phase used is literature study and field study. From the results of the literature study, it was found that many books in the library were still abandoned because they were not used, while the results of the field study obtained mathematics learning using Student Worksheets which only contained routine questions. From the results of the material analysis, information was obtained that trigonometry was not well understood by learners. At the design or planning stage, it is carried out by making plans for the development of Student Worksheets for the subject of trigonometry, namely determining the title, draft Student Worksheets, the number of learning activities and content presentation in Student Worksheets. In the development or product development stage, the researcher develops Student Worksheets based on the draft that was made before. Then carried out in the product validation stage by material experts, design experts and media. At the implementation stage, a product assessment is carried out through teacher and student response sheets. The evaluation phase aims to measure the validity, practicality and effectiveness of the developed Student Worksheets. The validation test was carried out using a validation sheet carried out by two expert lecturers.

## 2. Validity

The validation test was carried out using a validation sheet (Agustarina, 2019) which was carried out by two expert lecturers. The first revision was carried out after the HOTS-based mathematics learning product (Annisa Nur Faiqoh, Sony Irianto, 2019) was validated by two expert lecturers. According to expert lecturers, in general Student Worksheets are good, there are only a few revisions, namely regarding grammar, and ways of solving problems (Faturahman, 2015) which are not in accordance with the research title. Based on the analysis of validation data by two expert lecturers, the overall average score is 3.28 so that it can be stated that the development of HOTS-based Student Worksheets on Trigonometry material is valid to use.

## 3. Practicality

Practicality (Firmansyah & Rusimamto, 2020) in Student Worksheets development research to measure the level of practicality seen from whether educators (and other experts) consider that the material is easy and can be used by educators and students. Data on the practicality of Student Worksheets were measured based on data from observations of the implementation of the HOTS-based Student Worksheets development in Trigonometry material (Karmina et al, 2008). The observation questionnaire on the implementation of Student Worksheets development was carried out by 3 observers and obtained an average score for each aspect of the assessment was 3.4 so that it can be said that the development of HOTS-based Student Worksheets on Trigonometry material was practically used.

## 4. Effectiveness

Effectiveness (Asfar1 & Syarif Nur, 2019) in development research measures the level of effectiveness seen from the level of appreciation of students in studying the program and the desire of students to continue using the program. The effectiveness of Student Worksheets can be seen from three aspects, namely the results of tests of mastery of the material, the responses of educators and students' responses to Student Worksheets. Post-test results data obtained by students in the experimental class successfully completed classically with an achievement of 81.6%, so that the level of mastery of the material is said to be high. Based on the

analysis of the data from the questionnaire results of educators and students' responses to the development of HOTS-based Student Worksheets on Trigonometry material, the overall average score was 3.32, so it can be said that the development of HOTS-based Student Worksheets on Trigonometry material is effectively used in improving problem-solving skills. learners.

## CONCLUSION.

HOTS-based Student Worksheets on class X Trigonometry material was developed with the ADDIE development model. which consists of five stages which include analysis (analysis), design (design), development (development), implementation (implementation), and evaluation (evaluation). All of these stages have been carried out properly. Student Worksheets based on HOTS which was developed on Trigonometry material was validated by two lecturers at UIN SATU Tulungagung and obtained an average score of 3.28 so that it can be said that the development of Student Worksheets is valid. The practicality of the Student Worksheets development results based on the results of the Student Worksheets implementation data from three mathematics teachers, obtained an average score of 3.4 so that it can be said that the Student Worksheets developed are practically used. The effectiveness of the Student Worksheets development results is based on the responses of educators and students who get an average score of 3.43 so that it can be said that the Student Worksheets developed are effective in improving problem solving abilities.

Based on the description above, it can be concluded as a whole that HOTS-based Student Worksheets developed on Trigonometry material are valid, practical and effective in improving the problem solving abilities of class X students at SMKN 3 Boyolangu, Tulungagung

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