Daya Matematis : Jurnal Inovasi Pendidikan Matematika
Volume, 11 Nomor 2 July 2023 pagr. Hal. 119-129
p-ISSN:2541-4232 dan e-ISSN: 2354-7146

Development of ARCS-based learning tools containing hot questions to improve students' critical thinking abilities Class VIII SMP/MTS

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(***Received***: 13-03-2023; ***Reviewed:*** 21-04-2023; ***Revised:*** 23-06-2023; ***Accepted:*** 25-06-2023; ***Published:*** 29-07-2023)

Abstract
The literature study and preliminary analysis conducted showed that students' critical thinking skills were still low. This study aims to determine the characteristics of Attention, Relevance, Confidence, Satisfaction (ARCS)-based learning tools that contain valid, practical, and effective HOTS questions to improve the critical thinking skills of class VIII students of SMP N 6 Padang Panjang. This research is a development research using the Plomp model. The learning tools developed are in the form of Learning Implementation Plans (RPP) and Student Activity Sheets (LKPD). The research subjects were students of class VIII SMP N 6 Padang Panjang. Data was collected through documentation, observation, interviews, questionnaires, and tests of critical thinking skills. RPP Validity Score: 3.28 and LKPD: 3.21 with a valid category. Practicality of RPP: 92.08% and LKPD: 87.35% with very practical category. The effectiveness of learning tools based on testing the average critical thinking skills of the experimental class was 81.93, control class was 76.63. Based on statistical tests, a significance value of 0.048 <0.05 was obtained, and based on the list of t distribution tables with (df)=60 and a=0.05, 1.671. Because t_count= 2.108>1.671=t_(table) then H_0 is rejected and accepts H_1. Based on the test results, it can be concluded that the ARCS-based learning tools contain HOTS questions that meet valid, practical, and effective criteria to improve students' mathematical thinking skills.

Keywords: Learning Tools, ARCS, HOTS, Critical Thinking Skills

INTRODUCTION

Century 21st learning requires students to have 4 important abilities including critical thinking, collaboration, communication, creativity (Pratiwi et al., 2019). One of the important abilities above is critical thinking. Critical thinking is an intellectual discipline process that includes the active use of skills for understanding, application, analysis, synthesis, interpretation of experience, reflection, reasoning, and communication (Dolapcioglu & Doğanay, 2022). Thus, critical thinking skills through mathematics can encourage participants to answer questions and solve problems with detailed explanations.

However, currently students' critical thinking skills are still low, as stated by Dolapcioglu & Doğanay (2022) students cannot find meaning and develop higher-order thinking skills, because learning activities are only based on repetition of knowledge. Febrianti, et al (2021) said that one of the reasons for the low ability to think critically is because students are not familiar with questions that trigger critical thinking.

Meanwhile, Firdaus et al (2019) said that teaching and learning activities are still centered on educators, resulting in students' thinking abilities not being fully developed properly. Students tend to be guided or given complete problem solving instructions, so that students are not yet able to solve problems independently. Based on the 2021/2022 SMP/MTs End of Semester Assessment Grid (Appendix 1), the researchers saw that the questions given were dominated by C1-C3 levels. Of the 40 questions, only 2 questions are at level C4. Then, by testing the questions given, information was obtained that the students' critical thinking abilities were still relatively low. One of the students' answers in answering the test questions given can be seen in Figure 1.

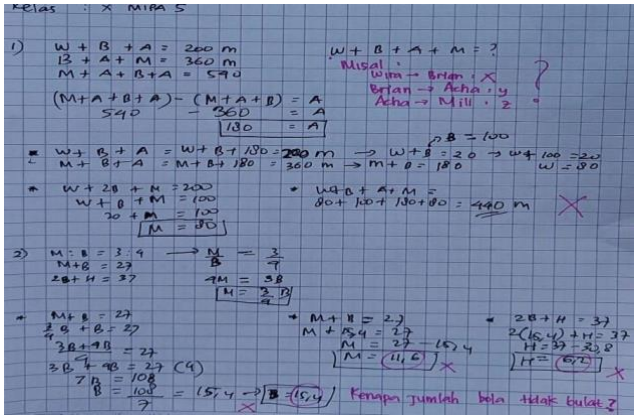

Figure 1. One of the Student's Answers in the Question Test

Based on Figure 1, students did not identify the problem clearly, so the answers they found were also inaccurate and did not write down the conclusions from the solutions obtained. Seeing the results of the students' answers above, it is known that students are not used to focusing on analyzing and identifying problems systematically and making conclusions/conclusions. The results of the recapitulation of the score analysis of the critical thinking skills pilot test conducted at three schools can be seen in Table 1.

Table 1. Achievement of Students' Critical Thinking Results

School	Test Average			Overall average
	1	2	3	
SMP N 1 Padang Panjang	36,23%	32,42%	34,15%	34,26%
SMP N 6 Padang Panjang	45,63%	36,25%	31,81%	39,89%
MTs N Padang Panjang	46,88%	37,50%	38,75%	41,18%%

Based on Table 1, it can be seen that the average proportional percentage of students' answers at SMP N 1 Padang Panjang was 34.26%, SMP N 6 Padang Panjang was 39.89%, and MTsN Padang Panjang was 41.18%. This means that students' critical thinking skills in the three schools are still relatively low.

Apart from that, the results of researchers' interviews with mathematics educators showed that students' self-confidence and independence were still low. Students lack the courage to work on questions or present in front of the class, and do not want to express opinions. Students often think the questions are difficult and say they can't solve them. After being guided through trigger questions by educators, students are slowly able to solve them. Furthermore, it was obtained that students were less interested and motivated in learning mathematics. Students consider learning mathematics difficult and boring, and still lack understanding of basic mathematical concepts. Then educators in teaching have tried to make teaching materials in the form of Student Worksheets (LKPD). LKPD that has been made by educators can be seen in Figure 1.

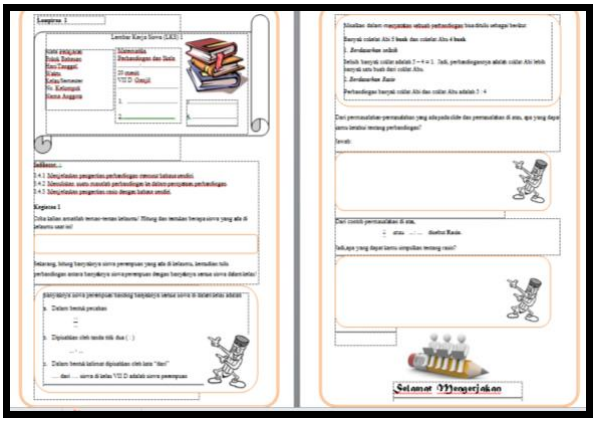

Figure 1. LKPD created by educators

Based on Figure 1, the learning material is presented very concisely and not yet varied so that not all students are able to understand it independently. The linkage of learning materials with real experiences of students is very necessary so that students are motivated in learning. Guidance on finding the concept of learning material in LKPD is needed so that students have confidence in learning activities. Many of the questions given on the LKPD only repeat knowledge, so it is necessary to add questions that can stimulate students' thinking power and critical thinking abilities.

Critical thinking skills must be developed and learning motivation must be created by educators in learning activities. Saputra (2016) stated that Higher Order Thinking Skill (HOTS) can improve students' thinking abilities at a higher level, especially those related to the ability to think critically in receiving various types of information, think creatively in solving a problem using the knowledge they have and make decisions in complex situations. The Attention, Relevance, Confidence, Satisfaction (ARCS) model is a model that designs motivational aspects and a learning environment that encourages and maintains students' motivation to learn (Keller, 2000). Suherman et al (2021) say that students who are motivated to participate in the learning process will improve their knowledge and thinking power. In line with what Zanthy (2016) stated, learning motivation has a big influence on students' critical thinking abilities. From this explanation, learning activities using ARCS components can maintain student motivation. Increasing motivation will be able to improve students' thinking power and getting used to giving HOTS questions will have an impact on students' critical thinking abilities.

Seeing the problems above, it is necessary to improve the process of learning mathematics in particular. Educators must be able to direct students to achieve learning objectives. In order to achieve maximum learning objectives, educators are responsible for designing learning tools that are oriented towards students' motivation in learning and guiding students to develop critical thinking skills. By improving students' critical thinking skills, educators have prepared the abilities required in 21st century learning and to achieve a passing standard of numeracy skills in reasoning using mathematical concepts, procedures, facts and tools to solve mathematical problems.

METHOD

This research is research and development or Research and Development (R&D). In this case, an ARCS-based learning tool was developed containing HOTS questions in mathematics learning for class VIII SMP/MTs students, so that it is expected to be useful in the process of learning mathematics and can improve students' critical thinking skills. ARCS-based learning tools were developed using the Plomp model which consisted of 3 stages, namely preliminary research, prototyping (manufacturing and development), assessment (assessment).

The learning device trial was carried out at SMP Negeri 6 Padang Panjang. The data from the trial results will be used as a basis for revising the product, so that the resulting product is really suitable

for use in learning. Data was collected through observation sheets on RPP implementation, questionnaires, and interview guides. The test subjects in this research were students of SMP N 6 Padang Panjang for the 2021/2022 academic year. The trial was conducted in one of class VIII SMP N 6 Padang Panjang to see the practicality and effectiveness of the ARCS-based learning tool containing HOTS questions to improve students' critical thinking skills.

The type of data in this study is primary data, namely data directly obtained from experts, educators, and students in the form of practicality validation results obtained through questionnaires testing the validity and practicality of learning tools, as well as tests of critical thinking skills. Data analysis techniques were performed using descriptive statistics and descriptive techniques, namely describing the validity, practicality, and effectiveness of ARCS-based learning devices containing HOTS questions. Descriptive statistics to analyze the results of critical thinking skills tests, observation sheets, and questionnaires. While descriptive techniques to analyze the results of interviews and field notes.

RESULT AND DISCUSSION

Result

a. Learning Device Validation Results

To obtain a valid learning device validation is carried out. There are two steps taken in validating learning tools, namely self-evaluation and validation with experts (expert review). In general, the results of the evaluation itself were that there were errors in typing words and using punctuation marks in the RPP and LKPD. The validity test of ARCS-based learning tools containing HOTS questions was carried out by 6 lecturers, namely 4 mathematics experts, 1 Indonesian language expert, and 1 educational technology expert. The recapitulation of the RPP validation results presented per aspect of the assessment is shown in Table 2.

Table 2. Summary of RPP Validation Results by Mathematics Experts

No	Assessment Aspects	Average	Criteria
1	RPP identity	3,75	Very Valid
2	Time Allocation	3,25	Valid
3	KI/KD and Formulation of Indicators Learning	3,5	Very Valid
4	Formulation of Learning Objectives	3,125	Valid
5	Selection of learning materials	3,67	Very Valid
6	Selection of Learning Models *Attention* *Relevance* *Confidence* *Satisfaction*	3,14	Valid
7	Learning steps	3,21	Valid
8	Selection of Learning Resources	3,375	Valid
9	Selection of Learning Media	3,125	Valid
10	Evaluation	3	Valid
11	Language and Writing	3	Valid
	Overall Average	**3,28**	**Valid**

From Table 2 it can be seen that the results of the validity test of the ARCS-based lesson plans as a whole are in the valid criteria. Obtained an average score of 3.28 which is in the valid criteria.

While the results of the ARCS-based LKPD validation contain HOTS questions by experts can be seen in Table 3.

Table 3 Recapitulation of the Average Results of ARCS-Based LKPD Validation Contains HOTS Questions by Experts

No	Assessment Aspects	Average Rating Score						Average	Criteria
		V1	V2	V3	V4	V5	V6		
1	Content Eligibility	3,22	3,39	3,00	3,11	-	-	3,18	Valid
2	Presentation	3,27	3,09	3,00	3,27	-	-	3,16	Valid
3	Graphic	-	-	-	-	3,09	-	3,09	Valid
4	Language	-	-	-	-	-	3,42	3,42	Sangat Valid
Overall Average								**3,21**	**Valid**

Keterangan:

V1, V2, V3 V4 : Mathematics Expert
V5 : Education Technology Expert
V6 : Language Expert

Based on Table 3, it can be seen that the average validity value for each aspect is within the valid criteria and the overall average validity of the LKPD is 3.21 with valid criteria. So it can be concluded that the ARCS-based LKPD containing HOTS questions is valid.

b. Results of Practicality of Learning Devices

The practicality of the LKPD can be seen from the results of the questionnaire analysis filled out by students and educators as users of learning tools. The following is a description of the analysis results for each of these instruments.

1) Practicality Questionnaire Results by Educators

The results of the practicality questionnaire filled out by educators aim to obtain information regarding the practicality of learning devices based on the opinions and considerations of educators after using the developed learning devices. The results of the practicality questionnaire filled out by educators can be seen in Table 4.

Table 4. Recapitulation of Practicality Questionnaire by Educators

No	Assessment Aspects	Practical Value	Criteria
1	Attractiveness	93,75%	very practical
2	Use Process	88,89%	very practical
3	Ease of Use	85,71%	very practical
4	Legibility	100%	very practical
Practicality Average Score		**92,08%**	**very practical**

Based on Table 4, it is known that the average practicality value is 92.08% in the very practical category. This means that the ARCS-based learning tool containing HOTS questions is considered practical.

2) Practicality Questionnaire Results by Students

Practicality questionnaires are given to students after participating in learning using ARCS-based LKPD. The results of the practicality questionnaire on LKPD can be seen in Table 5.

Table 5. Results of LKPD Practicality Questionnaire Data Analysis by Field Test Stage Students.

No	Assessment Aspects	Practical Value	Criteria
1	Attractiveness	89%	very practical
2	Use Process	85,95%	very practical
3	Ease of Use	86,53%	very practical
4	Legibility	87,92%	very practical
Practicality Average Score		**87,35%**	**very practical**

Based on Table 4.51, it is known that the average practicality value of LKPD by students is 87.35% in the very practical category. This means that after a field test was carried out the ARCS-based LKPD was declared practical.

1) Interview Results with Educators
Interviews were conducted to find out the practicality of lesson plans and worksheets used by educators in the process of learning activities in class VIII Madina SMP N 6 Padang Panjang. Interviews with educators were carried out after the learning process on flat-sided spatial building material was completed. Based on the results of interviews, it is known that educators are very happy with the ARCS-based learning tool integrated with HOTS questions because it is easy to use, can attract students' attention to learning, presents learning material in a sequential and fun way, and LKPD can overcome problems if different shifts do not enter the learning process day. Thus, it can be concluded that the ARCS-based learning tool integrated with HOTS questions used is practical.

2) Observation results of ARCS-based lesson plan implementation
Observation of the implementation of the RPP aims to find out whether the learning activities are in accordance with the RPP that has been designed. Observation of the implementation of lesson plans was carried out by a class VIII mathematics educator. Safa SMP N 6 Padang Panjang. The results of the observer's observation analysis for the implementation of the lesson plan at each meeting can be seen in Table 4.16.

Table 6 Results of Observer Observation Analysis for the Implementation of the RPP at each meeting

No	Aspek Penilaian	Nilai Kepraktisan	Kriteria
1	Kegiatan Pendahuluan	90,13%	Sangat Praktis
2	Kegiatan Inti	90%	Sangat Praktis
3	Kegiatan Penutup	93 %	Sangat Praktis
Nilai Rata-rata Kepraktisan		**91,04%**	**Sangat Praktis**

c. Learning Device Effectiveness Results

The effectiveness of learning tools is carried out by providing critical thinking skills questions. The test questions were validated on 2 mathematics education lecturers. Test questions were given to the experimental class and control class. Critical thinking ability test score data for participants in the experimental class and control class were analyzed using the independent sample t test. The results of the data analysis are as follows:

1) Normality Test
The results of testing the normality of the control and experimental class data can be seen in Table 7.

Tabel 7. Normality Test

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Control	,145	32	,107	,937	32	,077
Experiment	,099	30	,200*	,964	30	,393

Based on the results of the SPSS output above, it was found that the significance value for the control class was 0.77> 0.05 and the significance value for the experimental class was 0.393> 0.05. From the test results it can be concluded that the critical thinking ability score data of experimental and control class students is normally distributed.

2) Homogenity Test
The results of testing the homogeneity of the control and experimental class data can be seen in Table 8.

Table 8. Homogenity Test

Test of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
Results	Based on Mean	,263	1	60	,610
	Based on Median	,238	1	60	,627
	Based on Median and with adjusted df	,238	1	52,138	,627
	Based on trimmed mean	,227	1	60	,636

Based on the results of the SPSS output above, it was found that the significance value was 0.610> 0.05. From the test results it can be concluded that the students' critical thinking ability score data has the same variance.

3) Hypothesis Test
Hypothesis testing was carried out using the Independent Sample t Test. The test results are shown in Table 9.

Table 9. Sample Class Statistical Data

Group Statistics					
	Class	N	Mean	Std. Deviation	Std. Error Mean
Results	1 (Experiment)	30	81,93	8,952	1,634
	2 (control)	32	76,63	11,502	2,033

The SPSS output results show that the average critical thinking ability of experimental class students is 81.93, while the control class is 76.63.

Below are presented the output results of the Independent Sample t Test using the SPPP application in Table 10.

Table 10. Independent Sample t Test

		t-test for Equality of Means						
		t	df	Sig.(2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Hasil	Equal variances assumed	2,018	60	,048	5,308	2,630	,048	10,569
	Equal variances not assumed	2,035	58,080	,046	5,308	2,609	,086	10,530

Meanwhile, the results of the Independent Sample t Test using the MS Excel application can be seen in Table 11.

Tabel 11. Uji *Independet Sample t Test* Menggunakan Ms. Excel

t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	81,933	76,63
Variance	80,133	132,31
Observations	30,000	32,00
Df	60,000	
t Stat	2,018	
P(T<=t) one-tail	0,024	
t Critical one-tail	1,671	
P(T<=t) two-tail	0,048	
t Critical two-tail	2,000	

Based on the SPSS output results, the significance value (two-tailed) is 0.048, then the significance value (one tailed) is 0.024 <0.05, also the same based on Ms. output. Excel obtained a significance of 0.24 < 0.05, so it can be said that there is a difference in the average critical thinking ability of experimental and control class students. From the table listing the t distribution with degrees of freedom (df)= ($30 + 32 - 2$)= 60 and the probability $1 - \alpha$ is 1.671. Because $t_{hitung} = 2,108 > 1,671 = t_{tabel}$ it is H_0 rejected and H_1 accepted, namely that the test of students' mathematical critical thinking abilities using ARCS-based learning tools integrated with HOTS questions is better than the test of students' mathematical critical thinking abilities without using ARCS-based learning tools containing HOTS questions for class VIII students at SMPN 6 Padang Panjang.

Summary data on the mathematical critical thinking abilities of the sample group students can be seen in Table 12.

Table 12 Recapitulation of the Results of Students' Mathematical Critical Thinking Ability in the Sample Group

Class	N	X_{max}	X_{min}	μ	% Completeness (KKM=76)
Experiment	30	100	67	81,93	80
Control	32	96	45	76,63	66

Based on the results of hypothesis testing and Table 12, it can be concluded that ARCS-based learning tools integrated with HOTS questions are effective for improving students' mathematical critical thinking skills.

Discussion

The results of this study are in line with research conducted by Yi-Hsing Chang (2019) that the development of e-books using the ARCS model shows a more significant increase in learning outcomes in the experimental group than in the control group. Dincer's (2020) research shows that there is a positive influence on learning motivation. Student motivation increases as the duration of use of learning materials increases. Attention was found to be the largest effect among the components of the Attention, Relevance, Confidence Satisfaction (ARCS) model.

Relevant research regarding critical thinking skills by Rohmatulloh and Utami, (2022) where in this

research it was found that the more trained a person is in solving HOTS questions, the higher their ability to fulfill critical thinking indicators. As the results of this study found that subjects in the high category were able to fulfill all indicators of critical thinking skills. It can be concluded that someone can be said to be able to solve a problem if they are able to examine a problem and are able to use their knowledge in new situations. This ability is also known as HOTS or higher order thinking skills (Dinni, 2018). Widana et al. (2018) which shows that the use of HOTS-based questions can help educators improve students' critical thinking skills. Increasing mastery of critical thinking also directly influences analytical skills, which can help students map problems and the information needed as capital to solve a problem. (Chijioke & Offiah, 2013; Cullen et al., 2018 in Sidiq et al. 2021). This statement is in line with Taleb & Chadwick in Fadly, 2021) where problem solving skills are an important aspect of critical thinking skills.

Critical thinking skills are one of the important skills in dealing with the demands and challenges of the 21st century which will help students compete globally (Aslan, 2015). This makes critical thinking skills must be developed, trained, practiced, and integrated continuously in learning. Mastery of mathematical concepts can be achieved well if students have good critical thinking skills. This is in accordance with the opinion expressed by A.N. Chukwuyenum (2013) which states that critical thinking is also an effective way to improve students' understanding of mathematical concepts. Thus, the HOTS assessment indirectly makes a positive contribution to learning to improve understanding of mathematical concepts.

Based on the description above, it can be concluded that the use of HOTS questions in learning mathematics has a significant effect on students' critical thinking skills in learning mathematics. Thus, HOTS in learning mathematics is proven to be effective in increasing students' critical thinking skills. Therefore, it is suggested to mathematics educators to use HOTS questions as an alternative to improve students' critical thinking skills.

CONCLUSIONS AND SUGGESTIONS

Learning tools were developed using the Plomp model starting from Preliminary research, where at this stage needs analysis, curriculum analysis and student analysis. The results of the Preliminary research are used as a starting point to enter the second stage, namely designing and developing learning tools (Development or Prototyping Phase). Based on the results of the study, several conclusions were obtained as follows:

1. After going through the assessment and revision process according to self evaluation, expert review, one-to-one evaluation and small group evaluation, the learning tool using the ARCS model contains HOTS questions to improve critical thinking skills in the form of RPP and LKPD for flat-sided building materials. valid and in accordance with all indicators in each aspect, namely aspects of content, presentation, language, and graphics.
2. After going through the process of one-to-one evaluation, small group evaluation, field test the results of the research show that the learning device using the ARCS model contains HOTS questions to improve critical thinking skills that have been developed to meet practical criteria both in terms of implementation, convenience and time required .
3. After going through the field test and mathematical critical thinking ability tests as seen from the comparison of the average critical thinking abilities of the experimental class and the control class which were statistically analyzed using the independent t test showed that the learning device using the ARCS model contained HOTS questions in the form of lesson plans and LKPD for flat-sided building material has been effective in improving students' critical mathematical thinking skills.

For other researchers it is suggested to develop learning tools using the ARCS model for other materials and trials are carried out on several topics of discussion so that the products produced are better as well as further trials in other schools to see broader practicality and effectiveness of the development of learning devices besides RPP and LKPD that have been developed.

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