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Development of Learning Tools Assisted *by Lumio By Smart* to Improve Mathematical Problem Solving Ability

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ABSTRACT: This study aims to describe the process and results of the development of learning tools assisted *by Lumio by SMART* on flat building material to improve the mathematical problem solving skills of junior high school students in grade VII. At Sunan Kalijogo Junior High School, students' ability to solve varied geometry problems is still low. Students tend to focus on the end result without understanding the solution strategy, so they are only able to solve the problems that are modelled by the teacher. This research uses the 4D development model. The validation results showed the device was very valid (score 3.71). The learning was well implemented, student activeness reached 93.6%, and student response was 90.71%. Classical completeness reached 89.4% with ability improvement in the moderate to high category. The independent sample t-test resulted in a significance of 0.000 (<0.05), showing a significant difference between the experimental and control classes. Thus, the device developed was declared valid, practical, and effective. The implementation of the device also increased the involvement and motivation of seventh grade students of Sunan Klijogo Junior High School, as well as creating a collaborative learning environment and supporting a significant increase in mathematical problem solving ability. This research can be a reference for the development of innovative learning, and is recommended to be applied to other materials to improve mathematical problem solving skills.

KEYWORDS: Flat Buildings, Geometry, Learning Tools, Lumio, Problem Solving

INTRODUCTION

Mathematics is a basic subject that plays an important role in all levels of education. Many fields of science whose development and application depend on the mastery of mathematical concepts (Siagian, 2016). As a product of human thought, mathematics is closely related to the ability to understand concepts, apply procedures, and build logical reasoning (Kusumawardani et al., 2018). Therefore, it is important for students from primary to secondary level to master the basic competencies of mathematics. According to the Ministry of Education and Culture (2022), mathematics is included in compulsory subjects at all levels of primary and secondary education listed in the national curriculum. This shows the urgency of mathematics as the foundation of mastering science and technology.

In the context of 21st century education, skills such as critical, creative, collaborative and communicative thinking are needed. Mastery of these skills can be fostered through meaningful and contextualised mathematics learning. One of the important abilities that is the goal of learning mathematics is problem solving ability, which reflects higher order thinking skills (Pratiwi et al., 2023). The National Council of Teachers of Mathematics (NCTM, 2000 in Lubis et al. (2023) mentioned that problem solving ability is one of the five main standards in learning mathematics, in addition to communication, connection, reasoning, and representation. In line with Niskayuna (1993) in Mardiani et al. (2024) classify problem solving into three perspectives. First, problem solving as an *approach*, which means learning begins with a problem. Second, problem solving as a *goal*, which is related to the reason why mathematics is taught. Third problem solving as a process *(Procees),* which emphasises the importance of procedures, strategies, and steps in solving.

Indonesian students' mathematical problem solving skills are still relatively low. Based on the results of the 2018 *Programme for International Student Assessment* (PISA) survey, Indonesia ranked 73rd out of 79 participating countries, with an average mathematics score of 379, far below the international average. One of the aspects measured in the survey is students' ability to apply mathematical concepts to solve contextual problems. This result is in line with the conditions in the field, including at Sunan Kalijogo Junior High School. Based on interviews with mathematics teachers, it is known that in geometry material, less than 50% of students are able to achieve scores above the Minimum Completion Criteria (KKM). This shows the weak ability of students in solving varied problems, especially those that require understanding of concepts and application of solving strategies. Though in everyday life indirectly students have been in contact with the concept of geometry (Yudianto et al., 2022).

One of the reasons is that students tend to focus on finding the final answer without understanding the problem solving process or strategy (Firmansyah et al., 2022). Whereas mathematical problem solving ability is one aspect of higher order thinking which is a central goal in learning mathematics. In line with Branca's opinion in Agnesti et al. (2020) which states that problem solving skills include the ability to understand problems, plan strategies, implement solutions, and evaluate the results.

However, in reality, many students are accustomed to copying examples of problems given by teachers and are less accustomed to thinking critically or exploratively. This is reinforced by the findings of Supratman et al. (2021) that many students are only comfortable doing problems with the mechanism that has been exemplified. On the other hand, learning tools used by teachers such as teaching modules and LKPDs do not fully support the development of higher order thinking skills. The available tools are mostly prepared based on the basic characteristics of students, not to train problem solving skills (Sholihah & Hasanudin, 2024). So that innovation is needed in the development of learning tools that can facilitate active and meaningful learning. The use of technology-based media is one of the strategic solutions in learning. Technology not only helps visualise abstract concepts, but also increases student engagement and motivation (Syarifah & Yasin, 2024) because the development of digital technology has had a significant impact in the world of education, including in the presentation of more interactive and interesting learning materials. One of the innovations that can be utilised in the learning process is *Lumio by Smart* (Fajrianti et al., 2024).

This web-based interactive learning platform allows teachers to present digital content dynamically and engage students actively (Osipova E. & Bagrova Y. Y., 2022). It also helps students understand abstract and complex mathematical concepts through a fun and interactive approach, thus helping students in solving mathematical problems. Therefore, Lumio is not only used for material delivery, but also as a formative test media and ice breaking activities in learning (Nurmaulidiyah et al., 2024). According to Fahmi et al. (2024), the use of *lumio by smart* also encourages students to learn independently, share ideas with friends, and increase their creativity. This media is able to create learning that is more interesting, collaborative, and relevant to students' lives, in line with the opinion of Susanto et al. (2023) who stated that learning will be effective if there is a reciprocal relationship between teachers and students. So it can be concluded that Lumio is a web-based interactive learning platform used to present material dynamically, facilitate understanding of abstract concepts, and encourage active involvement, independence, creativity, and collaboration of students in learning mathematics.

The utilisation of Lumio in this study will be collaborated with the learning that has taken place at school to strengthen student involvement, increase the effectiveness of material delivery, and create a more interactive and meaningful learning atmosphere. A number of previous studies have been conducted related to the development of learning tools to improve mathematical problem solving skills. For example, research by Fitria et al. (2020), Hidayati Husna & Pritasari (2024) and Nasution & Lailia (2023) developed devices based on *Problem-Based Learning*, PjBL and the Use of Animated Media. However, most of these studies have not integrated interactive technology such as Lumio, especially in geometry materials. In addition, the utilisation of technology facilities available in schools such as computer laboratories is still not optimal.

Based on this background, this study aims to develop a geometry learning tool assisted *by Lumio by SMART* to improve the mathematical problem solving skills of junior high school students in grade VII. This device is expected to be able to answer the challenges of current mathematics learning by creating learning experiences that are interactive, contextual, and oriented towards 21st century skills.

RESEARCH METHODS

This research is a development research that uses the 4D model (*Define, Design, Develop, and Disseminate*) from Thiagarajan. This model was chosen because it is systematic and suitable for developing valid, practical, and effective learning tools. In addition, the 4D model provides clear stages from needs analysis to implementation testing, allowing the development of products that are in accordance with learning problems in the field.

The products developed in the form of geometry learning tools assisted *by Lumio by Smart* on flat building materials, namely teaching modules, LKPD and Problem Sets, which are directed to improve the mathematical problem solving skills of junior high school students in grade VII. After going through the development stage until a valid, practical, and effective product is obtained, further trials are carried out in the form of experiments to determine the effect of using the device on students' problem solving skills.

The experimental research was conducted using *pretest-posttest control* group design, where measurements were taken before *(pretest)* and after *(posttest)* treatment. The experimental class used lumio-assisted geometry learning tools, while the control class used learning tools without lumio. This research was conducted at Sunan Kalijogo Junior High School. The location was determined by *purposive sampling* by considering several criteria, including: (1) the availability of subjects according to the research objectives; (2) the unavailability of data on mathematics problem solving ability on flat building material; and (3) the school has implemented the Merdeka Curriculum and has supporting facilities, including a computer laboratory. The research sample consists of two randomly selected VII classes, each as an experimental class and a control class.

The data collection instruments in this study include: (1) validation sheet of learning tools and instruments; (2) observation sheet of learning implementation; (3) student activity sheet; (4) student response questionnaire; and (5) problem solving ability test consisting of pretest and posttest questions. Data analysis was carried out through several stages: 1) Analysis of the validity of devices and instruments was carried out by referring to the average score of the validator's assessment results, which were classified based on certain categories classified based on the categories in Table 1. Learning devices fulfil the validity criteria if they at least reach the valid category.

Table 1. Validity Level of Teaching Modules Learning Device Validity Interval

Value V_a	Validity Category
$1 \leq V_a < 2$	Not valid
$2 \leq V_a < 3$	Fairly Valid
$3 \leq V_a < 4$	Valid
V_a	Very Valid

2) Analysis of the practicality of learning devices. The interval level of practicality of the results of the observation analysis of learning implementation activities is presented in table 2. The instrument meets the criteria for practicality if it reaches at least the practical category. Learning devices meet practical criteria if they at least reach the high category.

Table 2. Practicality Criteria of Practicality Interval

Value V_a	Validity Category
$1 \leq I_o < 2$	Low
$2 \leq I_o < 3$	Medium
$3 \leq I_o < 4$	High
I_o	Very High

3) Analysis of student activity. Interval The level of student activeness of the observation results describes student activity during the process of mathematics learning activities. The instrument fulfils the criteria for student activeness if it reaches at least Good.

Table 3. Student Activity Interval

Score	Criteria
$90\% \leq P_s < 100\%$	Very good
$80\% \leq P_s < 90\%$	Good
$65\% \leq P_s < 80\%$	Good enough
$P_s < 60\ \%$	Not Good

4) Student Response Analysis. Interval level of student response describes the response of students when learning using the device is implemented. Presented in table 4. The instrument fulfils the criteria for student response if it reaches at least Positive.

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Table 4. Student Response

Criteria	Score
85%≤ RS	Very Positive
70%≤ RS < 85%	Positive
50%≤ RS < 70%	Less Positive
RS < 50%	Not Positive

5) Analysis of calcal completeness. Analysis of learning outcome test data on flat building material is categorised based on the Minimum Completeness Criteria (KKM) that has been set, which is 70 out of a maximum score of 100. Students who scored ≥ 70 were categorised as complete. To determine the level of classical completeness, the percentage of the number of students who are complete against the total number of students is calculated. If the percentage reached ≥ 70%, then the learning was declared classically complete. Conversely, if the percentage is < 70%, then the learning is not classically complete.

6) N-Gain analysis. N-Gain analysis was conducted to determine the improvement of problem solving ability. It is presented in table 5.

Table 5. Category of Improvement in Problem Solving Ability

Score	Criteria
$g > 0,7$	High
$0,3 < g \leq 0,7$	Medium
$g \leq 0,3$	Low

Prerequisite test analysis after all assumption tests are met, then the next step is to analyse the research data using normality test and homogeneity test. The basis for making normality test decisions is calculated using IBM SPSS 25 with the *Shapiro-Wilk* method based on the amount of probability, the valueα used is 0.05. While the homogeneity test, homogeneity test decision making is calculated using IBM SPSS 25 with the *Levene* test method based on the amount of probability, the valueα used is 0.05. Hypothesis testing aims to test the previous hypothesis. The data tested was the ability to solve mathematical problems from the *pretest-posttest* results. Decision making is based on the *independent t-test* as follows:

1. If the significant value (2-tailed) < 0.05 thenH_0 is rejected andH_1 is accepted which means there is a significant effect of the implementation of geometry learning tools assisted *by lumio by smart* on improving mathematical problem solving skills.
2. If the significant value (2-tailed) > 0.05 thenH_0 is accepted andH_1 is rejected which means there is no significant effect of the implementation of geometry learning tools assisted *by lumio by smart* on improving mathematical problem solving skills.

RESULTS AND DISCUSSION

Results

The process of developing learning devices with 4D (Thiagarajan) successfully developed through *Lumio by Smart* assisted geometry learning devices. The learning device is designed through how many stages as follows.

Define phase

This phase aims to establish and define learning needs by analysing the objectives and limitations of the materials used in the development of learning tools. This phase includes five basic stages, namely: 1) Start-end analysis, 2) Learner analysis, 3) Concept analysis, 4) Task analysis, 5) Specification of learning objectives.

Design Phase

At the Design stage, the initial design of learning tools was carried out based on the needs identified at the Define stage. The activity begins with the preparation of problem solving test instruments in the form of three description questions accompanied by grids, alternative answers, and scoring rubrics. The learning media chosen was *Lumio by Smart* and *Problem Based Learning* (PBL) based LKPD, designed to encourage collaboration and active student involvement in project completion. The selected device format includes teaching modules, user manuals, LKPD, and test instruments. The teaching module was designed for three meetings

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with contextual project activities on parallelogram, rectangle, and square materials assisted by Lumio, and one meeting for the final test. The instruction manual was prepared to help teachers implement learning with lumio integration. The LKPD contains project steps according to PBL syntax according to the model applied at school and is arranged contextually so that students better understand the concept meaningfully. The learning outcome test instrument was developed to measure students' problem solving ability. In addition, research instruments were also developed in the form of observation sheets for learning implementation, student activities, and student response questionnaires. All of them were designed to measure the quality of implementation and the impact of using the tools. All the tools were summarised in the initial *draft (draft 1)*.

Development Phase (Develop)

The initial activity carried out at this stage was expert validation of draft 1. Draft 1 has been validated and revised based on the experts' suggestions and input to produce draft 2 which is ready to be tested. The results of the validity analysis by experts are in Table 5.

Table 5. Recapitulation of Validity of Learning Tools

No	Device	Va	Category
1	Teaching module	3,82	Valid
2	Instruction manual	3,72	Valid
3	LKPD	3,8	Valid
4	Learning Outcome Test	3,7	Valid
5	Material on Lumio	3,64	Valid

The results of the fifth validation of lumio-assisted learning devices are categorised as valid. Based on the data analysis of the validation results, the validity coefficient (Va) for the research instruments can be seen in Table 6.

Table 6. Achievement of Research Instrument Validity Coefficient

No	Device	Va	Categories
1	Observation Sheet of Implementation of Learning Device Plan	3,73	Valid
2	Student Activity Observation Sheet	3,67	Valid
3	Student Response Questionnaire	3,67	Valid

The validation results of the three research instruments were categorised as valid, with an average score of 3.71. Similarly, the results of the validation of learning devices showed an average score of 3.71 which was included in the valid category. Observations of the implementation of learning devices obtained a score of 3.71 with high criteria, which indicates that the device is practical to use. Based on the results of observations of student activity during learning, the average activity was 93.6% with a very good category, so the device was declared effective. In addition, the results of the student response questionnaire showed a percentage of 90.71% with a very positive category, so it can be concluded that the device meets the criteria of practicality.

The effectiveness criteria in this study were measured using three indicators, including the completeness of learning outcomes, the N-Gain category, and statistical tests. Learning completeness was obtained through a learning outcome test containing three essay questions and given to students at the last meeting and had previously met the valid criteria based on the results of expert validation. Student learning outcomes are presented in table 7.

Table 7. Student Learning Outcomes

Highest score	100
Lowest score	65
Average	83,15
Number of students achieving score ≥ 70 (Completed)	17
Many students scored < 70 (Incomplete)	2
Percentage of classical completeness	89,4%

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The percentage of classical completeness was 89.4%. The percentage explained that students in the experimental class were categorised as classically complete. So that the learning outcomes of experimental class students have met the effective criteria with learning outcomes of at least 70% of the total number of students. In the 2nd indicator, the effectiveness of the research was measured using the N-Gain category using the value of the pre-test and post-test problem solving test questions carried out at the first meeting and the last meeting and then analysed using the N-Gain test. The details of the recapitulation of students' N-Gain scores in the trial class can be seen in table 8.

Table 8 Percentage of N-Gain Categories of Experimental and Control Classes

Class	Average N-Gain	N-Gain Category	Description
Experiment	0,71	High	High improvement
Control	0,51	Medium	Moderate improvement

Based on Table 8, the average N-Gain value in the experimental class was 0.71 and included in the high category. Meanwhile, the average N-Gain value in the control class was 0.51 and included in the medium category. Thus, it can be concluded that the increase in student learning outcomes in the experimental class is higher than the control class. In the third indicator, effectiveness is measured using statistical tests.

In the statistical test, data analysis of *pre-test* and *post-test* results from experimental and control classes was carried out to determine whether there was an effect of lumio-assisted geometry learning devices that had met the criteria of valid, practical and effective on improving students' mathematical problem solving. Quantitative data analysis using *IBM SPSS Statictic 25* which begins by conducting a prerequisite test, namely the normality test and homogeneity test, then proceeds with the hypothesis test, namely the independent sample t-test. The following is a normality test which aims to determine whether student data is normally distributed or not. The data used is the *pre-test* and *post-test of* the experimental class and control class can be seen in table 9.

***Pre-test* and *Post-test* Normality Test Results**

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
Class	Statistic	df	Sig.	Statistic	df	Sig.
Pretest A (Control)	.105	20	.200*	.978	20	.899
Posttest A (Control)	.117	20	.200*	.965	20	.641
Pretest B (Experiment)	.152	19	.200*	.973	19	.831
Posttest B (Experiment)	.108	19	.200*	.964	19	.655

Based on the results of the pre-test and post-test data normality test that the experimental class pre-test value has a sig value = 0.831 (sig> 0.05), the control class pre-test value has a sig value = 0.899 (sig> 0.05), the experimental class post-test value has a sig value = 0.655 (sig> 0.05) and the control class post-test value has a sig value = 0.641 (sig> 0.05). 0.05) and the control class post-test value has a sig value = 0.641 (sig > 0.05), referring to the hypothesis, the decision isH_0 accepted, this assumes that the *pre-test* and *post-test* values in the experimental and control classes are normally distributed. The results of the N-Gain normality test show that the N-Gain value of the experimental class has a sig value = 0.534 (sig> 0.05) and the N-Gain value of the control class has a sig value = 0.716 (sig> 0.05), then the decision isH_0 accepted, this assumes that the N-Gain values in the experimental and control classes are normally distributed.

The homogeneity test is used to determine whether the variants of student test scores in the experimental class and control class are homogeneous or not. The homogeneity test in this study used *Lavene Statistic*. The results of the homogeneity test on the *pre-test* and *post-test of* the experimental class and control class can be seen in table 10.

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Table 10. ***Pre-test*** **and** ***Post-test*** **Normality Test Results**

		Levene Statistic	df1	df2	Sig.
Pre-test	Based on Mean	2.186	1	37	.148
	Based on Median	2.229	1	37	.144
	Based on Median and with adjusted df	2.229	1	36.516	.144
	Based on trimmed mean	2.187	1	37	.148
Post-test	Based on Mean	.689	1	37	.412
	Based on Median	.633	1	37	.431
	Based on Median and with adjusted df	.633	1	35.307	.432
	Based on trimmed mean	.694	1	37	.410

Based on the results of the homogeneity test on the *pre-test* and *post-test of* the experimental and control classes in Table 10, it is known that the *pre-test* and *post-test* values of the experimental and control classes have homogeneous abilities. This can be seen in the results of the *pre-test* and *post-test* homogeneity tests which show the value of Sig. = 0.148 (sig > 0.05) and Sig. = 0.412 (sig > 0.05), then the decision that can be taken isH_0 accepted, which means that the *pre-test* and *post-test* data of the experimental class and control class have homogeneous variants. The results of the homogeneity test on the N-Gain of the experimental and control classes show that the N-Gain values of the experimental and control classes have homogeneous abilities. This can be seen in the results of the N-Gain homogeneity test which shows the value of Sig. H_0= 0.854 (sig > 0.05), then the decision that can be taken is accepted, which means that the N-Gain data of the experimental class and control class have homogeneous variants.

The hypothesis test is used to see if there is a significant effect of the implementation of lumio-assisted geometry learning tools on improving mathematical problem solving skills. Based on the results of the prerequisite analysis test, it was concluded that the pre-test and post-test data of the experimental class and control class were normally distributed and had homogeneous variants. Therefore, data analysis was carried out using a parametric test, namely the *Independent Sample t-test* in table 11 with the following hypothesis test:

1. H_0 = There is no significant effect of the implementation of lumio-assisted geometry learning tools on improving mathematical problem solving skills.
2. H_1 =There is a significant effect of the implementation of lumio-assisted geometry learning tools on improving mathematics problem solving skills.

Table 11: T-Test Results of Experimental Class and Control Class.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Posttest	Equal variances assumed	.689	.412	-4.475	37	.000	-15.708	3.510	-22.820	-8.596
	Equal variances not assumed			-4.501	35.974	.000	-15.708	3.490	-22.785	-8.630

Based on the t-test results of the experimental class and control class in appendix 38 point 3, it shows that the Sig value. (2-tailed) = 0.000 (sig. <0.05), referring to the hypothesis, the decision that can be taken isH_0 rejected, this interprets that there is a significant effect of the implementation of lumio-assisted geometry learning tools on improving mathematical problem solving skills. In the t-test results on the N-Gain value of the experimental and control classes, the experimental and control classes show that the Sig. (2-tailed) = 0.000 (sig. <0.05), , then the decision that can be taken isH_0 rejected this interprets that there is a significant effect of the implementation of lumio-assisted geometry learning devices on improving mathematical problem solving skills.

Dissemination stage

The deployment stage is the final stage that aims to spread the use of *Lumio by smart* assisted geometry learning tools that have been developed by researchers on a broad scale. This stage performs *packaging* (packaging) which aims to make the product can be utilised by other parties. Mathematics learning tools are distributed *offline*, namely at Sunan Kalijogo Banyuwangi Junior High School, *online*, namely social media which includes Instagram, whatshapp, facebook and also private mathematics teacher forums in Banyuwangi Regency by providing *Google Drive* links for all learning tools.

DISCUSSION

This study aims to develop geometry learning tools assisted *by Lumio by Smart* to improve students' mathematical problem solving skills. The discussion of the results of this study includes three main aspects, namely the validity, practicality, and effectiveness of the developed devices.

The validity of the learning tools was measured based on the assessment results by three validators, consisting of two mathematics education lecturers and a practising teacher. The validation results showed that all components of the device ranging from teaching modules, LKPD, instruction manuals, and questions obtained an average score of 3.71 from a maximum scale of 4. This shows that the device is categorised as valid and has met the criteria of content, presentation, language, and integration between components. Proving that learning devices designed with technological media such as Lumio are theoretically good for use in learning mathematics, especially in geometry material. In line with the results of research by Hidayati Husna & Pritasari (2024) who developed PJBL-based geometry learning tools and also obtained a high level of validity.

The practicality of the device was measured through the implementation of learning by the teacher, student activities during learning, and student responses to the device. The observation results showed that the teacher was able to implement the learning according to the device with an implementation score of 3.71 (very high category). In terms of student activeness during the learning process, the percentage reached 93.6%, while the results of the student response questionnaire reached 90.71%. These results show that the device is easy to use, understand, and able to encourage students' active involvement in understanding flat building material. This research shows that Lumio media not only supports the smooth implementation of learning, but also facilitates students' active and collaborative participation as the core of the project-based approach. This practicality is in line with the research of Rahayu et al. (2022) who developed learning tools to solve problems in students and obtained implementation results that were categorised as very good.

On the effectiveness aspect, the learning tools were declared effective based on three indicators, namely learning completeness, improvement of problem solving ability based on N-Gain value, and statistical test results. The classical completeness of students in the learning outcome test reached 89.4%, exceeding the minimum limit set at 70%. The N-Gain analysis showed that the majority of students experienced an increase in ability in the medium to high category. In addition, the results of the independent sample t-test showed a significance value of 0.000 <0.05, which means there is a significant difference between the experimental class (which used lumio) and the control class (which did not use lumio). These results are in line with Hidayah & Maharani (2025) who showed that the use of lumio media in *Problem Based Instruction-based* mathematics learning can significantly improve students' problem solving skills. In addition, research by Relawati et al. (2024) also confirmed that the use of lumio is able to create an interactive learning atmosphere and improve learning outcomes significantly.

The implementation of the tools in this study in the learning process also showed that students' involvement and motivation had increased. At the beginning of learning, students were awkward in using Lumio, but as the learning progressed, students became more enthusiastic, active in discussions, explorative in solving problems, and confident when presenting their learning outcomes. Students with low ability showed positive development in technology-assisted group work. In contrast, in the control class that did not use lumio, students seemed less engaged, and the resulting presentations did not reflect the in-depth problem-solving process. This shows that interactive learning media such as lumio can create a collaborative learning environment, support concept exploration, and significantly improve students' mathematical problem solving skills.

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CONCLUSION

The development of geometry learning tools assisted by Lumio by SMART is valid, practical, and effective in improving mathematical problem solving skills of junior high school students. The developed tools consist of teaching modules, teacher's manuals, Learner Worksheets (LKPD), and learning outcomes tests, which have gone through the expert validation process and limited trials. The results showed significant improvement in students' abilities, both classically and based on statistical analysis. The implementation of the toolkit was also able to increase the engagement and motivation to learn of seventh grade students of Sunan Kalijogo Junior High School, as well as creating a collaborative learning environment and supporting the significant improvement of mathematical problem solving ability.

This research is expected to be a reference in implementing innovative learning in other schools. Recommendations for future research are to develop learning tools on different materials, involving a wider range of subjects in various schools, in order to improve mathematical problem solving skills and other thinking skills.

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