Volume 8, Nomor 1, June 2024
Numerical: Jurnal Matematika dan Pendidikan Matematika
http://journal.iaimnumetrolampung.ac.id/index.php/numerical
DOI:https://doi.org/10.25217/numerical.v8i1.

Interactive Multimedia Development to Improve Computational Thinking Abilities And Student Learning Motivation

Dhara Chiltya Simamora[1], Mangaratua M. Simanjorang[2], Mulyono[3]

[1] Universitas Negeri Medan, Indonesia
Correspondence: dharachiltya0@gmail.com

Article Info
Article History:
Received: 10-06-2024
Revised: 25-06-2024
Accepted: 26-06-2024
Keywords:
Interactive Multimedia;
Computational Thinking;
Learning Motivation

Abstract
Interactive multimedia is one of the most popular types of learning media and provides a significant increase in the success of the learning process. The achievement of mathematics learning objectives can be seen based on the level of students' computational thinking abilities and learning motivation. Therefore, this research was conducted to develop interactive multimedia that can improve students' computational thinking skills and learning motivation. This development research uses the ADDIE (Analysis, Design, Development, Implementation and Evaluation) model. The sample for this research was class IX students at Tunas Karya Batangkuis Middle School. The research results show that the interactive multimedia developed meets the criteria of being valid, practical and effective in improving students' computational thinking skills and learning motivation. Interactive multimedia obtained a validity value of 3.6 with very good criteria. Interactive multimedia obtained a practicality score of 3.4 (very good category) from the response questionnaire and 3.2 (good category) from the learning implementation questionnaire. The effectiveness of interactive multimedia can also be seen from several aspects, including students' classical completion level which reached 92%, achievement of learning objectives by 80%, very positive student responses, and good levels of student activity. Apart from that, the use of interactive multimedia also succeeded in increasing computational thinking abilities by 0.54 (medium category) and student learning motivation by 0.65 (medium category).

INTRODUCTION

Learning media is a tool used by teachers to convey material to students so that students can receive and understand knowledge quickly [1]. Furthermore, [2] stated that learning media is anything that can convey messages through various channels so as to stimulate students' thoughts, feelings and willingness to learn. Thus, learning media has an important role in supporting the effectiveness of learning and helping increase student involvement in the learning process.

The use of media in the mathematics learning process will help convey abstract mathematical concepts to students. This is supported by [3] who state that learning media will facilitate the process of forming or organizing mathematical concepts in students' minds. Apart from that, the use of appropriate learning media can create enthusiasm for learning, enable direct interaction between students and the real environment and enable students to learn independently according to their interests and talents [4] . Several studies have also proven that the use of media in mathematics learning can improve various student abilities, such as the ability to understand mathematical concepts [5], communication skills [6], mathematical representation abilities [7], mathematical reasoning abilities.

However, based on observations made in class VIII of Tunas Karya Batang Kuis Middle School, it appears that teachers have not utilized technology optimally in the learning process. In teaching in this class, the teacher only uses the publisher's textbook as a learning resource. Teachers presenting lesson material tend to use the help of a whiteboard and markers. Apart from that, the teacher was also seen several times using power point media obtained from the internet to present lesson material. One of the power point displays that the teacher uses when teaching can be seen in Figure 1.

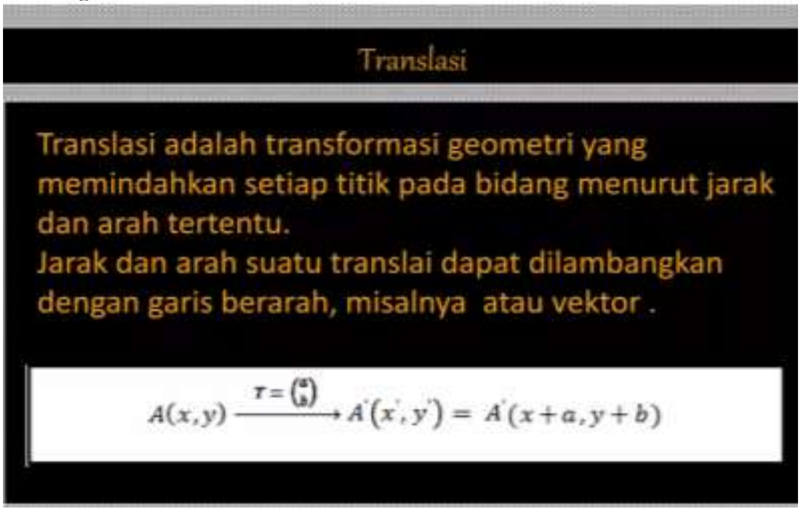

Figure 1. Teacher Power Point display

Based on Figure 1, it can be seen that the display of material presented by the teacher via the Power Point application is still very simple. PPT material presents definitions and formulas of mathematical concepts directly. The teacher does not utilize animation features and only uses text features to present the material. In other words, teachers still only use PowerPoint to substitute the process of presenting material on the blackboard into presenting material using technological devices.

One of the thinking skills that students currently need is computational thinking. The development of technology and information also demands computational thinking competence in society. This statement is supported by [8] who state that computational thinking is one of the 21st century skills that must be possessed. Of course computational thinking skills need to be taught in a school environment. Several countries have introduced and integrated computational thinking capabilities in their school curriculum, such as England [9], Korea [10], Finland. Meanwhile, Indonesia has also officially stated the obligation to master computational thinking skills at every school level. This was conveyed in the Ministry of Education and Culture's seminar on the recovery curriculum after Covid 19 on November 20 2021.

Furthermore, the urgency of computational thinking is also increasing, because this ability is one of the assessment indicators in the [11] assessment framework. In this framework, it is described that computational thinking activities are characterized by activities of formulating problems, mathematical reasoning, selecting appropriate computing tools. right during the analysis process and preparing a solution algorithm for a problem [11]. This is in line with the

[12] which states that the computational thinking process consists of identifying a problem, breaking it down into manageable steps, organizing important details or patterns, forming possible solutions, and presenting these solutions in a way that is easy to understand.

Based on the explanation above, it can be seen that computational thinking skills are very important and must be possessed by students because they are structured thinking skills in finding solutions to problems. However, in reality, based on the results of the initial test carried out on 23 students in class VIII of Tunas Karya Middle School, it showed that 18 students (78.25%) had very low Computational thinking abilities when solving mathematical problems. In this case, it will be described how students think incorrectly in solving number pattern problems for each indicator.

Decomposition is breaking down a complex problem into small, simple parts. In this indicator, students are asked to be able to write down any information contained in the question. The information in the question text includes: (1) known data, (2) the problem being asked, and (3) problem solving plan. Writing this information aims to enable students to break down problems into more defined components. So, in the end it will be easier for students to understand the problem they are going to solve. The error made by one of the students on the decomposition indicator can be seen in Figure .2

Figure 2. Student Answer Process

Based on the students' answers in Figure 2, it is known that the students did not carry out the decomposition process. This can be seen from the student's answer process, which immediately carries out the process of recognizing the pattern of incoming vehicles, without writing down the known information, the problem being asked in the question, and planning to solve the problem. The absence of a decomposition process carried out by the student makes students make mistakes in determining the pattern of incoming vehicles and misunderstand the problem being asked about.

Apart from computational thinking abilities, another important aspect that indirectly influences improving the quality of education is student learning motivation. Learning motivation is the internal and external encouragement of individuals who are learning to make changes in behavior [13]. Motivation is the first condition when carrying out learning tasks and is the driving engine in the learning process. According to [14], learning motivation is the overall psychological driving force within students which gives rise to learning activities, ensures the continuity of learning activities, and provides direction to learning activities. So, it can be concluded that learning motivation is encouragement from outside and within students to carry out learning activities, search for knowledge and skills.

Motivation to learn plays a very important role in the learning process. [15] stated that learning motivation is a determining factor for learning success, because learning activities require encouragement or awareness from outside or within the student. According to a lack of student motivation in education can damage the student learning process. On the other hand, students who have high motivation will show more desire to carry out learning activities, so that the learning process will run well [16].

However, the facts from the results of observations carried out in class VIII of Tunas Karya Batang Kuis Middle School show that students' learning motivation is still relatively low. Low student motivation is characterized by: (1) students who do not focus on listening to the teacher's explanation; (2) the level of student participation (asking, answering questions, giving opinions and arguments) in the learning process is low; (3) there are students who sleep in class; and (4) some students sometimes do not complete the assignments given by the teacher.

If not handled well, students' low computational thinking skills and learning motivation will hinder their progress to the next level. Therefore, to build students' thinking abilities and learning motivation, teachers must present lessons that train computational thinking skills by using learning media that suit students' characteristics, so that they are motivated to participate in the learning process. So the solution to overcome this problem is to use interactive multimedia during the learning process.

Interactive multimedia consists of two words, namely multimedia and interactive. Multimedia can be defined as the integration of several media elements (audio, video, graphics, text, animation, etc.) into a synergistic whole [17]. Meanwhile, the meaning of the word interactive is that users can control, comment on, and add elements to multimedia content using digital manipulation. So it can be concluded that interactive multimedia is a combination of several media that can be controlled and controlled by users via digital devices (computers, laptops, mobile phones, etc.) to carry out commands or presentations.

The use of interactive multimedia during the learning process is also believed to motivate students to participate in the learning process. As we know, emotional learning design involves thinking about how to stimulate positive moods and emotions in students. Herein lies the motivational factor that arouses students' interest and curiosity in learning. [18], stated that sensory curiosity is stimulated by sensory stimuli from the teaching environment such as sound, images, colors or movement, and this can be enhanced by manipulating digital elements and interactivity. Therefore, interactive multimedia consisting of various media elements can attract students' interest and curiosity in learning.

Several studies also prove that the use of interactive multimedia can increase student learning motivation. Like research conducted by [19]. The research results of show that interactive multimedia is effective in increasing students' learning motivation because providing learning materials supported by pictures, animations and learning videos will make learning activities more interesting for students to learn.

Based on survey papers conducted in the last five years, it shows that research into the development of interactive multimedia in mathematics learning which focuses on computational thinking abilities has obtained mixed results. Research conducted by [20] produced a product that was considered valid and practical, but the effectiveness of the product was not tested. Meanwhile, research produced a product that was considered valid, practical and effective. However, the product effectiveness value is only measured by the percentage of students who

Print ISSN: 2580-3573, Online ISSN: 2580-2437

pass the KKM. In fact, the effectiveness value is not only measured from the percentage of students who pass the KKM, but can also be measured from the achievement of learning objectives [21], the N-Gain value (Wahyuni & Ananda, 2022), student responses and activities during learning [22]. From the variations in the level of effectiveness, the criteria for the effectiveness of multimedia developed in this research will be seen based on the achievement of 75% of learning objectives, 75% of classical completeness, N-Gain scores, student responses and activities during the learning process.

Based on the problems that have been raised, as well as the urgency of computational thinking and student learning motivation. Through this research, valid, practical and effective interactive multimedia was developed to increase computational thinking and learning motivation. This research aims to serve as a guide for creating interactive media that is able to improve both aspects by considering the factors that make up both. Therefore, this thesis was prepared entitled "Development of interactive multimedia to improve computational thinking abilities and student learning motivation".

METHODS

This type of research is development research. [23] states that development research is a systematic study to develop, design and evaluate programs, processes and learning outcomes that must meet the criteria for internal consistency and effectiveness.

This development research is oriented towards developing educational products, the process of which will be described and the final product will be evaluated based on [24] assessment standards, namely valid, practical and effective. By using this development model, researchers will develop learning media in the form of interactive multimedia with the aim of increasing students' computational thinking and learning motivation. The location of this research is Tunas Karya Batang Kuis Middle School which is located on Jalan Batang Kuis – Tanjung Morawa, Tanjung Sari Village, Tanjung Sari, Kec. Batang Kuis, Kab. Deli Serdang, Prov. North Sumatra and will be implemented in the even semester of the 2022-2023 academic year.

The subjects in this research were class VIII students at Tunas Karya Batang Kuis Middle School. Meanwhile, the research object is interactive multimedia designed by considering aspects of computational thinking and learning motivation. So the goal of multimedia development is to improve computational thinking skills and motivation. As for Computational Thinking Data Analysis and Student's motivation to study:

Table 1. Computational Thinking Ability Levels

No.	Mastery Level	Category
1	$90 \leq$ Skor ≤ 100	Very High
2	$80 \leq$ Skor < 90	High
3	$75 \leq$ Skor < 80	Fair
4	$60 \leq$ Skor < 75	Low
5	$0 \leq$ Skor < 60	Very Low

Table 2. Student Learning Motivation Questionnaire Criteria

No.	Final Score Range (SA)	Category
1.	$3{,}25 < M \leq 4{,}00$	Very Good
2.	$2{,}50 < M \leq 3{,}25$	Good
3.	$1{,}75 < M \leq 2{,}50$	Enough
4.	$1{,}00 \leq M \leq 1{,}75$	Poor

Print ISSN: 2580-3573, Online ISSN: 2580-2437

The interactive multimedia development process will refer to the ADDIE development model which consists of five main stages, namely: (1) Analysis; (2) Design; (3) Development; (4) Implement; and (5) Evaluation of research procedures can be seen in Figure 3 below.

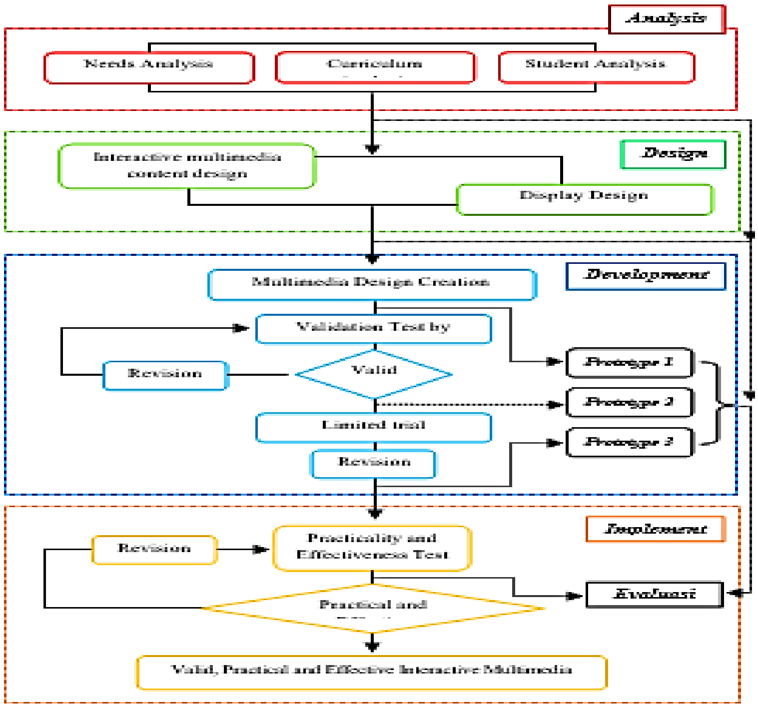

Figure 3. Interactive Multimedia Development Procedure

RESULTS AND DISCUSSION

The interactive multimedia development process will refer to the ADDIE development model which consists of five main stages, namely: (1) Analysis; (2) Design; (3) Development; (4) Implement; and (5) Evaluation. A description of the results of data analysis obtained from each stage is presented as follows:

Analysis

Based on the results of observations regarding the availability of learning media, it was found that there were weaknesses in the learning media used by teachers when teaching geometric transformation material. The media used by teachers as support in the learning process are printed images which are distributed to students and presented on the blackboard. During the learning process, teachers usually draw graphs of changes in the position of transformed geometric objects on the blackboard, then write formulas for changes in the position of geometric objects. Meanwhile, students will note down the formula while paying attention to the picture made by the teacher.\

The learning media used by teachers has several weaknesses, including: (1) The media cannot show motion. The image media presented by the teacher on the blackboard cannot show the movement process of the object being transformed; (2) The process of conveying information is inefficient, because explaining one transformation concept requires many procedures; (3) The process of conveying information takes a lot of time because the teacher has to draw clearly and neatly each object that will be transformed; and (4) When writing on the board, the teacher turns his back to the students for a long time, disrupting the classroom atmosphere and management.

Print ISSN: 2580-3573, Online ISSN: 2580-2437

The weaknesses of the learning media used by the teacher have an impact on the learning process that occurs in the classroom. Students don't seem enthusiastic and eager to participate in the learning process because they don't understand what they write. The learning process also does not provide opportunities for students to construct their own knowledge so that students' thinking processes are not trained. Learning conditions like this result in students' computational thinking abilities and low learning motivation. The test results show that 70% of students have very low computational thinking abilities. Apart from that, 66.67% of students appear to have low learning motivation.

Design

The design stage consists of two stages, namely the stage of designing interactive multimedia content (content) and designing interactive multimedia display designs. Content is the content of interactive multimedia in geometric transformation material. The design of interactive multimedia content is adjusted to the results of the analysis (needs, curriculum and students) and the basic rules of interactive multimedia components. According to [25], a complete interactive multimedia component must contain (1) introduction (title page, menu, learning objectives and instructions); (2) Material (control, interaction, navigation, text, sound, images, video, animation and simulation); and (3) Conclusion (summary and evaluation exercise). So interactive multimedia content will consist of media information, how to use it, concept maps, learning objectives, learning flow, material summaries and practice questions. All of this content is presented on the interactive multimedia home page. The flowchart for designing interactive multimedia content on geometric transformation material can be seen in Figure 4.

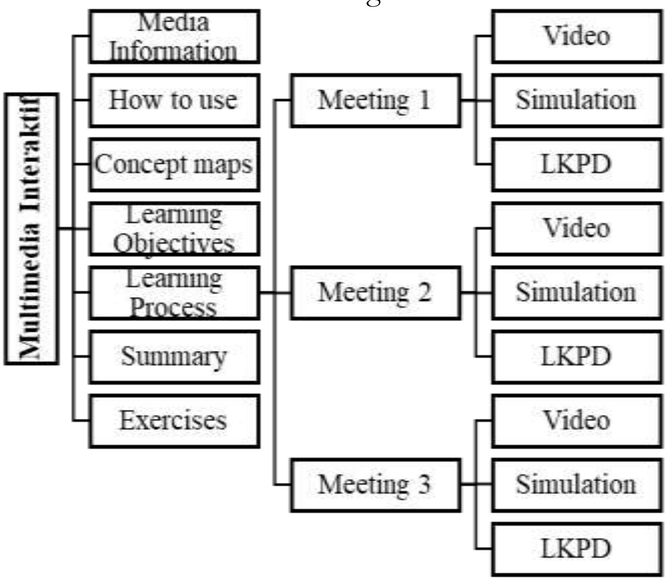

Figure 4. Interactive Multimedia Content Design

Development

At this stage, the results of the interactive multimedia design are evaluated and refined to produce interactive multimedia that reflects the desired design. The development stage consists of activities, namely: (1) creating interactive multimedia; (2) test the validity of interactive multimedia and research instruments; The following is a description of the results of these three activities:

Creation of Interactive Multimedia

At this stage, the results of the interactive multimedia design are evaluated and refined to produce interactive multimedia that reflects the desired design. The final result of creating this interactive multimedia will be referred to as Prototype I. The design of the interactive multimedia

Print ISSN: 2580-3573, Online ISSN: 2580-2437

components will be created using the help of the Powerpoint application. Meanwhile, interactive multimedia devices are created using Google Site services. The interactive multimedia display created with the Google Site service can be seen in Figure 5.

Figure 5. Display of the Interactive Multimedia Home Page

Analysis of Learning Device Validation Results

Interactive multimedia creation activities produce interactive multimedia prototype I. The second activity at the development stage is to validate prototype I and its supporting learning tools (RPP and LKPD). The interactive multimedia prototype will be given to experts before testing. The results of expert validation in the form of validation scores, corrections, criticism and suggestions are used as a basis for revising and improving the interactive multimedia being developed. Interactive multimedia that meets the valid criteria is called prototype II.

The validity test of the interactive multimedia that has been created will be seen in terms of media and material by experts. This interactive multimedia will be tested by three experts and two teachers. The selection of the number of validators is based on Sugiyono's opinion (in Andromeda, et al., 2015) which states that to test the validity of the instrument, a minimum of three expert opinions can be used. The interactive multimedia material will be tested by three lecturers from the mathematics education department and two mathematics teachers who teach at the school. The recapitulation of validation results carried out by the five validators can be concluded as in Table 1 below.

Table 3. Summary of Learning Validation Results by Experts and Practitioners

No	Appraised Object	Average value of Total Validation	Validation Level
1	Meda Multimedia Interaktif	3,61	Valid
2	Lesson plan	3,21	
3	Student Worksheets	3,24	
4	Computational Thinking	3,64	
5	Motivasi belajar	3,49	

Based on Table 3 above, the total average for each learning device is in the interval $4 \leq Va < 5$ with the valid category. Based on the validity criteria, it can be said that the learning developed meets the valid criteria.

Implement

Learning is designed by having students sit in groups consisting of six or seven students in one group. Group members are divided heterogeneously in terms of academic abilities so that each student can gain diverse learning experiences. With heterogeneous groupings, it can be said that the average characteristics and abilities of each group are relatively the same. Based on the learning process that occurs, the following is data obtained from the first trial of using interactive multimedia. The following is data obtained from field tests on the use of interactive multimedia.

From the average score of students' abilities before and after using interactive multimedia, it was found that there was an increase in scores. If categorized based on the level of mastery of computational thinking skills, the percentage of students' abilities in field test II can be seen in Table 2.

Table 4. Level of CT Ability at Posttest

Value Interval	Information	Pretest		Postest	
		n	Percentage	n	Percentage
$90 \leq$ Skor ≤ 100	Very high	0	0 %	1	4 %
$80 \leq$ Skor < 90	Tall	1	4 %	9	36 %
$70 \leq$ Skor < 80	Currently	1	4 %	13	52 %
$60 \leq$ Skor < 70	Low	7	28 %	2	8 %
$0 \leq$ Skor < 60	Very low	16	64 %	0	0 %

Based on Table 2, it can be seen that there is an increase in the percentage level of students' computational thinking abilities before and after using interactive multimedia. If viewed from classical completion, the percentage of students' computational thinking ability level has met the target. The results of classical completion of students' abilities in the pretest and posttest of field test II can be seen in Table 3.

Table 5. Levels of Classical Completeness

Category	Pretest		Postest	
	n	Percentage	n	Percentage
Complete	2	8%	23	92%
Not Completed	23	92%	2	8%
Amount	25	100%	25	100%

Based on Table 5 above, it can be seen that the percentage of classical completion of students' computational thinking abilities after using interactive multimedia in field test II was 92%. This shows that in Field Test II, the classical completeness criteria were met. Increasing students' computational thinking abilities in field test II can be obtained from the results of pretest and posttest analysis. Assessment of improving students' computational thinking abilities is seen based on the gain value category. A description of the increase in computational thinking abilities based on the gain value during field test II can be seen in Table 4.

Table 6. Description of CT Capability Improvement

N Gain	Category	Many Students	Percentage	Average Gain
$g > 0,7$	Tall	1	4%	0,54
$0,3 \leq g \leq 0,7$	Currently	24	96%	
$g < 0,3$	Low	0	0%	
Amount		24	100%	

Based on Table 6, it can be seen that there is still one student who experienced a low increase in computational thinking abilities. Meanwhile, if seen on average, the gain value obtained by students is 0.50 in the medium category. This shows that the criteria for increasing capabilities are not sufficient to meet the expected targets.

In this research, data on increasing student learning motivation was obtained from a learning motivation questionnaire given before and after the learning process. Assessment of increasing student learning motivation is seen based on the gain value category. A description of the increase in student learning motivation based on the gain value during field test II can be seen in Table 5.

Table 7. Description of Increased Learning Motivation

N Gain	Category	Many Students	Percentage	Average Gain
g > 0,7	Tall	6	24%	0,65
0,3 ≤ g ≤ 0,7	Currently	19	76%	
g < 0,3	Low	0	0%	
Amount		24	100%	

Based on table 7, it can be seen that there are still 6 students who experienced a high increase in learning motivation and 19 students experienced a moderate increase in motivation. Meanwhile, if seen on average, the gain value obtained by students is 0.65 in the medium category.

DISCUSSION

The interactive multimedia whose validity will be tested is the interactive multimedia prototype I. The validity test is carried out by submitting the interactive multimedia and validation sheet to the validator. The expert validators who assessed the feasibility of interactive multimedia consisted of five experts. Three of them are mathematics education lecturers at Medan State University, and the other two are mathematics teachers at junior high schools. The validity of interactive multimedia is assessed based on the standard theory of conformity of interactive multimedia products according to [26] which consists of components, contacts, interfaces, interactions and technology.

Components are an assessment aspect that assesses the completeness of interactive multimedia components. According to [25], a complete interactive multimedia component must consist of a title page, menu, learning objectives, instructions for use, materials, summaries and evaluation exercises. The interactive multimedia developed in this research consists of multimedia identity components, how to use it, learning objectives, materials, summaries, practice questions and developer information. The validation results in this aspect obtained an average score of 3.76 with a very valid category. This shows that the completeness of the interactive multimedia components is complete, clear and arranged systematically.

Contant is an aspect that assesses interactive multimedia content from a pedagogical perspective. This aspect highlights learning content and learning design [26]. The interactive multimedia developed in this research was adapted to the geometric transformation material in the 2013 curriculum. The validation results in this aspect obtained an average score of 3.51 in the very valid category. This shows that the content of interactive multimedia is in accordance with the learning in the 2013 curriculum. The suitability of this content will influence interactions in the learning process. As stated by [27], interaction occurs not because of the technology used in interactive multimedia, but because of the content design in interactive multimedia.

Print ISSN: 2580-3573, Online ISSN: 2580-2437

Interface is an aspect that assesses the nature of aesthetics and visual design. The interface can be interpreted as an interactive multimedia showcase or face, namely the intersection point that connects the user with the media screen. The interactive multimedia developed in this research is designed with animated cartoon images with white and pastel basic colors. The choice of animated image design in interactive multimedia is based on [28] who states that cartoon media can convey messages quickly, concisely and interestingly. Meanwhile, the choice of basic colors of white and pastel is based on [29] who say that white when combined with pastel colors can provide a calm, calm and harmonious effect. The validation results in this aspect obtained an average score of 3.68 with a very valid category. This shows that the interactive multimedia interface has a good aesthetic and visual design for students to use in the learning process.

Interaction is an aspect that assesses the level of multimedia interactivity using interaction design. The assessment of this aspect is not only limited to the technology used in interactive multimedia, but is also assessed from the presentation of content, interface design, and the device's ability to run interactive multimedia. The interactive multimedia developed in this research uses supporting communication media through Facebook comment columns and WhatsApp private conversations. The validation results in this aspect obtained an average score of 3.46 with a very valid category. This shows that interactive multimedia features are good for increasing interaction in the learning process.

Technology is an aspect that assesses the features and functions of hardware. Technology assessment relates to video resolution, images and sound in multimedia. Apart from that, the readability of interactive multimedia on various devices and conditions is also a focus in assessing this aspect. The interactive multimedia developed in this research uses the features provided by the Google Site platform. Where, the final result of the project is website-based interactive multimedia that can be accessed on various devices as long as there is a data package. The validation results in this aspect obtained an average score of 3.6 with a very valid category. This shows that interactive multimedia has good hardware features to increase ease of access in the learning process.

Based on all aspects of the interactive multimedia assessment above, the average validation score obtained from the five validators was 3.61 in the valid category. This shows that the interactive multimedia developed can be used in the learning process after carrying out several minor revisions from the validator.

Apart from that, the five validators also stated that the learning implementation plan (RPP) and student worksheets (LKPD) were valid. RPP and LKPD are assessed based on aspects of writing format, language and content. The RPP validation score from the five validators obtained a score of 3.2 in the valid category. Meanwhile, the LKPD validation score from the five validators obtained a score of 3.23 in the valid category. Interactive multimedia and learning tools (RPP and LKPD) are valid, caused by two factors, namely: (1) Interactive multimedia which is developed in accordance with the demands of the applicable curriculum (content validity), related to core competencies (KI) and basic competencies (KD). must be achieved by students in learning activities that are adapted to the material or content of the lesson; and (2) Interactive multimedia and supporting tools (RPP & LKPD) are designed to complement each other to measure computational thinking skills and learning motivation.

Fulfillment of these two aspects of validity, as stated above, is in line with the opinion of [30] who states that the validity of a product consists of two, namely content validity and construct validity. Content validity is characterized by a product that is developed in accordance with student needs and is built based on theoretical principles of scientific knowledge about the product to be developed. Meanwhile, construct validity is characterized by a product that is logically designed (all intervention components are interrelated).

Print ISSN: 2580-3573, Online ISSN: 2580-2437

Based on the description above, it can be concluded that the interactive multimedia and learning tools (RPP and LKPD) developed have valid value. Multimedia that has valid values is called prototype II. Prototype II interactive multimedia and valid learning tools (RPP and LKPD) can be used by teachers and students to test the level of practicality of their use in the geometric transformation learning process.

CONCLUSION

The interactive multimedia developed has fulfilled the aspect of effectiveness, so it is recommended that teachers use this interactive multimedia in mathematics learning to develop and improve students' computational thinking. The interactive multimedia developed has fulfilled the aspect of effectiveness, so it is recommended that teachers use this interactive multimedia in mathematics learning to grow and increase students' motivation in learning mathematics. Interactive multimedia in this research was used to measure computational thinking abilities on geometric transformation material. Therefore, researchers suggest to readers and educational practitioners to carry out similar research in more depth and add other mathematical skills such as critical thinking, communication, representation and problem solving. The interactive multimedia developed can be used as a reference for creating a learning media component with other materials to develop computational thinking abilities and learning motivation at both elementary, middle school, high school and tertiary education levels.

REFERENCES

[1] M. Akrim, "Media Learning in Digital Era. Advances in Social Science, Education and Humanities Research," *Amca*, vol. 2, pp. 458–460., 2018, [Online]. Available: https://doi.org/10.2991/amca-18.2018.127

[2] Hamid, *Media pembelajaran*. Jakarta: Yayasan Kita Menulis., 2020.

[3] I. Rusydi, "Peranan Perkembangan Teknologi," *J. Chem. Inf. Model.*, vol. 53, no. 9, pp. 1689–1699, 2019.

[4] D. Höffler, T. N., & Leutner, "Instructional animation versus static pictures: A meta-analysis," *Learn. Instr.*, vol. 17, pp. 722–738., 2017.

[5] Y. Fatimah, S., & Chrismardani, "Pengaruh Green Marketing Terhadap Keputusan Pembelian Produk Sephora," *). J. Kaji. Ilmu Manaj.*, vol. 2 (1), pp. 12–17, 2022.

[6] D. & M. Z. Zahroh, H., Hafidah, "Gerakan Literasi Matematika Dalam Peningkatan Kemampuan Pemecahan Masalah Matematis Siswa," *J. Mat. Dan Pendidik. Mat.*, vol. 9(2), pp. 165–177, 2020.

[7] S. Wahyuni, *Peningkatan Kemampuan Representasi Matematis dan Self Esteem Siswa Sekolah Menengah Pertama Dengan Menggunakan Model Pembelajaran ARIAS*. Bandung: UPI Bandung, 2018.

[8] M. Mohaghegh, M., & McCauley, "Computational Thinking: The Skill Set of the 21st Century," *Int. J. Comput. Sci. Inf. Technol.*, vol. 7(3), pp. 1524–1530, 2016.

[9] et al. l. Bocconi, S., Chioccariello, A., *Developing Computational Thinking in compulsory education, Implications for policy and practice (P. Kampylis & Y. Punie, eds.)*. Luxembourg: Publications Office of the European Union., 2016.

[10] APFC., "Preparing students for South Korea's creative economy," *successes challenges Educ. reform. Retrieved*, vol. 13, 2017, [Online]. Available: http://www.asiapacific.ca/research-report/preparing-students-south-koreas-creative-economy-successe

[11] OECD, *PISA 2018 Results: Insights and Interpretations*. Jakarta: Rajagrafindo Persada., 2019.

[12] IEA, "The IEA's international computer and information literacy study (ICILS) 2018. What's next for IEA's ICILS in 2018," *IEA's ICILS 2018*, 2016, [Online]. Available: http://www.iea.nl/fileadmin/user_upload/Studies/ICILS_2018/IEA_ICILS_2018_Computational_Thinking_Leaflet.pdf.
[13] Najjah, A. & Panggabean, E. M., "Pengembangan Media Permainan kartu UNO SPIN Matematika untuk pemblejaran matematika bentuk Aljabar pada Siswa SMP," *EduTech*, vol. 1, pp. 96-102., 2021.
[14] J. Wing, *Computational Thinking*. New York City: Association For Computing Machinery., 2016.
[15] A. Minarni, "On Eight Grade Students Understanding in Solving Mathematical Problems," *Asian Soc. Sci.*, vol. 13 (12), pp. 86–96, 2017, [Online]. Available: https://doi.org/10.5539/ass.v13n12p86.
[16] P. Shrestha, "mpact of student motivation on teachers' motivation to teach: A case study of Nepa," *J. NELTA,* vol. 23, pp. 1-12., 2018.
[17] U. V Reddi, *Multimedia as an educational tool. In U. V. Reddi, & S. Mishra (Eds.)*. New Delhi: CEMCA, 2013.
[18] M. R. Malone, T. W., & Lepper, "Making learning fun. A taxonomy of intrinsic motivations for learning," *Aptitude, Learn. Instr.*, vol. 3, pp. 223-253., 2000.
[19] R. S. Setiaji, *Pengembangan Media Pembelajaran Multimedia Interaktif Kolase, Mosaik dan Montase Untuk Calon Guru Sekolah Dasar*. Surabaya.: Universitas Negeri Surabaya, 2016.
[20] Ngalimun., *Strategi dan Model Pembelajaran*. Yogyakarta: Aswaja Pressindo., 2017.
[21] D. L. Saadah, N., & Hakim, "Respon Siswa Terhadap Multimedia Interaktif Liddle (Line and Angle Learning).," *Akad. J. Teknol. Pendidik.*, vol. 11(2), pp. 295-303., 2022.
[22] Hasratuddin, *Mengapa Harus Belajar Matematika?*. Medan: Perdana Publishing., 2018.
[23] P. Setyosari, *Metode Penelitian Pendidikan dan Pengembangan*. Jakarta: Prenadamedia., 2016.
[24] N. Nieveen, *Educational Design Research. Enchede*. Netherlands: Netherlands Institute for curriculum development., 2013.
[25] H. D. Surjono, *Multimedia Pembelajaran Interaktif (Konsep dan Pengembangan)*. Yogyakarta.: UNY Press, 2017.
[26] dan M. B. Bozkurt, Aras., "Evaluation Criteria for Interactive E-Books for Open and Distance Learning," *Int. Rev. Res. Open Distrib. Learn.*, vol. 16(5), pp. 58–82, 2017.
[27] I. E. Y. Yildiz, P., Gürel, R., Bozkurt, E., dan Özdemir, "Self-Regulation of Novice Middle School Mathematics Teachers in the Preparation Process for Teaching," *Int. Online J. Educ. Teach.*, vol. 9 (1), pp. 449–470, 2022.
[28] A. Sufianti, A. V., Darsono., Munaris., Ambarita, "Development of Students' Worksheet Based on Quantum Learning to Improve Students' Critical Thinking Ability in 5th Grade Elementary School," *J. Educ. Pravtice*, vol. 10 (12), pp. 132 – 133, 2019.
[29] M. W. Bruce Joyce, *Models of Teaching*. New York: Allyn and Bacon & Scuter, 2012.
[30] J. V. D. Akker, *Educational Design Reseach*. Netherlands: SLO Enshede., 2013.

.

Print ISSN: 2580-3573, Online ISSN: 2580-2437

Print ISSN: 2580-3573, Online ISSN: 2580-2437