Development of Interactive Mathematics E-Modules Based on Local Issues with a Personalized Approach to Facilitate Junior High School Students' Computational Thinking Skills

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Abstract
Computational thinking is a method or problem-solving technique that uses concepts from computer science, some characteristics of computational thinking are abstraction, problem decomposition, algorithmic thinking, and generalization. One of the efforts that can generally be done to facilitate students' computational thinking is to facilitate teaching materials (e-modules). Several previous studies have conducted various developments of mathematics e-modules, but there are several weaknesses including the materials and instruments are less related to the context or local issues in the student's environment, the materials and instruments are not oriented to the computational thinking aspect, the e-modules developed pay less attention to the interactivity aspect, so that students do not get optimal feedback from teachers and make it difficult for teachers to control students' abilities, and the e-modules developed do not facilitate students' diverse initial abilities, so a personalized approach is needed in developing e-modules. Therefore, this study aims to produce interactive mathematics e-modules based on local issues or local issues with a personalized approach to facilitate junior high school students' computational thinking abilities. This research is a research & development (R&D) using the Borg and Gall development model. The results of our study indicate that interactive mathematics e-modules based on local issues or local issues with a personalized approach are declared feasible, practical, and effective in facilitating junior high school students' computational thinking. These findings can provide significant contributions in the field of education, especially in teaching mathematics that is more contextual and adaptive to students' needs.
Keywords: computational thinking, e-modul interaktif, local issues, personalized learning.

Introduction

Computational thinking ability is one of the 21st century abilities that needs to be developed in the world of education. Wing (2006) provides the concept of computational thinking as thinking like a computer scientist in dealing with problems. This ability is a new literacy in the 21st century that is very important for students (Angeli & Giannakos, 2020; Denning & Tedre, 2019; Hickmott et al., 2018). Improving computational thinking abilities can be used as one way to improve mathematical literacy (Rodríguez-Martínez et al., 2020). This ability is very important for conceptual understanding in every discipline, through the process of problem-solving and algorithmic thinking (Lee et al., 2020). Computational thinking is not only introduced and developed in computer or programming lessons, but in other disciplines including mathematics learning.

Mathematics learning is a process of solving problems sequentially, so when viewed from computational thinking it includes clear steps and procedures (algorithms), calculations (computations), determining the right strategy (Kallia et al., 2021). Findings from Gadanidis et al. (2021) show that the relationship between problem solving and students' computational thinking when solving problems is when defining problems in the context of problem solving, they carry out the decomposition and abstraction stages in the context of computational thinking.

In the era of industrial disruption 4.0, where learning activities are carried out digitally. Digital-based learning is considered to be able to improve the quality of learning, efficiency, effectiveness, and accessibility of learning and facilitate students to be able to learn according to their respective needs (Nur et al., 2023). Digital learning is currently widespread in schools, one of which is reflected in the many teachers or educators who use e-modules as a source of student learning. However, the e-modules currently used are considered to have several weaknesses, namely only paying attention to the technical design aspects compared to the quality of the material. In fact, the quality of the material will make it easier for students to understand information or concepts (Ouchaouka et al., 2023). The materials presented in the e-modules are still conventional, where the materials taken are not developed according to the context of the student's environment, this will certainly have an impact on the ease of students in managing knowledge information (Rahmadhani & Efronia, 2021).

Research related to the development of digital teaching materials such as mathematics modules to facilitate students' thinking skills such as computational thinking is still very limited, what is mostly research related to the implementation or application of e-modules to improve students' learning achievement in general (Murod et al., 2021; Rismaini & Devita, 2022; Riyadi & Qamar, 2017). Research Agbo et al. (2023) reported that mathematics learning using e-modules is more effective than conventional modules. This is because e-modules can better facilitate students' diverse learning needs such as learning styles. In addition, research Saleh et al. (2018) revealed that learning activities that involve the student's environment can increase student involvement which in turn can improve student learning achievement. Furthermore, research Ardiyani (2018) revealed that to facilitate students' computational thinking in mathematics, the quality of the materials and instruments must be able to touch on aspects of students' computational thinking, so that students become more accustomed to computational thinking abilities.

Based on our literature search so far, several preliminary studies have actually developed mathematics e-modules as previously explained, but the weaknesses are: 1) The materials and instruments are less related to the context or local issues in the students' environment, whereas when students feel that learning is meaningful, they will find it easier to understand mathematical concepts (Ardiyani, 2018); 2) The materials and instruments are not oriented towards the computational thinking aspect; 3) The developed e-modules pay less attention to the interactivity aspect, so that students do not get optimal feedback from teachers and make it difficult for teachers to control students' abilities; 4) The developed e-modules do not facilitate the diverse initial abilities of students, so a personalized approach is needed in developing e-modules.

Based on the research gap, this study aims to produce an interactive mathematics e-module based on local issues that is feasible, practical, and effective to facilitate the computational thinking of junior high school students. This e-module will be developed with a personalized learning approach to facilitate the diverse cognitive abilities of students. The mathematics e-module that will be developed has several advantages compared to the development of existing e-modules, including: 1) The materials and instruments in this e-module are linked to the context or local issues that exist in the student's environment. This can make students feel closer to the learning context, 2) The materials and instruments are oriented towards the computational thinking aspect, 3) The e-module that is developed is more interactive, this will make students more optimal in getting feedback from teachers and make it easier for teachers to control students' abilities, 4) The e-module that is developed uses a personalized learning approach so that students can be more empowered according to their initial abilities.

Method

This study uses a Research and Development (R&D) research design with the Borg and Gall development model (Borg & Gall, 1983). The research procedure begins with the needs analysis stage, where a survey is conducted to identify deficiencies in existing mathematics e-modules. Furthermore, an interactive e-module based on local issues is designed using a personalized approach. After the initial design is completed, the e-module is validated by material experts and media experts. Product trials are conducted in two stages, namely limited trials and field trials. After that, revisions are made based on input from the trial, until the e-module is declared feasible for use. The subjects of this study were grade VII junior high school students in several schools in Ambon City who were selected using purposive sampling.

The instruments used in this study included observation sheets, feasibility assessment questionnaires by material experts and media experts, practicality questionnaires by students and teachers, and computational thinking ability tests. Observation sheets were used to observe student involvement during the use of the e-module, while questionnaires were used to measure student and teacher responses to the developed e-module. Data analysis was carried out descriptively quantitatively and qualitatively. Quantitative data were obtained from the results of questionnaires and computational thinking ability tests which were analyzed using descriptive statistics to see the percentage, average, and standard deviation. Qualitative data were obtained from observation sheets and interviews with teachers, which were analyzed using content analysis techniques. The results of this study indicate that interactive e-modules based on local issues with a personalized approach are effective in improving junior high school students' computational thinking abilities.

Results and Discussion

The interactive e-module product of mathematics based on local issues with a personalized approach to facilitate the computational thinking skills of junior high school students developed in this study has been adjusted to the Borg and Gall development model, namely, 1) research and information collection, 2) planning, 3) develop preliminary form of product, 4) preliminary field testing, 5) main product revision, 6) main field testing, 7) operational product revision, 8) operational field testing, 9) final product revision, 10) dissemination and implementation. The results of the development based on the model used are then tested for feasibility, practicality and effectiveness.

Product Feasibility Test

The product feasibility test is assessed based on the assessment of 2 material experts and 2 media experts. The assessment is carried out using an assessment questionnaire that has been validated by the instrument validator. The assessment by material experts is carried out to assess aspects of material suitability, material accuracy, material presentation, relevance to culture, evaluation and feedback. Table 1 presents a summary of the assessment results of the two material experts.

Table 1. Summary of Assessment Results by Material Experts

No	Assessment Aspects	Validator Score		Average Score	Maximum Score	Value
		I	II			
1.	Material Suitability	11	11	11	12	3,67
2.	Material Accuracy	10	10	10	12	3,33
3.	Material Presentation	10	11	10,5	12	3,50
4.	Relationship to Culture	10	10	10	12	3,33
5.	Evaluation and Feedback	11	10	10,5	12	3,50
Score Total		**52**	**52**	**52**	**60**	**3,47**

Based on the assessment results by material experts, the E-Module obtained an average score of 52 out of a maximum total score of 60, with an average value of 3.47 (feasible category). Thus, it can be concluded that the material to be used as a support for the e-module is declared feasible to use with revisions according to suggestions.

Furthermore, the assessment by media experts was carried out to assess aspects of visual design, content quality, and function and usability. Table 2 presents a summary of the assessment results of the two media experts.

Table 2. Summary of Assessment Results by Media Experts

No	Assessment Aspects	Validator Score		Average Score	Maximum Score	Value
		I	II			
1.	Visual Dsign	13	12	12,5	16	3,13
2.	Content Quality	13	12	12,5	16	3,13
3.	Function and Usefulness	7	7	7	8	3,50
Score Total		**33**	**31**	**32**	**40**	**3,20**

Based on the assessment results by material experts, the E-Module obtained an average score of 32 out of a maximum total score of 40, with an average value of 3.20 (feasible category). Thus, it can be concluded that the e-module is declared feasible to use with revisions according to suggestions.

Based on the results of the feasibility test by media experts and material experts, the development of the Interactive Mathematics E-Module Based on Local Issues with a Personalized Approach is declared feasible to use with several minor revisions. The presentation of appropriate and accurate materials is very important to ensure that students get the right and useful information, which is in line with the principles of instructional design proposed by Gagné (1985). The feasibility of this E-Module is also supported by the aspect of the relevance of the material to local culture. This relevance helps students to better understand and apply mathematical concepts in the context of their daily lives. According to constructivist education theory, contextual and relevant learning with students' life experiences can increase their motivation and involvement in the learning process. This is in accordance with Vygotsky (1978) view which states that effective learning occurs when students can relate new knowledge to their experiences and social contexts.

In addition, the attractive visual design and good functionality of this E-Module are also important factors in assessing feasibility. Media experts assess that this E-Module has an intuitive and user-friendly design, which makes it easy for students to access and understand the material. Good design is not only aesthetically appealing, but also improves readability and navigation, which are very important in digital learning media. According to Clark and Mayer (2016), well-designed learning media must combine effective visual elements with logical information structures to support students' learning processes optimally. Thus, the results of expert assessments indicate that this E-Module is suitable for use in mathematics learning in junior high schools.

Product Practicality Test

The practicality test of the e-module product is assessed based on student and teacher assessments. The assessment is carried out using an assessment questionnaire that has been validated by the instrument validator.

The practicality test by students is carried out to assess ease of use, design and presentation, and student involvement in using the E-Module. Table 3 presents a summary of the results of the student assessment.

Table 3. Summary of Student Assessment Results

No	**Assessment Aspects**	**Average Score**	**Maximum Score**
1.	Ease of Use	11	12
2.	Design and Presentation	10	12
3.	Student Engagment	14	16
Score Total		**35**	**40**
Percentage		**86,67**	**100%**

Based on the results of the practicality assessment by students, the E-Module obtained an average score of 35 out of a maximum total score of 40, with a practicality percentage of 86.67% (very practical category). Thus, it can be concluded that this E-Module is practical and easy to use by students.

Furthermore, a practicality test by teachers was conducted to assess ease of use, design and presentation, student involvement, suitability to the curriculum, and evaluation in using the E-Module. Table 4 presents a summary of the results of the assessment by teachers.

Table 4. Summary of Assessment Results by Teachers

No	**Assessment Aspects**	**Average Score**	**Maximum Score**
1.	Ease of Use	10	12
2.	Design and Presentation	10	12
3.	Student Engagment	13	16
4.	Kesesuaian dengan Kurikulum	14	16
5.	Evaluation	6	8
Score Total		**53**	**64**
Percentage		**82,81**	**100%**

Based on the results of the practicality assessment by teachers, the E-Module obtained an average score of 53 out of a maximum total score of 64, with a practicality percentage of 82.81% (practical category). Thus, it can be concluded that this E-Module is practical and easy to use by teachers.

Based on the results of the practicality test by teachers and students, it can be concluded that the Interactive Mathematics E-Module Based on Local Issues with a Personalized Approach is stated to be practical for use in mathematics learning in junior high schools to facilitate students' computational thinking abilities.

Teachers and students feel that this E-Module makes it easier for them to deliver materials and manage classes, because it can be used as an effective tool in the learning process. According to the theory of educational technology (Clark & Mayer, 2016), practical learning media are those that can be easily integrated into daily learning activities without requiring intensive training or significant changes in teaching methods.

Effectiveness Test

The effectiveness analysis stage begins by grouping the data from the results of the students' computational thinking ability assessment into two groups, namely the experimental group and the control group. The results of the statistical descriptive analysis of computational thinking abilities can be seen in Table 5 below.

Table 5. Descriptive statistics of computational thinking ability (Pretest and Posttest)

Group	N	Mean		Std. Deviasi	
		Pre-test	Post-test	Pre-test	Post-test
Experiment	30	68,21	83,69	8,21	8,13
Control	30	64,21	67,89	8,11	7,91

Table 5 presents descriptive statistics for students' computational thinking skills in the two experimental groups and the control group, both at the pre-test and post-test. In the experimental group, the mean value of computational thinking skills in the pre-test was 68.21 with a standard deviation of 8.21. After the intervention using an interactive mathematics e-module based on local issues with a personalized learning approach, the mean value of computational thinking skills in the post-test increased to 83.69 with a standard deviation of 8.13. Next, we conducted an independent sample t-test analysis to see the significance of the difference between the means of the control and experimental groups. For more details, see Table 6 below.

Table 6. Results of Independent Samples t-test for post-test

Group	N	Mean	Std. Deviasi	df	t-test		Decision
					t	Sig. (2-tailed)	
Experiment	30	68,21	8,13	58	7,16	0.00	Tolak H_0
Control	30	64,21	7,91				

The results of the independent sample t-test analysis in Table 6 obtained a Sig. 2-tailed value of 0.00. This means that the hypothesis H_0 is rejected. These results indicate that there is a statistically significant difference between the experimental group using the interactive mathematics e-module based on local issues with a personalized learning approach compared to the control group that did not receive the intervention.

The results of our study also show that the use of interactive mathematics e-modules based on local issues with a personalized learning approach is effective in improving junior high school students' computational thinking skills. This finding is consistent with previous studies showing that a personalized learning approach can improve students' learning achievement (Abedi et al., 2021; Chica et al., 2023). In addition, the results of previous studies also show that local wisdom-based mathematics learning can improve students' mathematics skills (Laurens, 2018; Parwati et al., 2018; Zheng et al., 2022). The use of interactive mathematics e-modules based on local issues with a personalized learning approach can improve computational thinking skills because it integrates real contexts that are relevant to students' lives. This can make learning more meaningful and motivating. According to Vygotsky's theory, effective learning occurs when material is linked to students' experiences and social contexts, so that they can more easily relate abstract concepts to everyday situations (Gee, 2021; Vygotsky, 1978; Zahrah & Febriani, 2020). For example, in this study, when students learned about data presentation through the local issue of waste management (See Figure 1), they not only learned theory but also how to collect, analyze, and interpret real data, which are important aspects of computational thinking.

Figure 1. Studying data presentation through waste management issues

The personalized learning approach in this interactive e-module is also significant in improving computational thinking skills, because it allows the adjustment of learning materials and methods according to the needs and learning styles of each student. According to Piaget's constructivism theory, learning is an active process in which students construct new knowledge based on their own experiences (Halliday, 2014; Piaget, 1955). With the personalized learning approach, the e-module can adjust to students' diverse learning preferences and provide specific feedback, which can then encourage students to actively engage in critical and analytical thinking. This is in line with research showing that learning that is tailored to individual needs can increase student effectiveness and engagement (Altıntaş & Özdemir, 2015; Liou et al., 2023; Stavrou & Koutselini, 2016).

In addition, the interactive e-module based on local issues with the personalized learning approach supports the development of computational thinking by facilitating real-world problem-based learning and providing opportunities for students to apply algorithms and problem-solving procedures directly. Based on the experiential learning theory by

Kolb (1984) shows that concrete experience and active reflection are the keys to an effective learning process. By facing real problems such as local waste management, students can learn to formulate and test hypotheses, develop and optimize algorithms, and analyze the results. This not only improves technical skills in solving problems, but also trains them to think logically and systematically, which are the main components of computational thinking.

Conclusion and Suggestion

Based on this research and development, the following conclusions can be drawn: 1) the interactive mathematics e-module based on local issues that was developed is feasible to facilitate the computational thinking abilities of junior high school students, 2) the interactive mathematics e-module based on local issues that was developed is practical to facilitate the computational thinking abilities of junior high school students, and 3) the interactive mathematics e-module based on local issues that was developed is effective to facilitate the computational thinking abilities of junior high school students.

Based on the process and results of this research, there are several suggestions from the researcher that need to be considered, including: (1) Improving the quality of the material, to further improve the feasibility of the e-module, it is recommended that the material presented be updated regularly by adding the latest local issues that are relevant to community developments. This will ensure that the e-module remains interesting and relevant to students, (2) Training for users, to improve practicality, it is recommended that training be conducted for teachers and students on the use of this e-module. This training can help ensure that all users can make maximum use of the interactive features and understand how this module can be applied in different learning contexts, (3) Continuous assessment, it is recommended that continuous assessment be conducted on the effectiveness of the e-module in various school contexts. Conducting regular evaluations and adjusting the module based on the feedback received can help improve effectiveness and ensure that the module continues to meet students' needs in facilitating computational thinking skills.

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