**Development Of Student Worksheets Based Computational Thinking For Algebraic Function Derivative Materials**

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|  |  | **ABSTRACT** | |
| **Article History:**  Received : D-M-20XX  Revised : D-M-20XX  Accepted : D-M-20XX  Online : D-M-20XX |  | Computational Thinking (CT) is one of the important thinking skills in the 21st century. However, mathematics has not been widely developed in the classroom learning process. The results of the initial study show that there is no LKPD based on compuational thinking for high school students. This study aims to develop a Student Worksheet (LKPD) based on Computational Thinking of algebraic function derivative material for high school students. LKPD is one way for teachers to develop the learning process in the classroom. This type of research is development research with ADDIE model development research design. The steps are analysis, design, development, implementation, and evaluation. The research subjects were high school students of class XI who received material on derivatives of algebraic functions. The research instruments were LKPD as a development product, expert validation questionnaires, teacher practicality questionnaires, and student response questionnaires. The product developed in this study is a CT-based math worksheet for the derivatives of algebraic functions for high school students. This product is validated by material experts and mathematics learning experts. Furthermore, the practitioner test by high school mathematics teachers and questionnaire responses by high school students. The results of this study are the Mathematics Student Worksheets based on Computational Thinking material for Algebraic Function Derivatives for high school students that are valid and practical. The resulting LKPD contains CT steps, namely abstraction, generalization, decomposition, algorithmic, debugging. This worksheet is one way to integrate computational thinking in mathematics learning. | |
| **Keyword*:***  computational thinking;student worksheet; derivative of algebraic function |
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1. **INTRODUCTION**

Several studies have stated that the ability of Computational Thinking (CT) or in Indonesian means computational thinking is important for the 21st century. The OECD even released that one of the most important abilities in future abilities and future education is CT (OECD, 2018). This capability was even included in the PISA framework for 2021. In the draft released by the OECD in 2018 that included CT in the 2021 PISA assessment (OECD, 2018). The National Education Technology Standard for Students even states one of six important skills that students must have and are taught in schools, namely the concept of technology and its operation (Syahputra, 2018).

The ability of students about technology, not only about how to operate a computer or surf the internet. This is a challenge for students and an inseparable part of human development. Students' knowledge of technology is not only about the web or how to operate a computer, more than that it must involve the ability to design, solve problems, contribute to technology creation, even to the stage of understanding the social and ethical consequences of the technology (Maharani, Nusantara, As’ari, & Qohar, 2020).

Computational Thinking is an ability that must be possessed and learned by students in learning. So it is important in learning this ability to be included and even paid attention to. Even mentioned CT is a cognitive skill and is expected to be owned by everyone. Furthermore, in education, CT abilities are very closely related to problem solving abilities (Maharani, Nusantara, As’ari, & Qohar, 2020).

His history of computational thinking is closely related to computer learning and informatics. In fact, since 2012 the UK has incorporated CT into its curriculum through learning informatics. Meanwhile, European Union countries have begun to discuss the integration of Ct into their educational curriculum from 2016-2017 (Bocconi, Chioccariello, Dettori, Ferrari, & Engelhardt, 2016). However, along with the importance of computational thinking skills not only as computer programmers but rather as thinking processes, so some experts state that this ability can be integrated and stimulated through mathematics subjects at school so that some experts state that this ability can be integrated and stimulated through mathematics at school.

Mathematics is considered the right science to apply and stimulate students to think computationally. This is closely related to the characteristics of mathematics. This is because mathematics can train students to think logically, systematically, and analytically whose goal is to solve problems (Cahdriyana & Richardo, 2020). In addition, according to Zapata-Ros mathematics is closely related to divergent thinking, creativity, problem solving, abstract thinking, recursion, literacy, collaboration, patterns, synthesis and metacognition which are all important parts of Computational Thinking (Zapata-Ros, 2019).

Computational Thinking is defined by some experts. Ansori defines computational thinking as a way of understanding and solving complex problems using computer science concepts and techniques such as decomposition, pattern recognition, abstraction and algorithms (Ansori, 2020). Some of the CT indicators are problem decomposition, algorithmic thinking, pattern recognition, abstraction and generalization (Cahdriyana & Richardo, 2020). This study defines Computational Thinking as a thinking process that involves abstraction, generalization, decomposition, algorithmic, and debugging.

Abstraction is defined as selecting the important elements of an object and selecting the basic ones so that they can be processed. While generalization goes hand in hand with abstraction, namely making general problems. Decomposition is defined as breaking or partitioning a complex problem into smaller problems to make them easier to work with. While the algorithm is the skill of compiling solutions and carrying out step by step solutions that have been compiled. Algorithms are technical skills needed to perform the calculation process. While debugging is the ability to recognize incorrect actions or calculations, including the ability to re-examine answers and correct these errors.

The importance of this ability according to experts needs to be stimulated through learning mathematics. This CT ability can be stimulated through the provision of questions in mathematics learning (Cahdriyana & Richardo, 2020). However, the questions given are not included in routine questions but are more complex questions.

Several previous studies have discussed about computing capabilities. Maharani examines the importance of computational abilities in learning mathematics to face the era of society 5.0 (Maharani A. , 2020). His research revealed that the development of computational thinking must involve complex thinking and given off difficult problems. Furthermore, Zahid examines the latest PISA framework which incorporates mathematical computational capabilities into the latest PISA 2021 assessment (Zahid, 2020). This study examines Indonesia's chances of achieving better PISA scores by strengthening students' computational thinking processes. However, from various studies on computational thinking, Cahdriyana & Richardo's research stated that computational abilities can be stimulated through mathematical problems (Cahdriyana & Richardo, 2020).

Basically the ability in mathematics apart from giving questions, can also be stimulated in the learning process through LKPD. According to its function, LKPD can affect students' abilities. Research states that students' STEM abilities can be stimulated through the use of STEM-based worksheets (Lathiifah & Kurniasi, 2020). In addition to this study, several previous researchers revealed the results that LKPD could improve students' critical abilities, learning outcomes, and mathematical reasoning (Malahayati, 2017) (Sari, Febrian, & Tambunan, 2021) (Prasetyono & Hariyono, 2020). However, until now there has been no LKPD based on Computational Thinking that has been developed for high school mathematics learning, especially the material derived from algebraic functions. The researcher conducted an interview with a mathematics teacher at one of the schools in Bangka Regency, that there was no CT LKPD given for high school students, especially mathematics. So far, what students have done is LKPD based on contextual problems and that is only for certain materials. Based on the above, the importance of computational ability and its integration in learning mathematics. So it is necessary to have student activities in learning that can support computing abilities. This study aims to develop LKPD based on Computational Thinking mathematics on algebraic function derivative material for high school students. The material derived from algebraic functions is chosen because the characteristics of this material are closely related to CT indicators, namely abstraction, pattern, algorithm, and decomposition.

1. **METHODS**

This research method is development research. The development model used is ADDIE (analysis, design, development, implementation, and evaluation). This development method was chosen because this study intends to develop CT-based mathematical worksheets derived from algebraic functions. The model is arranged systematically in an effort to solve problems in learning or related to learning resources and materials. The research phase follows the stages of the ADDIE research model. The research flow can be described in the following chart.

This stage makes a prototype of the CT-based LKPD development research design: Determining the title of the LKPD, Determining the LKPD Design, preparing the LKPD design, determining material indicators, namely analyzing the concept of the application of the derivative of algebraic functions in life.

Design

This stage produces LKPD,

Perform expert validation, stage 1 revision, and practitioner test

Development

Implementation

This stage limited the LKPD produced to 5 high school students

The results of the student response questionnaire on the small-scale test were revised

Then a large-scale test was conducted with 20 high school students as the subject.

Drawing conclusions, namely aspects that need to be improved from the results of large-scale tests.

Evaluation

**Figure 1.** ADDIE Model Research Flow

The research subjects for the small-scale test were 5 high school students. Meanwhile, in the large-scale test, there were 20 high school students. Expert validation, namely two experts. Mathematical material experts, especially algebra and mathematics learning experts who come from lecturers in the mathematics study program. Practitioner testing by high school teachers who teach class XI.

The data collection technique used an expert response questionnaire instrument, practitioner response questionnaire, student response questionnaire, observation sheet, and LKPD which were answered directly by students. Data analysis techniques are qualitative analysis based on expert and practitioner advice, as well as quantitative percentages involving questionnaire scores from experts, practitioners, and students.

Data analysis carried out on the data collection instrument was LKPD analysis, analysis of data validation results from material expert questionnaires, practitioner test analysis, analysis of small-scale test results. LKPD validation was measured using a 5-scale Likert scale, with a valid level of 1-5 with a description of 1 being invalid, 2 being less valid, 3 being quite valid, 4 being valid, and 5 being very valid. The scores that have been obtained based on expert judgment are then converted into percentages. This percentage is calculated using the formula (1):

*V*= ×100% ....................(1)

With the description of the formula is *V* the percentage of validity,

*x* is the total number of expert ratings, and *xi* is the total number ideal value. After the percentage results are known, the level of validity of the developed LKPD is then grouped into product validity criteria as shown in Table 1.

**Table 1.** LKPD Validity Level Criteria

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| --- |
| **Validity Criteria Validation Level** |
| 85% < *V* 100% Very validity |
| 70% < *V* 85% Validity |
| 50% < *V* 70% Less validity |
| *V* 50% Not Validity |

The level of practicality uses a scale of 1-5 with a statement of scale 1 stating impractical, scale 2 stating less practical, scale 3 stating quite practical and scale 4 stating practical, scale 5 stating very practical. Then this score is converted into a percentage calculated using the formula (2):

*V*= ×100% ....................(2)

With the description of the formula is V the percentage of practicality level,

x is the total number of student scores, and x\_i is the total number

ideal value. This percentage is used to see the level of practicality of a material or learning resource. Including LKPD. More complete in Table 2.

**Tabel 2.** Practical Level Criteria

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| --- |
| Practical Criteria Validation Level |
| 75.01% -100 % very practical |
| 50.01% -75,00% practical |
| 25.01% - 50.00% less practical |
| 00.00% - 25.00% not practical |

1. **RESULT AND DISCUSSION**
2. Research result
3. Analisis

The initial analysis resulted in the need for CT worksheets in mathematics learning. LKPD was chosen as a tool that needs to be developed in stimulating computational thinking because of the characteristics of LKPD as learning materials that students are familiar with and in accordance with student characteristics. Teachers are not difficult to develop LKPD. The next step is to analyze the appropriate material to support CT. That is the derivative of an algebraic function. Due to the characteristics of the derivatives of algebraic functions which are difficult for students, this material is full of mathematical reasoning, this material is also the basis of many other materials and other subjects. The KD chosen is KD 3.32. Analyzing the relationship between the first derivative of the function with the maximum value, minimum value, and the monotony of the function, as well as the slope of the tangent to the curve. KD 4.32 Solve contextual problems related to the first derivative of algebraic functions. The analysis carried out includes KD, SK, indicators, and learning objectives of high school mathematics for mathematics material derived from algebraic functions.

1. LKPD Development Process

This research resulted in LKPD with the number of meetings as many as 3. During the development stage, LKPD was made in accordance with KD, SK, and learning objectives. Based on the ADDIE model, the initial LKPD design was validated by experts. This worksheet is validated by mathematicians and mathematicians. The results show that the LKPD is valid with some suggestions for improvement. Based on the presentation of the validity of the formula number (1). The results of the expert validation questionnaire stated that it was very valid with the questionnaire score for content validation was 89%, the score for construct validity was 73%, for language in the LKPD was 80%, time allocation was 60% and the score for indicators regarding working instructions was 100%. Based on the results of the analysis of the construct aspect and the time allocation aspect, several improvements were made according to the suggestions.

As for some improvements based on the advice of experts. In the picture is the display result that has been corrected based on the advice given by the expert. Experts suggest that the order of steps in computational thinking should not be reversed. Then for the step part the algorithm must be made in a flowchart. Illustrations on some problems must be replaced because they do not support students' computational thinking.

After making improvements according to the advice of experts, the next stage is carried out, namely the practitioner or user test. At this stage, LKPD and user response questionnaires are given to teachers who teach mathematics in class XI. The results of the questionnaire obtained on content validation, namely 80%, construct validation score 80%, language validation 80%, time allocation validation 100%, and validation of work instructions, namely 100%. Suggestions for improvement include: (1). some uses of the x variable symbol should be italicized; (2). indicators and learning objectives should be arranged systematically in order to make it easier for students to read and understand them; (3). motivational use of the hero's words, excellent; (4). the use of flowcharts in the algorithmic step is very helpful for students in compiling solutions.

1. LKPD Testing Process

The next stage is to conduct a small-scale test. This is included in the delevopment stages of the ADDIE development model. The small-scale test came from 5 high school students. The student response questionnaire score is 4.5, which means it is practical. In the small-scale trial stage, students worked on this LKPD for 3 meetings. In accordance with the number of meetings on LKPD. The time it takes students to do it is almost two hours of lessons. In the debugging step or re-checking the compiled algorithm, students find it difficult.

Because this procedure they are not used to before. Then in the step of compiling the algorithm, students find it difficult to answer using a flowchart. But they mention that this is new and as a challenge to think more. After the LKPD small-scale test has been carried out, it can be continued with the implementation stage, namely large-scale testing. For the form of illustrations in the form of stories, students can understand well. It's just that following the computational thinking step by step, which is rather difficult, is in the part of compiling algorithms with flowcharts and then doing the debugging steps. Based on expert advice, students should be able to see the flow of procedures according to the flowchart so that the operations are similar to input, output, and outcome in a computer system. The following presents the results of students working on the LKPD.

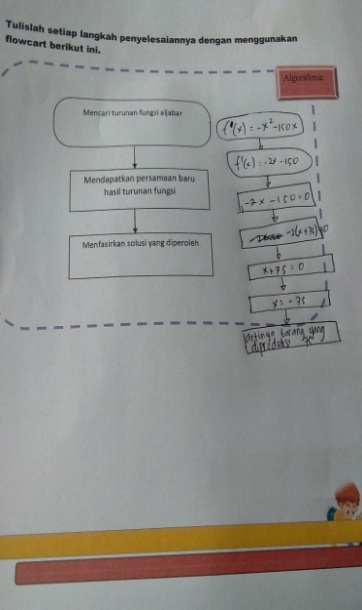
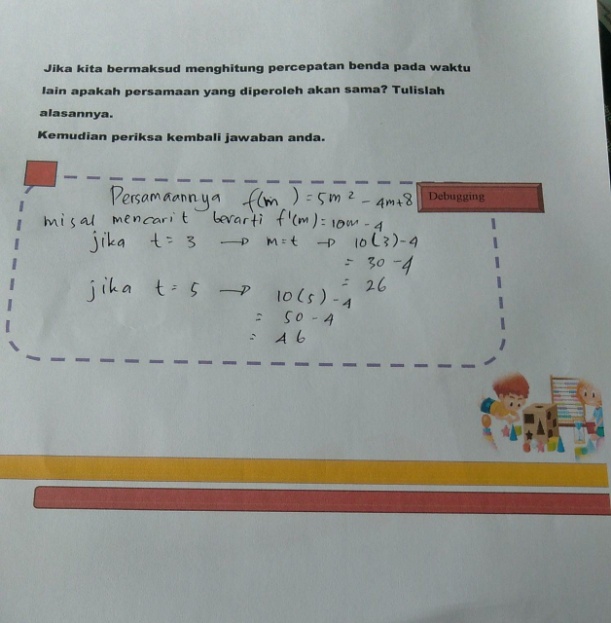


Figure 2. Student Answer Results on Small-Scale Test

In Figure 2, students make their usual answers in LKPD meeting 1. Students state that this new thing is difficult. However, for LKPD 2 and 3, they have started to get used to making flowcharts. practical test based on student responses. The results of the LKPD based on Computational Thinking are practical and can be used for algebraic function derivatives for high school students with a questionnaire score of 83%. Based on the criteria of practicality that 83% is included in the level of practicality is very practical.

In the large-scale test phase, 20 high school students were involved. At this stage students work on the LKPD and are given a student response questionnaire. This stage is carried out after revising the results of the small-scale test. The selected subjects are different from the subjects on the small-scale test. The results obtained at this stage are the LKPD practical test based on student responses. The results of the LKPD based on Computational Thinking are practical and can be used for algebraic function derivatives for high school students with a questionnaire score of 83%. Based on the criteria of practicality that 83% is included in the level of practicality is very practical.

1. Final Product: LKPD Based on Computational Thinking

The following is a cover display, problem illustration, and learning steps for LKPD Computational Thinking material derived from algebraic functions developed in this study.

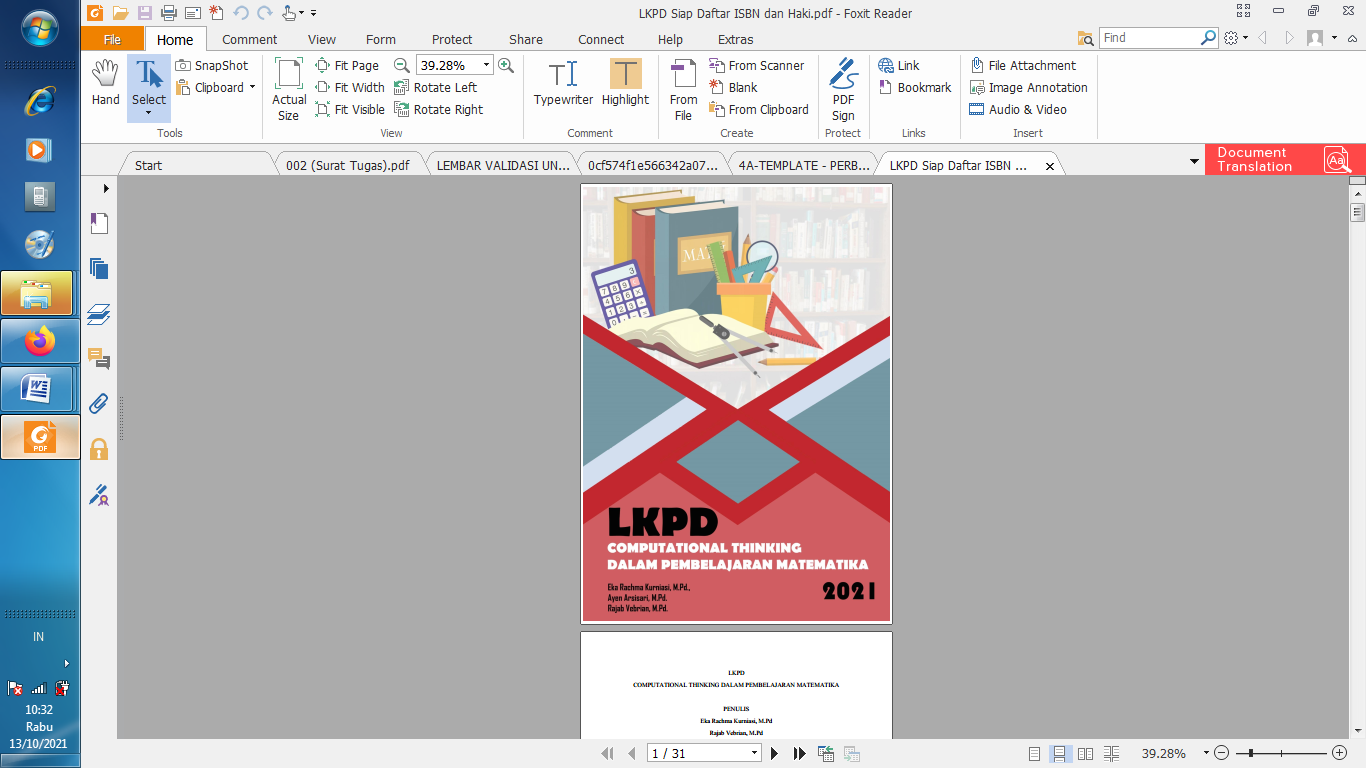


Figure 3. LKPD face view

In Figure 3, the cover is made to contain only the title. The KD, learning objectives, and learning indicators are presented on the next page. On the first page of the LKPD contains the student's identity, then material indicators and work instructions. Then students are given problem illustrations to lead to computational thinking. This illustration serves to lead students into problems which will be solved with the concept of derivative functions. Furthermore, the learning steps are made in the stages of computational thinking, namely abstraction, generalization, decomposition, algorithmic, debugging.

1. Discussion

Computational thinking is indeed something that must be stimulated in students. In this study, the results of the mathematical worksheets for the derivatives of algebraic functions are produced. The LKPD contains computational thinking steps, namely abstraction, generalization, decomposition, algorithmic, debugging. Based on the advice of experts, it turns out that in compiling a CT-based LKPD, the CT steps should not be reversed. The student's thinking process must start from abstraction, then proceed to generalization, the decomposition process of students begins to solve and separate some of the problems in the problem into small parts to make it easier to work on. Then the algorithm section, in this section specifically for computational thinking, must be structured with flowcrart. Finally, students check the results of their work with the debugging process.

This worksheet is one way to integrate computational thinking in learning mathematics. Later it can be used to stimulate students to think computationally. This stimulation relates to the importance of Computational Thinking as a cognitive ability in the 21st century. In a small-scale trial, it was found that students had difficulty interpreting each CT step. Because of the new term they found. So it is necessary to explain what process they should write for each step. In this study, the stimulation of computational thinking through LKPD is expected to make students accustomed to carrying out these thinking processes in learning. Accustomed to doing CT steps in analyzing a given problem in the problem.

The importance of this was also conveyed in previous research which stated that learning by including computational thinking skills and mathematical thinking with reference to their cognitive style will provide valuable experience to students as a provision for themselves in dealing with polemics and life phenomena in society later (Fajri, Yurniawati, & Utomo, 2019). The meaning of this is that learning mathematics is not only procedural ability, it is more important to interpret and build students' cognitive.

Furthermore, other research states that apart from learning, computational thinking can also be stimulated by giving questions or instruments with CT indicators. Research (Kawuri, Budiharti, & Fauzi, 2019) states that abilities that can be developed by applying tests with a computational thinking approach include problem-solving skills and critical thinking skills. Therefore, the next research (Sa’diyyah, Mania, & Suhartini, 2021) produced a test instrument to measure the computational thinking ability of junior high school students.

Research on computing capabilities is growing. Many things are done to support this ability, both through LKPD and through habituation of students to do tests with computational thinking indicators.

1. **CONCLUSION AND SUGGESTIONS**

Based on the results of the study, it can be concluded that, this research produces student worksheets based on computational thinking in mathematics subjects that are valid and practical algebraic derivatives for high school students. The steps in the CT LKPD generated use the definition of the CT thinking process, namely abstraction, generalization, decomposition, algorithmic, debugging. It was found that students need to be given information to clarify the execution of each CT step. The results of the validation state from the aspect of content, appearance, material, time suitability and students' thinking skills that this worksheet is valid. Meanwhile, based on the responses of students and practitioners, they stated that this LKPD can be used with a very practical level of practicality.

This study produced a CT worksheet to stimulate the CT thinking process in learning mathematics. Further research can also stimulate computational thinking through CT-based questions.

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