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The Development of Instrument Tests to Measure Students' Computational Thinking on Number and Sequence Pattern Topics

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Abstract
Mathematics learning in the 2013 curriculum emphasizes the pedagogic dimension, which aims to create active students so that they are able to develop their mindset and accustom them to finding solutions to their own problems. Computational thinking is the ability to form a frame of mind that can solve problems by forming effective and efficient solutions based on the knowledge and information obtained. This research aims to develop a test instrument to measure computational thinking on number and sequence pattern material in SMP Negeri 2 Sungguminasa that meets valid and practical criteria. This study aimed to determine the process of developing a test instrument to measure computational thinking on number and sequence pattern material in SMP Negeri 2 Sungguminasa. This research is a type of Research and Development (R&D) that focuses on the development model of B&G (Borg & Gall), which contains 4 stages: the information gathering stage, the planning stage, the development stage, the validation, and the trial stage. The subjects of the trial were students of class VIII SMP Negeri 2 Sungguminasa. The instruments used in this study were the validation sheet and the teacher response questionnaire. The study results found that (1) the validation results for the test instrument to measure computational thinking were 4,46, so they only used a teacher response questionnaire for all aspects in the very positive category with a percentage of 90,6%. It can be concluded that the test instrument to measure computational thinking on number and sequence pattern material in SMP Negeri 2 Sungguminasa meets the validity and practicality criteria.

Keywords*: Development; Test Instrument; Computational Thinking.*

INTRODUCTION

Education is a process where an educator can teach, and students can receive what is conveyed by the teacher systematically and mutually influence each other when learning activities and learning objectives can be completed. The learning process is characterized by the emergence of educational interactions, namely interactions that are aware of goals (Dasopang, 2017). The purpose of learning is achieved by providing guidance or assistance to students in the learning process to develop thinking skills and find their own problem-solving.

Development in learning can be interpreted as a process of designing and describing learning in a rational and structured manner to determine all things done in teaching and learning interaction activities, namely by looking at students' abilities (Majid, 2013). In a learning process, the development of both material development, questions are given, class procedures and several other developments are continuously updated following students' times and abilities. Among the lesson programs in education that can develop and grow the ability to think logically, creatively, critically, and systematically are mathematics lessons (Siagian, 2017).

Mathematics is found in almost every level of education because mathematics is very influential in shaping the mindset of students, starting from a systems thinking framework, critical thinking,

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Vol, 11 Issue 1

creative, analytical, logical, and active thinking. The purpose of learning mathematics in the 2013 curriculum is more to emphasize the modern pedagogic dimension, namely by using a scientific approach (Fuadi et al., 2016). Jerome Burner, in his theory, states that the best way to learn mathematics for students is to help them so that they can relate the solution of one problem to another in a relevant way (Angriani, Nursalam, and Tenri, 2018). The objectives of learning mathematics are an important element in the effort to form students' computational thinking frameworks, which can be seen from their ability to answer the test instruments given.

The measuring instrument used to collect and work on information and data to decide the learning outcomes achieved by students is referred to as a test instrument. The test instrument collects data by responding to the questions in the instrument; students will be encouraged to show their best (Purwanto, 2011). According to (Nursalam, 2016), to know the level of knowledge, skills, talents, and abilities of a person, a test can be carried out by presenting several questions that can be used when assessing and evaluating the extent to which the learning process has achieved the goals.

Several indicators must be met so the test instrument can be said to be good or valid. An instrument is called valid if the instrument that is applied can measure something that it really wants to measure (Sukardi, 2017). The test should clearly describe the results of a learning objective. The test used in this research is a test to measure students' computational thinking ability. Computational thinking is an innovative thinking ability to identify life phenomena to provide various practical solutions to the problems studied (Fajri Yuniwati & Utomo: 2019). To develop CT, one is required to formulate a problem and then arrange a better computational solution in the form of an algorithm (Malik, Prabawa, & Rusnayanti, 2019).

This shows that the core of CT is to form a thinking frame of students who are able to solve problems by forming effective and efficient solutions based on the knowledge and information that has been obtained. Considering the facts currently happening in the world of education, the importance of this ability or aspect to be developed cannot be separated from the ability to think computationally in solving a problem. Therefore, computational thinking skills need to be improved, considering that low computational thinking skills affect student learning outcomes.

From the initial observation activities carried out by the researcher, information was obtained that students were unable to describe the questions and find the pattern of completing the exercise correctly. This illustrates that students have low computational thinking skills that need improvement. According to research from Mufidah, in current mathematics learning, students are still less able to solve problems by linking the information obtained, which results in low computational thinking skills that need to be improved (Mufidah, 2018). Therefore we need an instrument that can improve computational thinking skills.

Regarding this research, Shute et al. (2017) found that computational thinking is the conceptual foundation required to solve problems effectively and efficiently with or without the assistance of computers with solutions that are reusable in different contexts (Shute et al., (2017), p. 152). Then the research conducted by Kawuri, Budiharti, and Fauzi (2019) showed that using a test that applies a computational thinking approach can be used as another solution to develop students' problem-solving skills that can also develop critical thinking skills. Therefore, the development of test instruments is important to measure students' computational thinking skills to produce test instruments that measure computational thinking skills that are valid and practical to use.

METHOD

This study applied a research and development process to develop a product as a test instrument to measure computational thinking skills based on continuously revised trials to produce products of good value and worth. By taking a trial sample of class VIII 4 at SMP Negeri 2 Sungguminasa, Gowa Regency, South Sulawesi, in semester 2. Research and Development Borg & Gall development model by Setyosari (2016) contains 4 stages, which are described in the following figure:

ICSAT INTERNATIONAL PROCEEDING
ISBN: 978-623-7496-62-5
Vol, 11 Issue 1

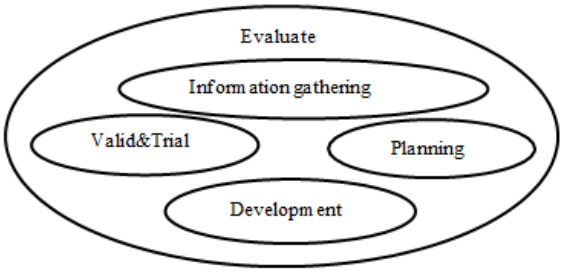

Figure 1. Borg & Gall Development Model
(Setyosari,2016)

Techniques in collecting information or data used are tests, student response questionnaires, and documentation. While the instruments used in collecting data are validation sheets and teacher response questionnaires. The validation sheet is useful for obtaining information regarding the suitability of the test instrument along with other assessments according to the assessment of the expert team. While the response questionnaire is practical support for the test instrument to be made. The data analysis technique is validity data analysis in the form of validation sheet analysis and practicality data analysis in the form of teacher response questionnaires. Below is a table that displays the criteria for the validity of the test instrument:

Table 1. Criteria for Validity of Test Instruments

Score Interval	Criteria
$4{,}3 \leq M \leq 5$	Very Valid
$3{,}5 \leq M < 4{,}3$	Valid
$2{,}7 \leq M < 3{,}5$	Quite Valid
$1{,}9 \leq M < 2{,}7$	Less Valid
$M < 1{,}9$	Invalid

(Arsyad, 2016)

The criteria indicate that the instrument has reached a degree of validity if the level of the analysis results for all aspects is at least in the fairly valid category.

RESULT AND DISCUSSION

Result

The development of the test instrument applies the B&G development model with 4 stages, namely the stage of collecting information, then the planning stage, then the development stage, and the validation stage, along with testing to produce a product in the form of a test instrument on the subject of number patterns and sequences. The first stage is gathering information; this stage is carried out to prepare various needs for developing computational thinking instruments.

According to Amirzan (2017), this stage is important to obtain information related to supporting data in the development of test instruments. At this stage, the researcher collects information (curriculum analysis, literature review, class observations) obtained by conducting observations and interviews. The results of interviews with mathematics teachers at SMP Negeri 2 Sungguminasa found that the curriculum used by the school was: the 2013 curriculum. The most basic principle in the 2013 curriculum is applying a challenging, meaningful, authentic learning process for students (Kurniaman

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Vol, 11 Issue 1

& Noviana, 2017). The development of this test instrument refers to the 2013 Curriculum, which aims to improve students' thinking skills and develop students' potential as expected.

Several other things that became the subject of discussion at the interview stage were the learning system in the classroom, learning tools, methods, strategies, and techniques used during the learning process. Class VIII was chosen to be the subject of this study because the test instrument to be developed raised material on number patterns and sequences where this material was programmed in class VIII of SMP.

After conducting interviews with one of the eighth-grade mathematics teachers and eighth-grade students of SMPN 2 Sungguminasa and observing the learning resources, the results showed that: 1) Their thinking skills in mathematics were varied. Some have high thinking ability, medium thinking ability, and low thinking ability. Broadly speaking, teachers or other researchers have never carefully studied students' computational thinking skills. Students in the school are also rarely given questions that are able to measure their computational thinking ability. 2) The test instruments used in schools only use questions contained in learning resources in the form of textbooks and questions from the internet so that students can guess the questions that will be raised at the time of the exam. 3) Students' assumptions about mathematics lessons are difficult to understand and understand. 4) The learning outcomes of the majority of students have yet to reach the Minimum Completeness Criteria (KKM).

The second stage is the planning stage, at this stage researchers begin to design test instruments that measure computational thinking skills, instrument grids, assessment guidelines, and teacher response questionnaires. According to Purnamasari (2018), to improve learning outcomes, everything related to the construction of test questions starting from determining instruments, compiling instruments, reviewing instruments, carrying out assessments, analyzing assessment results, and following up on assessment results, must be well prepared.

The test instrument is to measure computational thinking ability. The test instrument uses A4 size paper, 1.15 scale space, Times New Roman typeface, and 12 pt font. The test instrument is equipped with attractive pictures and colors. On the front is a cover of the test instrument, which contains the title of the material and pictures related to mathematics, class, and level of education. The test instrument is also equipped with instructions for using the test instrument to make it easier for students to work on the given test.

The test instrument grid consists of Basic Competencies (KD) raised in the test instrument, material indicators, subject matter, question indicators, and indicators of computational thinking ability for each question, number of questions, time to take the test, and class/semester.

The teacher's response questionnaire will contain responses from the teacher regarding the use of the test instrument developed to measure students' computational thinking abilities. The teacher response questionnaire made by the researcher consists of eight statements, where the teacher will put a checkmark in the column according to each statement given with answer choices (1) Very Poor, (2) Less, (3) Enough, (4) Good, and (5) Very Good.

Next is the development stage, which aims to create and modify test instruments until they are ready for use (Cahyadi, 2019). At this stage, the researcher begins to realize what has been designed at the planning stage. The steps taken in developing test instruments to measure computational thinking ability are 1) creating a grid of test instruments; 2) Making test instruments. After the lattice of the test instrument is made, it is then developed into a test instrument that is ready to be used to measure students' computational thinking abilities; 3) After the instrument is prepared, then the next step is to provide a picture of each item. The pictures made should be able to attract the attention of students, but still in accordance with the context of the questions that have been prepared.

ICSAT INTERNATIONAL PROCEEDING
ISBN: 978-623-7496-62-5
Vol, 11 Issue 1

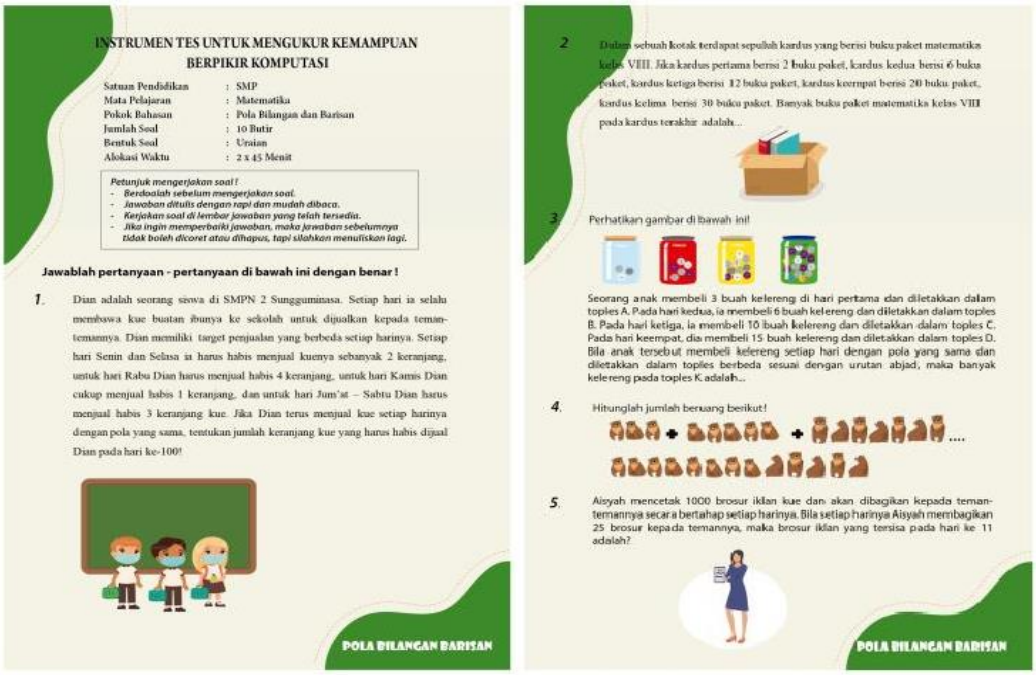

Figure 2. Test Instruments for Measuring Computational Thinking Ability

After the media creation has been completed and has received approval from the supervisor, the next stage is the validation process for the validator team. The validation process took place twice, with several improvements made based on suggestions from the validator team. Based on the validator's assessment, the test instrument to measure computational thinking ability is in the very high category in terms of content, construct, and language, with a validity coefficient of 0.82. In addition, the first and third validators stated that the test instrument was feasible to be tested without revision. The second validator stated that the test instrument could be tested with minor revisions. This indicates that the test instrument to measure computational thinking ability is feasible to be tested.

Development research aims to produce a product that is obtained by going through a series of stages to make a feasible product (Setyosari, 2016). Thus, the development objectives in this study have been fulfilled because they have produced a test instrument product to measure computational thinking abilities that are feasible because they have met valid and practical criteria. In a series of mathematics learning, the development of computational thinking is basically not a difficult thing if students are accustomed to doing it; the simplest practical step is through the presentation of everyday problems that have a gradual and hierarchical level of difficulty (Fajri, Yurniwati, & Utomo, 2019).

After the test instrument has been revised and meets the feasibility test, then a trial phase is carried out using the test instrument to measure computational thinking ability. The test instrument is designed with a colorful display and is easy to use. An attractive, colorful, and easy-to-use display will create an impressive evaluation atmosphere for students (Rahmawati, Husnadi, and Haj, 2019). This is expected to be able to make students feel more enthusiastic about doing tests compared to test instruments that are usually used in schools so far. This test instrument is also easy to use because it uses print media that is safe to use. In addition, this test has also been distributed to the internet site so

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Vol, 11 Issue 1

that anyone who needs it can easily access it. Researchers hope that with this test instrument, the teacher can find the location of students' problems when completing the tests given so far and can be improved so that their learning outcomes improve.

Discussion

Computational thinking is a thinking step for problem-solving that leads to the formation of solutions using certain computational steps and algorithms (Aho, 2012). Some indicators that exist in computational thinking are decomposition, pattern recognition, abstraction, algorithms, abstraction, and generalization.

The first component of computational thinking is decomposition. Decomposition transforms the problem into a smaller and more understandable form. To make it easier to solve the problem, it must be evaluated separately to simplify complex problems. Students are said to be able to do decomposition when they show their skills in identifying information and questions asked from the problems provided. In general, S.

Constraints faced in solving computational thinking problems are in the second and third components of computational thinking, namely pattern recognition, because they are considered to have to find appropriate inputs and outputs and require high reasoning and creative thinking. The abstraction section presents several other obstacles students face in completing computational thinking instruments. Not all of the patterns that have been found in solving problems can be used for all problems, so when they are generalized in a general form (abstraction), more in-depth thinking is needed. This is in accordance with the results of research by Zhang & Nouri (2019), which explains about some of the difficulties faced in relation to the development of computational thinking skills, including the use of branching repetitive structures, difficulties in utilizing variables, abstraction, use of logic, and modularization.

Mathematics is the basis of the subjects in preparation for this test. However, some students still diagnose that mathematics is a difficult subject. According to Siregar (2017), students who diagnose mathematics as a difficult subject will form a negative learning impression of mathematics and generally will also have a negative impact on learning motivation and adjustment of academic activities. One of the causes of the difficult assumption of mathematics lessons because in solving math problems, one fixated on one way of solving the problem without trying to solve other problems. According to Magdalena (2020), the conditions that must be met to be a good measuring tool for learning outcomes have to do with validity and reliability. This means all items of test development must pay attention to what should be asked for the important knowledge that students must know and understand. Not just taking from pieces - pieces of material from textbooks or other learning resources. Therefore, this test is structured in such a way as to suit the abilities of students. Students' ability to solve problems varies. According to Piaget, the age of students in junior high school ranges from 13-15 years and is in the formal operational stage (Piaget, 2010). This means that students at this age can think logically and abstractly and have the ability to conclude. Thus, test instruments were developed to find problems and solve problems with their abilities.

Computational thinking instruments can improve students' abilities when solving problems. This is in line with the opinion of Yasin (2020), who states that in the component of computational thinking, there are algorithms that, when successfully compiled, can help solve problems. With the habit of compiling algorithms, the mind will be more open to coming up with new ideas.

CONCLUSION

The process of developing a computational thinking ability test instrument consists of four stages, namely, the stage of gathering information, the stage of planning, the stage of developing, and the stage of validation and testing. The most difficult component experienced by students in solving problems in the computational thinking test instrument lies in the components of pattern recognition and abstraction. The results of the computational thinking ability test instrument that has been developed show that the instrument is able to measure the computational thinking ability of students and has met the criteria of validity and practicality. In addition to being able to measure computational thinking skills, the instruments that have been developed can also improve students' problem-solving abilities.

REFERENCES

Aho, A. V. (2012). Computation and Computational Thinking. 55(7), 2010–2013. https://doi.org/10.1093/comjnl/bxs074

Amirzan. (2017). Development of Basic Locomotor Movement Learning Model for Elementary School Students in Grade V. 2(1), 85–96.

[Mathematical Connection Ability. Alauddin: Journal of Islamic Basic Education, 5(1), 1–12.

Dasopang, M. D. (2017). Learning and Learning. 03(2), 333–352.

Fajri, M., Yurniawati., & Utomo, E. (2019). Computational Thinking, Mathematical Thinking Oriented Cognitive Style on Mathematics Learning in Elementary School. Dynamics of Elementary School Mathematics 1 (1), 1-18, 1(1), 1–18.

Fuadi, R., Johar, R., & Munzir, S. (2016). Improving Mathematical Comprehension and Reasoning Ability through Contextual Approach. 3(1), 47–54. https://doi.org/10.24815/jdm.v3i1.4305

Kawuri, K. R., Budiharti, R., & Fauzi, A. (2019). Application of Computational Thinking to Improve Critical Thinking Skills for Class X MIA 9 Students at SMA Negeri 1 Surakarta on Work and Energy Matter 6. 9, 116–121.

Kurniaman, O., & Noviana, E. (2017). Implementation of the 2013 Curriculum in Improving Skills, Attitudes, and Knowledge. 6, 389–396.

Magdalena, I., Hifziyah, M., Aeni, V. N., & Rahayu, R. P. (2020). Development of Test Instruments for Tangerang District Elementary School Students. 2, 227–237.

Majid, A. (2013). Learning Planning Developing Teacher Competencies. In Bandung: PT Pemuda

Malik, S., Prabawa, H. W., & Rusnayati, H. (2019). Improving Students' Computational Thinking Ability Through Interactive Multimedia Based on Quantum Teaching and Learning Models. International Journal of Computer Science Education in Schools, 8(1), 41. https://doi.org/10.13140/RG.2.2.34438.83526

Mufidah, I. (2018). Computational Thinking Profile in completing the Bebras Task in terms of the students' Mathematical Logical Intelligence. November.

Piaget, J., Jannah, M., Adinugraha, E. (2010). *Psikologi Anak = The Psychology of The Child*. Yogyakarta: Pustaka Pelajar.

Rahmawati, A., Husnadi, M., & Haj, M. I. (2019). Implementation of KAHOOT as a Physics Learning Test Instrument in the Digital Age. 3(November), 23–34.

Setyosari, P. (2016). Educational Research & Development Methods. In Educational Research & Development Methods. Jakarta: Kencana.

Shute, V.J., Sun, C., and Asbell-Clarke, J. (2017) Demystifying Computational Thinking, *Educational Research Review,* Vol 22 pp-142.

Siagian, M. D., Mathematics, P., & Introduction, A. (2017). Issn 2086-4205. Learning Mathematics in Constructivism Perspective, VII(2), 61–73.

Siregar, N. R. (2017). Students' perceptions of mathematics: a preliminary study of game-loving students. 224–232

Hard. (2017). Educational research methodology: competence and practice / Sukardi. In 1. EDUCATION - RESEARCH METHODOLOGY, Educational research methodology: competence and practice / Sukardi. https://doi.org/2009

Yasin, M. (2020). Journal Writing Assessment to Improve Computational Thinking Ability 1 1. 0–21.

Zhang, L., & Nouri, J. (2019). A systematic review of learning computational thinking through Scratch in K-9. July. https://doi.org/10.1016/j.compedu.2019.103607