THE DEVELOPMENT OF LEARNING KITS BASED ON CAUSALITY MODEL TO IMPROVE CREATIVITY THINKING SKILLS MOMENTUM AND IMPULSE OF STUDENTS

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ABSTRACT

Teachers still do not fully pay attention to the creative thinking abilities of students. This is seen from the selection of models in the teaching tools used by teachers in teaching. The selection of teaching models that tend to be directed towards direct teaching results in students being less active in following physics learning. Therefore, this research aims to determine the feasibility of a causality model learning device to improve creative thinking skills on the material of momentum and impulse. This type of research includes research and development (R&D), using a 4D model design. However, in this research, only the first three D's are carried out. The research procedures carried out refer to the steps of developing the 4D model, namely define, design, and develop. The developed learning device consists of a syllabus, lesson plans, and pre-tasks. Data collection is done through validation of the learning device by validators. The results of the validation of the learning device reached an average validation value of 87.50% with the criteria of very valid and the reliability score is 92.30%. Based on these results, it can be concluded that the causality model learning device to improve the creative thinking skills of momentum and impulse students is suitable to be used in learning.

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1. INTRODUCTION

The world is currently experiencing the fourth industrial revolution, also known as Industry 4.0. Industry 4.0 is a rapid advancement in industry characterized by the full use of digital technology in various fields. Indonesia is beginning the process of adapting to Industry 4.0 by increasing the competency of its human resources through a program linking education with industry (Satya, 2018). Education is the main sector that is expected to produce competent, superior, and competitive human resources.

To achieve this, the education curriculum is geared towards the development of higher-order thinking skills (HOTS) in every learning experience, which is intended as an effort to equip students to face the globalized world. Higher-order thinking skills are the ability to connect, manipulate, and transform existing knowledge and experiences to think critically and creatively in making decisions and solving problems in new situations (Malik et al., 2015). High-level thinking abilities are basically divided into 2 critical thinking abilities, creative thinking, and metacognitive abilities (Trianggono, 2017). Each of these abilities has different characteristics. Mursidik et al. (2015) explains that the competence of creative thinking for students is very important in the era of global competition because the level of complexity of problems in all aspects of modern life is increasing.

The facts in the field show the opposite. Based on a preliminary study through observation and interviews with physics teachers in 10th grade level at Narmada Senior High School, the researcher found that teachers still do not fully pay attention to the creative thinking abilities of students. This is seen from the selection of models in the teaching tools used by teachers in teaching. The selection of teaching models that tend to be directed towards direct teaching results in students being less active in following physics learning. In addition, teachers also still emphasize physics learning that only pays attention to mathematical equations.

As a result, students conclude that physics is difficult and filled with calculations.
This is in accordance with what was revealed by Rokhmat (2015) that teachers tend to introduce a number of equations (formulas) related to phenomena. Physics learning that only focuses on mathematical equations can inhibit creativity because it does not provide space for students to come up with new ideas that may arise due to the ability to think creatively. Furthermore, based on the analysis of tasks in the form of practice questions given by the teacher, students tend to directly imitate the example questions without understanding the meaning and detailed answers desired by the question.

Based on our observation, students also often leave their answers blank and answer casually when working on practice questions modified by the teacher. This indicates that the understanding of concepts as well as critical and creative thinking skills of students is still low. At the beginning of the learning activity, the teacher tends to focus directly on the material to be taught without providing guidance and motivation to awaken the students' learning spirit. The teacher less provides stimuli that train students' thinking skills, especially creative thinking skills. Students in this case feel bored and quickly bored when learning because they feel what is learned is less meaningful in everyday life.
Based on the above problems, teachers can use learning devices based on certain learning models as an effort to increase student participation and facilitate students to develop their creative thinking abilities. The learning model in question mainly provides meaningful learning to students. One of the learning models is the causality-based learning model.

The causality-based learning model is a learning model that habituates students to think openly. The causality-based learning model was introduced by Rokhmat (2012). This causality-based learning model is packaged with a problem-based physics foundation that is based on the ability to think causality and analytical thinking. In causality thinking, students are required to be able to determine the cause components and based on those cause conditions, students are required to be able to predict all possible events (consequences) that are likely to occur deductively. While in analytical thinking, students are required to be able to identify the conditions of the causes, so that they can cause certain consequences based on the knowledge they already have, which includes concepts, principles, theories, and/or related physics laws. The causality-based learning model is based on meaningful learning. The open-thinking facilities in the causality-based learning model can increase students' creative thinking abilities.

This is in line with the research results carried out by Tamami et al. (2017) which reveal that causality thinking adheres to divergent thinking which is expected to develop student creativity. Based on consideration of previous research results, the researcher is interested in developing a causality model learning device for momentum and impulse material. The momentum and impulse material taught in high school consists of the concepts of momentum, impulse, the law of conservation of momentum, and types of collisions. Emphasis on concepts in this material is the main goal in learning, so adequate learning devices are needed that can make it easy for teachers to convey teaching materials and facilitate students to develop their thinking skills. This is the main reason the researcher wants to conduct research to develop causality learning devices to improve the creative thinking skills of momentum and impulse students.

2. RESEARCH METHOD

The method used in this research is the 4D model. Research and development are a research method used to produce a certain product and test its effectiveness (Kurniawan & Dewi, 2017). The research and development method in the field of education according to Borg and Gall (as cited in Sugiyono, 2018) is a research method used to develop or validate products used in education and learning.

2.1 Research Design

The research design of this research and development refers to the 4D model developed by Thiagarajan (1974). The 4D model was chosen because it is systematic and suitable for developing learning devices. The 4D model consists of 4 stages: (1) Define (definition); (2) Design (planning); (3) Develop (development); (4) Disseminate (dissemination).

2.2 Research Procedure

This research uses the type of Research and Development (R&D) research with the 4D research model (Define, Design, Develop, and Disseminate). The procedure in this research follows the stages in the 4D model. (1) *Define*: The goal of this stage is to establish and define the learning requirements, starting with the analysis of the objectives of the material boundaries in the developed learning device; (2) *Design*: This stage is the stage of designing the initial draft of the causality model learning device product developed. The learning device consists of syllabus, lesson plans and introductory tasks; (3) *Develop:* The goal of this stage is to produce a learning set that consist of syllabus, lesson plan and introductory tasks.

2.3 Research Instruments

The instrument used in this research is a physics learning device in the form of syllabus, lesson plans, and introductory tasks. The learning device is then validated by a validator to determine its validity, which is then used as a reference to determine the suitability of the learning device.

2.4 Data Collection

The data collection technique used in this research is a validation questionnaire by validators to determine the suitability of the learning device.

2.5 Data Analysis

Validity analysis is calculated using the following equation:
The known validity results can be matched with validity criteria as presented in the Table 1. This criterion is adapted by research that conducted by Fatmawati (2016).

Table 1 Grade of Validity that use to categorize the level of validity of instrument development.

No	Score	Criteria
1	85,01% - 100,00%	Extremely Valid
2	70,01% - 85,00%	Adequate
3	50,01% - 70,00%	Less
4	01,00% - 50,00%	Not Valid

Percentage of agreement (PA) is a measure of the reliability of a test or assessment instrument. Then, the frequency of assessment by validators who give high scores (A) and the frequency of assessment by validators who give low scores (B). It is calculated by comparing the scores or ratings given by multiple raters or assessors to determine the level of agreement between them. The formula for calculating PA is as follows:

$$PA = 1 - \frac{A - B}{A + B} x 100\%$$

A test or assessment instrument is considered reliable if the PA is 75% or higher. This means that at least 75% of the scores or ratings given by the rates or assessors agree with each other. A high PA indicates that the test or assessment instrument is consistent in measuring the construct it is intended to measure.

3. RESULT

The results of this research explain every stage that used to develop the learning kit-based causality approach. The development used the Research and Development method that consist of Define, Design and Develop.

3.1 Defining Stage (*Define*)

In defining step, there are four following steps to reveal and analysis the problems based on teaching method and lesson material.

Initial Analysis

Initial analysis is an activity that is carried out to examine the problems that arise in the learning process. This initial analysis is done by interviewing the physics teacher of grade 10^{th} at Narmada Senior High School, West Nusa Tenggara. The interview was conducted twice, before and after the outbreak of Covid-19. Based on the results of the interview, it was obtained that the teacher had not fully paid attention to the creative thinking abilities of the students. This is evident from the choice of dominant direct teaching learning models, and the emphasis on physics that only pays attention to mathematical equations resulting in students being less active in participating in learning activities and considering physics to be difficult. Then there was a change in the implementation of learning during Covid-19, which was from face-to-face learning to online or network (daring) learning through WhatsApp as a place for attendance, delivering material, discussion, and task assignment, and Google Classroom as a place for collecting certain tasks. There were some problems during online learning, such as limited quotas and internet network disruptions that caused some students not to attend the learning.

Students Analysis

The characteristics of the students analysed in this research are the students of class 10th grade level of science class group 6 at Narmada Senior High School in the academic year 2020/2021, numbering 20 people. Based on information from the teacher, 10th grade level of science class group 6 is the most active class in asking questions compared to other classes. In addition, for the level of creative thinking of students is not sufficient as seen from the answers given by students when given questions. The students give answers that are in line with the book or other sources without analysing what is intended by the question.

Task Analysis

Task analysis aims to detail the teaching material based on the core competencies (KI) and basic competencies (KD) in accordance with the 2013 curriculum. The KI used is KI 3 and KI 4, while the material developed in this research is momentum and impulse, specifically on KD 3.10 and 4.10 of the Indonesia National Curriculum.

Concept Analysis

Concept analysis is the identification of the main concepts that will be taught and systematically arranging and detailing relevant concepts, connecting one concept with other relevant concepts, resulting in a concept map.

3.2 Designing Stage (*Design*)

This stage is the stage of designing the initial draft of the learning device to be used on the momentum and impulse material. At this stage, the researcher designs a draft of the learning device based on the causality model and data collection instruments, which are then validated by validators consisting of expert validators and practical validators. The draft produced at this planning stage is as follows.

Syllabus

The syllabus developed is based on the causality learning model by modifying the existing syllabus in the 2013 revised curriculum. This syllabus serves as the basis for the preparation of the Lesson Plan, which contains core competencies (KI), basic competencies (KD), main topics, learning activities, indicators, assessment techniques, forms of instruments, allocation of time and learning sources.

Lesson Plan

Lesson plan (RPP), which is developed based on the causality learning model, is a guide for teachers in implementing learning. The lesson plan is arranged in accordance with the format of lesson plan composition, which consists of identity; KI; KD and indicators; 50 learning objectives; learning material; approach, model and method of learning; media, tools and learning resources; steps of learning; and assessment. In the steps of learning, the causality learning model syntax is applied, namely orientation, exploration and development of causality concepts, argumentation, and evaluation.

Introductory Task

Preliminary assignments are a specific causality model learning tool given before the learning activity takes place. The preliminary assignments contain questions from the entire material that will be studied with the aim of providing an overview and determining the initial knowledge of the students.

3.3 Developing Stage (*Develop*)

This stage is the stage to produce a development product. The development stage is carried out through two steps, namely product validation testing and limited testing. The data generated is explained as follows.

Learning Set Validity

Validation aims to determine the validity of the learning tool, which is then used as a reference to determine whether the tool is suitable or not to be applied in learning. Validation is carried out by 3 expert validators from the Physics Education Department of Education Faculty Mataram University, namely Dr. Joni Rokhmat, M.Si., (validator 1), Muhammad Zuhdi, S.Si., M.T., (validator 2), and Drs. Sutrio, M.Si., (validator 3), as well as 3 practical validators, two physics teachers at Narmada Senior High School namely Drs. Rochmat Basuki (validator 4) and Mrs. Yuni Hardiyanti, S.Pd., (validator 5), and Mr. H. M. Yusuf AS, S.Pd., M.Pd., (validator 6) who teaches physics at Narmada Vocational High School. Data from the validation of the learning tool is obtained from the assessment of the validation sheet by validators using the Likert scale score 1-4 where 4 means very good, 3 means good, 2 means less, and 1 means very less. The results of the validity of the learning tool are displayed as follows.

Table 2. Validity of Learning Sets

No	Product	Grade	Sum	Percentage	Criteria

		1	2	3	4	5	6		Max Score		
1	Syllabus	31	34	26	30	32	31	184	216	85,18%	Extremely
2	Lesson Plan	45	46	40	41	44	44	260	288	90,28%	Extremely
3	Introductory Task	33	35	25	30	34	31	188	216	87,04%	Extremely
Avg. Score Total										87,50%	Extremely

Based on the analysis of the validity of the learning tool by validators, it is obtained that the syllabus, lesson plan, and preliminary assignments have a validity percentage above 85% with an overall average of 87.50%. According to Akbar (2013) in Fatmawati (2016), this value falls within the criteria of very valid. This criterion represents that the developed learning tool product is suitable for use in learning.

Learning Set Reliability

The analysis of the reliability of the learning tool aims to determine the consistency of the learning tool based on the agreement among validators. The agreement among validators is analysed using the percentage of agreement (Borich, 1994). The learning tool is considered reliable if the percentage of agreement is ≥ 75%.

Table 3. Reability of Learning Sets

No	Product	Percentage of Agreement	Criteria
1	Syllabus	92,12%	Reliable
2	Lesson plan	94,44%	Reliable
3	Introductory Task	90,35%	Reliable
	Overall Avg	92.30%	Reliable

4. DISCUSSION

The purpose of this research is to determine the feasibility of developing a causality model learning tool to enhance the creative thinking skills of students in the main topic of momentum and impulse. This research is a research and development (R&D) type. The research procedure carried out in this study consists of four stages: defining, designing and developing. The products produced in this research are causality model learning tools consisting of syllabus, lesson plans and pre-learning tasks. The feasibility of these learning tools is determined by analysing their validity and reliability.

4.1 Defining Stage (*Define*)

Based on the research results obtained in the definition stage, it shows that there are various problems faced by teachers and students. In the initial analysis stage, high-level thinking abilities are not yet the focus of learning carried out by teachers. Teachers tend to use conventional methods and have not yet used a particular learning model to facilitate the ability of students. The lack of emphasis on the concept of learning and only focusing on mathematical equations makes students less optimal in following learning because they feel bored. In the student analysis stage, it shows that creative thinking abilities are still low because they are only based on textbook, so there is a need for improvement in the type of questions that need to be developed in the form of developing a test instrument for creative thinking abilities.

Meanwhile, in the analysis stage of the concept and learning objectives, the focus is on Momentum and Impulse and the concept and learning objectives that focus on the causal model syntax is obtained. One of the formulated learning objectives is that students can apply appropriate concepts, principles, theories, and/or physical laws in solving problems related to momentum accurately. Based on this objective, it can be said that the development of learning materials is not only focused on learning concepts but also on improving creative thinking skills.

4.2 Designing Stage (*Design*)

The learning materials consisting of the syllabus, lesson plans, and preliminary tasks are designed based on the results obtained in the definition stage. In this stage, the syllabus is designed based on the Ministry of Education and Culture Regulation No. 59 of 2014 which states that the syllabus is a learning plan for a subject that includes Core Competencies, Basic Competencies, learning materials, learning activities, assessments, allocation of time, and learning resources. Sahidu (2017) in his book explains that the syllabus is one of the curriculum development products containing the broad outlines of the subject matter, learning activities, and research designs.

Similarly, the RPP designed refers to the Ministry of Education and Culture Regulation (Permendiknas) No. 41 of 2007, which states that the RPP is detailed from the syllabus to guide the learning activities of students to achieve KD. The RPP is used as a guide by teachers, containing 13 steps of learning so that the material presented is implemented systematically and in accordance with the goals. The steps of preparing the RPP are as follows (Sahidu, 2017).

Then, the questions in the preliminary assignment are based on the indicators from the causalitic model. The preliminary assignment is one of the learning tools found in the causality learning model. The preliminary assignment is a task given prior to the learning of related materials. Rokhmat (2015) and Rokhmat et al. (2020) explain that the Preliminary Assignment (PA) is a task given to equip students with prior knowledge to understand the concepts that will be taught at least one day before the learning takes place. The preliminary assignment contains questions that cover all the materials to be discussed in one learning unit.

4.3 Developing Stage

Syllabus

The feasibility of the causal learning model-based curriculum in this research is reviewed based on the validity value and the reliability of the validator's assessment. Based on the validation results, the average validity percentage of the curriculum is 85.18% with the criteria of very valid, but there is a slight improvement based on comments and suggestions from the validator. Improvements to the curriculum are aimed at elaborating the indicators of competence achievement to be adjusted to the operational verbs contained in the basic competencies (KD). The determination of validity criteria refers to Akbar (as cited in Fatmawati, 2016) that learning tools can be said to be very valid if the percentage range of validity is 85.01%-100%.

Next, the reliability of the curriculum is determined by calculating the percentage of agreement (PA) based on the validity scores given by the validator. The results of the data analysis obtained a PA value of 92.12% with a reliable criterion. Determination of reliability criteria is in line with the opinion of Borich (1994) that learning tools are considered reliable if the percentage of agreement is more than or equal to 75%. Based on the scores and criteria of validity and reliability, it can be concluded that the causal learning model-based curriculum is suitable to be used as a guide for preparing lesson plan (RPP).

Lesson Plan

The feasibility of the lesson plan (RPP) based on the causality learning model in this research is reviewed based on the validity values and the reliability of the validator's assessment. Based on the validation results, an average validity percentage of 90.28% was obtained with the criteria of very valid, but slight improvements are needed based on the comments and suggestions from the validators. The improvements in the RPP generally aim to clarify the indicators of competence achievement to be aligned with the operational verbs found in the basic competencies (KD) and to replace the use of the Zoom meeting application with WhatsApp for online learning. The reliability of the RPP is determined by calculating the percentage of agreement (PA) based on the validity scores given by the validators. The results of the data analysis obtained a PA value of 94.44% with the criteria of reliable. Based on the scores, as well as the criteria of validity and reliability obtained, it can be concluded that the RPP based on the causality learning model is feasible to be applied in learning.

Introductory Task

The feasibility of a task based on the causality learning model in this research is assessed in terms of validity and reliability of the validator's assessment. Based on the validation results, the average percentage of task validity is 87.04% with a very valid criteria, but there is a slight need for improvement based on the comments and suggestions from the validator. The improvement on the task generally focuses on question number 5 and 6, by replacing them with open-ended and conceptual questions, rather than just applying mathematical equations. The reliability of the task is determined by calculating the percentage of agreement (PA) based on the validity scores given by the validator. The result of the data analysis obtained a PA value of 90.35% with a reliable criterion. Based on the scores, as well as the validity and reliability criteria, it can be concluded that the task is suitable for use in learning to obtain an initial understanding of the momentum and impulse of students.

5. CONCLUSION

Based on the research and discussion, it can be concluded that the casuistic learning model apparatus to improve the creative thinking ability of momentum and impulse of the students has very valid criteria, thus it is suitable to be used in learning. Based on the difficulties encountered during the research, there are several suggestions for improvement of similar research, including the causality learning model that has been compiled, can be used by teachers for online learning or physics classes in the classroom.

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