Development of student worksheet to improve creative and critical thinking ability of students in causaltic-learning model

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Abstract. The causaltic learning model is a learning model and is designed based on a causaltic thinking approach (causality and analytics). Based on the research results, the causal learning model can be used as an alternative learning model that facilitates the ability to think critically, creatively, solve problems, and increase student learning motivation. The purpose of writing is to develop learning tools (student worksheets) to improve the critical and creative thinking skills of junior high school students in learning the causaltic model. The research method used is 4D which consists of 4 stages, namely define, design, develop, and design. The results of this research is a special design of student-worksheets for physics learning with a causaltic-model for the material of heat and temperature for the student of junior high schools. Conclusion The resulting worksheets have unique characteristics such as loading phenomena with several elements of cause and effect, recommending the content of phenomena related to daily life, having a causality table, having space for explanations, using scaffolding, using language that is short, clear, easy to understand. understand, and use companion images of the phenomenon.

1. Introduction
The 21st century is experiencing dynamic changes in both science and digital technology. This change requires 21st century skills that every learner must possessed. [1] stated that teachers are the main factor contributing to the development of 21st century skill competencies (for students) which consists of 4Cs, namely: 1) communication, 2) collaboration, 3) critical thinking and problem solving, 4) creativity and innovation.

The learning process leads to the formation of 21st century skills including critical thinking and creative thinking skills. The ability to think critically is line with higher order thinking skills, in Bloom's taxonomy it is characterized by the ability to analyze, synthesize, and make decision. Some of the experts, [2] stated that critical thinking, among others, is related to the disciplinary process being intellectually active and skilled in applying, analyzing, thesising, and evaluating information.
Meanwhile, Halpern's opinion in [3] can be interpreted that critical thinking is the use of cognitive skills and strategies to increase the possibilities of achieving the desired results. Critical thinking describes thinking in solving problems, formulating conclusions, predicting possibilities, and making decisions.

The goal of critical thinking is to achieve deep understanding. Understanding makes students able to make conclusions by considering data and facts that occur in the field. Furthermore, the ability to think creatively provides openness in looking at a problem to be resolved. [3] stated that creative thinking is an important skill when creating adaptive strategies to deal with change and find the answers. Another opinion, [4] stated that creative thinking is a thinking skill based on a way that encourages someone to produce creative products. According to [5], creative thinking is a series of cognitive activities that individuals use to deal with certain events and problems according to their capacity. Cognitive processes generate ideas, integrate ideas, or see things in a new way. Creative thinking skills take advantage of divergent thinking, free thinking is not fixated on one point.

In the learning process the teacher applies a learn model to facilitate students to have 21st century competence (critical and creative thinking). [6] states the learning model is a planning in the form of stages which is used as a guide in planning student learning activities in class. This is in line with the opinion of [7] which states that a learning model is a plan or pattern that can even be used to form a curriculum (long term learning plans), design learning materials, and guide learning in a classroom or other learning environment. The learning model that is applied has an important role in developing the competence of students. Another opinion, [8], and [9] stated that each learning model has its own style and characteristics in facilitating students to learn. In general, the learning model has the following characteristics: 1) helping students to learn how to learn, 2) directing students to learn constructively, 3) providing stage assistance (scaffolding) in the learning process, and 4) leading to a stronger understanding and greater independence in learning process.

There are several learning models can be applied. One of them is a causalitic learning model. Based on the research, the causal learning model can be used as an alternative learning model that facilitates the ability of students to improve critical thinking, creative and problem solving skills, as well as improve learning in high school students and students at the higher education level. Some researchers, such as [10, 11, 12, 13, 14, 15] has conducted research on the application of causalitic learning models at the tertiary education level and high school. The six studies above show that the causalitic learning model can improve critical thinking, creative and problem solving abilities. Of course, schools at lower levels (SMP) can apply this learning model.

Causalitic learning model is a learning model developed and designed of causal and analytic thinking approaches. According to 1 [16, 17] the activities of thinking of causality are understanding phenomena, determining causes, predicting effects deductively. Causality thinking has five models consisting of four basic causality thinking models plus a combined model as a development of the four basic models. According to [16] the five models of causality thinking are: 1) Simple causalitic model; 2) Divergent causalitic model; 3) Convergent causalitic model; 4) Chain causalitic model; 5) Combined causalitic model. Furthermore, [18] classifies the combined causal model into two, namely the simple combined causal model and the combined chain causal model.

Meanwhile, analytical thinking activities are identifying each of the causes so produce each predicted effect, providing explanations that connect the predicted causes and effects, and writing arguments for why each predicted effect occurs using sources of facts, concepts, principles, theories, and or physical laws relating to cause and or prediction of effects. According to [19], analytical thinking includes components of systematic thinking and critical thinking. [19] also stated that analytical thinking is closely related to creative thinking. Creative thinking indicators include fluency (thinking fluently), flexibility (thinking flexible), originality (original thinking), elaboration (thinking in detail). Strong conceptual mastery is needed in creating new creative ideas to be used in creating new ideas.

Based on the definitions of causality and analytic thinking, [9, 16, 18] stated that the causalitic learning model is arranged with an orientation to guide students in learning which emphasizes
developing ability to analyze the cause and effect of a phenomenon and arrange an explanation. Students are facilitated to explain how the causal conditions are so that they can predict possible consequences. In a statistical review, cause acts as an independent variable while effect as the dependent variable. Furthermore, the argument is the reason for relating the causal conditions of each. According to [8] causalitic learning process is based on planting concepts, not just solving problems using physics formulas.

Implementation of the causalitic learning model is characterized by the learning steps are contained in 4 phases. The first phase is orientation. At this stage the students activity listens to the contents of the learning objectives and equates perceptions. The second phase is exploration and development of the concept of causality. At this stage students analyze phenomenon in terms of the concept of causality, identify the elements of the phenomenon which are causes, predict the various possible effects deductively that can occur [9, 18].

Furthermore, the third phase is argument formation. In this phase, students identify the opportunity conditions of each element of the cause, determine the effects that are likely to occur by applying concepts, principles, theories, and or related laws to explain why each effect can occur. The fourth phase is evaluation. In this phase students convey perceptions and assess the perceptions of other students with regard to material discussed, answer further construction questions in order to strengthen mastery of the material, and conclude the results of classical learning activities [9, 18].

In applying the causalitic learning model, learning tools are needed, including student worksheets. Student worksheets for learning are developed based on the approach to thinking causality and analytic thinking. According to [20] developed student worksheets to facilitate the achievement of expected learning objectives. Another opinion, [21] states that student worksheets are an indication of activities for implementing learning tasks carried out by students referring to the basic competencies that must be achieved. One of the advantages of developing student worksheets is that they can be designed according to the circumstances of students and school characteristics, so that teachers can integrate or develop student worksheets with learning models according to the needs of students. The development of causalitical student worksheets facilitates students to develop critical and creative thinking skills. Student worksheets used for causal learning have a distinctive feature, namely that they contain phenomena that can be analyzed for their cause and effect, then put into a causality table, and explain the reasons.

Students have different characteristics according to their age level. The age of students affects their physical condition, emotions, psychomotor abilities, and cognitive abilities. Junior high school students generally have an age range of 12 to 18 years. This is in accordance with regulation of the Minister of Education and Culture number 44 of 2019 concerning New Student Admission (PPDB) which states that new seventh grade junior high school students up to 15 years old. [22] stated that children in the age range of 10 years to 21 years are classified as adolescents. At this time the attainment of self-identity is very prominent, thinking is increasingly logical, abstract, and idealistic. According to [23] adolescence begins with puberty, which is around 11 to 18 years old. At that age, adolescents experience changes in their emotions, bodies, interests, behavior patterns, and are also full of problems. This is in line with the opinion of [24] which states that adolescence or adolescence is a transitional period between childhood and adulthood. At this time there were various turmoil or turmoil relating to the affective, social, intellectual and moral aspects. This happens, due to changes both physically and psychologically that very quickly disrupt the stability of the child's personality.

According to [22], students in the junior high school age range, namely 11 to 17 years, are in the pre-adolescent and early adolescent phases. [23] argues that early adolescents are at the stage of formal operations (period of formal operations), which is a stage of cognitive development that starts at 11 or 12 years of age and continues until adolescents reach a calm or adult period. At this stage students cognitively have the ability to start thinking abstractly and hypotheses, are able to think about something that will or might happen, and have alternative abilities. So that at the formal operation stage, students have their own mindset in solving complex and abstract problems. The thinking ability of adolescents develops in such a way that they can imagine many alternative solutions to problems
and their possible consequences or results. Furthermore, [25] stated that junior high school students have cognitive abilities to develop reasoning skills in inductive and deductive analytical thinking by using concepts and principles to solve problems both qualitatively and quantitatively. This is supported by Piaget's theory that the age of junior high school students is included in the cognitive group of the formal operation stage, namely the stage of the child having his own mindset in an effort to solve complex and abstract problems.

Based on the description above, at the tertiary level and high school, the causalitic learning model has been applied, while at the junior high school level this model has not been applied. Of course, to apply the causalitic learning model in junior high schools requires student worksheets as a device that supports the learning process. In this paper, we will discuss the strategy of developing worksheets for junior high school students of physics (physics) learning oriented to improve critical and creative thinking skills through causalitic learning models sourced from literature (articles and books).

2. Method
The type of research used in this research is Research and Development (R & D). This research refers to the model of 4D that consists of four stages, namely define, design, develop and design. Development of student worksheets uses the 4-D model with the assumption that this model is more concise. The first stage is "define" to produces and analysis of the learning objectives in the student worksheet based on the curriculum. The second is "design" to produce student worksheets based on the characteristics of the causal learning model. The third, namely "development", produces a draft of student worksheets that is adjusted to a literature review that discusses the causalitic-learning model. The fourth, namely "disseminate", to disseminating the product of this research.

3. Results and Discussion
The result of this research is the design of student worksheets for physics learning with a causalitic-model. Especially for temperature and heat material and for junior high school students.

In this sub discussion will describe how strategies for developing learning tools for student worksheets (student worksheets) specifically for learning natural science (IPA) in the physics section at the junior high school level with a causalitic model to facilitate increased critical and creative thinking skills in learning temperature and heat material in class VII.

2.1 Conceptual framework for the preparation of student worksheets.
The unique characteristic of these student worksheets compared to other types of student worksheets is their orientation, which is to facilitate students to develop their abilities in critical and creative thinking. One of the important indicators of critical thinking is having the ability to draw conclusions from a problem or phenomenon and in critical analysis it is supported by other higher order thinking skills, such as the ability to analyze, synthesize, and evaluate. Meanwhile, one important indicator of creative thinking is generating lots of ideas and ways of solving problems.

The essential thing in the causality student worksheet lies in how to arrange the phenomena to be analyzed. Phenomena arranged in an analysis have more than one cause or effect. In the discussion of statistics, causes are defined as independent variables, while effects are the dependent variable. At the junior high school level with cognitive characteristics, they have the ability to start thinking abstractly and hypotheses, so the description of the phenomenon uses short, clear, easy to understand language and uses pictures. [13], in their research found that students often experience misinterpretation, when the description of the phenomenon is long. Based on these findings, the use of short language avoids wasting sentences, avoids lazy students to read, and makes students more focused. Language that is clear and easy to understand helps students better understand the phenomena presented and makes it easier for them to analyze the causal components. Image help serves to clarify descriptions effectively.

The phenomena presented in the student worksheets contain the phenomena of everyday life that are possible to be experienced by students directly, so that students are more interested and challenged
to analyze based on their understanding and experiences. Based on the causal model introduced by [6, 7], then this phenomenon is included in the simple combined causal.

The results of the analysis causal components this phenomenon are presented in the causality table. The causal column in the causality table develops cognitive processes of understanding, analyzing, synthesizing and evaluating (higher order thinking) of the phenomena presented. According to [8, 9] this cognitive stage is a stage of causality thinking that can train the development of critical thinking, among others, it is characterized by students being able to determine various possible causal factors.

The effect column in the causality table facilitates students to develop analytical thinking skills, which is to identify various causes so as to produce predictable opportunities for consequences. Based on the opinion of [8, 9] about analytic thinking and Brigili's opinion [20] about creative thinking, then analytical thinking trains the ability of students to think creatively. [26] stated that the creative thinking indicator consists of 5 indicators. The first indicator of creative thinking is fluency (thinking fluently). The ability to think fluently is characterized when students are able to provide ideas to determine the possible consequences of more than one answer. The second creative thinking indicator is flexibility (flexible thinking). Flexibility ability is characterized when students are able to see problems from different points of view, so that they can mention alternative causes and consequences of more than one possibility.

The explanation space trains students to arrange the arguments from the predetermined consequences. Fluency and variation in providing explanations is an indicator of fluency (thinking fluently). The arrangement of arguments using their own language without copying the language from books or other literature sources is an indicator of originality (original thinking). The arrangement of argument supported by concepts, principles, theories, and or related to laws an indicator of elaboration (detailed thinking).

2.2 Description of the students worksheet model.
Design of students worksheets is developed based on the characteristics of the causalitic learning model, so students are able to build concepts independently. The components of the causal student worksheet consist of: 1) the title of the student worksheet, 2) objectives, 3) basic competence, 4) competency achievement indicators, 5) instructions for completing student worksheets, 6) phenomena, 7) causality table, 8) explanation room, 9) practice questions.

2.3 Application of student worksheet students in learning.
In learning process the teacher divides students into groups and distributes student worksheets. The next activity of the students in the group looked at the student worksheet instructions and listened teacher's explanation to understand and fill in causality table. Furthermore, the teacher provides stage assistance (scaffolding). According to Rokhmat, et. al [27], scaffolding means providing stage assistance with certain portions. In the first stage, provide assistance with more portions of students. The form of assistance that can be given by includes simulating the completion of student worksheets using student worksheets to practice. This is highly recommended, based on research conducted by Abdani, et. al [10] and Anshori, et. al [11], found an obstacle, one of that the students were less familiar with the causalitic learning model, so they did not understand what to do and a lot of learning time was wasted to explain how to learn using a causalitic approach.

Then gradually, the portion of assistance is reduced to give students the opportunity to take over responsibility [27]. The next form of assistance by writing the number of possibilities causes and the number of possibilities effects in each column of the causality table. Provide some examples of causes, some examples of consequences, and some examples of explanations, after students understand, so the examples given can be reduced. Teachers can eliminate the assistance stage after students are able to work on their own [27]. Stage assistance is very important to do because the causalitic learning process is in diverge contrast to the learning process that is usually carried out.
The next activity students in their groups convey their perceptions and assessing the perceptions of students in other groups with regard to the material being discussed. Answering further construction questions in order to mastery of the material, and concluding the results of classical learning activities.

2.4 Examples of student worksheet models (on temperature and heat material).
The following is an example of a student worksheet to support the causalitic learning model on heat temperature material:

Causal student worksheets heat temperature material

Objectives:
With a causalic thinking approach, students can understand and analyze the concept of temperature.

Basic competencies:
3.4 Analyze the concepts of temperature, expansion, heat, heat transfer, and their application in everyday life, including mechanisms for maintaining body temperature stability in humans and animals.

Indicators of Competence Achievement:
3.4.1 Analyze the concept of temperature
3.4.2 Describing the types of thermometer
3.4.3 Determine the conversion between temperature scales

Working Instructions:
1. Read each phenomenon carefully
2. Analyze each phenomenon so that you find the components as cause and effect of the phenomenon!
3. Enter the components of cause and effect into the causality table
4. Make an explanation to relate each effect and cause using related concepts, principles, theories and / or laws.

Phenomenon No. 1. LKS - 1
A pot made of aluminum is used to heat water. There are 3 thermometers (Figure 1.) with the same physical condition. Two thermometers use the Celsius scale, one thermometer uses the Reamur scale. Two students A and B were asked by the teacher to measure the heat of the water in the pot. Each student takes a thermometer randomly. Determine the probability of comparison of the numbers shown by student A's thermometer and student B! (It is known that the same object measured with a Celsius thermometer shows a higher number than Reamur).
Causality Table Phenomenon No. 1 LKS -1

| Cause (there are 4 pieces) | Result (there are 3 pieces) |
|---------------------------|------------------------------|
| 1. Three thermometers with the same physical condition | 1. The number on student A's thermometer is the same as the number on student B's thermometer |
| 2. Two thermometers use the same scale | 2. The number on student A's thermometer is bigger than the number on student B's thermometer |
| 3. One thermometer uses a different scale | 3. The number on student A's thermometer is smaller than the number on student B's thermometer |
| 4. Measure water temperature using a random thermometer scale | |

Result 1 occurs if students A and B take the thermometer with the same scale.

Result 2 occurs if students A and B take a thermometer with a different scale, the thermometer scale taken by student A is bigger than student B

Result 3 occurs if students A and B take a thermometer with a different scale, the thermometer scale taken by student A is smaller than student B

Exercise:
1. Is it possible that the hand (skin) can be used to determine the temperature state of an object precisely? explain your answer!
2. Write down the 4 thermometer scale!
3. Write down the top and bottom edge points on each of the 4 thermometer scales!
4. Determine the ratio of the 4 thermometer scales!
5. Determine the relationship between the Celsius scale and Reamur!
6. Determine the relationship between the Celsius and Fahrenheit scale!

Italicized writing on the causality table in student worksheets is intended as a part that must be filled in by students in the learning process. Meanwhile, writing that is not italicized is part of the step instructions or assistance, as well as an example of filling out worksheets.

4. Conclusion
Based on the discussion that has been described, causalitic student worksheets for the junior high school level are adjusted to the stages of cognitive development and the characteristics of the causalitic learning model. It can be concluded that the strategies for designing student worksheets for causal learning at the junior high school level based on literature analysis are: 1) Contains phenomena that have more of an element of cause or effect, and are highly recommended in relation to daily life; 2) Has a causality table; 3) Has space for explanation; 4) Using the help stage (scaffolding); 5) It is recommended to use language that is short, clear and easy to understand; 6) It is recommended to use a companion image of the phenomenon.

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