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Abstract. This study aimed to produce physics learning tools based on inquiry that are valid, practical, and effective to improve students' creative thinking skills on heat material. This study is a developmental research using the 4D (define, design, develop, disseminate) model. Learning tools in the form of syllabus, lesson plan, student activity sheets, student textbooks, and test instruments were validated by 2 experts before being implemented on 22 students. The research data were collected using instruments of validation, observation, questionnaires, and tests which were then analyzed descriptively and statistically. The results showed that the learning tools produced was valid in terms of content and construct, was practical based on the implementation of learning and student responses, and was effective in improving students' creative thinking skills. Research findings based on indicators of creative thinking skills such as fluency, flexibility, originality, and elaboration are also described in this paper.

1. Introduction

Higher order thinking skills have a lot of definition and thinking activities [1] which not only requires skills to remember, but also requires higher thinking skills [2]. Creative thinking skills have aspects such as fluency, flexibility, originality, and elaboration [3] Creative thinking skills have aspects such as fluency, flexibility, originality, and elaboration [4]. Creative thinking is a unique form of expression for a person [5] which leads to novelty, the ability to create something, apply new forms, generalize various skills, or create something new from something that already exists [6].

Some studies showed that students' creative thinking skills were still low [3] and showed a downward trend over time among American students of all ages [7]. Implementation of learning in schools that is not as expected [8] and the minimal use of innovative learning models [9] is alleged to be the cause of these problems. In line with that description, another studies showed that 57.8% of students' creative thinking skills fall into the poor category [10] and can't show a detailed flow of problem solving [11] because science learning in Indonesia is more focused on remembering science concepts [12]. Inquiry learning model is often applied to improve students' creative thinking skills [13,14].

Inquiry learning model can help students to practice in a team, develop competence in research, knowledge, motivation, writing skills, cooperative learning and social skills [15]. The inquiry learning model can facilitate students in learning activities by giving initial questions and leading to a

discussion [16]. It is further explained that the inquiry learning model emphasizes observation, questioning, evaluating information sources to determine what is known [17,18], planning investigations, conducting experiments [19,20], utilizing tools for data collection, analysis and interpreting data, formulating answers, elaborating, predicting, and communicating the results obtained [21] from learning activities.

Inquiry learning has three main characteristics such as (1) emphasizing the maximum student activity to seek and find, which means placing students as learning subjects, (2) all activities carried out by students are directed to seek and find their own answers to something being questioned, so that is expected to foster self-belief, and (3) develop the ability to think systematically, logically and critically, or develop intellectual abilities as part of the mental process. [22] and six steps i.e. (1) gain attention and explain the inquiry process, (2) present the inquiry problem or discrepant event, (3) have students formulate hypotheses to explain the problem or event, (4) encourage students to collect data to test the hypothesis, (5) formulate explanations and/or conclusions, and (6) reflect on the problem situation and the thinking processes used to inquire into it [21].

Based on the results of preliminary observations, it was found that several obstacles caused the weakness of students' creative thinking skills, including (1) readiness of learning devices, (2) weak emphasis on process aspects, and (3) lack of use of innovative learning models that demand student activity in learning, so that the development of student-centered interactive model-based learning tools is important. Several studies related to the development of inquiry learning tools in various science teaching materials showed positive results in an effort to improve students' scientific literacy [22, 23] and critical thinking skills [24, 16,25] but these studies did not look at aspects of creative thinking skills. Research related to the development of inquiry learning tools to teach creative thinking skills was delivered by Ningsih et al [26] who found that structured inquiry with brainstorming strategy learning tools proved valid, practical and effective in improving students' creative thinking skills. The research was conducted on elementary school students and did not explicitly explain the teaching material that was integrated into the developed tools.

This study aimed to develop physics learning tools on heat material based on inquiry learning model in the form of a syllabus, lesson plan, student activity sheets, student textbooks, and test instruments to improve high school students' creative thinking skills with fluency, flexibility, originality, and elaboration indicators. This research is important to do considering higher order thinking skills are the goal of education globally [27] and the importance of emphasizing process aspects in school science learning [19,28,29,30].

2. Method

This study is a developmental research that using Four D Models with the stages of define, design, develop and disseminate [31]. The study data obtained are data on the validity, practicality and effectiveness of physics learning tools based on inquiry that collected using validity instruments, observation sheets and response questionnaires (practicality), and creative thinking skills test instruments (effectiveness).

Learning tools in the form of syllabus, lesson plan, student activity sheets, student textbooks, and test instruments were first validated by 2 competent validators to assess the content and construct aspects of the learning tools developed. The assessment of the validity of the learning tools uses four rating scales, namely 1 = invalid, 2 = less valid, and 3 = valid, and 4 = very valid [32] which then converted into qualitative data on a scale of 4 based on the criteria in Table 1.

Table 1. Validity of learning tools

Score Interval	Category	Description
$3.7 \leq S \leq 4$	Very valid	Can be used without revision
$2.8 \leq S \leq 3.6$	Valid	Can be used with minor revisions
$1.9 \leq S \leq 2.7$	Less valid	Can be used with multiple revisions
$1 \leq S \leq 1.8$	Invalid	Not yet usable and still requires consultation

The practicality of the learning tools is determined by observing the implementation of the lesson plan by 2 observers at each meeting. Observation data on the implementation of learning obtained are in the form of scores ranging from 1 to 4, with categories 1 = not good, 2 = good enough, 3 = good, and 4 = very good, which are then interpreted in the form of scores in Table 2.

Table 2. Scoring Criteria

Score interval	Percentage (%)	Category
1 – 1.5	0 - 50	Not good
1.6 – 2.5	50 - <65	Good enough
2.6 – 3.5	65 - < 85	Good
3.6 – 4	85 - 100	Very good

Student responses after learning are also a component of the practicality assessment of the learning tools developed. Students give responses after learning by choosing statements objectively consisting of 2 categories (yes and no). The percentage of student responses was then converted based on the criteria (1) 0% - 20% = very weak, (2) 21% - 40% = weak, (3) 41% - 60% = sufficient, (4) 61% - 80% = strong, and (5) 81% - 100% = very strong [33]. The reliability of the learning tools assessment is determined using the equation: *percentage of agreement= 100 [1-(A-B)/(A+B)]* [34].

This study was conducted on 22 students in one of the senior high schools in central Lombok who were observed in the pre-test stage (O_1) which was then followed by particular treatment (X) and *post-test* (O_2) [35]. Students' creative thinking skills are measured using a test instrument that refers to the Guilford and Hoepfner [36] creative thinking test. Students are declared creative if the creative thinking test score is $\geq$ 61.2% [37]. The analysis of the improvement of students' creative thinking skills was carried out by using paired sample tests on pre-test and post-test data with the help of SPSS 17 for windows software and equations: score = (obtained score/maximum score) x 100% which are further categorized based on the criteria in Table 3.

Table 3. Criteria for creative thinking skills

Interval	Category
81.00% - 100%	Very creative
65.00 % - 80.99%	Creative
41.00% - 64.99%	Less creative
0.00% - 40.99 %	Not creative

3. Result and Discussion

3.1. Learning tools validity

Physics learning tools based on inquiry model in the form of a syllabus, lesson plan, student activity sheets, student textbooks, and test instruments are validated before being implemented. The results of the validation of the learning tools developed are presented briefly in Table 4.

Table 4. Validity of learning tools

No	Item	Validity	Category	Reliability	Category
1	Syllabus	3.51	Valid	0.94	Reliable
2	Lesson plan	3.44		0.96	
3	Student worksheet	3.60		0.98	
4	Textbook	3.36		0.95	
5	Test instrument	3.50		0.98	

Table 4 shows that the learning tools developed are declared valid and reliable to be implemented to students to learn creative thinking skills. The learning model that is integrated in the developed tools is an inquiry learning model that emphasizes scientific activity [18] so that it helps students have the ability to see problems from various points of view and be able to generate many ideas [38].

3.2. Learning tools practicality

The learning tools developed were also stated to be practical to improve students' creative thinking skills based on the results of the analysis of the implementation of learning for three meetings. The results showed that the overall implementation of learning activities was categorized as very good (score: 3.62) and reliable (reliability: 0.99). The results of the analysis of student responses to inquiry learning and learning tools showed a positive response (94%) further strengthening the practicality of learning tools developed in improving students' creative thinking skills. Inquiry learning models that emphasize the presentation of scientific problems, formulate and test hypotheses, conclude, and reflect on the knowledge they have [18] can encourage students to be creative in solving problems at hand [39].

3.3. Learning tools effectiveness

The creative thinking test instrument developed is open-ended, which is a type of question that has many possible correct answers. The open-ended test instrument can help increase creativity by generating various ideas, and students can solve problems independently in the future [40][41]. The measured creative thinking skills are fluency, flexibility, originality & elaboration. The results showed that the percentage of students' creative thinking skills was categorized as less creative (46.1%) before learning and in the creative category (72%) after learning using inquiry-based physics learning tools developed. The results of the analysis of the normality test and paired sample test of students' critical thinking skills are in Table 5 and Table 6.

Table 5. Data normality of students' creative thinking skills

Item	N	Creative thinking skills			
		Asymp. Sig. (2-tailed)			
		Fluency	Flexibility	Originality	Elaboration
Pre-test post-test	22	.391	.491	.161	.054

Table 6. The results of the paired sample test of students' creative thinking skills

Pair	Indicators	Test	N	Mean	SD	p
Pair 1	Fluency	Pre-test	22	1.9545	.65300	.001
		Post-test		3.2273	.68534	
Pair 2	Flexibility	Pre-test		2.5227	.39271	
		Post-test		3.5455	.34188	
Pair 3	Originality	Pre-test		1.9091	.61016	
		Post-test		3.1818	.58849	
Pair 4	Elaboration	Pre-test		2.1818	.36337	
		Post-test		3.4773	.49946	

Table 5 shows that the significance of all indicators of students' creative thinking skills is> 0.05, so it can be stated that the pre-test and post-test data of students' creative thinking skills are normally distributed. Table 6 shows that the increase in students' creative thinking skills after learning was statistically also stated to have a positive and significant impact ($p < 0.05$).

The physics learning tool based on inquiry model developed emphasizes student activities in breaking down problems into simple parts so as to allow students to formulate as many hypotheses as possible. This statement is in accordance with the nature of creative thinking skills, which is the ability to unravel problems to enable students to develop various solutions [42].

4. Conclusion

Based on the results of the study, it can be concluded that physics learning tools based on inquiry are valid, practical and effective to improve high school students' creative thinking skills on heat material. The results showed that students needed to be given more contextualization of teaching material with daily life to make it easier for students to relate their initial knowledge to the new knowledge being taught. Further research using different teaching materials and research sites is also important in the future.

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