



## Development of Assessment Instrument for Steam-Based Thematic Learning to Measure the Critical and Creative Thinking Skills of Students in Elementary Schools

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Article history:

Received October 14, 2022; Accepted: November 30, 2022; Displayed Online: December 07, 2022; Published: December 30, 2022

### Keywords

### Abstract

*Critical Thinking;*  
*Creative Thinking;*  
*Assessment;*  
*Thematic Learning;*  
*STEAM;*

The problem in this study is the need for educators to assess critical and creative thinking instruments in STEAM-based thematic learning. This study aims to produce critical and creative thinking assessment instruments in STEAM-based thematic learning. The type of this research was Research and Development (R&D) with a sample of 69 elementary students. Testing the feasibility of the instruments developed in this study used validity tests, reliability tests, differential power tests and difficulty level tests. The instruments developed were 12 critical thinking skills instruments and 12 creative thinking ability instruments. The results of the product feasibility test obtained 11 critical thinking instruments and 10 creative thinking instruments which are valid, reliable, have differential power and an appropriate level of difficulty.

### 1. Introduction

The ability to think critically and creatively is needed to live in this fluctuating or ever-changing world (Tsai, 2013). The development of the 21st century demands creative people who continue to work critically and creatively for the nation's progress. Critical and creative thinking contributes to building a sustainable future (Baharin et al., 2018). Critical and creative thinking skills are high-order thinking skills needed in the 21st century (Ataizi & Donmez, 2014; Nilsson & Gro, 2015). This ability is related to logical, rational, and reflective thinking skills and the mental process of systematically

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analyzing or evaluating information to decide exactly what action to take and believe. Someone has a different way of thinking and ideas in making something new and different from others.

The Science, Technology, Engineering, Arts, Mathematics (STEAM) approach is a learning approach that integrates five fields of knowledge, namely science, technology, engineering, art, and mathematics. STEAM is a development of the STEM approach by adding art to the learning process. STEAM-charged learning is expected to adapt students to the needs of the times, foster scientific investigation skills and problem-solving abilities, and build awareness of the importance of STEAM literacy. To welcome the industrial revolution 4.0, as quoted from Kompas.com, "Increasingly rapid technological changes marked the era of the Industrial Revolution 4.0. The STEAM approach is one of the essential keys to the world of education facing the Industrial Revolution 4.0 era. STEAM can encourage the development of science, technology, engineering, art, and mathematics to be more creative (Kurniadi, 2009)(Putra & Putri, 2021).

The ability to think creatively and critically is an aspect that students need to have because in an increasingly developing digital era. This is in line with the competency demands that students must possess in the 21st century. Thus, measuring students' critical and creative thinking abilities are essential. Educators are the only subject that can help develop and enhance these critical and creative thinking skills line with (Wartono et al., 2018), state that the role of the teacher in creating critical and creative thinking in students is felt to be very necessary. Critical thinking and creative thinking are essential abilities in education, so they need to be developed in students.

But the fact is that some educators still need to use appropriate assessment instruments to measure the development of critical and creative thinking skills. The results of the pre-research need analysis through a questionnaire distributed via Google form on June 24, 2022, with the target of 10 grade V educators at SD Gugus Budi Utomo, Metro Selatan District, Metro City. Meanwhile, all ten educators have implemented the 2013 Curriculum in the learning process. Then out of 10 educators, as much as 40% needed help understanding the assessment instrument. Furthermore, of 10 educators, 50% had not made an assessment instrument grid, and of 10 educators, 30% had yet to apply the STEAM approach to thematic learning. Then of 10 educators, 70% had yet to make an assessment instrument on STEAM-based education to measure critical thinking skills. Of 10 educators, 80% still needed to make an assessment instrument on STEAM-based learning to measure creative thinking skills.

Based on interviews with 10 grade V educators at Gugus Budi Utomo Elementary School on June 24, 2022, information was obtained that several educators had used the STEAM approach in the learning process in class. Some educators still need to develop assessments to measure critical and creative thinking abilities; some are constrained by the limited examples of critical thinking and innovative thinking assessment instruments in STEAM-based thematic learning. Based on the results of interviews with the principal, it was found that the principal supports educators in innovating or updating terms of assessment instruments. Educators are expected to develop assessment instruments to measure critical thinking skills and creative thinking so that they can be used to measure STEAM-based learning. Teaching educators only require students to memorize all information neglected by educators. The assessment process so far has only emphasized mastery of concepts (knowledge) captured by objective and subjective paper and pencil tests as measuring tools and has not yet referred to abilities. Higher-order thinking includes the ability to think critically and think creatively. Based on the background of the problems described above, the researcher conducted a development study entitled "Development of Assessment Instruments in STEAM-Based Thematic Learning to Measure Critical and Creative Thinking Skills in Elementary Schools." The research focus includes; describing and analyzing Assessment Instruments on STEAM-Based Thematic Learning that are feasible for Measuring Critical Thinking Ability in Elementary Schools and describing and

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analyzing developing Assessment Instruments on STEAM-Based Thematic Learning that are feasible for Measuring Creative Thinking Ability in Elementary Schools.

## 2. Materials and Methods

This research is research and development or Research and Development (R&D) (Sugiyono, 2018) explains that R&D is a research method used to produce specific products and test the effectiveness of certain products (Suharsimi, 2008). This is done by the author's research, namely developing a product in the form of an instrument. This study aims to produce a product as an assessment instrument that will be applied to thematic learning in class V of elementary school. The resulting product is tested for validation by experts for validity and reliability. Products developed are validated before being tested in the field. The product is then revised to produce a quality and effective product. The modified final product can be disseminated and implemented. By the R&D research steps there are ten steps for implementing development research. The authors applied seven research steps for operational product revision: research and information collecting.

The reason the author only does these seven steps is because of the limitations of the author. The steps taken are as follows; (a) preliminary research and data collection; (b) planning; (c) product draft development, (e) instrument validation; (f) Initial Field Trials; (g) primary product test, and (h) Product Improvement Results. Product trial subjects in this study were expert validation, including material experts, evaluation experts, and linguists. The object of this development research is an assessment instrument in STEAM-based thematic learning to measure elementary school students' critical and creative thinking skills. The population in this study were Class V students at SD Gugus Budi Utomo, Metro Selatan District, for the 2022/2023 academic year, and the sample in this study were all Class V students at SD Gugus Budi Utomo for the 2022/2023 academic year. The data collection technique in this study is a test technique, non-test technique. Data Analysis Techniques include the Expert Validity Test; Evaluation expert validation; linguist validation; test of the validity of the Questionnaire test the reliability of the Questionnaire questions, Analysis of the Difficulty Level of the Questions; and analysis of the discriminating power of questions.

## 3. Results and Discussions

### *Assessment Instruments on STEAM-Based Thematic Learning that are feasible for Measuring Critical Thinking Ability in Elementary Schools*

The results showed that the Assessment Instrument developed was valid for measuring critical and creative thinking skills used in class V thematic learning Theme 2 Clean Air for Health Sub-theme 1 How the Body Processes Clean Air. The feasibility test of the Assessment instrument product was carried out by three validators consisting of 1 material validator, one evaluation validator, and one language validator. In the material expert validation, scores were obtained from the aspects of (1) Conformity of questions with critical thinking indicators, (2) Conformity of questions with creative thinking indicators, (3) Construction, (4) Content/substance suitability, (5) Answer key suitability. is 74 out of a maximum score of 84 with a resulting value of 88.09 included in the "Very valid" category. On the evaluation expert validation. Scores obtained on aspects (1) sentence formulation in the form of interrogative sentences or commands that demand unraveled answers (2) There are clear instructions on how to work on solving problems. (3) There are scoring guidelines (4) Tables, graphs,

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diagrams, cases, or the like (the explanation is clear or there is a connection with the problem being asked), (5) The items do not depend on the previous items. It is 19 out of a maximum score of 20, with a resulting value of 90 included in the "very valid" category. While the results of the validation by linguists, the score obtained in aspects (1) Straightforward, (2) Communicative, (3) Writing, (4) Use of terms, symbols, or icons is 50 out of a maximum score of 52 with a resulting value of 96.15 included in the category "very valid" After conducting validation tests by experts and practitioners, researchers revised the product based on the suggestions and input provided. Furthermore, the main product trial phase involved 89 students at Gugus Budi Utomo Elementary School, Metro Selatan District.

### *Development of Critical and Creative Thinking Assessment Instruments*

The research results show that in the validity test stage, the reliability of the differential power and the level of difficulty. The effects of 10 critical thinking questions that have been tested are valid, reliable, discriminatory, and level of difficulty. Ten essential thinking questions have been tested for good, reliable, discriminating power and difficulty level. Furthermore, this instrument can measure creative and critical thinking skills in STEAM-based thematic learning in class V SD Gugus Budi Utomo. According to (Popham, 1995), "Educational assessment is a formal attempt to determine student status concerning educational variables of interest." The assessment also has specific terminology to describe all the activities carried out by the teacher to obtain information about students' knowledge, skills, and attitudes. According to (Purnomo, 2016), assessment in learning is an activity to get various information on an ongoing and comprehensive basis about the process and learning outcomes during and after participating in education.

### *Instrument Validity Test*

At this stage of development, the critical and creative thinking instruments, each of which totaled 12 essential instruments of thinking and 12 innovative thinking instruments, were tested for validity by material, language, and evaluation experts. The next step was to test the validity of the instruments using the Pearson product-moment correlation. At this stage, critical thinking instruments are valid on points no, 1,2,3,4,5,6,7,8,9,10, and creative thinking instruments are valid on issues no 1,2,3,4,5,6; 7,8,9,10,11 good item items can be said to be valid because count > table with  $\alpha = 0.05$  valid item items are not necessarily reliable. Therefore the next stage is the reliability test.

### *Instrument Reliability Test*

The instrument reliability test was carried out to test whether the instrument was reliable; a reliable instrument is an instrument that, if tested repeatedly, will get the same results. The items were tested using Cronbach's alpha reliability in this reliability test. Invalid mechanisms are not tested for reliability. The items tested on the critical thinking instrument are ten questions with a count of 0.630, meaning that the device is included in the strong reliability level with an interval of 0.60-0.79. In the valuable creative thinking instrument items, there are 12 questions; the instrument

is then tested for reliability with an account of 0.683 in the strong reliability level with an interval of 0.60-0.79.

#### *Power Difference Test*

The discriminating power of the items can distinguish between the upper students, the group of test takers with high abilities, and the lower group, namely the group of participants who have soft skills. Discriminating power is calculated based on dividing the group into two parts, namely the upper group and the lower group. The division of this group can be done by various methods depending on the needs. At this stage the differentiating power of the critical thinking instrument totaling ten items resulted in 3 questions in the "outstanding" category, 4 questions in the "good" category, 3 questions in the "enough" category. In the creative thinking questions, which totaled 11 items, the results were 4 questions in the "outstanding" category, 4 questions in the "good" category, 3 questions in enough category.

Table 1 Recapitulation of Difference Power Test Results

No Question	Critical Thinking Ability Instrument		Creative Thinking Ability Instrument	
	Difference Power	Category	Difference Power	Category
1	0,444	Very good	0,449	Very good
2	0,232	Enough	0,253	Enough
3	0,401	Very good	0,406	Very good
4	0,339	Well	0,265	Well
5	0,232	Enough	0,245	Enough
6	0,288	Enough	0,357	Enough
7	0,359	Well	0,422	Well
8	0,391	Very good	0,449	Very good
9	0,345	Well	0,406	Well
10	0,377	Well	0,383	Well
11	-	-	-	-
12	-	-	0,400	Very good

#### *Difficulty Level Test*

The difficulty level test is used to see how difficult the item is. At this stage, the critical thinking items get ten results in the "moderate" category. For creative thinking questions, there are 11 questions in the medium category and 1 in the "easy category

Table 2. Recap of Difficulty Level Test Results

No Question	Critical Thinking Ability Instrument	Creative Thinking Ability Instrument
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	Difficulty Level	Category	Difficulty Level	Category
1	0,656	Currently	0,656	Currently
2	0,670	Currently	0,670	Currently
3	0,616	Currently	0,616	Currently
4	0,685	Currently	0,685	Currently
5	0,587	Currently	0,587	Currently
6	0,638	Currently	0,638	Currently
7	0,620	Currently	0,620	Currently
8	0,649	Currently	0,649	Currently
9	0,649	Currently	0,649	Currently
10	0,594	Currently	0,594	Currently
11	-	-	-	-
12	-	-	0,717	Easy

#### *Limitations of Research and Development of Critical and Creative Thinking Ability Assessment Instruments*

Creative thinking indicators are used to measure students' creative thinking abilities. According to (Rahayu & Yulianti, 2011), the ability to think creatively has five aspects: thinking fluently, thinking flexibly, originality, elaboration, and evaluation. Creative thinking is the activity of thinking to produce something creative and original. According to (Abidin, 2016), as a reference in compiling innovative thinking assessment instruments. The following are the steps for developing creative thinking instruments; (a) determine standards. Assessment standards are obtained from the competencies contained in the curriculum, (b) determine the construct. The type of construct measured is creative thinking, (c) determining authentic tasks that students will and must do, and (d) developing assessment criteria. This step combines original assignments that students must do with the creative domain and (e) compiles an assessment rubric.

Based on the research results, the development of critical and creative thinking assessment instruments has several limitations, namely as follows;

- a. This development research only covers one sub-theme of the three sub-themes in theme 2.
- b. This research and development only reached the seventh stage of the ten steps of Borg & Gall's research and development.
- c. The population in this study was only focused on class IV students of the Budi Utomo Cluster, Metro Selatan District.
- d. The tests carried out in this study only included validity, reliability, discriminatory power, and difficulty level tests as a condition for a good instrument.

#### **4. Conclusion**

The following results are obtained based on the research and development data analysis: an Appropriate STEAM-Based Thematic Learning Assessment Instrument for Measuring Critical Thinking Ability in Elementary Schools; An Appropriate STEAM-Based Thematic Assessment Instrument for Measuring Creative Thinking Skills in Elementary Schools. Based on the conclusions above, suggestions that can be submitted are as follows; Educators Can be input and insight in

carrying out learning, especially in developing instruments for STEAM-based thematic learning. Student Instruments can be used for students' creative and critical thinking skills in Elementary School Principals; they can be an input for schools to develop assessment instruments to improve students' creative and critical thinking skills.

**Acknowledgments:** This is a self-funding research. An appreciation is given to the reviewers of the TIJOSSW publisher who have spent more time making valuable corrections dealing with technical writing styles or ideas about this writing.

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