

DEVELOPMENT ANALYSIS OF CREATIVE THINKING TEST INSTRUMENTS ON NATURAL SCIENCE MATERIALS

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Abstract. Creativity is an important part of improving learning achievement and readiness to face the globalization era which requires innovation. The success of learning creativity can be assessed through an appropriate holistic assessment instrument that contains indicators of creative thinking. Based on that, the purpose of this study is to describe the development of creativity assessment instruments that have been carried out by previous researchers through journal literature sources. The research method uses a systematic literature review of 13 selected articles that meet the criteria for achieving the research objectives. From the analysis of the literature review, conclusions are drawn, 1) Creative thinking instruments have been developed through the 4D research model, ADDIE and Borg & Gall with their respective stages, 2) Aspects of creative thinking used in developing tests refer to Torrance's theory (fluency, flexibility, originality, and elaboration). 3) In the technique of making a creative thinking item that refers to Torrance's theory, these four indicators must simultaneously form the basis for making questions. This means that through one creative thinking question can measuring fluency, flexibility, originality, and detail of the answers given by the test takers, 4) Testing the feasibility of creative thinking instruments includes validity, reliability, practicality, effectiveness, and item analysis (distinguishing power and level of difficulty).

Keywords: *Test Instruments, Creative Thinking, Creativity, Systematic Literature Review*

INTRODUCTION

The 21st century is said to be the century of development of knowledge, economy, information technology, globalization and the industrial revolution 4.0. This century requires high quality human resources who have expertise, namely being able to work together, think at a high level, be creative, skilled, understand various cultures, have communication skills, and be able to learn for life (life long learning) (Wijaya et al., 2016). The needs of the 21st century in the context of curriculum, that educational institutions are oriented to create productive, creative, innovative, and effective generations through attitudes, abilities, and knowledge that are integrated with life skills (Andriani, 2016; Kabeel & Eisa, 2016; Taghva et al., 2014).

Education is an effort to provide knowledge, insight, skills, and expertise to students. The goals of education include creating a creative, competent and knowledgeable generation. Science and technology that continues to develop in the 21st century forces students to abandon their traditional ways of thinking. Students are expected to be

able to develop the ability to think creatively and innovatively.

Creative thinking is a thinking process that is capable of producing various ideas or ideas. Through creative thinking a person is able to analyze problems, generate new information and generate new ideas during the problem solving process (Nurjan, 2018; Astuti, 2017). A person who engages in creative endeavors does two basic things. The first is the effort to find ideas, plans or answers. Another thing is developing an implementation plan to prove and ensure that the idea is viable. By thinking creatively, individuals will not have limited thinking to find solutions and will not give up easily. Creative people are not afraid to face problems because they are able to solve problems with their creative power (Liberna, Nurfitriyanti & Agustini, 2022). There is a significant relationship between problem solving ability with students' creative thinking skills. They will affect learning outcomes and achievement of learning (Elvianasti & Dharma, 2021).

Creative thinking is a cognitive aspect to bring up and develop new ideas, new ideas as the development of previously born ideas and skills to solve problems in a

divergent manner (from various points of view) (Mardhiyana & Sejati, 2016). Creative thinking is needed to help students master data literacy and technology needed in learning in the industrial revolution 4.0 era (Anggereini, Budiarti & Sanjaya, 2018).

Creative thinking needs to be developed in students for several reasons, 1) By being creative, individuals can actualize themselves (Self Actualization). 2) The development of creativity in formal education has not been fully implemented, 3) Creativity can provide its own satisfaction because what is done is in accordance with the results of one's own thoughts and exploration, 4) Creativity is believed to be able to improve one's quality of life (Munandar, 2021). From the explanation above it can be seen that creativity has an important role in life, so that creativity needs to be developed, especially in the younger generation who carry out the ideals of being the nation's successor (Islami, Putri & Nurdwiandari, 2018).

Creativity is generally found as the ability to produce new things that are original, unique, and useful (Runco & Jaeger, 2012). Several literature reviews show that individual creativity can support academic achievement and innovative abilities (Gajda et al., 2017; Hammond et al., 2011). It is intended that creativity becomes an important part in improving learning achievement and readiness to face the times that require innovation. Creativity is one of the elements needed to actualize oneself by creating new works according to individual characteristics. This is referred to as the work of innovation resulting from individual self-actualization.

Classroom learning can be set up so that it can build and train students' creativity through contemporary learning models. Practicing creative thinking skills is very important to equip students to develop their abilities in solving problems and explaining phenomena that exist in everyday life (Maria et al., 2018). Learning content contains creative activities so that students get used to thinking and creating new things. The more creative educators are in managing learning will foster interest in learning which in turn can increase student learning achievement (Sari, Rasam & Karlina, 2022).

The success of learning creativity can be assessed through an appropriate holistic assessment instrument that contains indicators of creativity. Designing a good creativity assessment instrument is an important thing that needs to be understood. Such an assessment activity has the potential to determine the expected outcomes of creativity and identify factors that support the development of student creativity. Assessment instruments can also help develop a curriculum that describes the scope and sequence of creativity in a lesson so that educators and parents can better appreciate student creativity based on students' perspectives and experiences. More broadly, creativity assessment can improve students' creative control (McComas & Nouri, 2016).

In practice, creativity assessment faces challenges such as 1) there is a standardized scoring system that only assesses student knowledge, not assessing student creativity and 2) the use of inappropriate instruments with indicators that incorrectly assess forms of creativity (Long et al., 2022). Therefore, research on the development of creativity

instruments and the implementation of their assessment in learning continues to be carried out by researchers.

Based on the background of this problem, this article aims to describe the development of creativity assessment instruments that have been carried out by previous researchers through journal literature sources. The focus of the review is the research model, creativity indicators and feasibility tests that have been carried out so that it can be analyzed and summarized how the development of creativity assessment in learning.

RESEARCH METHODS

Literature review in this study used a qualitative approach with the type of systematic literature review or systematic literature review. The activities carried out in the systematic literature review are 1) Determine research questions, namely how to develop creative thinking instruments in natural science material that have been published in journal articles starting in 2018-2022. 2) Search articles using Mendeley with keywords according to research questions 3) Identify literature and select literature as research subjects. This selection is adjusted to indicators, namely articles that contain procedures for developing creativity assessments, creative thinking indicators and instrument feasibility testing carried out. From the identification results,

At the article search and identification stage, the researcher used the keyword "Developing Creative Thinking Instruments on Science Learning" and found that 138 articles using these keywords. From these 138 articles, the researcher identified and determined 13 articles that met the criteria. The criteria taken by the researchers were articles containing the development model used, creative thinking indicators, and instrument feasibility tests carried out and articles published in the 2018-2022 range.

The procedure for searching and selecting articles in this study used Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The procedure for searching and selecting articles can be seen in the following scheme:

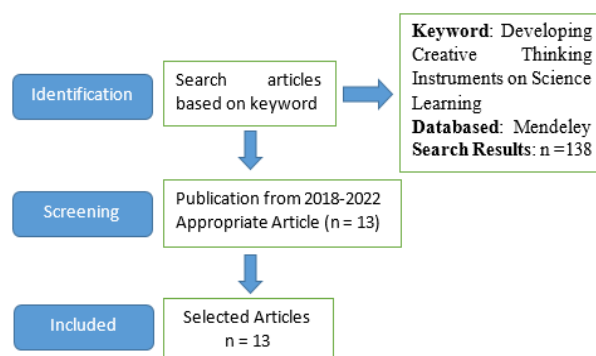


Figure 1. PRISMA Flowchart

RESULTS AND DISCUSSION

In order to be able to analyze and describe the development of creativity assessment instruments in learning, the selected article data is summarized in several metadata tables according to the variables analyzed. Table

1 shows a summary of the stages of developing creative thinking instruments.

Table 1. Development Stages

Article	Development Stages
Amrina et al., (2018); Rizkiyah, Miarsyah & Ristanto (2021); Radiah (2020); Rahayu, Haryani, & Dewi (2019); Setyawan & Siswono (2020); Siburian et al., (2019); Fauziah et al., (2021)	4D (Define, Design, Development and Dissemination)
Almuharoma & Mayasari (2019), Pradipta, Sariyasa, & Lasmawan. (2020), Yulianti & Alimah (2021)	ADDIE (Analysis or analysis, Design or design, Development or development, Implementation or application, and Evaluation or evaluation).
Dewi, Erna, & Rasmiwetti (2020); Tanjung & Nasution (2022)	The Borg and Gall model includes 10 stages.
Trimawati, Kirana, & Raharjo (2020)	Model Dick & Carey

In developing the instrument, it is necessary to take systematic steps so that the developed instrument can accurately assess creativity and is believed to give results that are in accordance with what is being assessed. Instrument development can be done with various development models. Based on Table 1, the development of creativity assessment instruments has been carried out through the 4D stage model, ADDIE, Borg & Gall and Dick & Carey with the proportion of 4D being more widely used. There is one reason 4D is widely used by researchers from this literature source because 4D has more detailed and more concise stages. This was reinforced by (Setyawan & Siswono, 2020; Faresta et al., 2020 & Radiah, 2020) who said that 4D was the choice of instrument development model because it was easier to understand and implement.

From the analysis of each of these models, all of them show the same technical stages, namely 1) Conducting an instrument needs analysis and setting objectives and question indicators, 2) Creating an instrument development framework, 3) Making an instrument grid, 4) Arranging item items based on indicators, 5) Make assessment guidelines/scoring rubrics, 6) Prepare test instruments, 7) Perform instrument feasibility tests, 8) Perform readability tests or user responses to the developed instruments, 9) Revision and evaluation. This technique corresponds to the stages of developing test instruments in general, namely determining the purpose of preparing the instrument, looking for relevant theory or scope of material, compiling instrument item indicators, compiling instrument points,

content validation, revision, conducting tests on respondents to obtain response data, perform an analysis (reliability, level of difficulty, and differentiating power), and assemble the instrument (Retnawati, 2016). An important part of test instrument development is the creation of instrument grids. The instrument grid is an outline design of the developed grids. The instrument grid is an outline design of the developed grids (Tanjung & Bakar, 2019).

All the technical stages are summarized in each model step. However, there are differences in the position of implementation, for example the feasibility testing and legibility of instrument products is carried out at the Development stage in 4D (Amrina et al., 2018; Rahayu, Haryani, & Dewi, 2019). Meanwhile, in the ADDIE model, the instrument product legibility test is carried out at the implementation stage. Another difference is in evaluation activities, of the four models of instrument development, only the ADDIE model conducts evaluations at all stages so that researchers can correct deficiencies or mistakes made before proceeding to other stages. This makes the ADDIE model more capable of controlling all possible errors that researchers can make.

From literature sources it is known that creative thinking instruments have been developed for natural science materials such as Work and Energy, reaction rates, the Human Excretory System, and Science materials for the Elementary School level. Based on this, the development of creative thinking instruments has the opportunity to be carried out on other natural science materials.

In developing test instruments, the suitability of the item items with the indicators achieved is an important thing for researchers to do. The creativity assessment instrument is prepared based on creative thinking indicators. Several researchers have developed creativity tests based on the theoretical indicators of Guilford, Wallach, Kogan, Torrance and SCSM (Scientific Creativity Structure Model) (Sani, 2019). However, Torrance's indicator is the most commonly used in developing creativity test instruments.

Table 2 summarizes the creative thinking indicators used by researchers from study article sources.

Table 2. Indicators of Creative Thinking Used

Article	Indicator
Almuharoma & Mayasari (2019); Faresta et al., (2020); Rizkiyah, Miarsyah & Ristanto (2021); Pradipta, Sariyasa & Lasmawan (2020); Radiah (2020); Rahayu, Haryani & Dewi (2019); Setyawan & Siswono (2020); Trimawati, Kirana, & Raharjo (2020); Tanjung&Nasution (2022)	Torrance theory indicators (fluency, flexibility, elaboration, and originality)
Amrina et al., (2018); Dewi, Erna, & Rasmiwetti (2020)	Guilford theory indicators (fluency, flexibility, and elaboration)

Siburian et al., (2019); Creative thinking indicator
Yulianti & Alimah
(2021)

Based on Table 2, the most widely used indicators of creative thinking refer to Torrance's theory (1990). Torrance proposed a creativity test called the Test of Creative Thinking (TTCT) divided into two types, namely verbal TTCT and figural TTCT. Verbal TTCT includes indicators of fluency, flexibility of thinking and originality of ideas. Meanwhile, figural TTCT is added with elaboration, namely the smoothness of the ideas being developed (elaboration). The Torrance test can be in the form of image creations or sentence descriptions (Sani, 2019).

The Torrance test itself is based on Guilford's theory of measuring divergent thinking skills (Sani, 2019) so that there are researchers who use Guilford's indicators with three aspects, namely fluency, flexibility and elaboration (Dewi, Erna, & Rasmiwetti, 2020). The selection of indicators in developing a creative thinking test instrument is adjusted to the purpose of developing the instrument itself.

Torrance's creative thinking indicators are used as a basis for researchers in making questions that can measure the level of creativity of students (Almuharoma & Mayasari, 2019; Faresta et al., 2020; Fauziah et al., 2021; Pradipta, Sariyasa, & Lasmawan, 2020; Radiah, 2020; Rahayu, Haryani & Dewi, 2019; Setyawan & Siswono, 2020; Trimawati, Kirana, & Raharjo, 2020; Tanjung & Nasution, 2022). A summary of Torrance's aspects and indicators is presented in Table 3.

Table 3. Indicators of Torrance's Creative Thinking

Aspect	Indicator
Fluency	- Generate answers quickly and smoothly - Generate alternative answers quickly - The number of original answers generated
Originality	- Produce answers that are rarely given by most people (own work) - Combine parts/elements to get a unique answer - Focus on the novelty of ideas
Flexibility	Able to generate various kinds of answers with different approaches
Elaboration	Produce more detailed answers so can enrich the answers

In the technique of making a creative thinking item that refers to Torrance's theory, these four indicators must simultaneously form the basis for making questions. This means that through one creative thinking question can measuring fluency, flexibility, originality, and detail of the answers given by the test takers. If one item uses one indicator, then there must be a balance in the number of questions made in one set of test instruments in order to produce a final assessment decision that represents the four

indicators of creative thinking. Questions were feasible and met criteria for creative thinking skills with Torrance theory must use four indicators together (Tanjung & Nasution, 2022)

The suitability of the test instrument with the indicators is one aspect of testing the feasibility of the instrument. According to Brown & Abeywickrama (2010), good instrument quality is seen from practicality, reliability, validity, authenticity and positive washback. More specifically, a good instrument has valid and reliable characteristics and goes through the process of analyzing the items, namely the level of difficulty, discrimination and deceptive effects (Tanjung & Dwiana, 2019).

Based on the results of the analysis of the article review, the instrument feasibility testing carried out at least included validity and reliability. Validity is divided into content validity, criterion validity and construct validity (Huck, 2012). The type of validity testing carried out on literature sources is content validity by: 1) Processing of Lawshe's Content Validity Ratio (CVR) technique (1975) in the research of Almuharoma & Mayasari (2019), Pradipta, Sariyasa & Lasmawan (2020) and Tanjung & Nasution (2022), 2) Aiken's formulation in the research of Faresta et al., (2020) and Dewi, Erna, & Rasmiwetti (2020). 3) Standard validation analysis with validation scoring (Riduwan, 2013; Arikunto, 2010; Ratumanan & Laurens, 2006) in research by Yulianti & Alimah (2021), Siburian et al., (2019) and Fauziah et al., (2021) 4) Does not specifically explain the validation technique carried out in the research by Radiah (2020), Trimawati, Tjandrakirana & Raharjo, (2020), Rahayu, Haryani & Dewi (2019) and Amrina et al., (2018). The results of content validity based on the assessment of the expert validator include aspects of content, language, graphics, construction.

There are researchers who add to the testing aspect by analyzing the items, namely discriminating power and level of difficulty (Almuharoma & Mayasari, 2019; Dewi, Erna, & Rasmiwetti, 2020; Yulianti & Alimah, 2021). An analysis of the effect of the detractor was not carried out because the type of test developed was in the form of an essay test. If the type of test being developed is in the form of multiple choice, it is necessary to analyze the distractor effect of the answer choices provided by the questions.

Testing the practicality and effectiveness of creative instruments is also carried out by instrument developers (Rahayu, Haryani & Dewi, 2019; Setyawan & Siswono, 2020; Trimawati, Kirana, & Raharjo, 2020;). Effectiveness is done by giving creative tests to respondents and seeing the results obtained. If the respondent shows achievement above 50% for all indicators, it can be said that the developed test instrument is effectively used as an assessment tool for creative thinking (Rahayu, Haryani & Dewi, 2019). Meanwhile, practicality was measured using a response scale from respondents regarding whether the instrument had work instructions, whether the instrument was practical to use and did not make it difficult for the test takers. It should be considered that for a creative thinking test instrument there must be clear work instructions so that test takers can fully unleash their creativity. That is, the test instructions contain clear information about what must be described if requested, the result is an image or what must be described if requested, the result is an explanatory

description. The rest are given the opportunity and freedom for test takers to explore their own answers or ideas according to their creativity.

Based on the review, it is known that no one has carried out the authenticity and washback process on the creative instrument product being developed. Authenticity is related to the ability of the test instrument to measure all the real activities carried out by the test takers, while washback is related to the conditions that are positioned as the impact of the test's influence on the learning process (Asma et al., 2014). These findings can be an input for future researchers to carry out quality testing of instruments to authenticity and washback for whatever type of test instrument is developed.

The development of a creative thinking assessment instrument must be carried out according to procedures in order to produce an instrument that can truly measure the creativity of test takers. The creative thinking assessment instrument is not just an ordinary cognitive instrument, but more than that the instrument must be able to bring out the creativity of the test takers.

CONCLUSION

Based on the analysis of the literature review, conclusions are drawn, 1) Creative thinking instruments have been developed through the 4D, ADDIE and Borg & Gall research models with their respective stages, 2) Aspects of creative thinking used in developing the test refer to Torrance's theory (fluency, flexibility of thinking/flexibility, originality of ideas/originality and detailed thinking/elaboration). 3) In the technique of making a creative thinking item that refers to Torrance's theory, these four indicators must simultaneously form the basis for making questions. This means that through one creative thinking question, fluency, flexibility, authenticity and detail of the answers given by the test takers can be measured. 4) Testing the feasibility of creative thinking instruments includes validity, reliability, practicality.

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