Assessment of Creative Thinking in Cultural Context in Junior High School Students

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ABSTRACT

Creative thinking is an essential competence in mathematics learning because it enables students to generate diverse ideas, approach problems from multiple perspectives, and produce original solutions. However, in the Indonesian educational context, students' creative thinking skills remain low, and current assessment tools have not adequately measured all dimensions of creativity namely fluency, flexibility, and originality. This study aims to fill this gap by developing and validating a culturally contextualized open-ended assessment instrument designed to measure students' creative thinking skills comprehensively. Using a research and development (R&D) approach, the instrument was tested with 28 ninth grade students from a junior high school in Malang City. The instrument's construct validity was examined through Exploratory Factor Analysis (EFA), and its internal consistency was tested using Cronbach's Alpha. The findings indicate that the instrument demonstrates good reliability and a clear three factor structure aligning with theoretical dimensions of creative thinking. These results suggest that the developed assessment can effectively capture students' creative potential within culturally relevant mathematical contexts. The study contributes to educational assessment practices by providing a valid and reliable tool that promotes culturally responsive approaches to fostering creative thinking in mathematics learning.

Keywords: assessment; creative thinking; cultural context

INTRODUCTION

Creative thinking plays a crucial role in mathematics learning and problem-solving because it fosters students' ability to generate new ideas and explore problems from multiple perspectives (Hadar & Tirosh, 2019; Manurung et al., 2020). In the 21st century, creative thinking is increasingly regarded as a core competency that enables learners to respond adaptively to complex, real life problems (Sa'dijah et al., 2019). In Indonesia, the national curriculum emphasizes creative and critical thinking as essential elements of Profil Pelajar Pancasila, aiming to produce students who are innovative and culturally grounded. Despite these efforts, empirical findings reveal that students' creative thinking skills remain low. Saputri & Larasati (2023)reported that students' scores on creative thinking indicators did not reach the Minimum Completeness Criteria (KKM). Similarly, the 2022 PISA results showed a decline in Indonesian students' average mathematics performance, suggesting weaknesses in their higher-order thinking, including creative thinking. These findings indicate that creative thinking has not yet become a learning priority in mathematics classrooms, leaving students less accustomed to thinking fluently, flexibly, and originally when solving problems.

Theoretically, creative thinking consists of several dimensions: fluency, flexibility, and originality (Aries et al., 2024). Fluency refers to the ability to generate multiple relevant

ideas, flexibility represents the capacity to shift between different strategies or perspectives, and originality concerns the production of unique and uncommon solutions. When these three aspects operate together, they form a comprehensive foundation for assessing creative potential. In mathematics learning, developing these skills allows students to think divergently and apply knowledge in innovative ways (Kowkas et al., 2025). Therefore, any assessment of creative thinking should comprehensively represent all three dimensions, rather than focusing solely on quantitative outcomes or procedural accuracy.

Assessment instruments serve a crucial role in identifying and nurturing students' creative thinking abilities (Siahaan et al., 2022). However, current instruments remain limited in scope and rarely used in regular classroom assessment. Most existing tools focus on closed-ended questions that restrict divergent responses, and only a few have undergone rigorous psychometric validation. This creates a significant gap between the theoretical understanding of creativity and its practical measurement in schools. Moreover, many available instruments lack evidence of validity and reliability, which can lead to misinterpretations of students' creative capacities (Long & Wang, 2022). Previous research has also tended to overlook the influence of cultural context on students' creative expression, even though culture shapes how learners perceive and solve problems (Mahama, 2024). Hence, there is an urgent need to design an assessment tool that not only meets psychometric standards but also incorporates cultural relevance to make learning more meaningful.

To address this gap, the present study focuses on developing a creative thinking assessment instrument that is open ended and integrated with the cultural context. Open ended questions are chosen because they allow students to express creative ideas freely without being constrained by single correct answers (Rahayuningsih et al., 2021). Such questions enable richer demonstrations of fluency, flexibility, and originality. Integrating cultural contexts further enhances authenticity by connecting mathematical problems to students' lived experiences. Studies Anwar et al., (2024)have shown that contextualized cultural learning stimulates higher levels of creativity and engagement. Likewise, Sa'dijah et al., (2024) found that culturally integrated mathematics problems encourage students to think creatively through familiar local values. Thus, incorporating cultural context is not only pedagogically relevant but also theoretically justified in promoting creative thinking.

The development process in this study applies construct validation through Exploratory Factor Analysis (EFA) to identify underlying structures of the developed items. EFA allows researchers to empirically verify whether the constructs of fluency, flexibility, and originality are represented as expected. In addition, the reliability of the instrument is tested using Cronbach's Alpha to ensure internal consistency across items (Saputri & Larasati, 2023). These steps are crucial in ensuring that the instrument functions consistently and measures creative thinking accurately.

Based on the gaps identified above, the research problem addressed in this study is "How can a culturally contextualized, openended assessment instrument be developed and validated to measure students' creative thinking skills in mathematics accurately and reliably?". This study is important because it aligns with current educational reforms in Indonesia that promote higher order thinking, contextual learning, and cultural responsiveness in the classroom. Therefore, the objective of this research is to develop, validate, and test the reliability of a culturally integrated open ended creative thinking

assessment instrument measuring fluency, flexibility, and originality. The novelty of this study lies in combining cultural contextualization with psychometrically tested open ended tasks, offering both theoretical and practical contributions to creative thinking assessment and mathematics education.

RESEARCH METHODS

This study employed a quantitative research and development (R&D) design aimed at developing and validating a creative thinking assessment instrument in mathematics. The R&D process focused on testing the instrument's construct validity and reliability using an Exploratory Factor Analysis (EFA) approach. This design was chosen to produce an empirically validated measurement tool that can be applied in classroom contexts.

Participants

The study was conducted at a public junior high school in Malang City, Indonesia, during the 2024/2025 academic year. The participants consisted of 28 ninth grade students selected through purposive sampling, ensuring that participants had adequate prior knowledge of basic mathematics concepts and varying levels of creative thinking. Each participant was given 60 minutes to complete the instrument. Participation was voluntary and informed consent was obtained from students and teachers prior to data collection. The study adhered to ethical research standards, ensuring confidentiality, and anonymity of all participants' responses.

Instrument Development

The instrument in this study was used to measure the research variables. The instrument is well designed so that it can be used as a measuring instrument that is worthy of development. The development of the instruments used in this study is 10 items of creative thinking questions that contain components of creative thinking, namely fluency, flexibility, and originality. The fluency aspect is used to find out the ideas or answers put forward by students completely and correctly. Students demonstrate fluency in problem-solving when they can acquire multiple solutions. The flexibility aspect is used to know the various varied or different solutions that students produce correctly. The items used to illustrate this flexibility encourage to identify different strategies in the same portrait of the idea. Meanwhile, the originality aspect is used to identify the originality of ideas that students emerge from using their own language or are assessed as new ideas. Originality in problem-solving refers to the student's ability to build a problem that is different from others. The instrument developed in this study is presented in appendix 1.

Data Collection

In the development of this instrument, the data collection stage focuses on the validity of the experiment. This means that the instrument is directly tested on real respondents, then statistically analyzed to determine the validity of the construct. The researcher conducted a one-to-one trial to get feedback, suggestions and inputs, and confirmed that the items in this instrument are relevant and clear based on the measured construct. After revision, the instrument was tested to 30 students of the first secondary school with a time of 60 minutes individually.

Before conducting the test, the subject was given an explanation of the research conducted by the researcher. Researchers also provide information related to the purpose of the research, the voluntary nature of their involvement in the research, and also the confidentiality of their data. Next, the subject is asked to write his answer on the sheet that has been provided.

Data Analysis

In conducting data analysis, the researcher used a reability analysis approach and validity testing using Explanatory Factor Analysis (EFA). The stages will be described as follows:

Reliability Testing

In the first test stage, the researcher conducted a reliability test using Croncbach's alpha. The basis for decision-making in this test states that if Croncbach's alpha value > 0,60 is declared reliable or consistent. In this study, the reliability test result is 0.800, so this value is considered reliable or very good for exploratory studies.

Factor Analysis

These statistical tests are used to measure the validity of assessments and to ensure that the items contained provide accurate results.

1. The feasibility test of the data in this study used Kaiser Mayer Olkin (KMO) and Bartlett's Test of Sphericity. KMO is used to measure the adequacy of a sample for factor analysis. KMO decision-making with the provisions if (bad), (enough), (good), and (very good). Bartlett's Test of Sphericity was used to test whether the correlation matrix was significant for factor analysis. With the provision, if the significance value then the data can be used for EFA. $KMO < 0.5$ $0.5 < KMO \leq 0.70$ $0.70 < KMO \leq 0.90$ $KMO > 0.9$ < 0.05

2. The communality test is carried out to show the value of the variable being studied whether it can explain the factor or not. The smaller the percentage of communalities, the weaker the relationship between the variables and the factors formed. The larger the percentage, the stronger the relationship between the variable and the factors formed. The variable is considered to be able to explain the factor if the extraction value >0.50.

3. Factor extraction is carried out by selecting factors based on factors that have more variance than one original variable (Eigenvalue>1). At this stage, the factor should account for most of the variance in the data with a cumulative variance of >60%.

4. Factor rotation is carried out to make it easier to interpret factors. Factor rotation is carried out to facilitate interpretation in determining the variables that are listed or included in a factor, where if there are several variables that have a high correlation with more than one factor or if part of the factor loading of the variable is below the smallest value that has been determined

5. The interpretation of the factors is done based on the rotated component matrix. Items with a high loading of >0.4 on a factor are considered bound to that factor.

RESULTS AND DISCUSSION

Reliability Test Results

The reliability test is a statistical test used to measure the level of consistency of a measuring instrument. In this case, it is an assessment. Reliability indicates the extent to which the assessment can be used reliably. The reliability test in this study uses Cronbach's alpha, which is a coefficient that describes the correlation between items.

Table 1. Reliability Test Result

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.800	.790	10

The results of the reliability analysis revealed that the developed creative thinking assessment instrument achieved a Cronbach's Alpha value of 0.800, indicating very good internal consistency for an exploratory study. This level of reliability suggests that each item within the instrument measures aspects of creative thinking consistently across respondents. According to Izah et al., (2023)reliability is closely linked to the inter correlation of items, when items share conceptual coherence, Cronbach's Alpha increases. In this study, the high coefficient reflects that the items were constructed from well-defined indicators fluency, flexibility, and originality that are theoretically interrelated. This result supports (Manurung et al., 2020), who emphasized that instruments based on clear theoretical constructs tend to yield reliable results. However, the reliability might also be influenced by the limited number of test participants, which can cause coefficient instability. Future work should replicate the analysis with a larger and more diverse sample to strengthen the generalizability of the reliability estimate.

KMO and Bartlett's Test Results

The Kaiser Meyer Olkin Test (KMO) and Bartlett's Test are among the tests used to determine the accuracy and correlation between factors. The KMO value is used to measure the adequacy of the sample for factor analysis. Meanwhile, a significant correlation for factor analysis can be seen based on the results of Bartlett's test.

Table 2. KMO and Bartlett's Test Result

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.583
Bartlett's Test of Sphericity	Approx. Chi-Square	156.595
	df	45
	Sig.	.000

The KMO value of 0.583, categorized as adequate, indicates that the data are suitable for exploratory factor analysis, although the sample size can still be improved. The significance of Bartlett's test ($p < 0.05$) confirms that correlations among variables were

sufficient to proceed with factor extraction. These results show that the developed items have an acceptable level of inter correlation and that the data structure meets the statistical assumptions required for factor analysis. Nevertheless, the moderate KMO value reflects a limitation related to the relatively small sample, which should be addressed in future studies by expanding the participant pool to improve factor stability.

Communality Test Results

Table 3. Communality Test Result

Communalities

	Initial	Extraction
S1	1.000	.570
S2	1.000	.796
S3	1.000	.678
S4	1.000	.685
S5	1.000	.935
S6	1.000	.897
S7	1.000	.716
S8	1.000	.458
S9	1.000	.806
S10	1.000	.707

Extraction Method: Principal Component Analysis.

The communality test showed that most items had extraction values above 0.5, meaning that they adequately represented their respective factors. Only item S8 demonstrated a lower communality value, suggesting that it may not have been well interpreted by respondents in relation to the originality construct. This result implies that while the majority of items functioned effectively, certain items may require revision to strengthen the representation of originality, which often involves more complex and abstract thinking compared to fluency and flexibility. The identification of S8 as a weak item highlights the importance of iterative refinement in developing valid creative-thinking instruments. According to Kusuma (2023), items with low communalities may reflect ambiguous wording or content misalignment with the intended factor. Therefore, this result highlights the need for item refinement, particularly for those measuring originality, so that all indicators can be interpreted consistently by respondents.

Variance Explained Results

The Total Variance Explained Test is one of the tests used to show how many factors are formed by combining several criteria to get the most appropriate number of factors. The results of the total variance explained test in this study are as follows:

Table 4. Variance Explained Results

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.914	39.139	39.139	3.914	39.139	39.139	3.246	32.460	32.460
2	1.912	19.123	58.262	1.912	19.123	58.262	2.173	21.733	54.193
3	1.422	14.223	72.484	1.422	14.223	72.484	1.829	18.291	72.484
4	.946	9.464	81.948						
5	.649	6.489	88.438						
6	.550	5.503	93.940						
7	.276	2.758	96.698						
8	.156	1.558	98.256						
9	.116	1.155	99.412						
10	.059	.588	100.000						

Extraction Method: Principal Component Analysis.

The total variance explained by the three extracted components reached 77.48%, exceeding the 60% threshold commonly considered acceptable for social science instruments. The dominance of the fluency factor, which contributed 39.14% of the total variance, aligns with earlier findings that fluency often emerges as the most observable aspect of creative thinking (Sa'dijah et al., 2019). This may occur because students tend to express ideas more easily in quantity than in flexibility or originality when responding to open-ended mathematical tasks. Flexibility and originality, while still significant, contributed smaller proportions, consistent with the theoretical notion that these skills require higher-order cognitive transformation and divergent reasoning (Hadar & Tirosh, 2019). Thus, the distribution of variance among the three factors reinforces the theoretical hierarchy of creative-thinking abilities.

Rotated Component Matrix Results

Based on the results of the analysis, it is known that the Rotated Component Matrix test result is as follows:

Table 5. Rotated Component Matrix Result

Rotated Component Matrix[a]

	Component		
	1	2	3
S1	.722	.215	-.058
S2	.824	.309	-.145
S3	.820	-.016	.074
S4	.802	-.093	.184
S5	.126	.954	.098
S6	.075	.940	.084
S7	.056	.463	.706
S8	.172	.041	-.653
S9	.602	.099	.659
S10	.561	.054	.624

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

The value of the loading component on each component shows that the higher the value of the loading component of a variable, the closer the relationship between the variable

and the component in question. Based on the figure above, the results of the rotated component matrix test are as follows:

1. Component 1 is a *fluency* component consisting of S1 of 0.722, S2 of 0.824, S3 of 0.820, and S4 of 0.802. In the 10 question items developed, it was interpreted that there were 4 items that were classified as being able to measure fluency.

2. Component 2 is *a flexibility* component consisting of S5 of 0.954 and S6 of 0.940. In the 10 question items developed, it was interpreted that there were 2 items that were classified as being able to measure flexibility.

3. Component 3 is the *originality* component consisting of S7 of 0.706, S8 of 0.653, S9 of 0.659, and S10 of 0.624. In the 10 question items developed, it was interpreted that there were 4 items that were classified as being able to measure originality.

Overall, the empirical findings address the main research objective to develop and validate a culturally contextualized assessment instrument for measuring students' creative thinking in mathematics. The emergence of three clear components fluency, flexibility, and originality confirms that the instrument aligns with the theoretical framework and can accurately measure creative-thinking constructs in a classroom setting. The dominance of fluency suggests that students are more confident in generating multiple ideas than in developing unique or varied strategies (Ishabu & Nugroho, 2024). This may be due to the influence of conventional mathematics instruction, which often emphasizes procedural accuracy over divergent thinking. Integrating culture based contexts into the test items allowed students to connect problems with familiar life situations, thereby enhancing their engagement and idea fluency (Hidayah et al., 2024). This finding supports claims that cultural relevance increases authenticity and stimulates creative responses in mathematics learning.

The novelty of this study lies in its combination of open-ended assessment and cultural integration, which provides new empirical evidence on how contextualized mathematical problems can measure creativity more authentically than standardized tests. The developed instrument contributes to both theory and practice by demonstrating that culturally grounded tasks can serve as reliable measures of creative potential.

However, this study also has several limitations. The relatively small sample size (n = 28) limits the generalizability of the findings. Future studies should include larger and more diverse samples to enhance the robustness of the factor structure. Despite these limitations, the study provides a strong foundation for future development of culturally responsive creative-thinking assessments in mathematics education.

CONCLUSION

This study concludes that the culturally contextualized creative thinking assessment instrument successfully identifies three main components of fluency, flexibility, and originality aligned with the theoretical constructs of creative thinking. The fluency component emerged as the most dominant, indicating that students tend to generate multiple ideas more easily than unique or varied ones. These findings confirm that the developed instrument is reliable and valid in capturing the multidimensional aspects of creative thinking within a cultural framework, contributing both theoretically by strengthening the

construct validation of creativity and practically by offering an authentic and contextually relevant tool for classroom assessment. However, given the limited sample size (KMO = 0.583), future research should involve more participants and employ Confirmatory Factor Analysis (CFA) to enhance the robustness of the factor structure. Overall, this study provides a valuable foundation for developing reliable and culturally responsive instruments to foster creative thinking in mathematics education.

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