

Scientific Creativity Profile of Grade X Students at SMA Negeri 3 Semarang on Climate Change Topic

Dina Larasati*, Wiyanto

Department of Physics Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang, Indonesia

*Correspondence to: dinalarasati789@students.unnes.ac.id

Abstract: 21st-century skills encompass critical thinking, communication, collaboration, and creativity (4Cs). One of the essential types of creativity in the development of student competence is scientific creativity. However, the current achievement of students' scientific creativity tends to be low. This study aims to describe the scientific creativity profile of grade X students at SMA Negeri 3 Semarang on the topic of climate change. This research employed a quantitative descriptive method with 150 subjects. The research instrument was a scientific creativity essay test that has undergone expert validation as well as validity and reliability testing. The results of the analysis show that the developed instrument meets the validity and reliability criteria through CFA analysis (CFI 0.914; GFI 0.870; RMSEA 0.096) and a Cronbach's alpha coefficient (0.726). Overall, the students' scientific creativity profile is in the fairly creative category with an average achievement of 44%. The fluency dimension is the most dominant, followed by flexibility and originality. Inter-class analysis shows that class X-8 has the highest achievement, while class X-7 has the lowest achievement, especially in the originality dimension (36%). Based on a gender perspective, both male students (53%) and female students (45%) are in the fairly creative category with a consistent dimension sequence pattern relative to the overall achievement.

Keywords: Scientific Creativity Profile, Climate Change, Gender, CFA Analysis

Introduction

Entering the 21st-century era, rapid and significant advancements in science and technology demand a transformation of the education system to prepare students for complex global challenges. One of the primary essential competencies is the 4C skills, which include critical thinking, communication, collaboration, and creativity. Creativity is defined as an individual's ability to discover innovative approaches or strategies to produce unique and optimal solutions. In the context of science education, scientific creativity becomes a crucial dimension as it integrates imaginative mental processes with systematic scientific methods. Scientific creativity is an intellectual ability to generate original and valuable products by utilizing and processing previously acquired information.

In the context of science education, scientific creativity becomes a crucial dimension because it integrates imaginative mental processes with systematic scientific methods (Safi'i, 2019). However, the reality in the field shows that student scientific creativity achievements are still relatively low. A study by Lailiyah & Suliyanah (2018) revealed that 64% of students are in the low creativity category, which is reinforced by the findings of Marwani & Sani (2020) regarding students' difficulties in solving physics problems that require inventiveness. Internationally, the 2018 PISA results recorded Indonesia in 69th place out of 78 countries with a score of 396 (Aninnas & Wicaksono, 2022). Therefore, strategies are needed to optimize these abilities, especially in physics learning, which often requires an understanding of complex and abstract concepts.

Physics has strategic potential to stimulate creativity through the exploration of natural phenomena and global issues, one of which is climate change. As part of the 2030 Sustainable Development Goals (SDGs) agenda, climate change material requires a contextual understanding of complex and abstract concepts. Despite its importance, the level of student understanding of this material is still low due to its multidimensional nature (Amalia & Hariyono, 2022). Consequently, valid and reliable test instruments are

needed to accurately map the profile of students' scientific creativity abilities.

To date, previous research has focused more on developing contextual teaching materials related to climate change (Sarmiasih et al., 2020), but it is still limited in providing test instruments that specifically measure scientific creativity. Research by Elysia et al. (2025) and Subali (2022) has indeed examined scientific creativity, but has not specifically integrated it with climate change material in physics learning. There is a research gap in the development of measurement tools capable of representing dimensions of creativity contextually without being tied to a specific learning model.

Based on this urgency, this study aims to describe the "Scientific Creativity Profile of Grade X Students at SMAN 3 Semarang on Climate Change Material." The research instrument was developed by adapting the theoretical framework of The Scientific Structure Creativity Model (SSCM) by Hu and Adey (2002), which encompasses three primary dimensions: fluency, flexibility, and originality. Fluency is defined as the ability to generate as many ideas as possible; flexibility refers to the ability to produce ideas from various perspectives; and originality is the ability to propose unique ideas that are relatively different from others. This research is expected to provide a comprehensive overview of students' creative ability maps and provide valid evaluation instruments for physics educators.

Methods

This research is a quantitative descriptive study that aims to map the profile of students' scientific creativity on the topic of climate change. The study was carried out at SMA Negeri 3 Semarang between January 12 and 28, 2026. The research subjects were selected using a purposive sampling technique, consisting of 150 Grade X students (Classes X-2, X-3, X-7, X-8, and X-12) who had already received the climate change material.

Data were collected using a scientific creativity essay test instrument adapted from The Scientific Structure Creativity Model (SSCM) by Hu and Adey. The instrument consists of 7 essay items designed to measure three main dimensions: fluency, flexibility, and originality. Items 1–5 measure all three dimensions, while items 6 and 7 focus on the flexibility and originality dimensions, with working time allocations varying between 3 to 20 minutes per item and a total duration of 45 minutes.

The validity of the instrument was tested through three validation stages. First, content validity was performed by four experts three physics education lecturers and one physics teacher using the Aiken's V index. Second, construct validity was tested through Confirmatory Factor Analysis (CFA) using the JASP application, referring to the Goodness of Fit criteria ($CFI > 0.90$; $GFI \geq 0.90$; $RMSEA \leq 0.08$). Third, the instrument's reliability was measured using the Cronbach's Alpha coefficient through SPSS 25, with a minimum reliability criterion of > 0.70 .

Data analysis was carried out through scoring procedures based on the scientific creativity assessment rubric by Wiyanto & Hidayah (2021). The fluency dimension was assessed based on the number of relevant responses, flexibility based on the variety of answer categories, and originality based on the probability of response occurrence ($< 5\%$ for the highest score). The raw scores were then converted into percentages and analyzed based on the students' scientific creativity level categories according to Qomariyah et al. (2021) as presented in Table 1.

Table 1. Percentage of Scientific Creativity Levels

No.	Interval	Category
1	81%-100%	Very Creative
2	61%-80%	Creative
3	41%-60%	Fairly Creative
4	21%-40%	Less Creative
5	$\leq 20\%$	Not Creative

Results and Discussion

Validity and Reliability The developed scientific creativity instrument was validated through three stages: content validity, construct validity, and item validity.

Content Validity

Content validity is an instrument assessment process that aims to ensure the suitability of instrument items with the measured construct, so that the instrument is feasible for use in research (Fitriana, 2022). The results of the content validity using the Aiken's V index are presented in Table 2 below.

Table 2. Results of Content Validity Analysis

Item No.	Assessed Aspects	V Score	Category
1	Content Appropriateness	1,25	High
	Language Clarity	1,25	High
	Item Construction	1,08	High
	Item Relevance	0,91	High
	Creativity Potential	1,16	High
2	Content Appropriateness	1,16	High
	Language Clarity	1,25	High
	Item Construction	1,08	High
	Item Relevance	1,25	High
	Creativity Potential	1,08	High
3	Content Appropriateness	1,16	High
	Language Clarity	1,25	High
	Item Construction	1,16	High
	Item Relevance	1,25	High
	Creativity Potential	1,08	High
4	Content Appropriateness	1,33	High
	Language Clarity	1,25	High
	Item Construction	1,25	High
	Item Relevance	1,25	High
	Creativity Potential	1,08	High
5	Content Appropriateness	1,08	High
	Language Clarity	1,33	High
	Item Construction	1,25	High
	Item Relevance	1,16	High
	Creativity Potential	1,08	High
6	Content Appropriateness	1,33	High
	Language Clarity	1,25	High
	Item Construction	1,16	High
	Item Relevance	1,33	High
	Creativity Potential	1,25	High
7	Content Appropriateness	1,25	High
	Language Clarity	1,25	High
	Item Construction	1,25	High
	Item Relevance	1,16	High
	Creativity Potential	1,25	High

Assessment by four expert validators showed a score range from 0.9167 to 1.3333, which is categorized as high validity.

Construct Validity

Construct validity testing was conducted through two stages of factor analysis. The Exploratory Factor Analysis (EFA) yielded a KMO value of 0.647 (> 0.5) and a Bartlett's Test significance of 0.001 (< 0.05), indicating that the data is suitable for further analysis. These results are presented in Table 3 below.

Table 3. Results of KMO and Bartlett's Test

Description	Value	Criteria	Conclusion
Keyser Mayer Oikin (KMO)	0,647	> 0.5	Feasible
Barlett's Test of Sphericity	0,001	< 0.05	Significant

After fulfilling the feasibility requirements through the KMO and Bartlett's tests, the determination of the number of factors formed within the scientific creativity variable was based on the eigenvalue, which is visualized through the scree plot in Figure 2 and the results of total variance explained in EFA analysis is showed in Table 4.

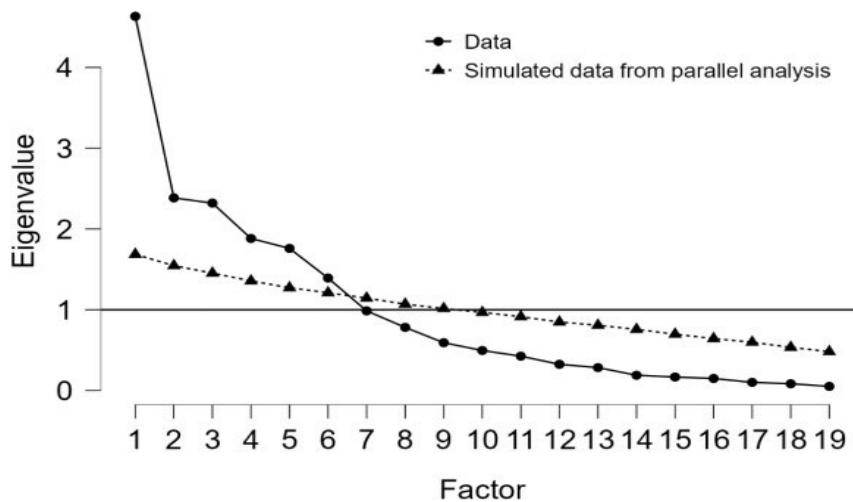


Figure 1. Scree Plot for Determining the Number of Factors in the Scientific Creativity Variable

Table 4. Results of Total Variance Explained in EFA Analysis

Indicator	Factor 1	Factor 2	Factor 3
Factor 1	4.184	3.067	0.161
Factor 2	2.062	2.499	0.132
Factor 3	2.005	2.432	0.128

The results of this study are in line with the theoretical framework stating that scientific creativity consists of three main dimensions. This three-factor structure was confirmed through the scree plot in Figure 1, which shows that three components have eigenvalues above the Kaiser Criterion (value > 1). In detail, the first factor has a value of 4.184, the second factor is 2.062, and the third factor is 2.005. Based on these findings, the first to third components are declared to meet the requirements as factors forming the

construct (Pangalila & Budiarto, 2017). The graph shows a decrease in eigenvalues that begins to level off after the third factor, leading to the conclusion that the optimal number of factors formed is three.

Once the number of factors was determined, a factor loading analysis was conducted to identify the distribution of each item across the formed dimensions. The results of the factor loading for each scientific creativity item are presented in detail in Table 5.

Table 5. Results of EFA Factor Loading Analysis

Indicator	Factor 1	Factor 2	Factor 3
Fluency 4	0.930		
Flexibility 5	0.925		
Flexibility 1	0.649		
Fluency 2	0,479		
Fluency 1	0.444		
Flexibility 2	0.356		0.313
Fluency 3	0,341		
Flexibility 3	0,303		
Originality 1		0.891	
Originality 2		0.870	
Originality 3		0.817	
Flexibility 5			0.995
Flexibility 6			0.899
Flexibility 7			0.569
Originality 4			
Originality 5			
Originality 6			
Originality 7			

Table 5 presents the factor loading values obtained through Orthogonal (Varimax) rotation with a maximum likelihood approach. The results of the analysis show that 14 out of 19 items are valid and retained (meeting the factor loading criteria of ≥ 0.5), while indicators with factor loading values below 0.5 are not recommended.

Confirmatory Factor Analysis (CFA)

Furthermore, the Confirmatory Factor Analysis (CFA) test results indicated a reasonably fit model with a CFI value of 0.914 (> 0.90) and a GFI of 0.870, although the RMSEA value (0.096) remained above the optimal threshold. Empirically, item validity testing using the Pearson Product Moment showed that all indicators had an r calculated $> r$ table (0.1603), thus they were declared valid. The internal reliability test yielded a Cronbach's Alpha coefficient of 0.728, which signifies that the instrument has acceptable consistency.

Table 6. final Results of Goodness of Fit Indicators from CFA Testing

Goodness of Fit Indicators	Cut-off Value	Result Value	Description
Chi-Square	$> 0,05$	147,373	Meets the cut-off value or meets the criteria
CFI	$> 0,09$	0,914	Meets the cut-off value or meets the criteria
GFI	$\geq 0,90$	0,870	Does not meet the cut-off value or below the criteria
RMSEA	$\leq 0,05$	0,096	Does not meet the cut-off value or below the criteria

Although several goodness of fit indicators is in the marginal fit category, the analysis proceeded to the measurement model evaluation to observe the contribution of each indicator to its construct. The standardized loading factor values, which indicate the construct validity from the CFA test results, are presented in Table 7 below.

Table 7. Results of CFA Standardized Loading Factors

Indicator	Loading	Description
Fluency 1	0,955	Valid
Fluency 2	0,923	Valid
Fluency 3	0,634	Valid
Flexibility 1	0,083	Valid
Flexibility 2	0,871	Valid
Flexibility 3	0,962	Valid
Flexibility 4	0,631	Valid
Flexibility 6	0,265	Valid with low factor loading
Originality 1	0,950	Valid
Originality 2	0,876	Valid
Originality 3	0,828	Valid
Originality 4	0,067	Valid with low factor loading
Originality 7	0,023	Valid with low factor loading

Based on Table 7, which is structured according to the Std. Estimate values from the CFA output, the results show that most items in the fluency, flexibility, and originality dimensions have factor loading values that meet the criteria (≥ 0.50). This indicates that they are capable of representing the construct effectively, although a few indicators still show relatively low values.

The visual representation of the factor structure and the relationships between items in the scientific creativity model, based on the confirmatory analysis results, is presented in Figure 2.

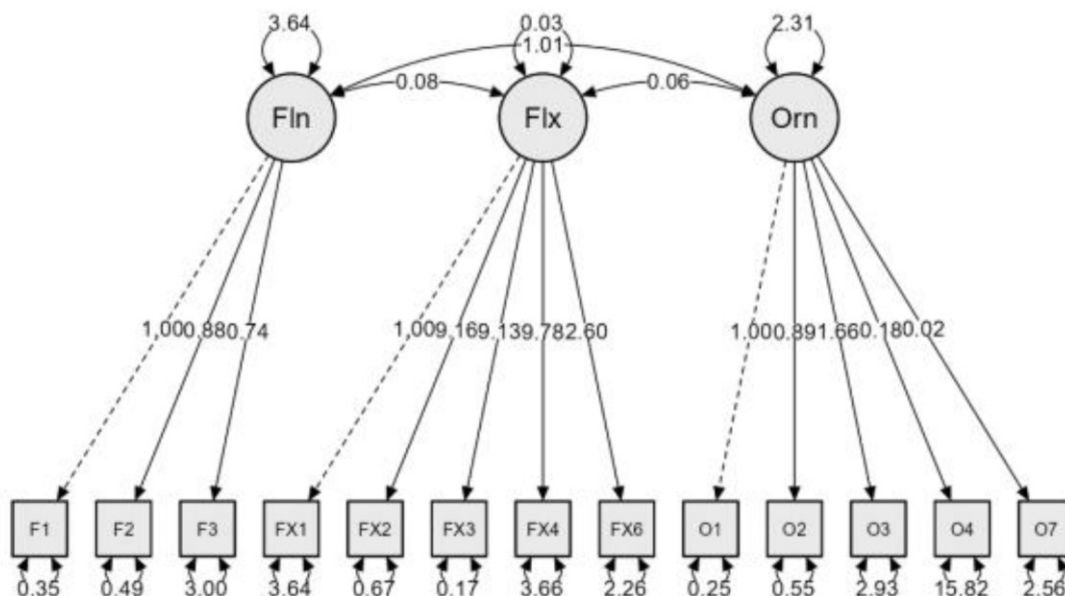


Figure 2. CFA Plot Showing Factor Structure and Item Relationships

Based on Figure 2, the relationship between the latent constructs (fluency, flexibility, and originality) and their respective indicators demonstrates good construct validity. The fluency and originality dimensions are dominated by indicators with consistent and adequate factor loadings. In the flexibility dimension, the indicators' contributions are considered strong, although they show a wider variance in values. In general, these results prove that the indicators used are capable of representatively measuring each dimension of creativity.

Item Validity

Validity indicates the degree of accuracy or legitimacy of an instrument. The validity test is conducted by correlating the score of each item with the total score of the instrument. An item is declared valid if it has a good correlation with the total score. The results of the item validity test are presented in the following Table 8.

Table 8. Item Analysis Results

Item No.	Indicator	r calculated	r table	Description
1	Fluency	0,573	0,1603	Valid
	Flexibility	0,654	0,1603	Valid
	Originality	0,371	0,1603	Valid
2	Fluency	0,438	0,1603	Valid
	Flexibility	0,385	0,1603	Valid
	Originality	0,378	0,1603	Valid
3	Fluency	0,471	0,1603	Valid
	Flexibility	0,464	0,1603	Valid
	Originality	0,347	0,1603	Valid
4	Fluency	0,420	0,1603	Valid
	Flexibility	0,396	0,1603	Valid
	Originality	0,378	0,1603	Valid
5	Fluency	0,526	0,1603	Valid
	Flexibility	0,549	0,1603	Valid
	Originality	0,492	0,1603	Valid
6	Flexibility	0,455	0,1603	Valid
	Originality	0,451	0,1603	Valid
7	Flexibility	0,528	0,1603	Valid
	Originality	0,256	0,1603	Valid

Based on the item validity analysis, the instrument was tested using Pearson's Product Moment correlation. The results show that most items have correlation coefficients (r calculated) ranging from 0.256 to 0.654. These values are higher than the r table value of 0.1603 (at a 5% significance level), indicating that all items are valid and suitable for use in the study.

However, item number 7 in the originality dimension shows the lowest r calculated value of 0.256. Although it is still above the validity threshold, the low value observed should be taken as an evaluative consideration for the further development of the instrument.

Instrument Reliability Test Internal Reliability

The reliability test was conducted to determine the internal consistency of the instrument in measuring the scientific creativity construct. Following the validity test, the instrument was analyzed using the Cronbach's Alpha coefficient. This test aimed to evaluate the alignment between items within a single unified assessment instrument. The results of the reliability analysis for the essay test instrument on climate change topics are presented in detail in Table 9.

Table 9. Results of the Instrument Reliability Calculation

Reliability Statistics	
Cronbach's Alpha	.726
N of Items	19

Based on the analysis results in Table 9, the Cronbach's Alpha coefficient was found to be 0.728. Given that this value exceeds the threshold of 0.70, the scientific creativity test instrument for the climate change topic is declared to have reliability that meets the acceptable criteria. This indicates that the instrument possesses good internal consistency for use as a research measurement tool.

Students' Scientific Creativity Profile

The students' scientific creativity profile was analyzed using descriptive statistics to provide an overview of the achievement in each measured dimension. Data analysis was performed using SPSS software version 25 to determine the mean, minimum score, maximum score, and standard deviation. The measurement data were then converted into percentages and classified to comprehensively identify the students' scientific creativity levels across each dimension.

Students' Scientific Creativity Profile Based on Indicators per Item

The students' scientific creativity profile based on each indicator is presented to determine the level of students' creativity for each measured item. This is presented in Table 10 as follows.

Table 10. Results of the Percentage Analysis of Students' Creativity Based on Indicators

Indikator	Max	Mean	Pst (%)	Category
Fluency 1	13	4.81	37	Less creative
Fluency 2	12	4.22	48	Moderately creative
Fluency 3	13	2.05	23	Less creative
Fluency 4	8	3.86	38	Less creative
Fluency 5	8	3.31	33	Less creative
Flexibility 1	8	1.90	35	Less creative
Flexibility 2	14	3.17	41	Moderately creative
Flexibility 3	14	2.69	19	Less creative
Flexibility 4	19	2.19	42	Moderately creative
Flexibility 5	10	3.81	30	Less creative
Flexibility 6	8	3.37	27	Less creative
Flexibility 7	14	2.55	29	Less creative
Originality 1	10	3.27	16	Less creative
Originality 2	9	2.68	24	Less creative
Originality 3	21	4.99	12	Less creative
Originality 4	24	6.56	18	Less creative
Originality 5	24	2.86	24%	Less creative
Originality 6	27	7.88	12	Less creative
Originality 7	15	4.15	28	Less creative

The results of the descriptive statistical analysis show variations in students' scientific creativity achievements for each indicator measured in Table 10. The highest achievement was found in the fluency dimension (item 2) with a percentage of 48%, which falls into the moderately creative category. A positive trend is also observed in the flexibility dimension, particularly in items 2 and 4, with achievements of 41% and 42%, respectively (moderately creative category). These findings indicate that students have relatively better abilities in aspects of fluency and flexibility of thinking compared to other aspects.

In contrast, the lowest achievement was identified in the originality dimension, especially in items 3 and 6, which only reached 12% (not creative category). The low scores in this aspect of idea originality are further emphasized by the achievements in item 1 (16%) and item 4 (18%), which still remain in the not creative category. In general, the students' scientific creativity profile is still dominated by the 'less creative' category.

This indicates that the overall scientific creativity of the students has not yet developed optimally and requires further intervention across all measured dimensions.

Students' Scientific Creativity Profile Based on Dimensions

A more in-depth profile of students' scientific creativity, reviewed based on the fluency, flexibility, and originality dimensions, is presented in Table 11 below.

Table 11. Results of the Percentage Analysis of Students' Scientific Creativity Based on Dimensions

Dimensi	Max	Mean	Pst (%)	Category
Fluency	36	18,69	52	Moderately creative
Flexibility	69	30,71	45	Moderately creative
Originality	58	20,68	36	Less creative
Rata-rata			44	Moderately creative

The analysis of scientific creativity achievement among 150 respondents shows significant variation across dimensions in Table 11. Overall, the average percentage of students' scientific creativity is 44%, which falls into the moderately creative category.

The Fluency dimension shows the highest achievement compared to other dimensions, with a percentage of 52% (moderately creative). The mean score of 18.69 (SD = 5.326) out of a maximum score of 36 indicates that students' ability to generate ideas is at a moderate level. However, the wide score range (8–36) represents considerable variability in individual abilities.

The Flexibility dimension is also in the moderately creative category, with a percentage of 45%. The average score of 30.71 out of a maximum of 69 suggests that students' ability to propose alternative answers is not yet optimal. The high standard deviation (SD = 10.169) reflects a significant gap in ability among students, where most are still at a moderate to low level.

The Originality dimension records the lowest achievement, with a percentage of 36% (less creative). The mean score of 20.68 out of a maximum of 58 indicates serious challenges for students in producing unique ideas. The standard deviation of 7.950, with a score range of 7–58, suggests that only a small proportion of students are able to reach a high level of originality, while the majority of students remain in the category of

Overall, the profile of students' scientific creativity is not yet evenly distributed and has not approached the maximum score across all dimensions. This condition confirms that the development of flexibility, and especially originality, remains a major challenge in science learning, even though the fluency aspect has shown relatively better progress.

Students' Scientific Creativity Profile Based on Class

Students' scientific creativity profiles were analyzed based on class to identify variations in achievement across each dimension. Data from classes X-2, X-3, X-7, X-8, and X-12 are presented in Table X. This aims to provide a comprehensive overview of the comparison of scientific creativity levels among the studied class groups. The Table 12 showed the comparison of scientific creativity percentage by class.

Table 12. Comparison of Scientific Creativity Percentages by Class

Class	Fln	Fxy	Ori	Category
X-2	62%	43%	36%	Moderately creative
X-3	52%	45%	36%	Moderately creative
X-7	46%	41%	36%	Moderately creative
X-8	58%	44%	34%	Moderately creative
X-12	57%	58%	38%	Moderately creative

The data in Table 12 shows the consistency of the fluency dimension as the highest achievement across most classes, with the peak percentage found in class X-2 at 62%. This indicates that students generally have the confidence to express a large number of ideas fluently. In contrast, the originality dimension consistently ranks as the lowest across all classes, with the minimum percentage observed in class X-8 at 34%.

The dominance of the fluency dimension over flexibility and originality (except in class X-12, where flexibility reaches 58%) suggests that students' thinking processes are still quantitative in generating many ideas. However, they have not yet achieved an optimal level of novelty (uniqueness) required to produce truly original scientific ideas.

Scientific Creativity Profile Based on Gender

The results of the study indicate differences in the level of scientific creativity between male and female students. Overall, male students have a higher average level of scientific creativity compared to female students across all dimensions.

Table 13. Percentage of Scientific Creativity Based on Gender

Gender	Fln	Fxy	Ori	Category
Boy	50%	42%	33%	Moderately creative
Girl	53%	46%	37%	Moderately creative

Female students show slightly higher achievement in the originality dimension (37%) compared to male students (33%). The higher standard deviation in the female group ($SD_{flexibility} = 10.416$) indicates that the diversity of creative thinking abilities among female students is wider than that of male students, whose data distribution is more homogeneous.

Overall, the trend in both groups shows a similar pattern, with the highest performance in the fluency aspect and the lowest in the originality aspect. This suggests the need for learning strategies that place greater emphasis on stimulating unique and original ideas among all students, regardless of gender differences.

A visualization comparing the percentage achievements of scientific creativity between male and female students across each dimension is presented in Figure 3 below.

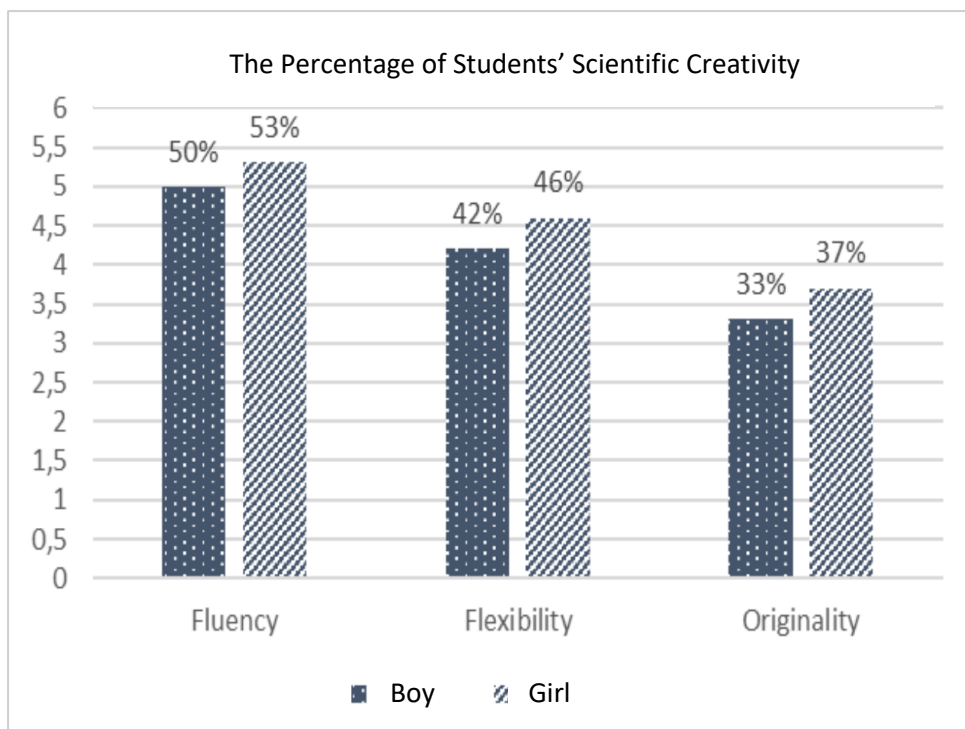


Figure 2. Bar Chart of Students' Scientific Creativity Percentage Based on Gender

Based on the analysis in Figure 2, female students show slightly higher percentages of scientific creativity compared to male students. Across the three dimensions of scientific creativity fluency, flexibility, and originality the scores obtained by female students are consistently higher than those of male students.

However, both gender groups display a similar pattern of ability distribution, in which the fluency dimension becomes the highest-performing aspect and the originality dimension represents the lowest achievement among all students.

Analysis and Discussion of Students' Research Results (Test Results Description)

The following presentation provides a comprehensive description of students' test performance regarding their understanding of climate change concepts. This data description aims to map the extent to which students are able to integrate theoretical knowledge into contextual problem-solving related to global climate phenomena.

Analysis of Human Activities Causing Climate Change (Question 1)

In this question, students were asked to identify human activities that contribute to climate change. Student HR (X-12) demonstrated high fluency and flexibility by stating: "private transportation use, waste burning, deforestation, disposing of used oil into drains, releasing laboratory experiment waste into the wild, and converting protected forests into palm oil plantations." These responses cover a spectrum from domestic to industrial aspects. Conversely, student GC (X-3) only answered "air pollution," indicating low creativity by providing only one very general idea.

Analysis of the Benefits of Trees for the Environment (Question 2)

Student HA (X-7) was able to perceive the benefits of trees from various perspectives (flexibility), with the answer: "providing clean air, preventing landslides, materials for handicrafts, fulfilling the need for tables and chairs, and assisting water flow because trees absorb water." However, a conceptual understanding barrier was found in student DS (X-3), who answered "chili, spinach, and rice." This response is irrelevant as it lists types of plants rather than their benefits in the context of climate change.

Analysis of Eco-Friendly Objects (Question 3)

In this question, a unique response (originality) emerged from student SA (X-2), who mentioned: "loofah dish sponges, paper straws, cassava-based plastic bags, beeswax, popcorn fabric for clothing, and washable cotton cloth." Although the ideas were highly creative and diverse, the scientific explanations provided were limited, suggesting that creative ideation has not yet been accompanied by depth in scientific reasoning.

Analysis of Extreme Weather Impact Predictions (Question 4)

Student AR (X-8) showed good regional analysis skills by predicting: "in lowlands, prolonged droughts and difficulty accessing clean air occur; in forest areas, the risk of fire increases; and in highlands, it affects water discharge, causing rivers to dry up." This comparison demonstrates good flexibility. In contrast, student AL (X-12) answered generally: "drought, crop failure, economic disruption, inflation, and melting glaciers," without differentiating between regional conditions.

Analysis of Factors in Air Quality Decline (Question 5)

Student MN (X-12) provided specific answers: "deforestation, transformation of forests into palm oil plantations, CFC gas emissions, vehicle carbon monoxide emissions, and power generation from coal-fired power plants (PLTU)." This indicates originality in scientific knowledge. On the other hand, student AS (X-7) missed the mark by only explaining the impacts: "cracked soil due to drought leading to community hunger," but failed to mention the contributing factors.

Analysis of Air Temperature Measurement Methods (Question 6)

Student TJ (X-3) proposed a variety of methods: "satellite-connected mobile applications, thermometers, and IoT-based sensors." This diversity of tools indicates flexibility. Meanwhile, student BA (X-12) focused on a single technical method, namely the "Automatic Weather Station (AWS)," with detailed steps: "installing the device at a height of 1.25–2 meters so the sensor works automatically," which demonstrates originality in the aspect of scientific procedures.

Analysis of Forest Fire Monitoring Device Design (Question 7)

Question 7, which asks students to design a forest fire monitoring device, serves as the most effective instrument for mapping the originality dimension.

Sample AR (X-12) in Figure 4 developed an innovation called "FOMO 69," a UFO-like drone integrated with a smartphone application named "CelciousZ." The design includes detailed functional components such as antennas, cameras, and color indicator lights.

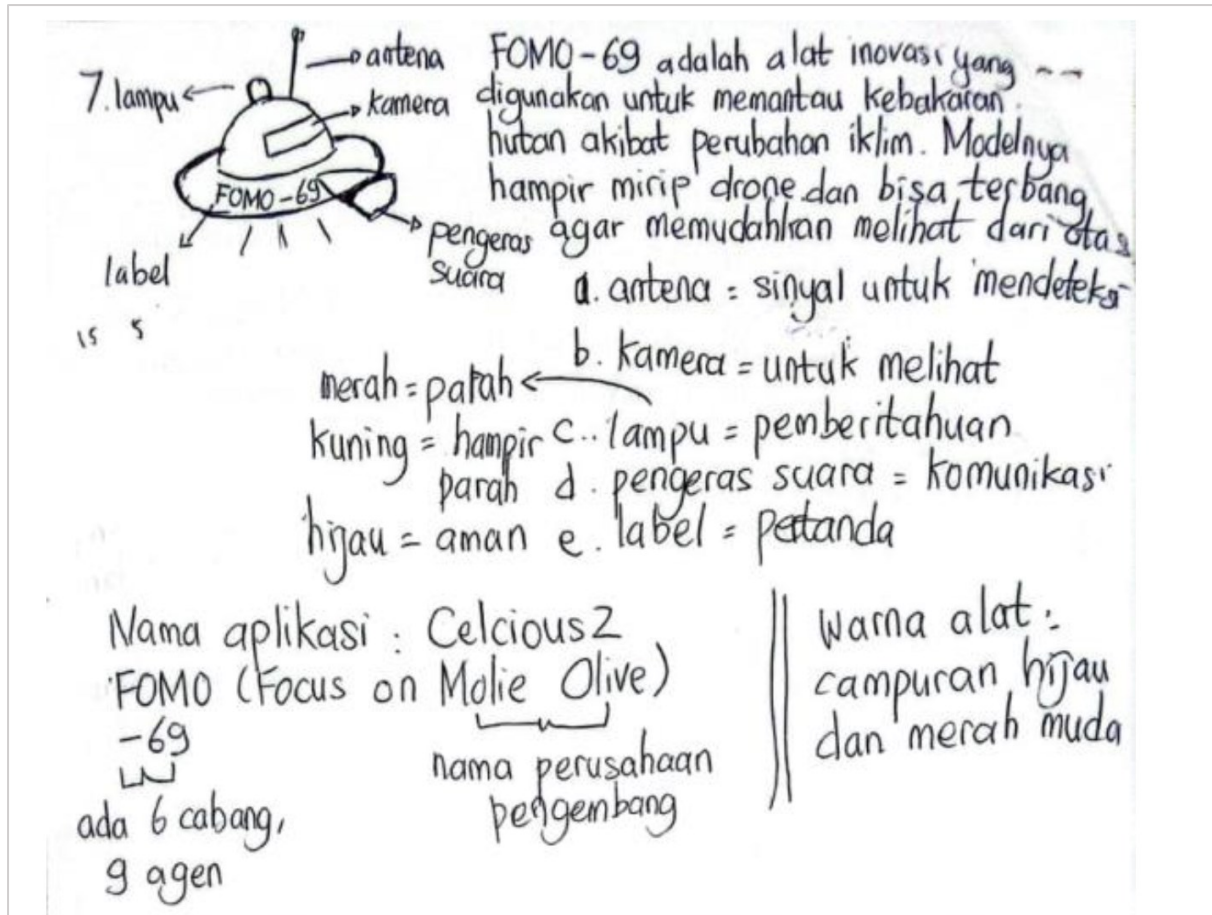


Figure 4. Sample Answer AR (X-12)

Sample AA (X-12) in Figure 5 also designed a drone, but with standard features resembling existing products on the market (using a controller similar to a PlayStation stick).

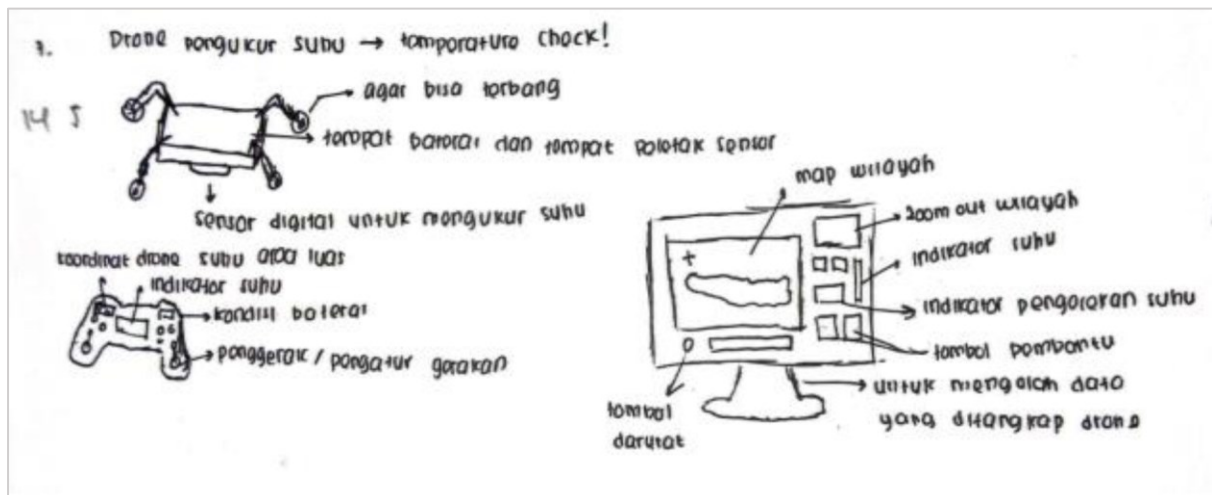


Figure 5. Sample Answer AR (X-12)

CONCLUSION

Based on the research results and data analysis conducted, it can be concluded that the scientific creativity instrument developed based on the theory of Hu & Adey (consisting of the dimensions of fluency, flexibility, and originality) has met high criteria of validity and reliability. The results of the confirmatory factor analysis (CFA) test confirm that the instrument has good goodness-of-fit indicators, making it suitable for measuring the scientific creativity profile of senior high school students.

In general, the level of students' scientific creativity falls into the moderately creative category, with an average achievement of 44%. There is a consistent pattern in students' creativity profiles across classes and gender groups, where the fluency dimension is the most dominant aspect, followed by flexibility, and originality as the lowest achievement. Gender-based analysis also shows relatively comparable results; female students recorded an average of 45% and male students 41%, both of which fall into the moderately creative category.

An important finding of this study reveals a common challenge across all class and gender samples, namely the low level of students' ability in the originality dimension, which falls into the less creative category. This indicates that although students demonstrate sufficient fluency and flexibility in generating ideas, they still face significant barriers in producing scientific ideas that are unique and novel. Therefore, more specific science learning strategies are needed to stimulate the originality aspect of students' thinking.

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