Domain Level of Creativity of Bumiputera Chemistry Students in Rural Sabah

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DOI: https://dx.doi.org/10.47772/IJRISS.2025.90400204

Received: 25 March 2025; Accepted: 03 April 2025; Published: 06 May 2025

ABSTRACT

This study aims to identify the level of creativity of Bumiputera chemistry students in rural areas of Sabah. Creativity assessments are conducted based on four main creativity domains by Torrance (1974), fluency, elaboration, flexibility, and originality. The objectives of this study include identifying the level of fluency of students, identifying the level of elaboration, assessing the level of flexibility in solving problems, and the level of originality of ideas generated by students. The study used the STEM Creativity Test questions as a measurement instrument. The study sample consisted of 38 Sabah Bumiputera chemistry students from rural areas in the Kota Belud district. The findings of the study showed that the fluency domain obtained scores of 3.89 and 2.24, the elaboration domain recorded scores of 1.21 and 1.87, the flexibility domain showed scores of 1.58 and 2.00, while the originality domain recorded scores of 0.84 and 3.47. Overall, the results of this study show that the level of scientific creativity of students is still at a low level. This study gives the impression that students in rural areas face challenges in terms of creativity, which may be influenced by various factors such as access to learning resources, teaching methods, and the teaching and learning environment of students. Therefore, this study suggests that more innovative and exploratory teaching strategies should be applied in chemistry learning to increase the level of scientific creativity of students.

Keywords: Scientific creativity, chemistry students, Sabah Bumiputera, rural, STEM creativity

INTRODUCTION

Bumiputera chemistry students in rural Sabah face various challenges in the development of their creativity capabilities, especially in science subjects. This is due to various factors that affect this development, including the infrastructure needed by students in learning. Students' lack of access to laboratory facilities, lack of reference materials, and modern technology that is still far behind are among the main challenges for Sabah Bumiputera students in rural areas in increasing the level of creativity of these students. However, on the other hand, students who are in rural areas also have an advantage in their own creativity. This includes their ability to adapt to limited resources and the ability to explore in order to find alternative solutions based on their local environment.

Creativity in today's education is very important because it allows students to understand abstract chemical concepts more deeply. Chemistry that involves the reaction between two substances or particles to form a result is an abstract reaction. This makes it difficult for students to understand because it cannot be seen by the naked eye. Therefore, students' creativity in understanding this concept is very helpful for students. Students can also apply their sciences knowledge in their daily lives.

This study is important in contributing to the understanding of how scientific creativity can be applied in chemistry education, especially for Sabah bumiputera chemistry students in rural areas. The results of the study are expected to help teachers and policy makers in formulating strategies to increase students' creativity and enhance chemistry education in rural areas.

Problem Statement

There is a gap in creativity skills between urban and rural students as a whole based on a study by Yahyaawal et al. (2022). This is influenced by various factors such as teachers' teaching methods, exposure to technology and so on (Sukardi et al, 2022). Yahyaawal et al. (2022) in their study among B40 students throughout Malaysia, found that the level of creativity of B40 students in Malaysia Borneo, which involves the states of Sabah and Sarawak, is far behind that of students from Peninsular Malaysia. He also stated that Information Comunication Technology (ICT) exposure is one of the main factors in increasing students' creativity.

In Sabah itself, most of the secondary schools are located in rural areas, with 151 schools out of 211 secondary schools in Sabah. Based on the overall Sijil Pelajaran Malaysia (SPM) achievement statistics published, Azman (2024, May 27) said in The Borneo Post news, there has been an increase in SPM achievement throughout Sabah. However, there is still a gap of 0.53% in terms of the number of passes between rural students and urban students. Although the SPM achievement statistics show an increase from the previous year, the achievement of students in terms of creativity is still at a low level. Muhibbudin et al. (2021) believes that the learning outcomes of students who are still at a low level are greatly influenced by students' thinking skills.

Furthermore, in Wawasan Kemakmuran Bersama 2030 stated the current need to increase innovation in the fourth edition of the Industrial Revolution requires human resources who are literate with digital, data and creativity skills as well as the ability to adapt to current changes (Government of Malaysia, 2019). In the chemistry Assessment and Curriculum Standard Document (Ministry of Education Malaysia, 2018), scientific skills involving problem-solving and critical thinking in the context of chemistry are the main points. However, previous studies have clearly stated that these skills have not reached the desired level. Therefore, there is a need for further studies on student creativity to improve the quality of student learning in the field of chemistry in particular.

Objectives Research

The study is based on the following objectives:

i. Measuring the level of fluency of Sabah Bumiputera chemistry students in rural areas.

ii. Identify the level of elaboration of Sabah Bumiputera chemistry students in rural areas.

iii. Identify the level of flexibility of Sabah Bumiputera chemistry students in rural areas.

iv. Analyze the level of originality of Sabah Bumiputera chemistry students in rural areas.

LITERATURE REVIEW

Creativity plays an important role in the development of knowledge and academic improvement, especially in the field of science such as chemistry. In today's Education, creativity is not only related to the ability to come up with new ideas but also involves the ability of students to solve problems creatively. Chemistry students now need creativity to understand complex concepts, plan experiments and apply chemical concepts in their daily lives.

In the lab or student learning class, creativity is required by students to plan effective experiments and make predictions based on student observations. In addition, students also use their creativity in adapting procedures to get better results from experiments or problem solving. These creativity skills are vitally important for students in global learning challenges that involve students' daily activities.

Apart from that, Mulatsih et al. (2023) believes that creativity can help chemistry students in developing higher-order thinking skills based on Bloom's Taxonomy up to the level of analyzing, synthesizing and evaluating. Creative students usually tend to ask more critical questions often and often strive to explore

different ways or approaches in solving a problem. Teaching and assessment in chemistry should focus on the level of assessment based on Bloom (1956) to help students achieve their creativity to a higher level.

This study discusses with a focus on the Domain of Creativity introduced by Torrance (1974) in his model of creativity. The model identifies four main domains in creativity which are fluency, flexibility, elaboration and originality. Each of these domains has a primary function for students to master the concept of learning. However, these four domains are needed by students in solving a problem. In the context of chemistry education, the Torrance model can be used to assess the extent to which students are able to apply each of these domains in solving chemical problems or planning an experiment.

Domain of Fluency

The Torrence model is one of the models that is often used by researchers in measuring and understanding creativity. This is because a detailed domain can measure a student's creativity. With the domain of fluency, this model proposes a measure of a student's ability to come up with as many ideas or solutions in a short time. Heong et al. (2011) found in their study that impasse is difficulty generating ideas is the main problem of students. They stated that the difficulty of generating ideas will result in students having trouble completing individual coursework assignments. In this regard, students need to be assisted to acquire and improve high order thinking skills for the generation of ideas, either through the teaching and learning environment of students.

Domain of Flexibility

Meanwhile, the flexibility domain is a measure of students' ability to see problems from various perspectives and come up with different approaches. According to Yu et al. (2020), flexibility plays an important role in adapting problems to the situation that should lead to new challenges in the current environment. This domain of flexibility is based on Torrance (1974) which refers to the ability to produce various ideas or solutions that demonstrate possible solutions from various approaches or strategies. This requires students to be more flexible in producing various problem-solving patterns.

Domain of Originality

The domain of originality is the ability of students to come up with unique and unusual ideas. Originality in the assessment of creativity is often determined by an idea that is rarely put forward by others. When an idea is rare, it is considered more original than the answer is already accepted. Niwlikar (2024) also stated that this domain of originality is very suitable in teaching and learning across curricula. Teachers should include this domain into their teaching to build students' creativity development.

Domain of Elaboration

As for the elaboration domain, it is also a measure of a student's ability to develop an existing idea by adding details to the idea and refining the problem-solving. Torrance (1974) states that elaboration is one of the main components in creative thinking, where individuals with a high level of elaboration are able to refine their ideas better, making them more meaningful and easier to understand. According to a study by Runco and Acar (2012), elaboration in creative thinking helps improve the effectiveness of idea communication as well as show a deeper level of understanding of a concept.

Previous studies have shown that the level of creativity of Bumiputera students as a whole in chemistry tends to be lower than that of urban students (Puteh et al., 2016). Similarly, a study by Yahyaawal (2022) stated that the difference in creativity levels between Malaysian Peninsular and Malaysian Borneo students was very significant. This is due to a variety of factors including lack of educational resources, lack of exposure to creative teaching in Science, Technology, Engineering and Mathematics (STEM) and an unconducive learning environment (Huda, 2022). However, there are also studies that show an increase in the level of creativity by using interventions through teaching models introduced by several researchers previously (Kareem et al.,

2022). Therefore, these studies emphasise the importance of a holistic approach in enhancing students' creativity, including teacher training, infrastructure development and community engagement.

In summary, creativity plays a crucial role in chemistry education, especially in shaping students who are creative in solving everyday problems. The Torrance model provides the right work to understand and measure the creativity of Sabah Bumiputera chemistry students in rural areas. However, the factors that hinder this creativity need to be taken into account, especially in the context of rural Sabah students. These past studies also have shown that if appropriate interventions are implemented, the level of creativity of these students can be increased, further contributing to their success in the field of chemistry.

STUDY METHODOLOGY

This study used a quantitative design to identify and measure the level of creativity domain among Bumiputera chemistry students in rural Sabah. Through this approach, the level of creativity of students can be measured more accurately based on the scores obtained from the study instruments that have been developed.

The study sample consisted of 38 form four students who took chemistry subjects from two rural schools in the district of Kota Belud. Although the number of students involved in this study is relatively small, it nevertheless reflects the real situation as the number of students taking chemistry subjects in rural schools is limited.

Two schools were selected from five rural schools in the district. These schools were chosen because they have the highest number of STEM students, compared to the other three schools. In addition, both schools are also made up entirely of Sabah Bumiputera students, thus ensuring suitability with the objectives of the study which focuses on the students of the group. With careful design and sample selection, this study is expected to provide a clear picture of the level of creativity of Bumiputera chemistry students in rural Sabah as well as be the basis for efforts to empower creativity in STEM education.

This study instrument uses the STEM Creativity Test (UKSTEM) which is specially designed to measure Torrance's four domains of creativity, which is fluency, flexibility, elaboration and originality. The instrument consists of 6 open-ended questions and has been verified for reliability through a pilot study prior to use. After correcting the questions, this research instrument was validated by an excellent teacher of Malay, English, two excellent chemistry teachers and an experienced chemistry lecturer from Universiti Teknologi Malaysia (UTM). The data collection technique involves the administration of UKSTEM face-to-face in selected schools. Bumiputera chemistry students are given an hour to answer questions that test their ability to generate ideas, solve problems and develop creative problem solving.

The data collected was analyzed using descriptive analysis methods. Descriptive analysis is used to calculate the mean and standard deviation for each of those creative domains. The findings of this study are presented in the form of tables to facilitate interpretation. Overall, the methodology of this study is designed to provide a comprehensive and accurate picture of the level of creativity of Sabah Bumiputera chemistry students in rural areas.

Study Findings

This study thoroughly examines the findings in order to effectively address and analyze the following research objectives.

i. To measure the level of fluency of rural Sabah Bumiputera chemistry students in coming up with ideas related to chemical reaction rates.

ii. Identify the level of elaboration of rural Sabah Bumiputera chemistry students in detailing and developing their ideas.

iii. To identify the level of flexibility of rural Sabah Bumiputera chemistry students in adapting chemical concepts in various situations.

iv. To analyse the level of originality of rural Sabah Bumiputera chemistry students in creating new ideas related to chemical reaction rates.

Domain of Fluency

In this study, descriptive analysis was carried out to find out the mean, standard deviation and frequency to understand the patterns and characteristics of the data obtained from the results of the STEM Creativity Test conducted by students. There are two questions that measure the student's fluency domain which is question 1a and question 2. Question 1a is a question that requires students to list how many ways to keep the food fresh so that it does not spoil. Meanwhile, the second question requires students to list how many ways students can cook quickly. The findings are shown in Table 1 below:

Table 1: Descriptive Findings and Analysis of Fluency Domains

Questions	Highest Scores	Lowest score	Mean	Standard Deviation
1a	9	0	3.89	1.97
2	3	0	2.24	0.75

Based on Table 1, the analysis results show that the mean for the fluency domain is 3.89 and 2.24 for question 1a and question 2 respectively. For question 1a, the highest score scored by students was 9 and 3 for question number 2, but the score value of 0 was for the lowest score for both questions. The standard deviation for these two questions is 1.97 and 0.75 for each of the questions. The standard deviation value for question 1a shows a large variation between the answers generated by the students. However, for question number 2, the standard deviation was relatively small because all students could not state many ways to cook quickly, which was the highest number of only three ways.

Based on these findings, the study shows that the domain of student fluency is still at a low and medium level. These findings are in line with a previous study by Madah Marzuki et al. (2024), which stated that fluency in creative thinking depends on the level of exposure of students to environments that stimulate their imagination. By using exposure to teaching modules designed by teachers, students' creativity can be enhanced. A study by Munahefi and Waluya (2024) also supports these findings, where they found that individuals with a high level of fluency tend to generate more ideas in problem-solving situations.

Domain of Elaboration

Furthermore, this study identified the level of clarity of Bumiputera chemistry students in rural Sabah. In this section, there are also two questions asked in the STEM creativity test questions, which is question 3b and question number 4. These two questions required students to explain in more detail about the previously stated idea. For question 3b, students are asked to explain ideas that have been generated previously. Meanwhile, for the second question, this elaboration domain is to ask students to explain in detail the experiments that students can do. Findings and analysis data as shown in Table 2.

Table 2: Descriptive Findings and Analysis of the Elaboration Domain

Questions	Highest Scores	Lowest score	Mean	Standard Deviation
3b	3	0	1.21	1.17
4	8	0	1.87	2.18

Based on Table 2, the analysis results show that the mean for the elaboration domain is 1.21 for question 3b and 1.87 for question 4. In this domain question, the highest scores obtained are 3 and 8 for each question. The

lowest score is 0, indicating the student gave an incorrect answer or did not answer the question. The standard deviation for these two questions was high, which are 1.17 and 2.18. This high standard deviation value indicates that students' scores are not homogeneous, meaning that students' level of clarity has a large variation. On average, students are still at a low level in the domain of elaboration, with only a few achieving high levels of creativity in this domain. However, the four students who were categorised as high level, which are those who scored 6, 7 and 8 in question 4, only scored 2 and 1 in question 3b. This was highly influenced by the students' previous experience, on question 4 which involved practical descriptions, which had been made in the laboratory, while question 3b only explained the students' drawings in the previous question.

A study by Amabile (2018) examined factors such as learning environment, teacher support, and intrinsic motivation that influence students' elaboration and creativity. The findings of this study may explain why there is such a large variation in student performance. In a study by Ambo et al. (2019), although this study aims to evaluate the effectiveness of STEM in enhancing creativity in teaching and learning, they believe that the need to inculcate and improve the level of creativity is a necessity among students and teachers. This requirement clearly shows that the level of creativity of students is still at an unsatisfactory level, and there are still opportunities to improve. Jonassen and Kim (2010) also believes that the level of elaboration influences students' ability to choose or evaluate the best ideas in creative problem-solving.

Domain of Flexibility

The domain of creativity refers to a person's ability to come up with an idea, solution, or product that is original and valuable in various fields or contexts (Guilford, 1982). Amabile (2018) also states that the word "flexibility" itself is closely related to fortitude, adaptability, and the ability to think outside the box. In the context of creativity, this domain emphasizes diversity and the ability to move between different areas of knowledge, skills, and perspectives to create something new and innovative. For this study, the level of flexibility among bumiputera Form 4 chemistry students in rural Sabah is shown in Table 3.

Table 3: Descriptive Findings and Analysis of the Flexibility Domain

Questions	Highest Scores	Lowest score	Mean	Standard Deviation
1b	8	0	1.58	1.35
5	5	0	2.00	1.19

Based on Table 3, the questions asked in the creativity test are to ask students to explain on the chosen solution based on the chemical concepts for question 1b. Meanwhile, question 5 asks students to elaborate or explain the appropriate solution to a given problem. The mean score scored by students in the creativity test was 1.58 and 2.00 for the questions respectively. For question 1b, the highest point value obtained is 8 while question 5 is the highest point value obtained by students. The average mean value obtained by the whole of these students shows that overall, these students are in the low-level category of the flexibility domain. The standard deviation values for these two questions were also 1.35 and 1.19 respectively. This high standard deviation value also indicates the student's level ranking in large variation.

The level of creativity of Sabah rural students expressed in the study of Ambo et al. (2019) also stated that the flexibility domain of these students is low. The findings of this study show that Bumiputera Chemistry students in rural Sabah face great challenges in developing their thinking flexibility. One of the main factors is the lack of adequate learning resources, such as incomplete laboratories, limited teaching materials, and difficult internet access (Al-Worafi, 2024). All this makes it difficult for them to delve into the subject of chemistry more creatively and in-depth. Additionally, a more teacher-centered approach to teaching makes students rarely given the opportunity to think critically and find solutions in their own way (Yulianto et al., 2024). Coupled with a lack of self-confidence and motivation, students face difficulties in facing more complex learning challenges, thus preventing them from reaching their full potential in chemistry.

Domain Originality

The domain of originality in the context of creativity refers to a person's ability to come up with an original or unique idea, solution, or product. It emphasizes the ability to create something new, not just imitate or repeat something that already exists (Torrance 1974). In this sense, originality is closely related to innovation, in which the individual seeks to create something completely new and valuable. In this study, the level of originality domain among bumiputera chemistry students who are in rural areas is shown in Table 4 below:

Table 4: Descriptive Findings and Analysis of Originality Domains

Questions	Highest Scores	Lowest score	Mean	Standard Deviation
3a	2	0	0.84	0.72
6	4	0	3.47	0.95

Based on Table 4, the findings and analysis for the level of originality domain among Bumiputera chemistry students in rural Sabah. The questions shown in question 3b and question 6. In question 3b, ask students to draw a diagram that they understand about a given chemical reaction. While question 6 asks students to make a short story related to the concept of chemistry based on the statement given. The average mean for these two questions was 0.84 and 3.47 respectively with the highest score scored by students 2 and 4 for the questions respectively. For the originality domain, the mean score which indicates non-unique originality is that almost all students only produce the same answer and there is no uniqueness for each student's question. This standard deviation of 0.72 and 0.95 also indicates that the levels of these students are almost homogeneous, and the variation is concentrated on the mean score. This implies that almost all students have the same answer. Therefore, this study found that the level of student originality was low.

The low and medium level of the authenticity domain of Sabah's rural chemistry students is indeed influenced by various factors, both external and internal. This is a challenge for these rural Bumiputera students in Sabah to compete for better quality education. Therefore, teachers need to be aware of this situation and adapt teaching approaches that are more suitable for the needs of students (Tomlinson, 2001). Heading and Loughlin (2018) also stated that teachers' teaching methods should be implemented based on the materials around them. This provides students with the opportunity to relate learning theories to their real daily lives. Experiential learning introduced by Kolb (1984) is very helpful for students and teachers to exploit their environment. Thus, students' social and intellectual development can be developed to support students' motivation to deepen their learning in chemistry. However, this situation requires the encouragement and guidance of teachers to increase students' interest and confidence in producing students' creativity in their learning.

DISCUSSION

Although the study on the level of creativity of rural Sabah Bumiputera chemistry students is not clearly stated, a study by Adam et al. (2022) states that there are many challenges faced by students in the learning process. The study of Adam et al. (2022) is also in line with what Yahaya and Hasan (2014) have discussed about challenges such as laboratory conditions, management problems, teachers' confidence in teaching, and chemistry class time constraints among the things that are of concern in the development of the chemistry curriculum. In Chemistry's DSKP (2018) proposes 3 hours a week of chemistry learning in class. However, this allotted time is not enough for students and teachers to master 8 learning chapters in 1 year in form 4.

Irawan et al. (2024) found that the main factors that affect the level of creativity of these students are knowledge, thinking skills, personality, motivation and environment. It is clear that the environment of rural Bumiputera students in Sabah greatly influences the skills and level of creativity of students. The situation of rural Sabah students who lack infrastructure and are still strong with local customs and beliefs has an impact on the way students think. However, the conditions of the students' learning environment, including the guidance and encouragement of teachers and access to learning resources, have helped to improve students' learning to some extent. A study by Sari et al. (2024) also states that teachers are facilitators who increase

students' interest and motivation in class. Similarly, Ajisoka et al. (2024) emphasized that the use of digital in education plays a very important role in improving teaching and learning in the classroom and further improving teachers' skills. Similarly, a study by Barley and Beesley (2007) states that factors such as environment, teachers, and family influence the success of outstanding students in rural areas to determine the excellence of those students.

The implication for chemistry learning in rural areas is the development of a more contextual and relevant approach to students' situations. Limited environmental conditions require the use of available resources, such as simple experiments with surrounding materials. Teachers need to provide more guidance to improve student understanding. Limited access to technology and learning materials can affect students' creativity and motivation. A study by Sari et al. (2024) emphasizes the important role of teachers in creating a supportive learning environment and providing access to students, even in disadvantaged areas, to improve learning and academic achievement.

Thus, the formation of the KSSM curriculum that emphasizes elements such as knowledge, skills and values is emphasized in classroom teaching. Mohamad Hasim et al. (2022) suggest that STEM teaching methods are very suitable for teachers and students. STEM teaching methods such as, Project-Based Learning Method, Problem-Based Method, Inquiry-Based Method, and Game-Based Learning are among the student-centered teaching and learning methods. These methods are well suited to the environmental conditions of students in rural areas. However, teachers need to be more practical and sensitive to the student's environment so that teaching and learning materials and equipment are easily available.

CONCLUSION AND RECOMMENDATIONS

The findings of the main study showed that the level of creativity of students in all four domains was low. The domain levels of fluency, flexibility, elaboration, and originality refer to important aspects of a student's creativity. Fluentness refers to the ability to come up with many ideas or solutions in a short period of time, while flexibility refers to the ability to think in different ways and change approaches. Elaboration, on the other hand, refers to the ability to convey an idea clearly and easily understood, while originality assesses how unique and different the idea is.

Among rural Sabah Bumiputera Chemistry students with low creativity, these aspects are often limited due to the lack of access to adequate resources, experience, and guidance. In rural areas, challenges such as lack of facilities and access to technology hinder the development of students' creativity in the subject of Chemistry. However, with an experiential teaching approach, the use of readily available environmental materials, and ongoing support from teachers, students can improve their understanding and skills. Teachers need to adapt teaching methods to meet the needs of students and maximize their potential in limited circumstances.

The implication of this low level of creativity on education is the need for more emphasis on equal access to resources and technology for rural students. Education policies should prioritise the development of better infrastructure in rural areas and ongoing development training for teachers.

The low level of creativity among students has major implications for the education system, especially in rural areas. This situation underscores the need to create equal access to learning resources and technologies for rural students so that they do not continue to be left behind. Therefore, education policy should give priority to the development of better infrastructure in remote areas, such as laboratory facilities, internet access and quality learning materials.

In this context, the role of teachers is very important. Creative teachers are able to spark students' interest in subjects that are considered difficult such as chemistry. Through engaging and innovative teaching approaches, teachers can change the perception of rural students and make learning chemistry more fun and easy to understand. In addition, teachers who have experience teaching in rural areas are able to use their understanding of students' backgrounds to adapt pedagogical approaches that are more effective and contextual in nature.

Continuous professional development training should also be emphasized so that teachers can continue to empower themselves with the latest teaching strategies. Recommendations for future studies should focus on assessing the effectiveness of teaching methods in classrooms faced with resource and facility constraints. In addition, further research should focus on the role of families and communities in supporting educational efforts, in order to create a more comprehensive and conducive learning environment for rural students.

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