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VALIDITY AND RELIABILITY OF CHEMISTRY CREATIVITY TEST FOR MALAYSIAN CHEMISTRY STUDENTS

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ABSTRACT:
In this 21st-century education, the Ministry of Higher Education has highlighted thinking skills, especially creative thinking skills among Science, Technology, Engineering, and Mathematics (STEM) students. Scientific creativity is more suitable to be applied in the STEM field compared to general creativity. This study aims to describe the Chemistry Creativity Test (CCT), validity, and CCT reliability. The research used a survey design involving five experts from diverse expertise to validate the CCT. This CCT used an open-ended question, including eight items to access the fluency, flexibility, originality, and elaboration. The pilot tests' data from 27 Chemistry students are taken to analyze the reliability. The study found that the Chemistry Creativity Test can be used for the implementation of research. The reliability result from the SPSS shown that the alfa Cronbach is 0.700 after one item is deleted and became seven items in total. The implication of this study is to provide the correctness and consistency of the instrument. The tool can be applied to the research sample depending on the researchers' research's suitability.

INTRODUCTION

In this 21st-century education, creativity is one of the main elements in Science, Technology, Engineering, and Mathematics (STEM) education over the world (Byrum, 2015; Siti Najihah Binti Jamal, Nor Hasniza Binti Ibrahim, Noor Dayana Binti Abd Halim, & Muhammad Ikram Bin Alias, 2020; Shahlan, Kumin, & Ramli, 2017). Malaysia Education Blueprint 2013-2025 has stated that knowledgeable, highly skilled, highly prudent, creative, innovative, and competitive human capital can be developed by strengthening STEM education (Ministry Higher Education, 2016). Besides, STEM subjects' learning and teaching demand teachers' and students' creativity to build innovative, active, and inclusive teaching and learning for all (Muhammad Abd Hadi Bin Bunyamin, 2017). Indeed, traditional learning and teaching are irrelevant to be applied in the 21st classroom (Siti Najihah Binti Jamal, Nor Haniza Binti Ibrahim, & Johari Surif, 2019) as it is less helpful to develop students' creativity.

Newton and Newton (2014) and Siti Najihah Binti Jamal, Nor Hasniza Binti Ibrahim, Noor Dayana Binti Abdul Halim, & Johari Surif (2020) mentioned that

creativity might offer a solution to a real-world problem. The essential thinking skill to master in this revolution are creative thinking skills and problem-solving (Taufiq Hidayat, Endang Susilaningsih, Kurniawan, & Cepi, 2018). Both are related to each other to solve the exact problem. However, educators cannot understand creativity appropriately or value it strongly (Amy Azzam, 2009; Newton & Newton, 2014). In particular, there are two types of invention, which is general creativity and scientific creativity. Available creativity is commonly used to solve the arts (Amy Azzam, 2009) and language problems (Luqman M. Rababah, 2018). Meanwhile, scientific creativity is used to solve Science, Technology, Engineering, and mathematics (Sak en Ayas 2013). Hence, the development of students' creative thinking ability is emphasized in the contemporary curriculum (Sternbergn en Sternbergn 2016). In the opinion of Istiqomah, Rochmad, & Mulyono (2017), they claimed that creative thinking ability is crucial to allow students to acquire new knowledge, approach, and perspective.

LITERATURE REVIEW

The Concept of Creativity

The concept of creativity has been proven for many years, but the definition of creativity itself is difficult to understand (Amy Azzam, 2009; Hu & Adey, 2002). That statement depends on how a researcher defines creativity (Newton en Newton 2014). As early as 1960, Rapucci (quoted by Welsch, 1980) had calculated between 50 and 60 definitions of the definition of creativity. Different perceptions of the meaning of creativity have led to a variety of appropriate techniques for evaluating creativity. However, Hu & Adey (2002) have tried to trace some common themes and incorporate them into scientific creativity models. For example, many researchers combine two or more aspects of the creative process, creative product, creative person, and creative environment in defining creativity. However, this model only measures three dimensions: the creative process, creative products, and creative people. The creative environment is not emphasized as a dimension of creativity because it is quite challenging to control students (Hu and Adey, 2002). Students are categorized as creative people with personality traits such as fluency, flexibility, originality, and elaboration. Hu and Adey's creative domain is different from Torrance's creative domain, where Torrance also pays attention to another domain, which is elaboration other than fluency, flexibility, and originality. However, there are several other domains of creativity that have been renewed by some past researchers (please refer to Table 1).

Creative products consist of four problem domains: science problems, science phenomena, scientific knowledge, and product technology. The science problem in question is a problem or problem that requires scientific knowledge to solve. By presenting scientific issues to students, they can likely come up with creative scientific solutions. Scientific phenomena refer to natural physical events or events that can be explained scientifically. Johnston (2005) stated that students' science concepts daily are related to the scientific phenomena they experience in their world. Students' fluency, flexibility, originality, and elaboration are measured through their imagination in proving their understanding of scientific phenomena. Students' science imagination is judged by the quantity and relevance of their experience to the phenomenon. Scientific knowledge is knowledge gained through systematic study through scientific methods, based on evidence that can be seen and measured (Wilson 1998) and accepted by the scientific community. Scientific knowledge refers to knowledge in science-based

fields such as Physics, Biology, Chemistry, Geology, Engineering, and others. Students' fluency, flexibility, originality, and elaboration are measured through the practice of creative thinking in demonstrating their scientific knowledge. Product technical refers to science-based, which is technically engineered to perform specific tasks and is subject to innovation (Qureshi et al. 2015).

Generally, in this category of creative products, students strive to find answers to new problems rather than solve routine problems using recipes alone (Cattell, Raymond 1971). Siti Salbiah Binti Omar, Noor Dayana Binti Abdul Halim, Johari Bin Surif, & Jamaluddin Bin Harun (2013) asserted that problem-solving could lead to creativity. If there is a problem, then there is a possibility of a creative solution. According to Einstein (1952), languages such as speech or writing are not enough to symbolize creativity. It needs to be supported by the student's thought process. His statement has been endorsed by psychologists (Gardner 1983) and (Johnson-Laird 1987). In this research, the creative process consists of creative imagination and creative thinking (Hu and Adey, 2002). Hence, Figure 1 shows an overview of Hu and Adey's Scientific Creativity Model (2002).

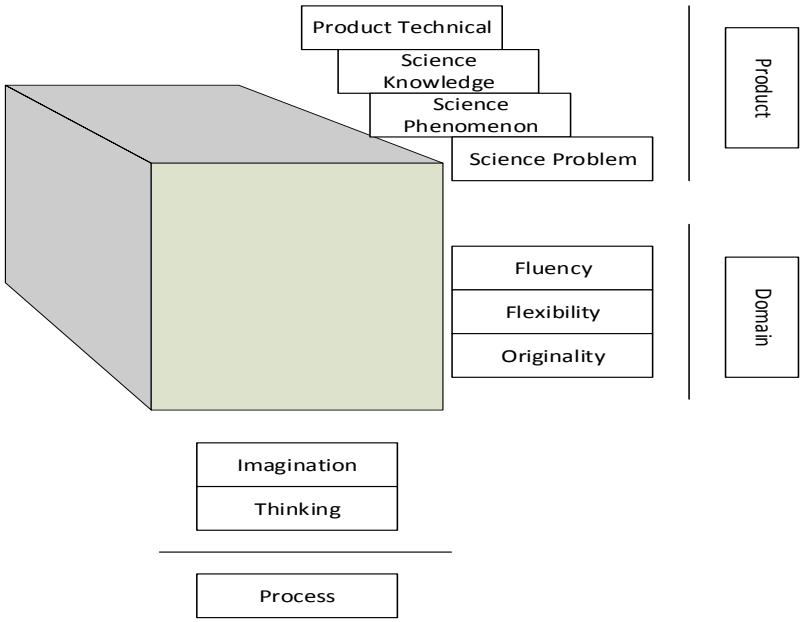

Figure 1 Hu and Adey's Scientific Creativity Model
Source: Hu and Adey (2002)

Table 1 below shows an assessment of the creativity domain used in the problem-solving STEM field by the previous researchers.

Table 1. Evaluation of Creativity Domain Used by The Past Researchers

Authors/ Years	Creative Thinking Skills/Creativity Dimension/Creativity Domain
(Eldy en Sulaiman 2013)	*The creativity dimension is fluency, flexibility, originality, and elaboration.*
(Ersoy en Baser 2014)	*The creativity dimension is fluency, flexibility, and elaboration.*
(Nurdin en Setiawan 2016)	*The creativity dimension is fluency, flexibility, and elaboration.*

(Orozco en Yangco 2016)	*The creativity dimension is fluency, flexibility, originality, and elaboration.*
(Wawan, Kurnia, en Rohaeni Nur 2016)	*The creativity dimension is fluency, flexibility, originality, elaboration, and evaluation.*
(Talens 2016)	*The creativity dimension is fluency, flexibility, originality, and elaboration.*
(Sihaloho en Ginting 2017)	*The creativity dimension is fluency, flexibility, originality, and elaboration.*
(Ratnasari, Supriyanti, en Rosbiono 2017)	*The creativity dimension is authenticity, original action, and advanced skills.*
(Nuswowati et al. 2017)	*It May have an effect, expected expectations, can be considered, express ideas, and provide explanations and actions.*
(Ratnaningsih 2017)	*The creativity dimension is fluency, flexibility, originality, elaboration, and sensitivity.*
(Sari, Banowati, en Purwanti 2018)	*The creativity dimension has summarized the problem, builds necessary skills, explains, and identifies actions.*
(Ulger 2018)	*The creativity dimension is fluency, originality, title, closing, and strength.*
(Wartono, Diantoro, en Bartlolona 2018)	*The creativity dimension is fluency, flexibility, originality, and elaboration.*

Indeed, there are many studies on the power of thinking to generate student creativity in various contexts. An example is based on the meta-analysis of Table 1. The researcher can conclude that all creativity domains, especially fluency, flexibility, originality, and elaboration, are fundamental in assessing creative thinking skills among STEM students. All these domains of creativity are evaluated after the problem-solving takes place. However, all researchers pay less attention to scientific creativity. They measured science stream students' inventions based on Torrance's general creativity tests and not based on Hu and Adey's scientific creativity tests.

According to Zeng, Proctor, and Salvendy (2011), scientific creativity tests are better than Torrance's general creativity tests if researchers want to measure student creativity in the science stream. Thus, the researcher argues that further research on high school students' creativity from science streams using scientific creativity test assessment should be implemented. This statement is also supported by a study by Hu and Adey (2002). Besides, there is lacked research on the evaluation of scientific creativity in the STEM field, especially Chemistry subjects for Malaysian High School context to support the past researchers' findings such as (Siti Salbiah Binti Omar, Jamaluddin Bin Harun, Noor Dayana Binti Abdul Halim, Johari Bin Surif, & Suraiya Binti Muhammad, 2017) and (Nyet Moi Siew, Chin Lu Chong, & Kim On Lee, 2015). Therefore, in this research, the researcher tried to study scientific creativity by developing a Chemistry Creativity Test that might be suitable for the teacher to access students' creative thinking skills.

RESEARCH METHODOLOGY

Method and Data

In this research, the experts are required to validate the draft of the Chemistry Creativity Test. There are five elements that experts need to focus on during content validation. It is learning objectives, linguistic validation, focusing on the

spelling, the instruction, the time is given, the suitability of the test in line with the syllabus, the appropriateness of scores, and the clarity of each item's meaning. In this case, the content validity must be from the experts that experts in the research areas. After completing the experts' truth, the researcher did a pilot test for students in the classroom. The collected data is then analyzed through Statistical Package for the Social Science (SPSS) for its reliability. For this research, the reliability of the Chemistry Creativity Test is tested using an internal consistency method. Figure 2 and Figure 3 have shown the validity and reliability processes. Besides, the researcher also discussed sampling and a research instrument.

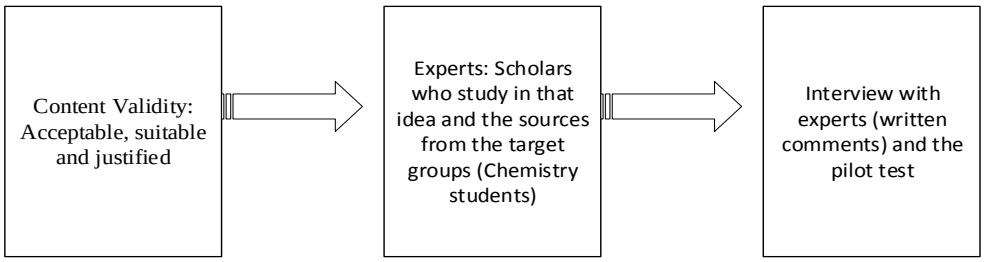

Figure 2 The Process of Validity
Source: Chua Yan Piaw (2014)

Based on Figure 2 above, the researcher underwent the contents' validity process through three phases. The first phase is preparing the form of content validity to ensure the Chemistry Creativity Test instrument is acceptable, suitable, and justified by the experts. The second phase is the researcher choose the experts from the scholars who study those ideas and target groups (Chemistry students). For example, the researcher recognized the experts in STEM education, problem-based learning, creativity, and Chemistry knowledge. The experts must have that criteria to ensure that the Chemistry Creativity Test is in line with the Form Four Chemistry Syllabus. Lastly, the researcher interviewed experts, such as the experts, written their comments, also, after doing the pilot testing with Chemistry students.

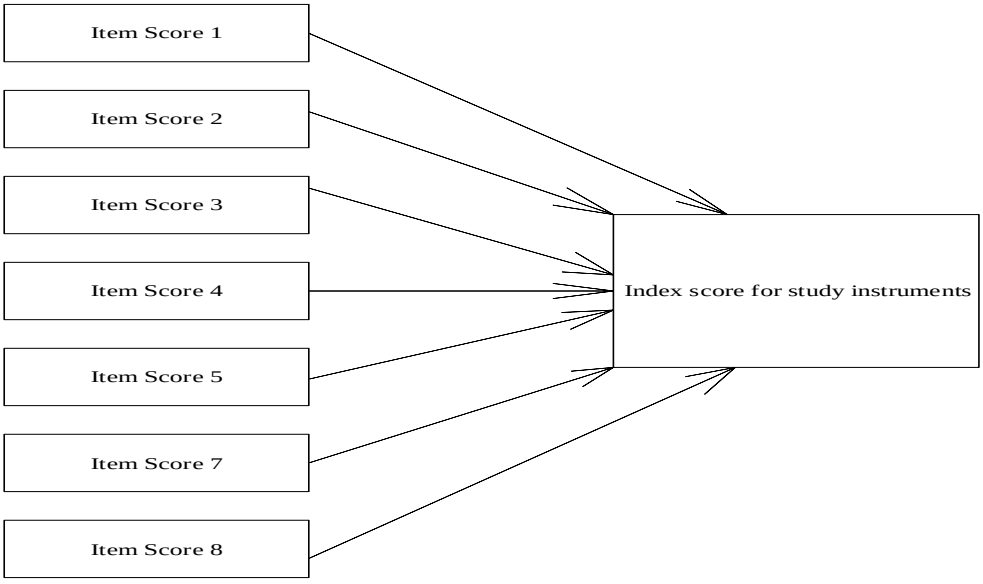

Figure 3 The Process of Reliability
Source: Chua Yan Piaw (2014)

Figure 3 has shown the process of reliability during the study. In this study, the researcher used the Cronbach method. Cronbach's strategy is the internal consistency approach that involved the correlation score value for each item in the test with a total score for all tests (test index score) (Mohamed Najib Bin Abdul Ghafar, 2015; Chua Yan Piaw, 2014). Through this method, items with high correlation value with test index scores have high reliability. In contrast, items with low correlation values have low reliability and should be removed from the test (Chua Yan Piaw, 2014).

Sampling

In this pilot study, the respondents are Chemistry students from the high school in Melaka Tengah. 27 Chemistry students are involved in answering the Chemistry Creativity Test. For the validation process, the six experts are involved in validating the Chemistry Creativity Test. The summary details of the respondents' number for each analysis in the pilot study are as shown in Table 2.

Table 2. Each Analysis of Respondents' Number in Pilot Study

The Type of Analysis	Respondents' Number	Respondents' Role
Content Validity	6	*The respondents validated the Chemistry Creativity Test (CCT) through the validated form.*
Reliability	27	*The respondents evaluated the reliability of the Chemistry Creativity Test through the Cronbach method (internal consistency approach).*

Instrument

The instrument used in this study is the Chemistry Creativity Test (CCT). The CCT consists of seven items. The first section deals with the demographic information of the respondents. The second section includes the information on the student's creativity level questions about acid and base topic. The researcher applied acid and base topics due to students' difficulty understanding and learned the acid-base compared to other Chemistry subtopics (Akani 2017). Besides, these items in CCT is adapted from the instrument of Orozco and Yangco in 2016. Also, the characteristic of scientific creativity is adapted from Hu and Adey in 2002. The researcher applied the Hu and Adeys' instrument compared to Torrance's tool in 1990. That statement is because Torrance's device is only for general creativity, not specifically science creativity. The duration time of CCT is 40 minutes. Table 3 has shown the design of items before the pilot test to measure the creativity domain.

Table 3. The Design of Items Before the Pilot Test

Operational Definition: Fluency is the ability to produce ideas quickly; Flexibility is the ability to create flexible ideas; Originality is the ability to create unique ideas; Elaboration is the ability to elaborate ideas from the original statements. Creative thinking skills are a combination of fluency, flexibility, originality, and elaboration.			
No. Items	Items (Adapted from Hu & Adey, 2002; Orozco & Yangco, 2016)	Characteristic of Items Based on Scientific Creativity (Adapted from Hu and Adey, 2002)	Creativity Dimension (Adapted from Torrance, 2006)

1.	*Usage of acid and alkali.* *Acids and bases are some of the essential chemicals in everyday life. One day, Hamizah came across a friend named Siti. Hamizah asks Siti, "Where do you want to go?". Siti replied, "Want to go to the store to find sodium chloride." Hamizah was stunned by the answer given by her friend. Then asking, "What is it?". Siti replied: "Sodium chloride is a chemical name for salt. One of its uses is to preserve food. "Now, Hamizah realizes that there are many uses of acid and alkali in everyday life. As a Chemistry student, explain to her by giving as many answers as possible to the acid and alkali in daily life for the following questions;* *Sulphuric acid:*	*Scientific Process: Thinking. Scientific Product: Science Knowledge.* *The first test item measures fluency creativity through students' creative thinking exercises to demonstrate their scientific knowledge.*	*Fluency* *The fluency seen in this question is that students can list how many answers to hydrochloric acids and ammonia in daily life.*
2.	*Usage of acid and alkali.* *Acids and bases are the essential chemicals in everyday life. One day, Hamizah came across a friend named Siti. Hamizah asks Siti, "Where do you want to go?". Siti replied, "Want to go to the store to find sodium chloride." Hamizah was stunned by the answer given by her friend. Then asking, "What is it?". Siti replied: "Sodium chloride is a chemical name for salt. One of its uses is to preserve food. "Now, Hamizah realizes that there are many uses of acid and alkali in everyday life. As a Chemistry student, explain to her by giving as many answers as possible to the acid and alkali in daily life for the following questions;* *Ammonia:*		
3.	*Produce a product or other chemical reaction.* *Last week, Hamizah and his colleagues conducted investigations to study the chemical properties of acids in chemical laboratories. Their research shows a flare-up, gas, and a 'pop' sound with burning wood. Their teacher has given them a Chemistry subject. His teacher asked him to state as much metal and acid to make a product. So, create as many products as possible answers using the materials provided. Write down how many of these chemical reactions;* *Hydrochloric acid and metal:*	*Scientific Process: Thinking. Scientific Product: Science Problem.* *The second test item, which is the domain of flexibility creativity, is measured through students' creative thinking in showing their creativity to produce products*	*Flexibility* *The flexibility seen in this question is that students can suggest as many different methods in producing a product or other chemical reaction.*
4.	*Produce a product or other chemical reaction.* *Last week, Hamizah and his colleagues conducted investigations to study the chemical properties of acids in chemical laboratories. Their research shows a flare-up, gas, and a 'pop'*		

	sound with burning wood. Their teacher has given them a Chemistry subject. His teacher asked him to state as much metal and acid to make a product. So, create as many products as possible answers using the materials provided. Write down how many of these chemical reactions; *Sodium hydroxide and acids:*	*through the reaction of materials given through chemical equations.*	
5.	*Solve the Problem.* *There are some problems that Hamizah faced;* *Lately, acid pollution has been widespread in Malaysia. Some of the contributors to this acid rain are motor vehicles, manufacturing activities, and open burning. Hamizah and other students significantly hampered this situation. That statement will affect students' health, soil and plant fertility, aquatic ecosystems, and school buildings. So, write down as many unique solutions students can suggest for this problem. How can we reduce acid rain?*	*Scientific Process: Thinking. Scientific Product: Science problem.* *The third test item, the original creativity domain, is measured through students 'creative thinking in showing students' ability to solve problems with possible unique answers.*	*Originality* *The originality seen in this question is that students can suggest a unique solution method to reduce acid rain pollution and acidity in the body.*
6.	*Solve the Problem.* *There are some problems that Hamizah faced;* *A few days ago, Hamizah suffered from gastric and vomiting. Farhana's parents took her to the clinic for treatment. The doctor advised her and gave her some oral hygiene tips to prevent the pain from happening again. So, the problem is, what are the unique tips for reducing acidity in Hamizah's body that the doctor told you?*		
7.	*Create a scientific story.* *Fauziah's teacher commissioned Hamizah to compose a creative scientific story to qualify him for a science novel. Write as much as possible in an interesting scientific story in which the maximum statement is made up of ten sentences;* *Aziem has gastritis.*	*Scientific Process: Thinking and Imagination. Scientific Product: Scientific Phenomenon.* *The four test items, namely the elaborative creativity domain, are measured through students' imagination to understand scientific phenomena.*	*Elaboration The explanation seen in this question is that students can compose a creative and scientific story based on the given statement*
8.	*Create a scientific story.* *Fauziah's teacher commissioned Hamizah to compose a creative scientific story to qualify him for a science novel. Write as much as possible in an interesting scientific story in which the maximum statement is made up of ten sentences;* *Aziemah has insect bites.*		

Measurement

The researcher also adapted Torrance's rubric scores to measure fluency, flexibility, originality, and elaboration. The researcher did not use Hu and Adey's rubric score because the rubric score did not have the elaboration indicator. So, Torrance is more relevant to use the rubric score as he has the elaboration indicator. Thus, Torrance's rubric score can guide the researcher to measure creative thinking skills in fluency, flexibility, originality, and elaboration. Table 4 has shown Torrance's rubric score before the pilot test to measure the creativity dimension.

Table 4. Rubric Scores for Creativity Dimension Before The Pilot Test

Creativity Dimension	Score	Description
Fluency	0	*Students cannot provide ideas/answers.*
	2	*Students can come up with one to two ideas/answers.*
	4	*Students can come up with three or more ideas/answers.*
Flexibility	0	*Students are not able to provide ideas/methods.*
	2	*Students can come up with one to two ideas/methods.*
	4	*Students can come up with three or more ideas/methods.*
Originality	0	*Students do not answer / general ideas / common ideas and no originality.*
	2	*Students come up with moderate unique ideas.*
	4	*Students come up with unique ideas.*
Elaboration	0	*There is no addition of ideas from students.*
	2	*The ideas from the students are less.*
	4	*Extraordinary Ideas from students.*

RESULT & DISCUSSION

The findings' validity and findings' reliability are described in the study's validity and study reliability.

The Validity of Study

According to Creswell (2014), validity means that the inference acquisition of scoring and a sample assessment is accurate and meaningful. Accordingly, a panel of assessors will evaluate this instrument's validity assessment, namely two university lecturers in education and three Chemistry teachers who have been teaching Chemistry for more than five years. After that, each evaluator panel was asked to fill in a researcher's content verification form. A discussion session between the researcher and the evaluator's board was conducted jointly to improve further and strengthen the instrument. Table 5 has shown the comments or improvements that have been made by experts.

Table 5. The Comments, Improvements, or Suggestions from The Experts

The Experts	The Comments, Improvements, or Suggestions of CCT
A *(Experience in Chemistry subject. Expert in problem-solving in*	*The instrument can be applied to the research sample.* *General comments:* *The study of objectives is suitable, the language used is applicable, the students' cognitive level is practical, the construction of constructs and dimensions is accurate, and each item's meaning is clarified. The content appropriated and met Form Four Chemistry Syllabus's requirements, the answer scheme appropriate to*

Chemistry and Creativity)	*Torrance scoring rubric for flexibility, originality, and elaboration gave. But the scoring can be adjusted after the pilot test depends on the suitability of students' respond.*
B *(Expert in Chemistry subject. Experience in STEM education and problem-based learning)*	*The instrument can be applied to the research sample.* *General comments:* *The study of objectives is suitable, the language used is applicable, the students' cognitive level is practical, the construction of constructs and dimensions is accurate, and each item's meaning is clarified. The content appropriated and met Form Four Chemistry Syllabus's requirements, the answer scheme appropriate to Torrance scoring rubric for flexibility, originality, and elaboration gave.* *The improvements or suggestion:* *Item 1 and item 2: Give an example of acid or alkali is better than sodium chloride because it is salt.* *Item 5: Acidic pollution is converted to acid rain.* *Item 6: Acidity in the body is converted to acidity in the stomach.* *Item 7 and item 8: Need to put a storytelling topic.*
C *(Expert in Chemistry subject. Experience in STEM education)*	*The instrument can be applied to the research sample.* *General comments:* *The study of objectives is suitable, the language used is applicable, the students' cognitive level is practical, the construction of constructs and dimensions is accurate, and each item's meaning is clarified. The content appropriated and met Form Four Chemistry Syllabus's requirements, the answer scheme appropriate to Torrance scoring rubric for flexibility, originality, and elaboration gave.*
D *(Expert in problem-based learning, STEM education, and creativity. Experience in Chemistry subject)*	*The instrument can be applied to the research sample after the improvement of CCT has been done.* *The improvements or suggestion:* *Item 1 and item 2: Appropriate questions to test the domain of fluency creativity. However, the narrative storytelling in the introductory part of the problem is not continuous with the question asked. What does Hamizah have to do with you as a Chemistry student, as stated in the question? Ideally, the problem is slightly modified to see the relationship between the initial narrative and the situation. For example: "As a Chemistry student who is also a friend of Hamizah, explain to her ….."* *Item 3 and item 4: This question is a bit confusing. There are three instructions or questions posed sequentially, namely:* *1. State how many metal and acid materials to produce a product.* *2. Create as many products as using the materials provided.* *3. Write down how many of these chemical reactions are:* *Examples of student answers only focus on questions number 2 and 3. The scoring rubric concentrates solely on the quantity of product production alone (focus on question number 2); what about quality? What about question number 1. Check and adjust the questions to make them more transparent and accessible for students to read and understand. Also, align the item with the scoring rubric.* *Item 5 and item 6: Appropriate questions to be used to test the domain of original creativity.*

	Item 7 and item 8: Question form is suitable for testing the domain of descriptive creativity. *However, the instructions given are less clear and confusing, especially in language and expected students. Improve the question to make it more straightforward and provide adequate information to students about what to do.*
E *(Expert in Chemistry subject, STEM education, problem-solving in Chemistry. Experience in creativity)*	*The instrument can be applied to the research sample after the improvement of CCT has been done.* *General comments:* *The study of objectives is suitable, and the language used is applicable. The students' cognitive level is practical. The construction of constructs and dimensions is less accurate, especially items three and four, and each item's meaning is clarified. The content is appropriated and meets the Four Chemistry Syllabus requirements. The answer scheme less appropriate to Torrance scoring rubric for flexibility given.* *The improvements or suggestion:* *Since bilingual questions, front-page instructions should also be bilingual.* *Item 1 and item 2: Suitable for use, but it should be noted whether students should not list the benefits of sulfuric acid or ammonia due to students not knowing or not being creative. What are the methods to avoid such bias? Is it possible to use only acids and alkalis without having to be specific to certain types of acids and alkalis?* *Suggestions:* *1. If you want to use the existing situation, please make the conversation in the form of dialogue so that it is easier to read and understand.* *2. It is enough to say that alkali acid is widely used in daily life. Among the uses of acids and alkalis in general in everyday life are …… As a chemistry student, give as many answers as acids and alkalis in daily life.* *Item 3 and item 4: Items cannot measure the flexibility domain. That statement because it is the same as fluency, which is how many ideas can be issued. Flexibility is how many categories students can generate from their list of answers.* *Suggestions:* *1. Can study the flexibility domain based on question 1 only. Categorize the use of acids and alkalis to, for example, food, industry, household products, and others.* *Item 5 and item 6: Suitable for testing the authenticity domain.* *2. Can use this question to test the domain of fluency and flexibility. Fluency is tested by how many ideas the study participants can list. Flexibility is tested by how many categories can be created from student answers. Authenticity is tested by identifying students' unique visions.* *Item 7 and item 8: Items are suitable for testing descriptive domains. However, it gives a 'hint' to students to answer question 1.*

	The situation given is not appropriate. Perhaps it is 'you' yourself who is instructed to write scientific writing and not Hamizah. *Suggestions:* *Domain descriptions can also be studied using solution questions to acid rain how participants describe their answers. If the participant only answers short replies, such as neutralization, the participant does not have a descriptive domain. But if participants explain 'acid rain is acidic, rainwater reacts with acidic gases present in the air. It is, therefore, necessary to neutralize the gases before they are released into the air.' Such answers can be categorized as having a descriptive domain.*
F *(Experience in Chemistry Education)*	*The instrument can be applied to the research sample after the improvement of CCT has been done.* *General comments:* *The learning objectives, linguistic validation, spelling, instruction, and time are suitable. The questions developed to correspond to the domain of fluency tested. What about scoring for students who do not generate wrong ideas or answers? Is a score of 0 calculated?* *The improvements or suggestion:* *1. I suggest putting a scoring rubric of 0 for students who answer incorrectly or do not generate ideas.* *2. Because this test is evaluated using scoring, I suggest putting the number of answers or marks needed for students to give ideas.*

Based on the table above, the researcher checked all the experts' comments and suggestions. Upon completing the discussion with the experts and pilot testing, the researcher amended existing items. Finally, the finalization of items and rubric scores have been made. The completion of items and rubric scores are shown in Table 6.

Table 6. The Finalization of Items and Rubric Score After the Validation and Pilot Test

No. Items	Items (Adapted from Hu & Adey, 2002; Orozco & Yangco, 2016)	Rubric Scores for Creativity Dimension (Adapted from Torrance, 2006)
1.	*The usage of acid.* *Acids and bases are one essential chemical in everyday life. One day, Hamizah came across a friend named Siti. The following is the situation of a dialogue between Hamizah and Siti;* *Hamizah: Where do you want to go? Siti: I want to go to the store to find acetic acid. Hamizah: What is it? Siti: Acetic acid is a chemical compound of organic acids known as sour taste and aroma in foods. One of*	*The scoring rubric for the domain of fluency creativity is stated as below;* *The score of 0: The students unable to provide ideas/ incorrect answers. The score of 1: The students can produce one idea correctly. The score of 2: The students can create two ideas accurately. The score of 3: The students can create three ideas correctly The score of 4: The students can produce four or more ideas correctly.*

	its uses is to preserve in a pickle. *Hamizah: Oh! I see.* *Hamizah realizes that there are many uses of acid and alkali in everyday life. As a Chemistry student who is also a friend of Hamizah, give examples of acids. Explain to her by providing as many answers as possible to applying acid in daily life.* *The example of the type of acids and its application:*	
2.	*The usage of alkali.* *Acids and bases are some of the essential chemicals in everyday life. One day, Hamizah came across a friend named Siti. The following is the situation of a dialogue between Hamizah and Siti;* *Hamizah: Where do you want to go?* *Siti: I want to go to the pharmacy to find aluminum oxide.* *Hamizah: What is it?* *Siti: Aluminium oxide is a substance that can be used to produce antacid. The function of antacid is to reduce the gastric pain in our stomach.* *Hamizah: Oh! I see.* *Hamizah realizes that there are many uses of acid and alkali in everyday life. So, as a Chemistry student who is also a friend of Hamizah, give examples of alkalis types and explain to her by providing as many answers as possible to applying alkalis in daily life.* *The example of the type of alkalis and its application:*	
3.	*Produce the product or other chemical reactions.* *Last week, you and Hamizah had been investigating to study the chemical reactions of acids in the chemical lab. Later, you and Hamizah are asked to write down as many different balanced chemical reactions as possible based on these materials provided;*	*The scoring rubric of the flexibility creativity domain is stated as below:* *The score of 0: No idea of the students' chemical reaction category or wrong answer.* *The score of 1: One idea of the students' chemical reaction category and the vision is corrected.*

	Hydrochloric acid and metals:	*The score of 2: Two ideas of the students' chemical reaction category and the views are corrected.*
4.	*Produce a product or other chemical reactions.* *Last week, you and Hamizah had been investigating to study the chemical reactions of acids in the chemical lab. Later, you and Hamizah are asked to write down as many different balanced chemical reactions as possible based on these materials provided;* *Sodium hydroxide and acids*	*The score of 3: Three ideas of the students' chemical reaction category and the views are corrected.* *The score of 4: Four or more ideas of the students' chemical reaction category and the views are corrected.* **The category ideas are based on the metals (reactivity series of metals). The category of metals is the least reactive, decreasingly reactive, increasingly reactive, and most reactive.* **The category ideas are based on the acids (the strength of acids). The category of acids is a powerful acid, strong acid, weak acid, and very weak acid.*
5.	*Solve the Problem.* *There is a problem that you and Hamizah faced; Lately, acid rain has been widespread in Malaysia. Some of the contributors to this acid rain are motor vehicles, manufacturing activities, and open burning. You and Hamizah significantly hampered this situation. That statement will affect students' health, soil and plant fertility, aquatic ecosystems, and school buildings. So, you and Hamizah need to write down as many unique solutions that can suggest problems with reducing acid rain?*	*The original creativity domain scoring rubric is stated as below;* *The score of 0: No unique idea generated by the students or the wrong answer.* *The score of 1: General idea of the ideas is not cleared, but the vision is corrected.* *The score of 2: The students' ideas are medium unique, and the views are corrected (the same number of ideas produced by seven and above students).* *The score of 3: The students' ideas are medium unique, and the views are corrected (the same number of the opinions created by two to six students.* *The score of 4: Unique idea and the views are corrected (Unlike other students' opinions).* **From the above scores, the idea's highest marks are chosen as the students' originality.*
7.	*Create a scientific story.* *Fauziah's teacher commissioned you and Hamizah to compose a creative and scientific story (science-fiction storytelling) entitled the application*	*The scoring rubric of the elaborative creativity domain is stated as below;* *The score of 0: No addition of science ideas by the students or wrong answers.*

	of acid and base in everyday life to enable her to compete in science novel writing. So, you and Hamizah are asked to describe and develop the storyline as described below; *Aziem has gastritis.*	*The score of 1: One addition of science ideas by the students and the scientific opinion is corrected.* *The score of 2: Two addition of science ideas by the students and the science ideas are corrected.* *The score of 3: Three addition of science ideas by the students and the science ideas are corrected.* *The score of 4: Addition of more than four science ideas by the students and the science ideas are corrected.* **The students can get the points if they explained as following; the cause and effects of gastritis/bitten by a spit/sting bite; how the scientific process of gastritis/gets bitten by a spit/sting bite; how to overcome gastritis/gets bitten by a spit/sting bite; and the lesson of the storyline.*
8.	*Create a scientific story.* *Fauziah's teacher commissioned you and Hamizah to compose a creative and scientific story (science-fiction storytelling) entitled the application of acid and base in everyday life to enable her to compete in science novel writing. So, you and Hamizah are asked to describe and develop the storyline as described below;* *Aziemah gets bitten by a spit / sting bite.*	

The Reliability of Study

In this pilot study, the respondents involved a total of 27 Chemistry students. Figure 4 and Table 7 shows the results of the reliability analysis after the pilot test.

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Item 1	19.11	19.256	.380	.641
Item 2	20.04	21.729	.344	.649
Item 3	18.04	15.191	.695	.533
Item 4	18.89	18.256	.391	.642
Item 5	18.70	23.447	.236	.669
Item 7	17.59	23.712	.333	.661
Item 8	18.37	18.781	.510	.605
Item 6	18.59	24.328	.062	.700

Figure 4 The Reliability Analysis-Scale (Alpha)
Source: SPSS processed data

Table 7. The Reliability Analysis of Items

Cronbach Alpha	Total of Items
.674	8
.700	7

Based on the analysis results, the Cronbach's alpha reliability coefficient for the eight items is .674. This reliability value is unsatisfactory. However, looking at the value of "Alpha if Item Deleted," it is found that if Item 6 is removed, the alpha reliability coefficient will change to .700. The correlation value can explain this situation between these items with a weak index of study instruments .062.

This low correlation indicates that these six items are less uniform with the other items in the study instrument.

After Item 6 is removed, the alpha coefficient changes to .700, and the value of "Alpha if Item Deleted" for all other items is lower than .70. That statement means the alpha coefficient will no longer increase with any entity. The researcher reported the study instrument's high reliability for this study instrument (alpha coefficient = .700), which contains seven items, namely items 1,2,3,4,5,7, and 8. Cronbach's alpha coefficient from .65 to .95 is considered satisfactory (Chua Yan Piaw, 2014). This statement is also supported by (Hinton *et al.*, 2014; Creswell, 2014; Johnson and Christensen, 2017). They say that Cronbach's alpha values of .70 to .90 are considered acceptable and have high reliability. That statement because Cronbach's alpha value depends on the total number of items in the question and the respondents' total number (Hinton et al. 2014). So, all these items can be accepted and used in actual research.

CONCLUSION AND RECOMMENDATION

Conclusion

This paper focuses on the validity and reliability of the Chemistry Creativity Test (CCT) as an instrument for the research. In particular, it aims to study instrumentation development. According to past researchers, the development of the tool has four principles. The principles are objectivity, validity, reliability, and usability (Mohamed Najib Bin Abdul Ghafar, 2015; Black, Harrison, Lee, Marshall, & William, 2003; Bridges, 2007; Cohen, M. L, & Morrison, 2007). This Chemistry Creativity Test has the purpose of measuring the chemistry students' level of creative thinking skills. Creative thinking skills included fluency, flexibility, originality, and elaboration. In this study, the Chemistry Creativity Test's primary source is an adaptation from Hu and Adey in 2002 and Orozco & Yangco in 2016.

Meanwhile, the rubric score for Chemistry Creativity Test is an adaptation from the Torrance in 2006. The researcher is adding items and scores suitable for the target population. Next, the CCT and the rubric scores are provided with evidence on validity and reliability. The truth of the Chemistry Creativity Test is content validity. To prove high content validity, the researcher has reported in the research reports on the researcher's followings. Firstly, the researcher acquired the experts' opinions and views in the area discipline, sourced from the literature reviews and interviews—secondly, the sources from the pilot studies. Besides, the researcher provided statistical evidence to prove the internal reliability of the Chemistry Creativity Test. The sample survey findings confirmed that the instrument could be applied to the research sample and homogeneous items. The reliability analysis-scale (Alpha) has shown that Cronbach's Alpha is .700, which is accepted and moderate or high reliability. There is much debate among researchers as to where appropriate cut-off points are for reliability. In particular, reliability will depend to a certain extent on the number of items in the test and the number of participants. However, Hinton and his colleagues have suggested a useful guide for reliability. The following: 0.90 and above shows excellent reliability; 0.70 to .90 shows high reliability; 0.50 to .70 shows moderate reliability; 0.50 and below shows low reliability. Otherwise, the Cronbach's Alpha between .65 to .95 is satisfied, and the items can be used (Chua Yan Piaw, 2014).

RECOMMENDATION

The apparent limitation of this study is the sample size. The examined sample of Malaysian Chemistry students is tiny. Future studies should have a broad sample sampling so that the results of the course can be generalized. Furthermore, various real-world problems covering other subjects such as Physics, Biology, Engineering, and Mathematics are needed to measure creative thinking skills. Also, only one country is focused on this study. Future researchers should extend the examined sample and cover cases from different countries for a prospective study. Future research can also use all the items to measure fluency, flexibility, originality, and elaboration.

Nevertheless, the researcher hoped that the discussion and the pilot study could help the other researcher understand the instrument's validity and reliability. Notably, current research gives teachers insight into applying this Chemistry Creativity Test to access the students' creative thinking skills, not just to access the achievement of Chemistry only. The other researchers can also adapt this tool for further study, specifically in problem-solving, scientific creativity, and creative thinking skills.

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