

Comparing Models to Assess Creative and Critical Thinking in Vocational College Student

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ABSTRACT

Creative and critical thinking are the two abilities required to grasp the opportunities and to upper-hand the challenges in the current digital era. Both complement each other. However, the assessments that involved both aspects of ability in one package are relatively limited. Further exploration is needed to develop new assessment model. The construction of the model begins with literary studies, develop, and try out the model. There are six constructions composed as the procedural framework, and another one for creative thinking: (C1) Parse, (C2) Deviate, and (C3) Modify, while the ones for critical thinking are : (C4) Verify, (C5) Compare, and (C6) Conclude. There are three assessment models that were feasible to be developed which refers to the 6 sub-variables: Self-Assessment, Multitype Objective Test, dan Problem Solving Case Study. The models have been tested on 32 informatics students, Hasnur Polytechnic, Indonesia. It turned out that the problem solving case study was no longer reliable, the best option were only Self-Assessment and Multitype Objective Test. The findings show that with Kruskal Wallis there are significant differences detected based on the assessment results among the models. So Multitype Objective Test is considered to be the best option.

Keywords: Creative Thinking, Critical Thinking, Self-Assessment, Multitype Objective Test, Problem Solving, Case Study.

INTRODUCTION

Creative and critical thinking ability is acknowledged as the most essential abilities based on the majority of previous studies. Both are the abilities that considered very important to have in gaining the opportunities and facing the challenges in the digital era. Creative thinking allows create new innovations of opportunities and creative thinking also helps us to come up with solutions to life challenges that is getting more complex by the day. As presented below in table 1 are the differences between creative thinking and critical thinking. The characteristics separate each of those two abilities are shown in the following table in order to understand the concept easier (DiYanni, 2016).

Table 1. Creative Thinking Vs Critical Thinking

Creative Thinking	Critical Thinking
Intuitive	Analytical
Taking action in a spontaneous and random moves	Taking action in an orderly and logical move
Innovation	Problem Solving
Finding a method in order to gain more than what have been achieved	Finding a method on achieving the expectation results that was failed to gain
Alternative Making	Decision Making
Aiming at creating a various alternatives	Aiming at making a decision out of several alternative choices
Possibility	Probability
Taking action without any definite assurance	Taking action based on a definite assurance
Imagination	Data
Based on an imagination to be proved in the future	Based valid data gained as the proof
Divergent	Convergent
Deconstruct one unity into several different parts	Combining differences into one unity
New Direction	Right Direction
Avoiding the previous direction to explore the new one	Avoiding wrong direction to reach onto the right direction
Lateral	Vertical
Finding solutions in an abnormal or uncommon method	Finding solution in a normal method that commonly used

Based on the explanations above, we can conclude the definition of each ability as follows: Creative thinking is the ability to create a brand new alternative of method through spontaneous, random, and divergent thinking, it is created based on imagination and relatively non-general method that has never been proved of its efficacy before. Meanwhile, critical thinking is the ability to determine a problem solving method through an orderly, logical, and convergent thinking, created based on data and general solution that has been tried out before.

UNESCO (2014) suggested that, previously, the focus of assessments in the traditional academic knowledge was too narrow and should be shifted into creative and critical thinking abilities. There have been previous studies that partially discussed about the assessment on creative and critical thinking. The studies generally aimed at (1) measuring the creative and critical thinking ability using the existing instrument or by developing a new instrument, or (2) testing the validation of an existing instrument using correlational and factor analysis. Each of the instruments has its own characters as it is adjusted with the subject. In the context of problem solving, the assessment for creative and critical thinking is best to be carried out in one package. If it only concerns to creative thinking, the solution created will not always successfully solve the targeted problem, so does with critical thinking, when it becomes the sole parameter then the alternatives of solution will not be as varied for the targeted problem solving.

The research that combines the assessment for both creative and critical thinking in one package is relatively very limited but very necessary. Piaw (2010) combined creative and critical thinking assessment using a test containing multiple choice questions. Every selection of answers in the questions encompasses a linear scale, whether the subject tends to think creatively or not, under the concept that both are not correlated. This belief is quite the opposite to some other statements which argued that

creative thinking and critical thinking are moderately correlated (Wechsler et al., 2018) and positively correlated (Tsai, 2019). Even though these two abilities are two separate features or even have backlashing natures, however both actually complements each other (DiYanni, 2016). Therefore, the measurement of both abilities should not be assessed separately but side by side instead. Another study which combines the assessment for creative and critical thinking is the one conducted by Shively, Stith, & Rubenstein (2018) where the assessment was carried out using the framework of Design Thinking that includes the five stages of : empathize, define, ideate, prototype, and test.

Other than the two assessment model above, the assessment collaboration between creative and critical thinking was also conducted by Herpiana & Rosidin (2018), they tried to develop an early product and the research was continued to testing the product (Herpiana et al., 2019). The research focused on physics, however the detail of the form of questions administered during the test was not explicitly explained. Other studies, such as the one by Priyatni & Martutik (2018) composed several essay questions and the answer was measured by determining whether it contains the six objectives test. A scoring rubric was also prepared to give the score of 0-4 for every test objective. Priyatni & Martutik (2020) made some alterations on their test objectives though the number of the questions remains 6 items. Question in the form of essay was also implemented in the study by Suyana, Nadaipah, Sinaga, & Feranie (2019) that blends it in scientific context by utilizing the rubric of Scientific Structure Creativity Model (SSCM) and Assessment of Critical Thinking Ability (ACTA).

Based on the discussions regarding the previous studies on this grounds, it can be concluded that the type of questions used for the assessment are multiple choices and essay, also the questions formulated based on design thinking framework. Further exploration is still required to develop a new model. More importantly, it is essential to develop an assessment with a different type of questions but still emphasizing the framework that is easy to understand as design thinking. Hence, this study aims at developing an assessment that meets those expectations above, continued by testing out. The validity and reliability of each model will be measured so that it can be decided which one can be used. Valid and reliable models are then compared whether there is a significant difference or not, if not then several assessments can be used, but if there is one then only one model can be used.

Literature Review

The conceptual development of the model is carried out through Literary Review Studies in order to analyse the theory and the previous studies concerning this matter Articles that specifically discuss about the assessment on either creative thinking or critical thinking was collected. The articles collected are those issued in a reputable journal according to Scopus Index published within the range of 2010 to 2020. On creative thinking, the assessment is carried out using existing instruments such as Torrance test of Creative thinking (TTCT) Form A Figural (Krumm, Arán Filippetti, et al., 2016) and form B Verbal (Krumm, Aranguren, et al., 2016).or developing their own

instruments such as: DTCT (Hawthorne et al., 2016), WCR (Pizzingrilli et al., 2015), and Five-Dimensional Model of Creativity (Lucas, 2016). On critical thinking, assessment was also carried out using existing instruments such as SOLO taxonomy (Rickles et al., 2013), DEAL (Odom et al., 2014), AAC&U (Heinrich et al., 2015), CCTST & HSRT (Peeters & Boddu, 2016), and CCTDI (Mahmoud & Mohamed, 2017) or developing their own instruments such as: SSACT (Khoiriyah et al., 2015), CTEM (Tiruneh et al., 2017), CriTT (Stupple et al., 2017), N-CT-4 Practice (Zuriguel-Pérez et al., 2017), and ELIPSS Rubrics (Reynders et al., 2020).

The sub-variable that construct the creative and critical thinking in of the articles were analysed, the citation of the sub-variable were also investigated to find the main source of reference. Among all of the literatures that had been reviewed, three main sources of reference on creative thinking and another three for critical thinking were selected. For creative thinking, the main reference is from Lipman (2003), Torrance in Rad et al (2010), and Pizzingrilli et al (2015). However, it was difficult to find the initial reference for Torrance, so the article belongs to Rad et al was selected as the reference. On the other hand, for critical thinking, the main references are from Watson & Glaser (2010), Davies (2015) and Facione (1990). Creative thinking is the initial process in creating various solutions to be carried out, while critical thinking is the latter process in selecting the most appropriate solution to the situation.

Lipman mentioned imaginative, holistic, inventive, and generative as the sub-variables of creative thinking. While Torrance chooses Flexibility, originality, fluency, and elaboration. Then again, Pizzingrilli & Antonietti uses the sub-variable of: widening, connecting, and reorganizing. As for critical thinking, Watson & Glaser mentioned recognize assumptions, evaluate arguments, and draw conclusion or usually abbreviated as RED as the sub-variables. Davies divided critical thinking into several cognitive elements (argumentation, inference making, and reflective judgment) and propensity (dispositions, abilities and attitudes). Since the scope of this research concerned on thinking abilities, then the sub-variables selected were only from cognitive dimensions. Later on, Facione mentioned these following sub-variables as the element of critical thinking: interpretation, analysis, evaluation, inference, and explanation. Facione took six cognitive skills for critical thinking that became the consensus in Delphi research study by the American Philosophical Association in 1990, but Facione did not include the element of Self-Regulation as part of the developed construct.

Based on the literary review it is formulated that Parse (C1), Deviate (C2), and Modify (C3) serve as the sub-test in creative thinking. The correlation among the three previous theories is illustrated in figure 1. Meanwhile, Verify (C4), Compare (C5), and Conclude (C6) are selected as the sub-test for critical thinking, and the correlation among the three previous theory is illustrated in figure 2.

RESEARCH METHOD

The study began with the initial stage that is developing the alternative instrument by referring to the framework which has been developed based on literary studies. After that, all the alternatives were tested using Google forms in which every alternative was

tried out with one week time frame. The subjects who participated in the research were the students of Informatics Engineering from Hasnur Polytechnic, South Kalimantan, Indonesia, starting from those who enrolled in 2019 to 2020 with the total number of 63 students. The students of Informatics Engineering were selected as the key activity of a programmer is thinking, that was why it is deemed essential to measure their ability in creative and critical thinking. Each alternative was tested for its validity and reliability, when it had been proved to be valid and reliable, then those alternatives will be compared to each other to see if there were any significant differences in the result. If there were no any significant differences in the result, then all the alternatives are fairly applicable. Whereas when there were any significant differences detected, then the best alternatives were to be prioritized. As for the testing and comparing instruments, the data used were only those belonged to students who fully involved in all types of the assessment only. The analysis method used in comparing the instrument was Manova, but in a case where the data was not normally distributed or the variant was not homogeneous then Kruskal Wallis will be used instead.

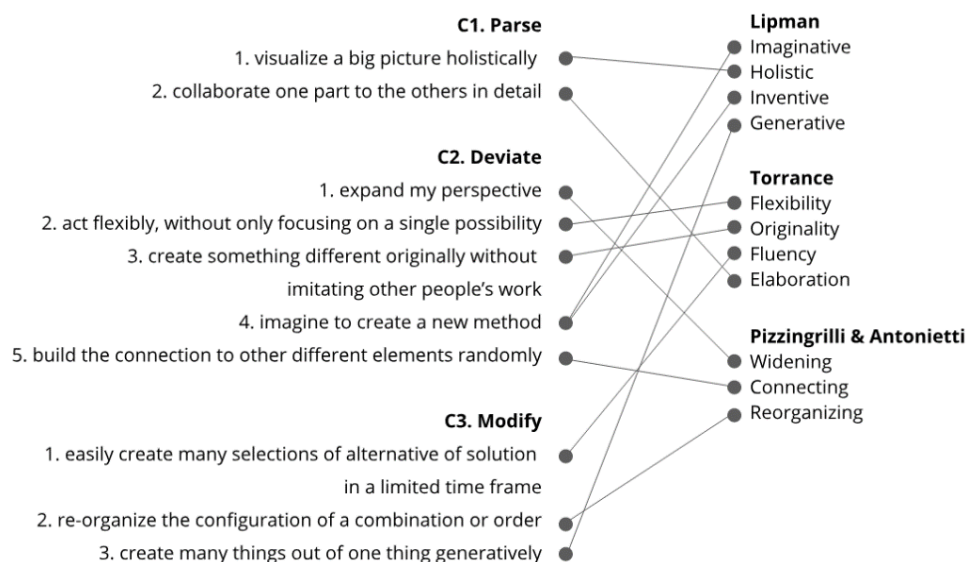


Figure.1. Construct of Creative Thinking

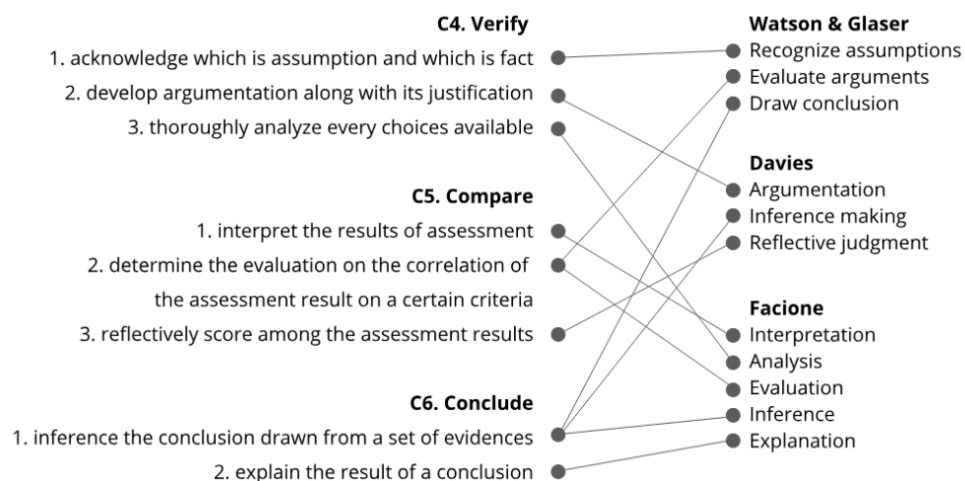


Figure 2. Construct of Critical Thinking

RESULTS AND DISCUSSION

Self-Assessment

In this particular type of assessment, the number of test participants involved were 43 people. But during the instruments test, only 32 students who were fully engaged in all the three assessments selected. A list of questions with 5 points likert scale was administered to them and they ought to choose one out of the options: 1= 'strongly not agree (SNA)', 2 = 'not agree (NA)', 3='neutral (NA)', 4='agree (A)', and 5= 'strongly agree (SA)'. The questions were arranged and classified based on the construction result acquired as shown in figure 1 and 2 and formulated into table 2.

Table 2. Self-Assessment Questionnaire

No	Item
C1. Parse	
1	I am able to visualize a big picture holistically
2	I am able to collaborate one part to the others in detail
C2. Deviate	
1	I am able to expand my perspective
2	I am able to act flexibly, without only focusing on a single possibility
3	I am able to create something different originally without imitating other people's work
4	I am able to imagine to create a new method
5	I am able to build the connection to other different elements randomly
C3. Modify	
1	I am able to easily create many selections of alternative of solution in a limited time frame
2	I am able to re-organize the configuration of a combination or order
3	I am able to create many things out of one thing generatively
C4. Verify	
1	I am able to acknowledge which is assumption and which is fact
2	I am able to develop argumentation along with its justification
3	I am able to thoroughly analyze every choices available
C5. Compare	
1	I am able to interpret the results of assessment
2	I am able to determine the evaluation on the correlation of the assessment result on a certain criteria
3	I am able to reflectively score among the assessment results
C6. Conclude	
1	I am able to inference the conclusion drawn from a set of evidences
2	I am able to explain the result of a conclusion

Validity test that was conducted using Pearson Correlation presented that there was on item, C1-1, which is invalid as it was scored 0.623. That particular item was omitted, and validity test was redone and resulted that all the items were considered valid with the Sig. value below than 0.05. On the other hand, the reliability test with Cronbach's Alpha resulted the score of 0.778 for creative thinking and 0.726 for critical

thinking. Since both were already higher than 0.6, hence the instruments were deemed reliable. The accumulation of the average from the answers to the sub-scale questions results to the calculation for the scale of ability on the sub-scale. Figure 3 presented the accumulative results of all the test participants after the invalid item being omitted. All the sub-tests, either those included in creative or critical thinking are categorized as medium. As seen in the indicator scale, the comparison of each sub-scale is presented along with the score of creative and critical thinking as calculated based on the average from each of the three sub-scales. There are four categories of result: high, medium, low, dan very low.

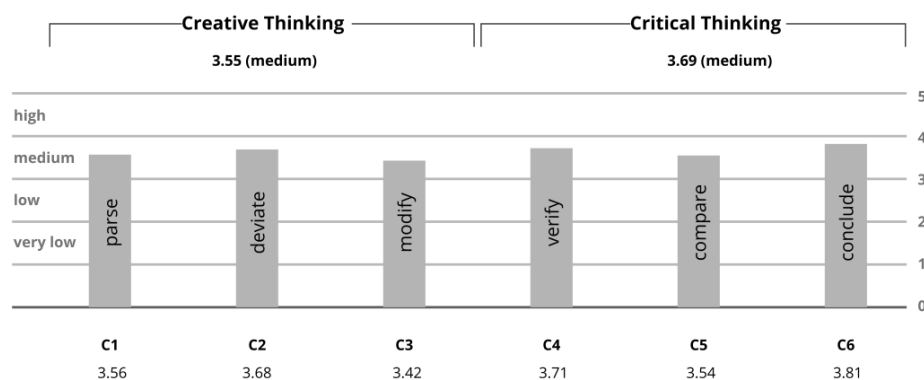
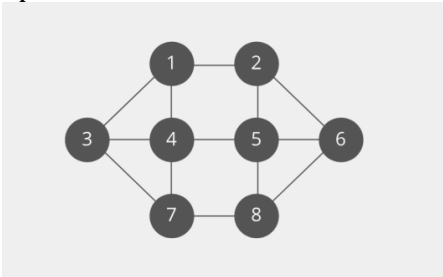
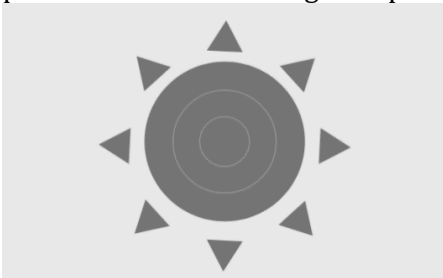


Figure. 3 Indicator Scale of Self-Assessment

Multitype Objective Test

On this type of assessment, the questions inventory on ever sub-parts are constructed in a framework, such as in Table 3. The type of questions for each sub-test is adjusted with the characteristics of sub-variable that will be constructed, in the point of creative thinking, sub-test C1 Parse, used the questions type of selection, C2 Deviate used the questions type of multiple choice, and C3 Modify used the questions type of matching. Then, in the point of critical thinking, subtest C4 Verify used the questions type of true-false, C5 Compare used the questions type of rearranging, and C6 Conclude used the questions type classifying. Questions of C1 oblige the observation upon the structure of a figure that can only be answered by a good skill of deconstructing. On questions of C2, the answer chosen by choosing the most deviant choices that can only be answered by a bravery in taking different option. Questions of C3 is answered by modifying the elements, modification means to be creative but not out of the control of concept and initial function. If C2 demanded the test taker to be deviant, C3 demanded creation from the deviant result. C4 questions can only be answered by not rushing is stating true or false, instead by testing it out thoroughly. Questions of C5 is rearranging, it it can only be answered by the skill of comparison. Questions C6 are answered by grouping, concluding it by dividing the options into two or more group of conclusion.

Table 3. Question Example

Item	Question	Answer
C1-7	Choose the best answer according to the result of the summation of the numbers that directly linked by the line. You may choose more than one answers by ticking the options a, b, c, d, or e.  A. $24 = 5+4+7+8$ B. $24 = 3+7+8+6$ C. $24 = 2+6+5+4+7$ D. $24 = 2+4+7+5+6$ E. $24 = 5+6+8+5$	A, B, C, E
C2-11	Choose one word in the options that is irrelevant to the picture. Cross one among the options a, b, c, d, or e.  A. Light B. Hot C. Dawn D. Noon E. Bright	C
C3-1	Connect them by drawing a line from the choices of answer in the left (a, b, or c) to the right (1, 2, 3, 4, or 5), connect to the set of numbers written in the opposite order 5 7 3 9 .a 5 7 3 6 .b 2 7 3 6 .c 3 7 5 6 1. 9 7 3 5 2. 5 9 3 7 3. 7 2 3 6 4. 5 3 7 9 5.	A2, A3, A5, B1, C4
C4-12	Rooster crows that the sun rises True or False?	false

C5-1	Compare and arrange them according to the month 1. Monday, 20 November 2020 2. Friday, 8 March 2019 3. Wednesday 13 July 2022 4. Tuesday 23 February 2021	4, 2, 3, 1
C6-11	Arisa and Lidia are looking for new members in their team, there are four candidates remaining. Please determine who can join to contribute be in the team of Arisa and Lidia, but Rudi should be in Arisa's team. 1. Tom, 28 years old, Programmer 2. Rudi, 17 years old, Marketing 3. Yuli, 19 years old, Marketing 4. Dina, 24 years old, Designer	Arisa's Team (2,4) Lidia's Team (1,3)

The items on the question inventory will show the dimension of the subtest that will be measured. For example, for C1-1 the item will measure the subtest of deconstructing. Every type of items will determine the type of question, such as in the multiple choice, rearranging, and classifying, etc. The test was participated by 33 people in total, but only 32 people were considered valid as for the data of the tryout as described in the self-assessment. Every sub-test consists of 8 items, thus there are 48 items, 24 were specified for creative thinking and the other 24 were for critical thinking. All those 48 question items were collected from the question bank which had been assessed by 3 expert validators in advance. Only questions that are deemed valid without any revision required used in the test. The validity test using Pearson Correlation proved that several items were considered invalid and 15 items remains for creative thinking, such as: 4 items in C1. 3 items in C2, the complete set of 8 items in C5, as well as 3 items in C6. The Reliability test using Cronbach's Alpha resulted to the score of 0.860 for creative thinking and 0.863 for critical thinking, since both were higher than 0.6 then all the instruments were proved to be reliable. After the assessment conducted, the combined score is gained, the skill of critical thinking in the level of high, medium, low and very low. The indicator scale on the assessment of such type is similar with the self-assessment but it is a little different on the group score range as seen in Figure 4. High level is classified in the range score of 100-75.01, medium is in the range of 75-50.1, low is in the range of 50-25.01 and very low is in the range of 25-0. The perfect score is 100 and the lowest score is 0. The final score gained from the percentage of the point from correct answers divided with the total points of all the sub-variable. Same with the self-assessment, the score of critical and creative thinking is calculated from the average of the three subtests. Figure 4 is the result accumulation from 32 test participants. They were graded low for creative thinking and medium for critical thinking. These results were calculated only based on the valid items.

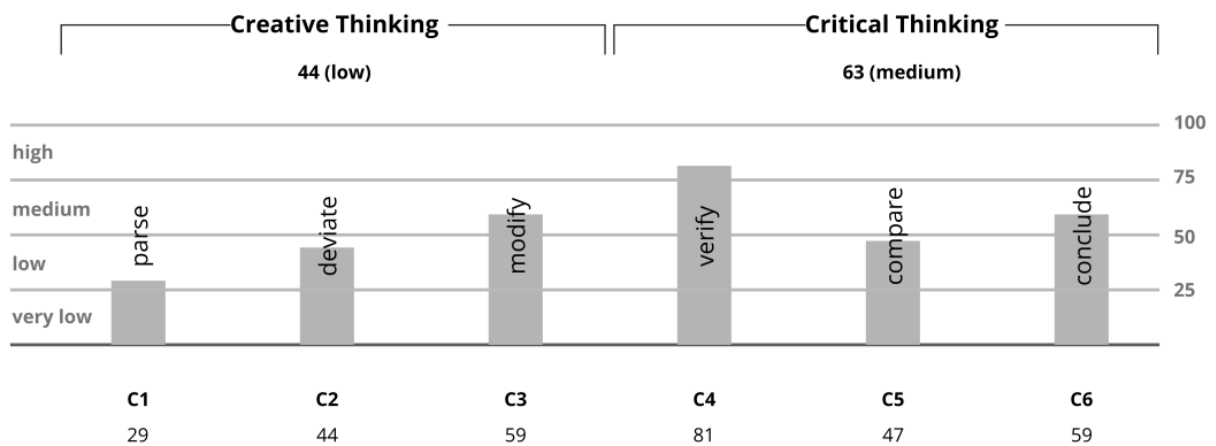


Figure 4. Indicator Scale of Multitype Objective Test

Problem Solving Case Study

On this type of assessment, Creative Critical Canvas sheets, the example of the one filled by the participant is provided in figure 5. This sheet can be printed or manually drawn on a piece of A4 paper or even on a bigger size of paper in a landscape position. The number of participants involved in it was 40 people. However the data of the assessment participants that considered valid during the test was only 32 people as they are the ones who fully participated in all of the sessions. The list of the eligible participants is similar to the ones in the previous assessments. They were given a case study to fill out all the six columns in order to create solutions to the problem. We testes them with one case “I find it difficult to fulfil the need to drink 2 litres of water a day”.

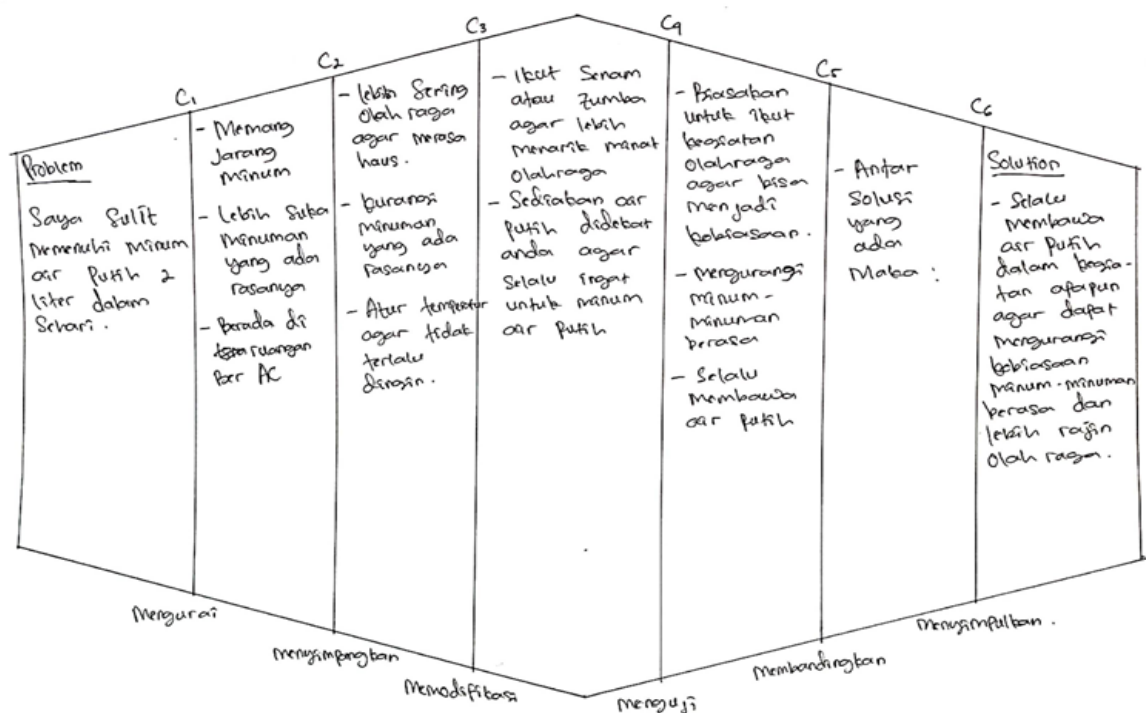


Figure. 5 Creative Critical Canvas

Table 4. Rubrics of Creative Critical Canvas

Aspect	0	2	4
Creative Thinking			
C1. Parse	Unable to fill in the answers	Able to fill in the detail, but some parts are incomplete	Able to fill in the detail completely and able to find the troubling part
C2. Deviate	Unable to fill in the answers	Able to replace the troubling place with other thing, but there is nothing new and still too general	Able to replace the troubling part with other thing that is new and specific
C3. Modify	Unable to fill in the answers	Able to create only one variation from the deviant result	Able to create multiple variations from the deviant result.
Critical Thinking			
C4. Verify	Unable to fill in the answers	Able to discover one variable (the "what" or "how") in testing the created variation	Able to discover the variables of what and how in testing the created variation
5. Compare	Unable to fill in the answers	Able to rearrange based on the testing result	Able to rearrange based on the testing result while considering various criteria
C6. Conclude	Unable to fill in the answers	Able to draw conclusion of the solution chosen according to the comparison	Able to draw conclusion of the solution chosen according to the comparison after classifying

The column on Creative Critical Canvas enlarges from the left side to the middle part and then shrinks to the right side. This indicates and directs the participants in creating various alternative solutions divergently, which then at the end used to decide the best convergent solution. The scoring will be done to each column with the range of score of 0 to 4, referring to the rubric provided in Table 4. Creative Critical Canvas filled and assessed by 4 lecturers. The indicator scale on this type of assessment is the same with the two previous assessment, it is only that there are difference on the scale of scoring range from 0 to 4 like provided in Figure 6 that is adjusted to the rubric.

The validity test consisted of 4 questions in the form of likert scale ranging from 1 (very disagree) to 5 (very agree) directed to the experts, those were: (1) This creative critical canvas is easy to understand and use, (2) The scale used in this rubric provides clear difference in grading, (3) The compatibility between the worksheet of Creative Critical Canvas and the rubric is considerably good, and (4) Description in each point of every assessment aspect is simple. The validation result showed that the average of item 1 gained the score of 3.75, item 3 was scored 3.75, item 3 was scored 4.25, and item 4 was also score 4.25. Accumulatively, the final score of the validation was 4, since the scale was ranged from 1 to 5, then the instrument was classified as valid. The reliability test was conducted using Kruskal Wallis in order to identify of there is any disparity among the graders. The result showed sig 0.000 both for creative thinking and critical thinking. Hence, it was concluded that there was a significant differences among the grader and it means that the instrument was valid, however, not reliable. Figure 6

presented the accumulative average from the results given by 4 lecturers onto the 32 test participants.

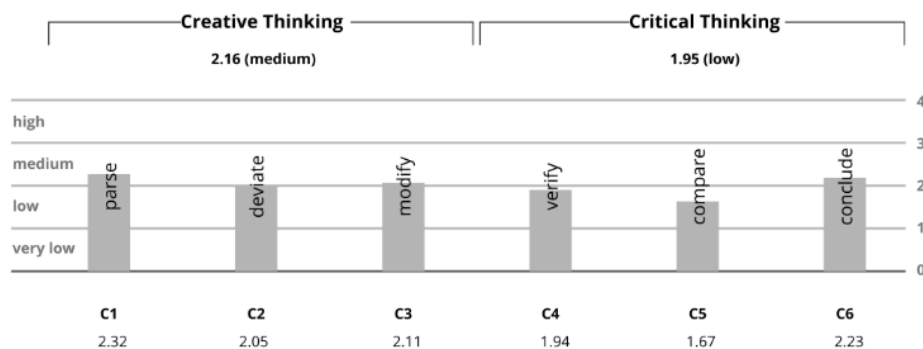


Figure. 6 Indicator Scale of Problem Solving Case Study

The Comparison Among Three Assessments

The comparison among the three assessments was analyzed using Kruskal Wallis to be tested further and the result is described as shown in figure 7 and 8. Considering that the problem solving in the case study was no longer reliable, the best option were only multitype objective test and self assessment. There were a significant difference between multitype objective test and self assessment, both in terms in scoring the result of creative thinking (Adj.Sig 0.001) and critical thinking (Adj.Sig 0.001). It showed that the result of the two were far different. Thus, in order to identify the most appropriate, it is not possible to choose both, there should be one that apprehended the other. Using both is not recommended.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
case study-objective test	13.469	6.961	1.935	.053	.159
case study-self assessment	39.172	6.961	5.627	.000	.000
objective test-self assessment	25.703	6.961	3.692	.000	.001

Figure. 7 Comparison Test Result of Creative Thinking

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
case study-objective test	23.953	6.960	3.442	.001	.002
case study-self assessment	49.734	6.960	7.146	.000	.000
objective test-self assessment	25.781	6.960	3.704	.000	.001

Figure. 8 Comparison Test Result of Critical Thinking

Discussion

The third type of the assessments was Problem Solving Case Study. This type of assessment is more appropriate to the realistic condition of the simulation. Furthermore, it could also achieve higher order thinking, but it requires longer time in assessing the answer. Problem solving approach was proved to improve higher order thinking. (Yurniwati & Soleh, 2020). The simplicity in using Thinking Design in creative and critical thinking assessment based on the study of Shively, Stith, & Rubenstein (2018) was very inspiring, the assessment could be carried out is a procedural framework. The framework consists of six stages (parse, deviate, modify, verify, compare, conclude) which had been developed in this study and conducted in a procedural manner. Additionally, Creative Critical Canvas was also prepared for the problem solving case study in order to make it easier to implement like how Business Model Canvas works (Osterwalder & Pigneur, 2010). Based on the findings and inputs from the assessors, this type of assessment the chances of students to copy their friends' answer were higher than the other assessments. And the students did not fully comprehend the process in filling out the Creative Critical Canvas that the researchers decided that Creative Critical Canvas was more suitable to be applied as a learning strategy using different example of case, before being used as an instrument of assessment.

As for the second type of assessment, self-assessment, serves for reflection process and self-assessment using likert scale as presented in other researches, like the one conducted by Stupple et al (2017) for critical thinking. But considering that this type of assessment targeted the subjective perception of the participants, this type of assessment was deemed inaccurate in measuring the level of creative and critical thinking, both in the level of lower order thinking and higher order thinking, especially, where creative and critically thinking are used in. Therefore, this type of assessment was only suitable for metacognitive awareness (Pantiwati & Husamah, 2017).

Meanwhile the objective test where in this research has varied types of question was adjusted to the sub-test that will be scored, the options of response was made to be limited so that the assessment participants could simply choose from it. If the sub-variables were strong in value, then the creative and critical values will be strong as well. This assessment was positioned more to measure the factual and conceptual knowledge that constructs the creative and critical thinking. Especially, for the usage of large scale where it required a high speed calculation. On this type of assessment, instead of using Google Forms, it will be easier if it is digital system based. The combination with the feature of randomizing questions will help to reduce the risks of cheating in a test, since every students will get different set of questions (Istiyono et al., 2019).

In relation to the presence of significant difference between the self-assessment and the multi-types objective test, then the best alternative choice must be one of the two. Considering that the scoring using the self-assessment that leans to the subjective perception of the test participants and that multi-types objective test avoids such subjective perception from the participants. Besides, the other consideration is the

feature of questions and answers randomization that is taken from the questions bank, then the best alternative to measure the creative and critical thinking is the multi-types objective test.

CONCLUSIONS

This research generates the framework of creative and critical thinking procedurally. For the creative thinking are the: (C1) Parse, (C2) Deviate, and (C3) Modify, meanwhile for the critical thinking are the : (C4) Verify, (C5) Compare, and (C6) Conclude. The three forms of assessment models that are possible to be generated are the: Self-Assessment, Multi-Types Objective Test, and Problem Solving Case Study. The validity and reliability tests indicated that self-assessment and multi-types objective test are ready to use. However, the problem solving case study is not ready to use. Also, the analysis using the Kruskal Wallis indicated that there is a significant difference on the assessment results between models. The best choice of scoring the creative and critical thinking is the Multi-types Objective Test..

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