Assessing Creativity Skill Development in Art and Design among Undergraduate Students:

Implementing creative potential simulation software to capture creativity-relevant personal characteristics

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***Abstract*—Identification of creativity skill development among undergraduate art and design students was assessed using a computer software creativity simulation. This software has been developed and evaluated with two groups of Art and Design students of a private university in Indonesia. The study presents preliminary findings of an examination creative behavioral model. This examination presents data supporting reliability and validity of the instrument. Student learning of creativity skill was evident using the creative potential simulation software. Results of a factor analysis indicated a five factor solution of creative characteristics and behavior. Discussion of findings and the benefits of computer simulations for learning and assessment of creativity skills are presented.**

Keywords— Creative behavior; Creative-relevant personal characteristics; Creativity simulation software; Art and Design Student Learning

I. INTRODUCTION

Globalization and competition have produced new challenges for business. One of the reactions is that many corporations have 'discovered' creativity. According to Munroe [1] 70 per cent of the cost of a production is determined by its design, so that the creative design can lead to substantial savings. As a result, creativity training and learning for students is becoming widespread [2], [3]. When creativity is properly employed, carefully evaluated, skillfully managed and soundly implemented it is a key to business success. This is interesting to remind us that it is not just in the output that creativity should be assessed but also the input, the process and perspectives that are brought to unravel creative thinking and execution.

Teaching creativity is challenging but assessing whether or not students have learned creativity concepts and are able to demonstrate related skills is even more difficult. Active learning techniques have proven to be valuable in teaching students specific skill sets and creativity skills are often taught using training, sowing the seeds, dynamic systems and control with a video game or active learning methods [4]. While these methods of learning are useful, they can pose problems from an assessment standpoint. Using any activity that requires demonstration of a skill such as training or sowing the seeds requires a great deal of time in working through activities, vicarious learning from students observing others must be controlled, and consistent grading must occur among different instructors. Some evidence of the advantages of computer simulation has been noted as simulation provides an efficient means of supporting instruction [5], [6]. Several previous studies have been initiated when we conduct a study on identification of the constituent elements of the nature of change (change of DNA) in the establishment of ways and mindset of undergraduate students [7]. Similarly, the results of Wahdiaman's [8] study on a series of visual expression to grow in the realization of space-based art medium and time provide the inspiration for the sustainability studies in attempt to determine the factors that encourages creativity and creative industries. Based on Horng and Lin [9], and Setiadi, Boediprasetya and Wahdiaman's [10] studies, the study was conducted. The results are expected to obtain a clearer description of the identification of Creativity-relevant Personal Characteristics among undergraduate Art and Design Students.

It is clear that teachers of art and design school must do more than teach creativity and must have the ability to identify creativity skill development as well as verify student learning, particularly if the program promote creativity development as a target outcome. However, teaching and assessment of skill development must be done in an effective and efficient way. Computer simulation offers promise as a teaching tool but perhaps it can be used to assess student learning. Therefore, the purpose of the study is to assess whether or not computer simulation can be used to identify differences in creativity skill development.

II. LITERATURE REVIEW

Creativity is addressed in most undergraduate programs at least from a conceptual standpoint but often includes a skills-based emphasis in additional to conceptual knowledge attainment. It can be more straight-forward to teach and measure functional knowledge of creativity concepts than skills. However, developing the ability to generate ideas is often touted in Art and Design programs as an outcome of undergraduate programs. Setiadi, Boediprasetya and Wahdiaman [10] emphasize the importance of creativity skills as an essential skill needed by Art and Design students. At all levels of education in art and design programs, teachers and

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educators are faced with the need to help students develop their creativity skills [4].

A. Creativity Skill Development

Creative talent is a skill set often referred to as a soft skill versus a more tangible, quantitative skill set or hard skills. Creativity, ingenuity, and innovation are the keys to success in the evolving global economy. To prepare young people for work and life in the 21st century, educators must cultivate students' creativity. Many of the fastest-growing jobs and emerging industries rely on workers' creative capacity—the ability to think unconventionally, question the herd, imagine new scenarios, and produce astonishing work [11]. Students must learn how to imagine the unimaginable and hone their creative skills. Creativity expert, Robert Epstein, a visiting scholar at the University of California, San Diego, has identified four competencies essential for creative expression:

- Capturing—preserving new ideas.
- Challenging—giving ourselves tough problems to solve.
- Broadening—boosting creativity by learning interesting new things.
- Surrounding—associating with interesting and diverse things and people.

Epstein says that the most important of these competencies is capturing. He suggests teachers provide students with a way to capture their ideas on a daily basis in an idea folder or idea box [11].

B. Assessing Creativity Skill Development

Despite the method of instruction used to teach creativity skills, student learning must be assessed. Computer simulations may have advantages as an instructional method but may also have advantages related to assessing student learning. Simulations in general typically allow for repeated play so that students can enact different behaviors and decisions and compare outcomes. The instructor can easily observe the number of times students engage in the simulation and how many designs that are made. There is little or no class time that must be used for practicing simulations and, unlike role play or case analysis, the simulation can be done by students individually so that no vicarious learning from watching other student perform skills contaminates measurement of learning. From an administrative viewpoint, a computer simulation is convenient and can be administered to many students at a time. The measurement is formulated by the index scale, which is called as the Creative-relevant Personal Characteristics Index (CPI). It can be used to measure whether an individual creative workers showed a high potential for the performance of his creativity or not. Magnitude of this measurement index ranges between 0 (zero) to 1 (one). Closer the index value of 1 (one) indicates the higher the potential for creative workers to show the performance of individual creativity. Its formulation is as follows:

$$CPI = \frac{[\![(n_{pos}/n)(alpha_{pos}) + (n_{neg}/n)(alpha_{neg}) + 2r(n_{pos}/n)(n_{neg}/n)]\!]}{(n_{pos}/n) + (n_{neg}/n) + 2r(n_{pos}/n)(n_{neg}/n)}$$

Where, n = number of item properties; n_{pos} = number of items that support the nature of creative behavior; n_{neg} = number of items that do not support the nature of creative behavior; and r = the correlation between the properties of positive and negative in favor of creative behavior. The value for the level of reliability ($alpha_{pos}$, and $alpha_{neg}$) is calculated based on the weighted composite technique.

III. Method

In this study, a Simulation Software package was used to assess creativity skill development. The simulation software has five personal characteristics dimensions, each emphasizing a different aspect of creative-relevant personal characteristics. Two groups of students were used in this study, one group had no instruction on creativity stimulations and the other group had completed an entire course on ideas generation.

The present study is conducted to identify people characteristics and behavior in term of generating new and useful ideas by Art and Design students of a private university in Indonesia. Therefore, unit analysis of the present research is individual. Interviews to 96 participants were conducted during the data collection. Interview result was used to validate the operational definition of creativity, generate additional creativity rating, and identify archival sources of the individuals' creativity assessment. Factor analysis is needed for this type of research [12], and thus, efforts were made to encourage the targeted respondents to respond. Questionnaires and rating-forms were distributed to the target respondents in classroom, and they were instructed to put the completed questionnaire in a computer lab.

IV. Results

To identify people characteristics and creative behaviour among Indonesian art and design students, the instrument has been prepared. This instrument is a self-assessment version developed by Setiadi, Boediprasetya and Wahdiaman [13]. Validity of the instrument is based on the content validity involving art and design experts, namely Prof. Permadi Tabrani, Rudy Farid, and Benny Yustim when the Focus Group discussion was held. Table 1 presents the results of the extraction factor of measurements. This result is a further step after measuring the adequacy of the sample demonstrated the value of KMO and Bartlett's Test (0.737) showed a significant value for 0.000.

Results of extraction factor in term of the creative nature have been grouped into five factors. Twenty seven characteristics have been identified as a measure of the behavioural characteristics of creative people who are useful to determine which of them to support the performance of creative work and which do not encourage the performance of creative people. These results show that the elements were grouped according to the NEO-FFI personality dimensions of Costa and McCrae's study [14]. Therefore, the first factor can be called as Neuroticism factor, because it describes the item relating to the attributes of emotional stability. It means that the low levels of neuroticism shows the individual's ability to control his emotions, for example, calm attitude in solving problems, tough, not easily give up, self-conscious and anxious. The second factor is Extraversion. This factor

represents the attributes associated with the characteristics of someone who is outgoing and assertive, friendly, warm, and always think positive. The third factor is Conscientiousness. This factor represents the attributes associated with more typical of someone who is meticulous, responsible and hardworking or industrious, obedient, orderly, and disciplined. The fourth factor is Agreeableness as representing the attributes associated with the typical people you trust and polite, willing to sacrifice for the benefit of others, and rather blunt. Finally, the fifth factor is Openness to experience. This factor represents the attributes associated with creative thinking, sensitive, a lot of ideas, and artistic. Element that has the highest factor loading in each group shows the magnitude of the contribution element in determining the creative nature of creative workers. These elements are enthusiastic, low level in depression, self-discipline, trust and ideas.

This result is confirm with the belief that the creative is a creative mindset of the actors which underlies the whole ideas (creative thinking) and action (creative action) in their life, not just how to get fresh ideas for making the design of posters, brochures or other promotional media meditative for example. Basis of creative thinking is so important, and its implementation in real terms in everyday life for career development, management ideas and promote the achievement of the creative people's performance, improving the welfare of even the achievement of the objectives of their higher life again [10].

Table 1 presents reliability test through the testing of internal consistency Cronbach's alphas [15] for each group. In this reliability testing, included test-retest reliability and mean inter-item correlations. Results shows that all dimensions of the measurement characteristics of creative people for group 1 is reliable (above 0.60), except for the dimension of Openness to experience (0.44). While for students in group 2 showed a somewhat different result, namely the dimension of Openness to experience and Agreeableness showed results of internal reliability test did not consistent. Results of reliability testing through the inter-item correlations showed that only Neuroticism and Conscientiousness dimensions that have a high correlation, both in groups 1 and 2.

TABLE I. INTERNAL CONSISTENCY RELIABILITIES (CRONBACH'S ALPHA), MEAN INTER-ITEM CORRELATIONS BASED ON GROUPS SIMULATION

Personal Characteristics	Reliability (internal consistency)		Test–retest	Mean inter-item correlation	
	Group1	*Group2*		*Group1*	*Group2*
Neuroticism	0.82	0.83	0.87**	0.28	0.28
Extraversion	0.63	0.70	0.70**	0.14	0.18
Openness to experience	0.44	0.56	0.46*	0.06	0.09
Agreeableness	0.64	0.44	0.27	0.14	0.07
Conscientiousness	0.81	0.81	0.68**	0.27	0.27
n	48	48	96	48	48

*p<0.1; **p<0.05; ***p<0.01(2-tailed)

The dimensions of the measurement characteristics of creative people is quite stable during the study carried out (48 participants for each groups), except for the dimensions of Agreeableness and Openness to experience that produces a low correlation coefficient. The results of test-retest correlations indicate 0.87 for Neuroticism, 0.70 for Extraversion, 0.68 for Conscientiousness, Openness to experience to 0.46, and 0.27 for Agreeableness.

V. DISCUSSION

Students with prior instruction on generating ideas concepts were required to use the simulation as a part of the course. Students with no prior instruction on generating ideas concepts were required to complete the simulation packages and awarded points for doing so; however, the simulation was not a graded component of the course. A link to a brief instructional video was provided to both groups of students and an MS PowerPoint slide presentation was available for review. Both groups received the same materials before attempting to operate the generating ideas simulation for the first time. It was expected that scores from students in the early class would be lower than scores of students in the later class because students should have accumulated conceptual knowledge and practical skills throughout the program, and in particular, during the prerequisite course.

Data were analyzed using averages and standard deviations for each group for the first and best scores for each of the two simulations. Standard deviations were examined for each group for the first and best scores for each simulation to determine if within-group variances were significant. The result was used to determine the type of t-test to apply to examine differences in mean scores for first and best scores for each group and simulation. Results are shown in Table 2.

Table 2 presents the mean value and standard deviation of each measurement of the characteristic dimensions of creative people. These measurements were divided into 2 groups (group1 and group2) based on groups simulation.

TABLE II. THE MEAN VALUE AND STANDARD DEVIATION OF EACH DIMENSION OF PERSONAL CHARACTERISTICS MEASUREMENT OF CREATIVE STUDENTS BASED ON GROUPS' SIMULATION

Scale	Mean	SD	S/ness	K/sis	*t*-test
Group 1					
Neuroticism	2.95	0.79	0.24	-0.89	-0.88
Extraversion	3.42	0.57	-0.61	0.46	0.13
Openness to experience	3.24	0.35	0.34	-0.39	0.67
Agreeableness	3.22	0.49	-0.41	-0.22	-1.42
Conscientiousness	3.61	0.52	-0.04	-0.91	-0.64
n	48				
Group 2					
Neuroticism	2.84	0.53	0.15	-0.67	-0.43
Extraversion	3.51	0.47	-0.16	-0.01	0.10
Openness to experience	3.26	0.34	0.63	0.30	-0.69
Agreeableness	3.39	0.48	-1.01	2.74	-3.62***
Conscientiousness	3.64	0.42	-0.63	0.71	-0.79
n	48				

*p<0.1; **p<0.05; ***p<0.01(2-tailed)

Levene's test was conducted to examine whether there are differences in each dimension of the measurement of creative-relevant personal characteristics based on group's simulation. Results showed that there was no significant difference between these two groups of samples when tested each dimensional measurement of creative people's characteristics.

Findings indicate that the first attempt using the software results in approximately similar scores but improvement of scores with repeated play was generally higher for students with prior instruction on generating ideas. This is important because it may indicate the differences in skills based on prior instruction and it provides some evidence of student learning and, more importantly, skill development. Results are shown in Table 3. The purpose of this study was to determine if scores of students with prior instruction on generating ideas would be higher than students with no prior instruction. Indeed, students with prior instruction scored higher on the first time using the computer simulation and overall, across all plays. This finding lends support to the fact that the computer simulation can indeed identify differences in knowledge of concepts and ideas and students' ability to apply those concepts in the computer simulation.

Jamison [16] mentioned that throughout the years there has been a horrible stereotype that creative people are manic depressive. Some creative geniuses have had a variety of mental illnesses, but that is not to say that one must be mentally ill in order to be considered creative. Creativity is not the result of a mental illness and, can be found within every human being. There have been studies done showing that creativity can be taught and even enhanced [17]. An individual's subconscious minds and the way in which, it processes information can have an effect on the way that an individual is creative. Strengthening and exercising different parts of the brain can affect creativity, as well. Also, there are different states of mind that can contribute to or hinder the creative process.

TABLE III. THE DIFFERENCES IN SKILLS BASED ON PRIOR INSTRUCTION AND SOME EVIDENCE OF STUDENT LEARNING

Group 1: with no prior instruction on generating ideas	Group 2: with prior instruction on generating ideas
Normal	Different from other people's ideas
Ordinary	A little bit more creative
standard	A little bit more creative
Static	More out of the box
Rather slow	improving
Little with no variation	More alternative and variation
Approximating	Very helpful, making thinking more enjoyable
Rather blurred, difficult to defend	Results are a lot wider, more detail
Standard, ordinary, not interesting for other people	More quality
A bit difficult, thinking narrowly	Brighter, crazier ideas
Rigid	Flexible
Abstract, unstructured, random, not sure where to go, some problems are often unaddressed	Structured, clear goal and directions, respond to problem more accurately
Lousy	Pretty good
Not constant, sometimes good, sometimes bad	Ideas are more objective and constant
Quite interesting	Deeper and still interesting
Score: 6 – 7	Score: 7 - 8

Everyone has the potential to be creative. There are even things that an individual can do to enhance their creativity. For every positive there is a negative and, there are also acts and ideals that can hinder an individual's creativity. On the other hand, there are some of the obstacles that one must overcome in order to be creative. The most common does not believe oneself to be creative. If a person believes themselves to be lacking in creativity they will not pursue creative ways of expressing themselves. Also, if an individual is too busy or involved in a problem they will not be able to find time to focus on a creative endeavor. Individuals that do not allow enough time for relaxation usually will be stressed and their minds will not be able to think creatively because it will be absorbed in the problem at hand.

Researchers have noted the benefits of interactive learning methods and particularly the advantages of computer simulation [18]. This study extends findings of others and indicates that computer simulation may be a good instructional tool but also may be a useful tool for assessment of student learning. As a learning tool, students become engaged because of the interactive nature of simulation and the quick feedback from decisions. As an assessment tool, the computer simulation allows for efficient collection of student performance scores and administration of assignments. Given the nature of the computer simulation, students were able to use the simulation on their own time and for as long or short a time as they wished. Student time spent on the simulation, scores attained for each attempt at every scenario and trends of improvement can all be easily seen by instructors, making this, and many types of computer simulations useful tools in assessment. Further, the data recorded can be compared over time to determine whether or not improvements or maintenance of learning is taking place.

The computer simulation has many advantages, as an instructional tool and method of assessment. The computer simulation is convenient for students and instructors and allows students to work as a class in a computer lab setting to complete an assignment or, if the instructor prefers, students may work at their own pace on their own computer. The computer simulation eliminates contamination of measurement because it requires students to complete their own work without observing the work of other students as is often the case in role plays or case analysis completed in class. Computer simulations also mitigate the group learning effect where one or two groups of students may start a thread of thought or focus on specific concepts and then subsequent student groups' focus on similar issues. Finally, there is an objective aspect of computer simulations that ensures that all student responses and activities are evaluated similarly. There is no need for inter-rater reliability checks or rater training.

The observation from the post-hoc analysis on repeated play sheds some light on the potential usefulness of a simulation. As is typical in the search for useful instructional materials, many instructors seek out materials that students with which student will become engaged. It appears from the repeated play of the simulation, even among those students not receiving a grade on their performance, students were willing to spend more than the required amount of time to complete one or two rounds of play in the simulation software. For those

students receiving a grade, the repeat play was particularly compelling. Implementation of the simulation in class as a graded component, along with embedded concepts from the simulation into class discussion might provide a learning experience for that is perceived as interesting and engaging.

VI. Conclusion

This study investigated the usefulness of computer simulation software on creativity skills in assessing student learning and skill development. Findings indicate that, after familiarizing themselves with the software, students with prior instruction on generating ideas performed better than students with no prior instruction. Support was found for student learning of skills identified by the computer simulation software. Benefits of using computer simulation software in teaching and assessment may provide many benefits including efficiency in delivering instruction and assessing learning and objectivity in rating student performance.

Assessing student learning has moved beyond simply measuring functional knowledge and many academic programs publicize both knowledge and skill development to potential employers and students. However, in touting programs and helping to develop students' skill sets, some assurance of that skill development based on the program content must be assessed. However, the extent to which real skill development occurs is difficult to assess. If creativity skill development is touted as an important outcome of a program, we must be able to improve generating ideas and our ability to assess improvements in student skill. Incorporating interactive methods such as computer simulation may be one means by which we can improve instruction and assessment of student learning.

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