DEVELOPMENT OF RUBRIC TO MEASURE CHILDREN'S CREATIVITY IN GAME DESIGN

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ABSTRACT

Today's Alpha generation have high competency playing digital games. This privileged ability demands creativity in terms of cognitive and higher order thinking skills when it comes to designing and developing digital games. Therefore, this study aims to delineate the process of developing a rubric to measure primary school children's (age 7 to 12) creativity when creating games as a digital game designer. The constructs of the rubric were enthused by Torrance Creativity Theory which highlighted on originality, fluency, flexibility and elaboration that adapted to fit the concept of the game design process. The development of the rubric underwent three distinctive phases; i) library research; ii) feasibility study; and iii) expert evaluation. Cohen's Kappa Coefficient formula was used to validate with average value $\kappa = .81$ *(excellent) and the reliability was measured by Cronbach's Alpha formula with value* $\alpha = .88$ *(excellent). Researchers found that by adopting the concept of game-based learning specifically through game design activity, children's creativity was significantly enhanced. The rubric of children's creativity would be essential for sustainable performance of quality education to produce a generation of critical thinkers, problem solvers while celebrating children's uniqueness and diversity in line to develop creative personality towards digital generation.*

KEYWORDS

Children, Creativity, Quality Education, Game Design & Rubric

1. INTRODUCTION

The natural experience of children's lives has been enhanced by multimedia technology integrated into their play activities through digital games. Digital games, in particular, perhaps more than any other media, have brought interactive technologies into their everyday lives that have also impacted their intellectual abilities and creativity. Apart from playing digital games, in fact they can also play role as a game designer. Related research led by Kafai [1, 2] and other researchers demonstrate that children benefit greatly in terms of creativity and innovation when they play the designer's role [3, 4, 5]. This discursively stimulates the national economy specifically in the creative industry sector. Unfortunately, there is currently little awareness of how creativity in digital entertainment can be nurtured through the design process [6]. This leads to negative perceptions often leveled against digital game, which is not relevant with current situation [7]. Therefore, creativity assessment needs to be explored not only in psychology but also in technology-integrated education. Furthermore, the indicators in determining the level of creativity involved in the use of technology have not yet been identified [8]. As a result, the nature of creativity in conceptual form is difficult to interpret be along with measuring creativity as a generic skill [9].

Creativity indicators are definitive benchmarks to determine children's creativity. Consequently, more empirical research should be conducted to precisely and systematically measure the children's creativity in game-based learning (GBL) practice. It is believed that games can be developed as a means of enhancing collective creativity [10][11][12]. Thus, this paper will explain the conceptual framework of the research that contains library research, feasibility study, expert evaluation, and conclusion from the research findings. The following research objectives are considered, i) to identify aspects of creativity in the game design process based on Torrance Creativity Theory; and ii) to validate creativity indicators in the rubric of children's creativity when creating games as a digital game designer. The rubric was developed during the design process of a digital game for the use of classroom setting. The research findings would contribute to the instrumentation of creativity measurement for children, particularly through the integration of technology and education.

2. CONCEPTUAL FRAMEWORK OF THE RESEARCH

The conceptual framework for this research is comprised of three phases – the library research, feasibility study and expert evaluation, as shown in Figure 1. The objective of library research and feasibility study was to explore theories and approaches related to GBL affiliated with the creativity element measured during the game design process. Game design activity is a part of GBL components which adheres to the constructivist theory where students will guide their own learning [2] besides reaching the needs of 21st century skills in information, media and technology skill [13]. The Torrance Creativity Theory [14] which established the Torrance tests of creativity has four (4) indicators (originality, fluency, flexibility and elaboration) as a guide in determining the indicators of creativity that suit game design stages during generating of ideas, design processes and game products produced.

During the evaluation phase, the developed rubric was evaluated by experts which involved academic experts in the field of assessment and evaluation, information technology and multimedia and educational technology for children. Cohen's Kappa Coefficient analysis was used as the formula to determine the validity of the rubric and the reliability was measured using Cronbach's Alpha formula to ensure that the rubric was suitable for children. After analysing the findings, the objective of this research has been fulfilled with the creation of a rubric to measure children's creativity through game design activity.

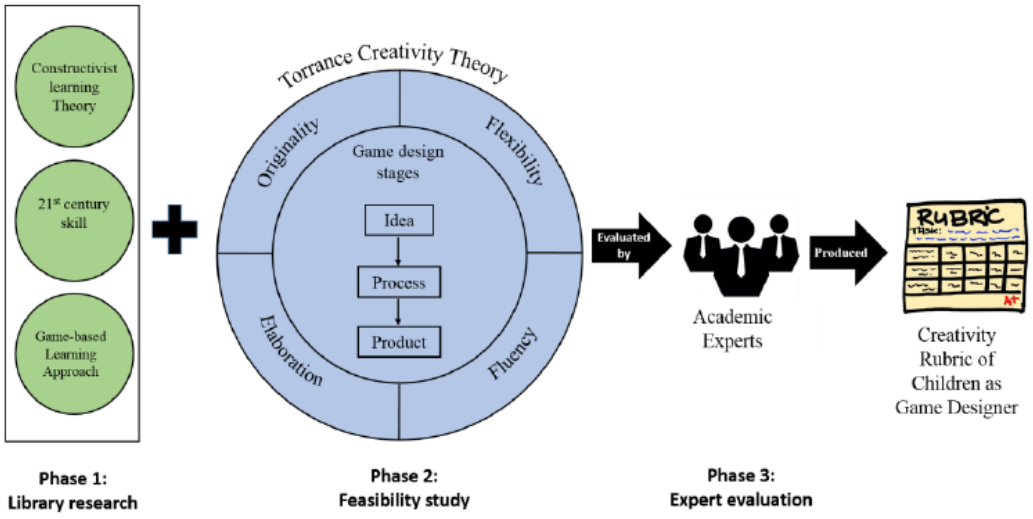

Figure 1. Research conceptual framework

3. LIBRARY RESEARCH: THE INJECTION OF CONSTRUCTIVIST LEARNING THEORY IN GAME-BASED LEARNING TO CULTIVATE CREATIVITY IN 21ST CENTURY SKILL

GBL approach is a remarkable alternative for educators when they administer educational digital games in their classroom besides the existing learning approaches. There are two methods in GBL: learning by playing games and learning by making games. Students learn extensively when they design games compared to when they merely playing games [15]. GBL is aimed to capture students' excitement to learn the content of the subject while playing or making games. Indirectly, children can involve with active learning based on constructivist learning that helps children to build and strengthen knowledge more effectively [16].

Through the game design process, children can adopt the GBL approach which enables them to design a game and develop their creativity while cultivating a positive attitude in a gaming environment designed for educational purposes. In relation to the learning approach, Kafai [2] states that children can apply constructivist learning based on how they present their idea and express their feelings during the design process. In addition, constructivist learning can be supported because of its rewarding benefits and can serve as a catalyst that help to increase children's motivation for deeper and meaningful learning.

Another goal of GBL is to encourage children to learn cooperatively, think creatively, work collaboratively manage themselves and learn independently without depending on the teachers. This is supported by dos Santos, et. al [17] who agree that children could develop their thinking skills and develop their critical capacity for digital literacy. Moreover, the digital game design activity is stimulating students to develop an in-depth knowledge [18], as opposed to just playing a game for enjoyment. The activity also can stimulate creativity and creative thinking skills among children, helping them to navigate their future life.

The world today regards creativity as an added value of an individual. Moreover, creativity has been highlighted as one of the key skills for employment expected in 2020 [19]. In the field of information technology and innovation, creativity means the digital technologies exhibit features that enable learners to be creative [20]. Introduction of game design activity to digital generation will become a multi-skill generation as a result of using a fitting learning approach in line with 21st century education [13]. This is evident during the design process where children need to plan the goal and rules of the game, identify the design of gameplay, determine the design of game response, select an appropriate gaming interaction and develop an interesting game narrative. Children nowadays are facing great challenges as they are not only required to compete with their peers, but also needed to compete with technology [21]. Thus, 21st century skills would create a comprehensive package of skill sets for children in the effort to develop the next generation, which is competent, creative, innovative and efficient. We need to realize that technology is constantly evolving. Therefore, creativity process needs to evolve.

4. FEASIBILITY STUDY: THE INTEGRATION OF TORRANCE CREATIVITY THEORY IN GAME DESIGN PROCESS

Feasibility study is an important process in identifying real phenomena in a study, particularly in planning the methodology and developing the measurement instrument [22]. Measurement in education requires specific indicators and evaluation to ensure the results obtained are accurate, valid and precise. When measuring the creativity among children, the meaning of "creativity" differs across discipline, depending on the purpose measurement. For instance, the use of correct educational measurement tools can match the children's learning needs, so that their skills would

be in line with the latest digital development [13]. It is well known that Torrance is the father of creativity who has produced many of the most creative and the most popular instruments is the Torrance Creative Thinking Test (TTCT) [23]. TTCT is used in many studies to explore creative thinking through drawing. A study by Navarrete [24] suggest that creative thinking process via student-centered approach through design activity can provide rich and fun learning experiences with the use of technology, other than authentic learning environment. Thus, game design activity is relevant for this study, especially in relation to children's creativity based on the creativity elements founded by Torrance [23], namely originality, fluency, flexibility and elaboration.

The feasibility study is commonly carried out during the initial phase, were the actual research. A feasibility study can help researchers to reduce errors and time, cost and energy wastage when conducting the real research [25]. In practice, the feasibility study was conducted with 20 children in pairs (10 males and 10 females), aged 7 to 12 years old. The parents of participants completed the consent form as approved by the Research Management and Innovation Center to ensure that this study was in line with the true ethics of research. The participants were given a task to design a digital game using Scratch (a game development authoring tool). By using a checklist, the researchers, assisted by five facilitators, observed how the participants visualized their idea into a storyboard and the process to convert it to a digital form. Then the product was analysed based on Torrance creativity elements that suit with the game design. The data was analysed using qualitative categorization and thematic analysis through typology method as suggested by Braun and Clarke [26].

Through the observation during game design activity, the study found a set of creativity aspects, as shown in Table 1. In terms of originality, the participants informed whether the source of idea to design the game was based on their experience or inspiration from others' design. Fluency is shown from the narrative and goal of the game. Flexibility is measured on how participants can upgrade and modify their game design and elaboration demonstrates how participants can design a game that is user-friendly.

Table 1. Creativity indicator found in the games design process

Torrance Creativity Elements	**Creativity Indicator Description**
Originality	A child's ability to generate ideas, build and create game designs that are unique, innovative and exceptional.
Fluency	A child's ability to generate ideas, build and create game designs that are logical, appropriate, continuous and meaningful.
Flexibility	A child's ability to generate ideas, build and create game designs based on expectation, diversity, can be modified, and can be upgrade.
Elaboration	A child's ability to generate ideas, build and create a game design that is easy to translate, easy to understand and specific.

5. VALIDATION FROM EXPERTS

Upon obtaining the set of the suitable creativity elements in game design activity for children through library research and the feasibility study, a rubric was developed to match every creativity indicator with a specific stage of design process based on four levels (L0 to L3), as illustrated in Table 2. Themes were constructed based on the data derived from the observational checklist using thematic analysis into more specific categories to determine the validity of the scale for rubric development. A rubric is a score-based measuring approach which enables teachers to conduct evaluation in a more organized, consistent and directed way based on specific criteria [27]. The consistency of scores in a rubric could measure children's creativity holistically

and analytically. The rubric was created to provide a clear prediction on the score needs to be achieved, which may help the child to provide response and conduct self-assessment. Therefore, a consistent rubric should have high validity and reliability [28].

Cohen's Kappa Coefficient analysis was used as the formula to analyze the validity of the rubric. This formula has been applied in previous research that proves the scale is compatible to measure inter-rater and intra-rater reliability for qualitative (categorical) item [13]. The analysis was crucial in determining the approval of the expert regarding the validity of the rubric, so that the rubric can achieve its intended objective, i.e. to yield precise and consistent measurement [28].

Table 2. Example of creativity rubric for Originality indicator in digital games design process (idea stage)

Torrance Creativity Elements	**Creativity Indicator**	**Game Design Stage**	**Level**	**Item**
Originality	Uniqueness	Idea	L3	This child is able to generate ideas for entirely different game designs as the existing game design.
			L2	This child is able to generate ideas for similar game designs as other game designs, but modified.
			L1	This child is able to generate ideas for similar game designs as the existing game design.
			L0	This child is unable to generate ideas for similar or different game designs as the existing game design.

Nine (9) expert evaluators were recruited from three knowledge disciplines: assessment and evaluation, information technology and multimedia and educational technology for children. Table 3 illustrates the level of agreement obtained based on creativity elements and level of creativity indicator in the proposed rubric.

Table 3. Results of Cohen's Kappa Coefficient on the validity of rubrics for measuring children's creativity in digital game design

Expert Evaluator	**Specialization**	**Kappa (κ) Value**	**Degree of Agreement**
Evaluator 1	Assessment and evaluation	.75	Good
Evaluator 2		.69	Good
Evaluator 3		.63	Good
Evaluator 4	Information technology and multimedia	.90	Excellent
Evaluator 5		.78	Good
Evaluator 6		.92	Excellent
Evaluator 7	Educational technology for children	.82	Excellent
Evaluator 8		.94	Excellent
Evaluator 9		.88	Excellent
Average value		**.81**	**Excellent**

Based on the Kappa value shown in Table 3, all three (3) experts in the field of assessment and evaluation commented that it was tricky to assess creativity based on merely observation. This is also influenced by the different interpretations of each evaluator referred for each item in the rubric. This is important to ensure that rubric can measure accurately, achieve objectives and easy to use in real situations [28]. One (1) of the evaluators suggested that interview should also serve as a means to complement the observational data. Different from experts in the field of information technology and educational technology for children, majority of them commented that this rubric is suitable for use as it focuses more on technology-related activities. For children, activities involving cognitive skills and motor skills motivate them to remain engaged in learning

activities. This supports Robertson and Good [29] who stated that the best game design activity should provide new knowledge and experience for the children to optimize their development. Each element can also be clearly defined and the evaluator can distinguish the level of creativity based on the description of each indicator of creativity. However, there is a concern that anyone using this rubric should have a basic knowledge of games and game design because it may affect the usability of this rubric. A study by Romero [9] confirmed that pedagogical and content knowledge are challenged when designing games if children are not familiar with the activity. Improved rubric as suggested by expert evaluators to develop accurate, comprehensive and easy-to-use have gone through reliability testing during pilot test. This pilot test utilised this rubric to test its' as an instrument to determine the level of children's creativity in the game design process. Based on Cronbach's Alpha formulation, the reliability of the rubric is $\alpha = .88$ (excellent). All in all, the rubric is found suitable to be used to measure children's creativity during the digital games design process.

6. CONCLUSION

All children regardless of their background have the ability to do convergent and divergent thinking. Divergent thinking is a thought associated with creativity. The digital games design activity may generate and stimulate creativity among children. In line with the rapid growth of digital games, the GBL approach planned inside the game design process can be applied to stimulate creativity and specific 21st century skills among children. This study shows that Torrance Creativity Theory is not only focuses on the arts area, but it can also be expended in the fields of technology and games that are gaining popularity among today's generation. Children's creativity is perceptible can be seen when they propose game ideas and then go through the process of developing games using authoring tools to design their own games. The finding showed that each level of creative elements should be measured analytically which specifically based on game design activity. Researchers found that by adopting the concept of game-based learning specifically through game design activity, children's creativity was significantly enhanced. The rubric of children's creativity would be essential for sustainable performance of quality education to produce a generation of critical thinkers, problem solvers while celebrating children's uniqueness and diversity in line to develop creative personality towards digital generation. It concludes that game-making is an engaging way to not only encourage students to pursue but prepare them to succeed in their future careers. Designing and developing games as an activity can be a fertile ground to cultivate such competencies through multi-disciplinary collaboration, and by providing an engaging, creative and innovative space for people to meet and learn how to cooperate fruitfully. Ongoing efforts need to be made to foster creativity among students to ensure this aspiration could be fulfilled, a rubric was developed as an educational measurement tool to assess the creativity of children holistically and analytically. For future planning, a more structured program that comes with rubric, modules and kits of the game making can be created for further developing the children's creativity to a higher level.

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