An Analysis of Creative Process Learning in Computer Game Activities through Player Experiences

Wilawan Inchamnan, Dhurakij Pundit University, Thailand

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Abstract

This research investigates the extent to which creative processes can be fostered through computer gaming. For investigating creative processes in this domain is proposed. This research tends to focus on games that have been specifically designed for educational purposes: Digital Game Based Learning in terms of creativity. This paper describes a behavior analysis for measuring the creative potential of computer game activities and learning outcomes.

Creative components are measured by examining task motivation and domain-relevant and creativity-relevant skills factors. The research approach applies heuristic checklists in the field of the gameplay to analyze the factors that the stage of player activities involved in the performance of the task and to examine player experiences with the Player Experience of Need Satisfaction (PENS) survey. The player experiences are influenced with the most complex of game play interactions through player experiences; competency, autonomy, intuitive controls, relatedness and presence. It examines the impact of these activities on the player experience for evaluating learning outcomes through school record.

The study forms designed to better understand the creative potential that people engage for knowledge and skills being learned during the course of playing. The findings show the creative potential that occurred to yield levels of creative performance within game play activities to support learning. The anticipated outcome is knowledge on how video games foster creative thinking as an overview of the Creative Potential of Learning Model (CPLN). CPLN clearly understand the interrelationships between principles of learning and creative potential, the interpretation of the results is indispensible.

Keywords: Creative Potential; Learning Model; Digital Game Based Learning; Player Experience; Game; Creative component

Introduction

A digital game involves role-play characters, clever and complex problems to solve, and compelling music and graphics (Shute, 2011), knowledge and skills being learned influence during the course of playing. While there has been significant growth in game-based learning research in the past two decades (Habgood and Ainsworth, 2011), among those studies, this research focuses on the games that have been specifically designed for educational purposes and facilitate problem-solving skills.

Games, in general, support the development of critical thinking through visualization, experimentation, and creativity (Amory, 2007). Game elements normally provide problem solving experiences as players try to break down the tasks, engage meta-cognitive skills, and think critically (Turcsányi-Szabó et al., 2006). Games also offer an opportunity to explore new ideas and actions through the diversity of game play opportunities generated by communities of players. As a consequence, the anticipated outcome is knowledge on how video games foster creative problem and learning processes.

Creative Potential

To identify the potential of games to engage the players in creative processes, criteria related to activity undertaken need to be clearly defined. As mentioned in the works of Paras and Bizzocchi (2005) , games had great potential to support creative processes (Paras and Bizzocchi, 2005). Furthermore, creative ideas resulted from the novel combination of ideas (Spearman, 1930), this creativity involves a process of divergent and convergent thinking (Amabile, 1996), and that problem solving plays an important role (Clark et al., 1965).

Divergent and convergent thinking are the core elements of the creative process. Divergent thinking is important for idea generation (Amabile, 1996), and is necessary to produce many alternative solutions to the problem (Gordon, 1961). Convergent thinking, as a creative process, occurs in the idea validation stage (Amabile, 1996). It allows an individual to select the correct way to approach the task at hand (Sviderskaya, 2011), with the ability to select a single response from a series of alternatives (Clark et al., 1965). To develop interactive experiences that incorporate these valuable and educative learning processes, it firstly needs a clear understanding of how different game elements are combined to produce the creative potential.

Game Activity Components for Creative Gameplay

Some studies yielded a specification of particular task behaviors that are strongly possible to predict creativity the creative game potential measures identified by analyzing game activities. The game play activities and the creative process components can facilitate creative processes, the game activities related to the creative potential during playing game. Thus, these activities are able to support learning of individuals (Inchamnan and Wyeth, 2013). Playing games has a significant role to help people to learn to solve their problem (Myers et al., 2010).

Game activities have influences on the creative potential through creative gameplay. For example, game activity facilitates creative-relevant skill and provides greater

opportunities for players to take a wide focus when engaging in gameplay with open-end goals. The feedback activities provides positive reinforcement which enhances free-choice and self-awareness (Inchamnan and Wyeth, 2013).

Self-Motivation Reports

The game environment is the medium that allows players to achieve such experiences. Games significantly extend the range of experiences available to an individual. Enjoyable game experiences result from players being able to work through the game interface to become immersed in playful activity. Within this study project measurement of player experience is based on self-determination theory (SDT) (Ryan, 2000). SDT has been successfully applied in many study discipline such as sports, education, and leisure domains. Przybylski, Rigby and Ryan (2010) applied SDT to the video game player motivations. Based on SDT and other relevant theories (e.g. presence), Przybylski and his colleagues developed the Player Experience of Need Satisfaction (PENS) measure, which assesses the game play experiences in terms of competence, autonomy, relatedness, intuitive controls, and presence/immersion (Przybylski et al., 2010).

In this study, to assess game play experiences, the 21-item PENS survey was adopted. It evaluates game play experience from five dimensions: competency, autonomy, relatedness, presence, and intuitive controls. Each item consists of a statement on a seven-point scale, ranging from 1 to 7. The interactive experience with the game environment allows players to express their creativity and intentions (Sweetser and Johnson, 2004). This learning experience allows players greater freedom in term of decision-making.

Game Based Learning

There are many new approaches toward the education, teaching and learning. Challenge and engage all young people are influenced to identify rewarding learning experiences that will inspire in the 21st Century (Perrotta et al., 2013). The use of video games in education is focused the emergence of new trends like ‘Game Based Learning’ that supports teaching and learning. Game-based learning refers to the use of video games to support teaching and learning (Perrotta et al., 2013). Game environment have influence on the learners to foster their skills. Games and play are an essential part of child development (Prensky, 2005a). Digital Game-Based Learning is exactly about fun and engagement (Prensky, 2002).

Games for Learning

Learning experiences allow players greater freedom in terms of decision-making. Games offer an opportunity to explore new creative uses through the diverse ideas generated by communities of players. Learners gain meta-cognitive skills and group identity that could influence experiences for life through motivating game play (Turcsányi-Szabó et al., 2006). Game is keeping learners motivated (Prensky, 2005b). The main reason that people play games is the process of game playing is engaging.

Principals	Mechanics
– Intrinsic Motivation – Enjoyment and fun – Authenticity – Autonomy – Experiential Learning by doing	– Rules: simple and binary – Clear and challenging goals – Fantasy and difficulty – Self-control and feedback – Social element

Table 1: Principals and Mechanics of Learning (Perrotta et al., 2013)

Table 1 shows the principals of learning based on game activity. The principles refer to the underlying assumptions and concepts. The mechanisms refer to processes and dynamics involved in game-based learning are interdependent (Paras and Bizzocchi, 2005). The principals and mechanisms involved in game-based learning are spitted based on the extent that video games can impact overall academic achievement. The majority of the studies examine the impact of video games on student motivation and their school record: programming, math and art subject. Video games allow learners to engage with topics and ideas through interaction and simulation, rather than through the conventional materials and formats of schooling: textbooks, lessons, assignments and so forth (Perrotta et al., 2013). To understand what extent did gaming impact on learning outcomes, we examine the relationships between participant's self-report and academic learning outcomes.

Behaviour Analysis

Behavior is the activities of living organism that everything people do, including how they move, what they say, what they think, or how they feel. The experimental analysis of behavior has discovered a number of basic principles-statements about how behavior works as a function of environmental variable (Cooper et al., 2007). Behavioral assessment involves a variety of methods including direct observations, interviews, checklists, and tests to identify (Cooper et al., 2007). Direct measurement is concerned with measurement of the specific behavior to be taught. For example, direct measurement must provide data on student response to the actual materials used during the instructional setting (Cooper, 1982). Applied behavioral analysis is concerned with the manipulation of environmental stimuli (Cooper, 1982), games create environments where each atomic challenge is stand-alone and is addressed that way by a player. This study focuses on the game environments that foster creative processes by using behavior analysis. Behavioral assessment allows analysis of creativity from a divergent thinking and convergent thinking perspective. The measurement can be used in the identification and development of creative potential (Schaefer, 1969).

Factor Analysis

Factor analysis is one of the most commonly used procedures in the development and evaluation of psychological measures (Floyd and Widaman, 1995). The factor analysis method is used to divide criteria into groups (Tzeng et al., 2007). Factor analysis is particularly useful with multi-item inventories designed to measure behavioral styles, cognitive schema, and other multifaceted constructs of interest to

clinical psychologists (Floyd and Widaman, 1995). Assessing creative potential requires a focus on how and why an individual responds to activities (Kaufman et al., 2011). The behaviors that related to the creative activity must be clearly stated and readily translated into the assessment (Amabile, 1983).

This study used the three main factors. Firstly, the model proposed by Ruscio et al. (Ruscio et al., 1998) to identify task motivation as a measure of involvement in tasks. Behaviors such as set breaking, task pace, exploration, enjoyment, and concentration are identified as the ways in which intrinsic motivation manifests itself within the creative process. Secondly, domain-relevant factors determine the initial set of pathways to search for a solution and the ability to verify an acceptable solution (Amabile, 1983) through assuredness, difficulty and exhibited uncertainty activities within gameplay.

Thirdly, the creative-relevant factors are the component of creative thinking including the ability to break away for standard thinking, approaches, and solutions during problem solving. Individuals can gain experiences from ideas generation that may inform their own strategies for creative thinking processes (Amabile, 1996). Creativity-relevant skills are measured through the specific process factors of concrete focus, concept identification, wide focus and striving (Ruscio et al., 1998). This leads to the following questions to be answered in this study.

Methodology

The proposed methodology is broadly divided into two stages. The first stage involves a game study which adapted from existed a creative potential method (Inchamnan et al., 2012). This creative potential method examines players by using established creativity criteria in order to determine the levels of creative activity. The process focuses on the reliability of the factors used for measurement determining those factors that are more strongly related to creativity. The second stage involves the determination of relationships of game play elements. The objective of this stage is to investigate and establish related elements that support creative performance and learning outcome.

To examine the creative process, participants were video recorded while playing the games and a video coding scheme was used to capture the type and frequency of observable behaviors and participant verbalizations. To assess the game experiences, this study used the 21-item PENS survey that consists of five dimensions: competency, autonomy, relatedness, presence, and intuitive controls. Each item consists of statements on a seven-point scale ranging from 1 to 7. Specifically, the research reported in this paper examines the relationship between creative game play processes and game play experience as measured by the Player Experience of Need Satisfaction (PENS) survey: In game Competence; In game Autonomy; In game Presence; In game Intuitive Control (IC) and In game relatedness.

Study Procedure

To explore the relationships between the uses of creative processes during game play and the player experiences, this study decided to adopt four games, that is, Portal 2, I-Fluid, Gunz 2: The second Duel, and Braid. While these games have different

mechanics, goals and settings, they all require the players to solve problems in the game tasks to keep progress thorough the game play. Evaluation method involved examining in relation of the creative process as measured by task motivation, domain-relevant skills and creativity-relevant skills. Game task behaviors and verbalizations were coded to obtain the empirical indices of the creative processes in which game players were engaged. Participations (n=120) in the study involved were observed during playing the four selected games.

To examine the creative process, participants were video recorded while playing the games. A video coding scheme was used to capture the type and the frequency of the observable behaviors and verbalizations. This coding scheme was implemented based on the measures criteria below that developed for analyzing creative process (Inchamnan et al., 2012).

The results from stage 1 will be used to establish the extent which the games facilitate creativity and how the components of creativity are involved. A video coding scheme will be used to capture the type and the frequency of the observable behaviors and verbalizations in which participants engaged. The coding uses items that are identified as the significance in the creative process (Ruscio et al., 1998) and the coding is performed using both 7-point Likert scales and frequency counts.

According to the timeline and data gathering, the pilot test adopted only 15 students. The unit outcomes of participants during study period were observed in order to evaluate logical skills (Math and Programming subjects) and creative art skills (i.e. Animation Drawing subject). The majority of the studies examine the impact of video games on student's motivation and their school records: programming, math and art subject. Focuses participants group played the game Gun Z 2: The second Duel online between their friends and Bots. In the experiments, gameplay finished in approximately 15 minutes in total and completed a Player Experience Needs Satisfaction (PENS) questionnaire (Przybylski et al., 2012) after playing.

Result: Factor Analysis of Creative Potential Game Activities

The levels of creative problem solving that occur during game play and the determination of the game design elements are necessary to facilitate creative game play. Objects and resources manipulation within the games are a source of behavior variation across all components. Table 4 shows the actual factors that were extracted from all 16 variables. In the table 4, all factors account for 72.51 percent of the variability in all 16 variables.

The pilot testing of items should be performed to ensure that items that designed to measure a common construct are moderately correlated with one another and are correlated with the total scale score. If one item does not satisfy the moderate correlation constraint (e.g., $r \geq .20$) to other items in the construction process, that item tend to perform poorly in a factor analysis. Kaiser-Meyer > .5 (.789,n=120) is acceptable confident to use this data for factor analysis technique.

Factor	Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	6.231	38.947	38.947
2	2.470	15.439	54.386
3	1.618	10.110	64.495
4	1.282	8.012	72.508

Table 4: Behavioral factor Total Variance Explained

According to the table 4, Factor 1 accounts for 38.95% of the variability value of all 16 variables. Ten variables that are loaded strongly on this factor are Involvement (Task), Set breaking (Task), Pace (Task), Planning (Task), Playfulness (Task), Exploration (Task), Enjoyment(Task), Concentration (Task), Assuredness (Domain), Difficulty (Domain) and Wide focus (Creative).

Results: Strong Factor Component

Component Matrix[a]				
	Factor			
Creative Component	1	2	3	4
Involvement (Task)	.753	-.257		-.131
Stability (Task)	.232	.705	.314	
Set breaking (Task)	.863			
Pace (Task)	.787	-.246		
Planning (Task)	.888	.149		.127
Playfulness (Task)	.830	.361	-.111	
Exploration (Task)	.843	.317		.111
Enjoyment (Task)	.804	.384		
Concentration (Task)	.790		.118	
Exhibited uncertainty (Domain)		.605	.569	
Assuredness(Domain)	.748	-.506		.185
Difficulty(Domain)	.298	-.461	.574	-.157
Wide focus(Creative)	.329		-.556	-.321
Striving(Creative)	-.257	.834		-.215
Concrete focus(Creative)		.131	-.328	.860
Concept identification(Creative)	.248	.295	-.515	-.328

Table 5: Components Matrix of Creative Components

This issue regarding to measured variables concerns the scale on which scores fall. Factor 1 finding refers to the player can work on solving the problem (Involvement game activity). The game play provides players to manipulate materials; uses or attaches them in new combinations (Set breaking game activity). Speed during play game at which the participant works on tasks/challenges (Pace game activity) allows players to organize material; establishes an idea, order to build in (Planning game

activity). Playfulness (Playfulness game activity) activities engage the player in tasks in the curious manner; trying out ideas in a carefree way and exploration (Exploration game activity) as curious, or playful testing out of ideas. The enjoyment (Enjoyment game activity) refers to the player has a good time experience, finding pleasure in the task / challenge and focusing on the task; not distracted (Concentration game activity). The task motivation game activities relates to the learning domain-relevant skills during play game.

The results in the domain-relevant skills categories might be expected. Players are confidence: certainty of ability to complete task; assuredness in going about the task; not doubtful, timid, or anxious (Assuredness game activity). Player faces the problems within the game activities and reflexes the game tasks by making a negative statement (Difficulty game activity). The creative-relevant skill has a relationship between the effect of intrinsic motivation and domain-relevant skill required in game play activities. The creative-relevant skill allows the player to have a future oriented; restatement of problem given, self-imposed goal, and statement dealing with a desired final goal (Wide focus).

Results: Player experiences have an influence on people's creative process skills.

The significant mean differences of PENS scores (Player experience) across creative components shown in Table 6 point out that players felt competence during involvement in the game. The autonomy scale assesses the degree to which participants felt free, and perceived opportunities to do activities that interest them with striving. In game relatedness, the scale assesses the desire to connect with the others in a way that feels authentic and supportive.

These results show significant ($\alpha < .05$) player experiences that are significant to the concept identification within the game play. The intuitive control scale aims to assess the degree which participants control their character's actions in the game environment. These results show significant ($\alpha < .05$) player experiences that were significant to the concept identification and striving within the game play activities. These findings show that player experiences have an influence on people's creative process skills.

ANOVA Between Group	Df.	F	Sig.
Involvement and Competence	9	7.698	.018
Striving and Autonomy	9	5.301	.040
Concept identification and Relatedness	7	5.003	.025
Striving and Intuitive Control	10	6.587	.042
Concept identification and Intuitive Control	10	6.305	.045

Table 6: The significant mean differences of PENS scores across creative components

Results: Game activities encourage people to learn more effectively.

The significant mean differences of school record scores across creative components shown in Table 7 point out that players faced speed at the particular task which play a slow to fast gradient of task rate. The logical skills as programming subjects related how students organize game elements; establishes an idea, order to build in, and steps to take with in game activities.

ANOVA Between Group	Df.	F	Sig.
Programming and Pace	5	4.104	.032
Programming and Planning	4	5.649	.012
Art and Concept Identification	8	4.406	.044

Table 7:The significant mean differences of school record and creative components

These results show significant ($\alpha < .05$) the relationships between Art subject and creative-relevant skill as concept identification within the game play activities. These findings show that game activities encourage people to learn more effectively.

Results: Game activities facilitate the creative process during the game play experiences.

The finding identifies (in Table 8) a significant ($\alpha < .05$) player experience of playing game that were significantly with involvement (Task motivation), Exhibited uncertainly (Domain-relevant skill) and Concept identification (Creative-relevant skill) within the game play. The programming and mathematics results aim to assess the degree that a player has a logical thinking of learning. These results show a significant ($\alpha < .05$) player learning that was significantly with exploration, wide focus, and concept identification within the game play.

ANOVA Between Group	Df.	F	Sig.
Involvement and Year of Game Experience	3	8.103	.004
Exploration and Programming	5	7.784	.004
Exhibited uncertainly and Year of Game Experience	3	5.721	.013
Concept identification and Year of Game Experience	3	14.707	.000
Wide focus and Math	4	6.424	.008
Concept identification and Programming	5	9.068	.003

Table 8:The significant mean differences of PENS scores across creative components

Results: Creative Potential and Learning Outcome

The creative-relevant skill encourages learning activity through the degree to which player has a logical thinking of learning (Involvement, Concept identification and Year of Game Experience). It appears that the ideal conditions for creativity are achieved within self-initiated backtracks by using intentionally moves to previous locations or revisits a particular game task/ challenge (Exhibited uncertainly and Year of Game Experience).

ANOVA Between Group	Df.	F	Sig.
GPA and Competence	9	8.361	.015
GPA and Intuitive Control	10	5.977	.050

Table 9:The significant mean differences of PENS scores across creative components

Table 9 shows the significant difference of learning outcome (GPA) within players' feeling competence and intuitive control during play games. These findings refer to game activities can facilitate individual's learning outcomes by using the creative process skills.

Guidelines for Digital Game Based Learning

As aforementioned, the guidelines presented herein are used to assist game developers to produce games that facilitate creative problem solving. In the guideline, firstly, learning outcomes have to be mapped to the mechanisms of learning that are identified for facilitating creative potential. These conceptual guidelines are shown in the figure 4 as an overview of the Creative Potential of Learning Model (CPLN). In the figure, one can see that all principle concepts are linked into the circular module. In order to clearly understand the interrelationships between principles of learning and creative potential, the interpretation of the results is indispensible. A game's ability to facilitate task motivation centers on the creating an environment that instils confidence to complete tasks and ensures that players have a logical skill to exploration their experiences.

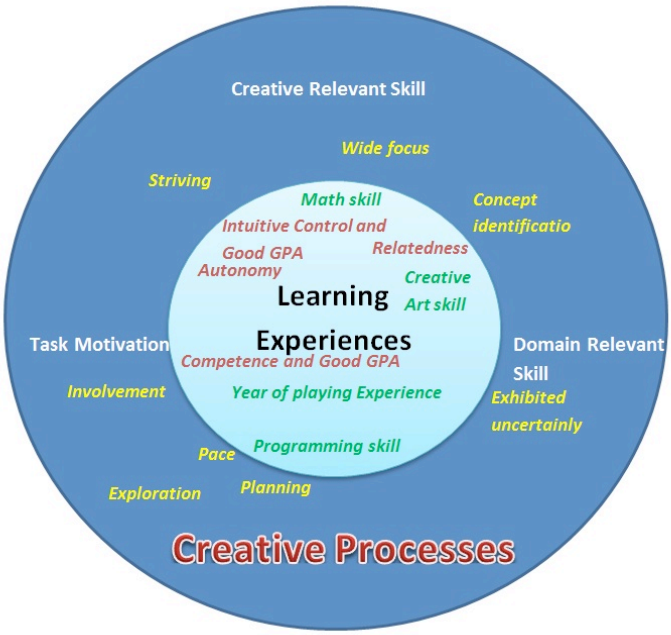

Figure 1 The Creative Potential of Learning Principles Model (CPLN).

From a creativity-relevant skills perspective included providing greater opportunities for players to take a striving while engaging in gameplay. This can be achieved by allowing activity that is the learning mechanisms (Striving and Autonomy; Striving and Intuitive Control). The results refer to the game activity experiences as intuitive control affects the learning outcome.

This can also may be achieved by allowing activity that is the future-oriented, to let players work through the problems that require facilitating interactions with others, and require feeling of intuitive control (Concept identification and Relatedness; Concept identification and Intuitive Control). The creative-relevant skills encourages learning activity through the degree to which player has a logical thought of learning (Concept identification and Creative Art skill; Wide focus and Math; Concept identification and Programming)

The tension parameter has been identified between providing an experience that encourages striving (creativity-relevant skills) and producing gameplay where the player finds it straight-forward to understand what they are required to do and how they might go about doing it (domain-relevant skills). In identifying process, it appears that the ideal conditions for creativity are achieved within self-initiated backtracks by using intentionally moves to previous locations or revisits a particular game task/challenge (Exhibited uncertainly and Year of Game Experience).

Task motivation activities results found that the game challenges effectively allowed for cognitive and logical thinking and strategic planning. There were multiple types of challenges available that players could approach in their own way and at players' own pace, the level of challenge was well matched to player skill level.

The subsequent step of the producing guideline is to map the game activity components to the mechanisms identified(Inchamnan et al., 2014), and learning skills

in Figure 3. These guidelines are outlined below, notice that the creative component facilitated included in brackets.

- Ensure that the class includes clearly goals that allow students to develop their own sub-goals and problem solving skills (Wide focus, Math skill).
- Create challenges in the class that require logical thinking involvement and strategic planning in the class (complexity in problem solving, planning, refining problem solutions)
- Implement challenges that develop at an appropriate pace and match a student's skill level (facilitate striving activity, environments that instill feeling Autonomy)
- Implement rules that offer freedom of choices, where students have the options about what actions to use to solve a problem in the class lesson (wide focus, object use and manipulation, planning)
- Manage student errors by allowing supports for the recovery from errors, and by ensuring that the impact is minimal (facilitate striving activity, environments that instill confidence)
- Allow students to receive immediate and continuous feedback on their actions (environments that instill competence, understand what is required, clear pathways to complete lesson)

Conclusion

This study examines the activity of game potential for helping people to learn more effectively. The study maps the results of the analysis of players engaging in creative problem solving during on line game play. The analysed data have been used to gain better understanding of how in-game activities influence a player's engagement in creative activity and learning. Furthermore, this study developed preliminary guidelines are proposed. The guidelines consider the specific ways that game developer can align learning mechanisms to support creative problem solving processes. The lesson activities should provide the involvement, exploration and planning during study. The class should be engaged the problem solving skills of striving, wide focus, concept identification and exhibited uncertainly.

Future works will investigate the applicability of the Creative Potential of Learning Model to other different game genres. Furthermore, the guidelines proposed will be applied and evaluated in the game development to support creative activity for educational purposes. Finally, the future work will focus on larger samples in order to find the factor analysis of how the game have potential to help people to learn more effectively in terms of creative processes.

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