

The Creative Process Components: Puzzle Gameplay Experience

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Abstract: This paper analyses the relationship between creative behavioral processes that occur in the games and the gameplay experience. The research approach applies a behavioral and verbal protocol to analyze the factors that influence the creative processes used by people as they play computer games from the puzzle genre. Creative processes are measured by examining task motivation and domain-relevant and creativity-relevant skills factors. This paper focuses on the reliability of the factors that are more strongly related to creativity. The findings show the creative components occurred to yield levels of creative performance within puzzle game play activities. Results show that increased engagement in creative processes during gameplay resulted in a better player experience. Task motivation and domain-relevant skill as a component of the creative problem solving processes were particularly influential, as was the use of creativity-relevant skills.

Keywords: Creative components, Task motivation, Domain-relevant skill, Creativity-relevant skill, Puzzle game, Behavioral assessment, Verbal assessment, Gameplay Experience, Learning Practice

1. Introduction

The dramatic growth of gaming as entertainment and the pervasive quality of game play experiences has led to a need to better understand the phenomena. Much research in this area has focused on the negative (for example, game addiction), and only recently have researchers begun to examine the positive consequences of gameplay experiences. While there has been significant growth in game-based learning research in the past two decades (e.g. (Prensky, 2003), (Habgood and Ainsworth, 2011)), this research focuses on games that have been specifically designed for educational purposes. The positive benefits of commercial games primarily designed for entertainment purposes, have only recently become a focus within the games research community (e.g. user experience(Wang, 2008), mood (Ryan and Deci, 2000) and cognitive reasoning(Spence and Feng, 2010). Prior research has suggested that problem ability depends on applying domain knowledge and a skill associated with analyzing information in problems(Sutherland, 2002). Jeffries (2011) studied a conception of skills relevant to creativity within game design. While current research demonstrates the effectiveness of some games in facilitating creativity, this study focuses on the extent puzzle games foster people creative problem solving processes.

In terms of problem solving, video games have contributed to the practice of enhancing problem-based learning processes. The experiences and learning that occur in computer games may enhance creative processes (Yee Leng et al., 2010). Games support the development of critical thinking through visualization, experimentation and creativity (Amory, 2007), and provided players with the theoretical tools to think critically about challenges (Rockwell, 2002). Visualization and problem-solving are an integral part of adventure and strategy games and players are able to visualize the cause and effects of their own actions and develop intrinsic decision-making skills (Amory et al., 1999). Game elements may provide a problem solving process experience as players break down tasks, engage meta-cognitive skills and think critically.

2. Creative Components

The componential model of creativity describes the ways in which people enter the stages of the creative activity. The componential framework of creativity has problem solving at its core and includes three major components: domain-relevant skills, creativity-relevant skills and task motivation (Amabile, 1983). As people solve problems they generate response possibilities from an array of available pathways and explore the environment to determine the best solution. Domain knowledge plays an important part in the generation of an acceptable solution. Engaging in playful activities or fantasy can have a positive effect that influences the active engagement of creativity-relevant processes (Amabile, 1996). Creative-relevant skills influence the quality of the ideas produced and task motivation influences the quantity of ideas (Amabile, 1983, Amabile, 1989, Amabile, 1996). In seeking to understand the creativity, El-Murad and West (2004) adopted a similar approach to Amabile work. Amabile emphasizes aspects of managerial practice that affect creativity. The componential framework of creativity (Amabile, 1989) has problem solving at its core and includes three major components: domain-relevant skills, creativity-relevant skills and task motivation. In an appropriate environment, high levels of three components occur to yield high levels of creative performance (Lubart and Sternberg, 1995).

2.1 Task Motivation

The task motivation is specific to a particular task that is a baseline attitude toward the task and matches the person's own interest (Brown, 1989). It is an important component during the problem presentation stage and during response generation. Task motivation refers to determinant of the difference between what an individual can do and what he/she will do. Convergent thinking in 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, with the ability to select a single response from a series of alternatives (Clark et al., 1965).

2.2 Domain-relevant Skill

Domain-relevant skills form the basis from which any performance must proceed. This component incorporates factual knowledge, technical skills and special talents in a particular domain. The information, skills and talents that an individual brings to a task influence the creative preparation process. Domain-relevant skills define the set of possible responses available to a person (Amabile, 1996). Any problem domain consists of a unique set of rules and practices (Wang, 2008) and this knowledge allows people to identify various strategies for conducting information analysis. Domain-relevant skills provide the material drawn on during operations that determine problem-solving pathways. They also provide the criteria that will be used to assess the response possibilities (Amabile, 1996). Knowledge of a particular domain influences the evaluation process (Brown, 1989).

2.3 Creativity-relevant Skill

Creativity-relevant skills include cognitive style, application of heuristics for the exploration of new cognitive pathways, and working style (Amabile, 1983). These factors influence the response generation process. Heuristic thinking is individual skills that rely comfortably on their feeling for the situation. Differences in cognitive style result in different behaviors with respect to the way individuals gather and evaluate information (Gutierrez and Greenberg, 1993). Creativity-relevant skills act as an executive controller that influences the way in which the search for responses will proceed (Amabile, 1983). Brown (1989) stated that creativity-relevant skills include abilities to concentrate for the long periods of time. The relevant characteristics are commonly reported as correlates of creative people, including self-discipline, ability to delay gratification, perseverance, and absence of conformity (Brown, 1989). Problem solvers automatically activate areas of knowledge that are associated with the past problem solving experience and relevant knowledge (Santanen et al., 2002). This component includes a cognitive style characterised that refer to ability to break set during

problem solving. Individuals can gain experience with idea generation that may devise their own strategies for creative thinking processes (Amabile, 1996).

3. Games for Learning

Playing games has a significant role in helping people to learn (Paras and Bizzocchi, 2005). Learning the rules of a game allows players to interact with game objects and avoid an environment of frustration and confusion. This learning experience allows player greater freedom in terms decision-making. The interactive experience with the game environment allows people to express their creativity and intentions (Sweetser and Johnson, 2004). Creating authentic and engaging gaming activities that incorporate educational content and process may lead to new learning practices. The informal learning linked with games can provide a foundation for innovation which can be applied in a formal learning situation (Spikol and Milrad, 2008).

4. Puzzle Games

In terms of problem solving, video games have contributed to the practice of enhancing problem-based learning processes. Game performance may be influenced by the player's prior experience (Hong et al., 2012). This study focuses on the engagement in creative activity that is the result of individuals being intrinsically motivated to interact, and the learning that occurs through prior positive experiences. The relationship between educational theory and game design appears to require appropriate puzzles integrated into strong story line where game technology is used to create an entertaining experience (Amory, 2007). Modeling creative gameplay focuses on puzzle games. In a puzzle game, the gameplay is the physical and mental activities. Gameplay includes the game's rules, the various choices and challenges (Prensky, 2002). The relationship between the use of creative processes during gameplay and player experience is examined in the context of three puzzle-based games – Portal 2, I-Fluid and Braid. While these games have different mechanics, goals and setting, they all require the player to solve puzzles to progress through the game.

5. Assessing Creative Potential of Computer Games

Measurement of creative potential involves examining the relationship between tasks, from both domain skill and creative skill perspective, and the effect of intrinsic motivation (Ruscio et al., 1998). It has been used previously to measure creativity in structure building activities, collage making and poem writing. The research yielded a specification of particular task behaviors that strongly predict creativity. The model proposed by Ruscio et al. (Ruscio et al., 1998) identifies 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. The creative game potential measures identified good reliability for the 9 task motivation factors through these behaviors are (Inchamnan et al., 2012):

- Involvement (A1): Work on solving the problem;
- Stability (A2): Refining the integrity or stability of a problem solution within the game;
- Set breaking (A3): Manipulates materials; uses or attaches them in new ways;
- Pace (A4): Speed at which participant works on tasks/challenges; a slow to fast gradient of working rate;
- Planning (A5): Organizes material; establishes an idea, order to build in, steps to take;
- Playfulness (A6): Engaging in tasks in curious manner; trying out ideas in a carefree way;
- Exploration (A7): Curious, or playful testing out of ideas
- Enjoyment (A8): Having a good time, finding pleasure in the task / challenge; and
- Concentration (A9): Focused on the task; not distracted.

The measures identified by Ruscio et al. (1998) as predictors of creativity are assuredness, difficulty and exhibited uncertainty. Some researchers have been adapted to formulate creative game potential measures in terms of domain-relevant skills in the context of computer gameplay. They include (Inchamnan et al., 2012):

- Exhibited uncertainty (B1): Self-initiated backtracks by using intentionally moves to previous locations or revisits a particular game task / challenge.
- Assuredness (B2): Confidence: certainty of ability to complete task; assuredness in going about the task; not doubtful, timid, or anxious. Pace and the speed at which particular task /challenge are addressed; a slow to fast gradient of playing rate; and
- Difficulty (B3): Problem with self: uncertainty, self-doubt, and negative statements about ability or mood. Negative exclamations by using usually one word, can be two or three; curses or otherwise sharply negative statements.

Creativity-relevant skills are measured through the specific process factors of concrete focus, concept identification, wide focus and striving (Ruscio et al., 1998). These have been adapted for the gameplay context. The creative game potential measures, in terms of creativity-relevant skills, are (Inchamnan et al., 2012):

- Wide focus (C1): Goal statements: Something that cannot be done in one step, future oriented; restatement of problem given, self-imposed goal, statement dealing with a desired final goal, etc. Irrelevant to task: Anything not related to performing the task / challenge;
- Striving (C2): Difficulty: encountering problems or obstacles to completing some or all of the tasks/challenges. Transitions: Movement to new area of action; includes place holding utterance. Question how: Questioning how or what to do; what is currently being done. Repeat something: Repeats instructions, words or concepts presented in the game: Exclamations: based on positive or negative outcomes;
- Concrete focus (C3): Talks about task: statements of like or dislike about the task. Describes game elements: statement about texture, color, or other attributes of elements, naming game elements; and
- Concept identification (C4): Analogies: Description or statement containing an analogy or metaphor. Aha: Eureka-type statements; abrupt change in activity. Transitions: movement to new action; includes place holding utterances.

6. Research Design

This study assesses components occurred to yield levels of creative performance within puzzle game play activities. The methodological contribution of the study is the demonstration that creative behaviors and processes that occur during puzzle gameplay can be examined using behavioral observation techniques and verbal protocol analysis. Using behavioral observation techniques and verbal protocol analysis were may be able to identify and quantify predictors of creativity(Ruscio et al., 1998). Game task behaviors and verbalizations were coded to obtain empirical indices of the assessed factors: task motivation, domain-relevant skills and creativity-relevant skills.

6.1 Participants

Nineteen participants participated in the study (31.6% of female, 68.4% of male). They had an average age of 24, ranging from 18 to 34($M = 23.79$, $SD = 4.35$). Most participants were familiar with playing games with 52.6% indicating that they played games daily, 15.8% several times a week, 15.8% once a week, 5.3% once a month; 10.5% indicated that they do not play videogames.

6.2 Procedure

Participation in the study involved being observed while playing the three selected games: Portal 2, Braid and I-Fluid. The order in which players were presented with the games was varied to avoid order effects. Participants played approximately 45 minutes in total. They played each game for 15 minutes. To examine the creative process, participants were video recorded while playing the games. Two researchers gathered data through behavioral and verbal coding techniques. A video coding scheme was used to capture the type and frequency of observable behaviors and participant verbalizations. Video coding was completed for each of participant. Two raters coded pilot videos to ensure rater reliability for details of the development of this technique and all measurement items.

This approach provides a good approximation of the significance level for the treatment and time effect, through three treatments as playing the three selected games.

6.3 Materials

Game related behavior was used to assess participants' level of creativity during various game activities on a seven-point Likert scale ranging from 1 (low) to 7 (high), and through the use of a frequency tally. Seventeen items related to task motivation (e.g., "Participant works on solving problems within the game."). The items were grouped within nine variables: Involvement, Stability, Set breaking, Pace, Planning, Playfulness, Exploration, Enjoyment, and Concentration. All of items were assessed using 7-point Likert scales. Twelve items were included to analyze domain-relevant skill factors (e.g., "Participant feels certain about his/her ability to complete tasks in the game"). The items were grouped into 3 variables: Exhibited uncertainty, Assuredness, and Difficult. Seven items were assessed using a 7-point Likert scales and data for five items was captured as frequency counts. Eighteen items were designed to measure creativity-relevant skills (e.g., "Participant is able to develop his/her own goals within the game"). The items were grouped into four variables: Wide focus, Striving, Concrete focus, and Concept identification. Only three items were assessed using a 7-point Likert scales. Fifteen items were assessed using frequency counts.

7. Results

To make each variable contribute equally to the mean, values of frequency items are standardized. Figure 1 shows the comparison of average scores based on standardized values as variables for creativity components: Task motivation, Domain-relevant skills and Creativity-relevant skills for each game. In Portal 2, the level of task motivation and Domain-relevant skills are highest. I-Fluid has the average for three components. Braid has the highest for creativity-relevant skills and lowest for both task motivation and domain skills. While player behavior indicative of task motivation and domain-relevant skills were generally high for each of the games, engagement in creativity relevant skills was low in comparison.

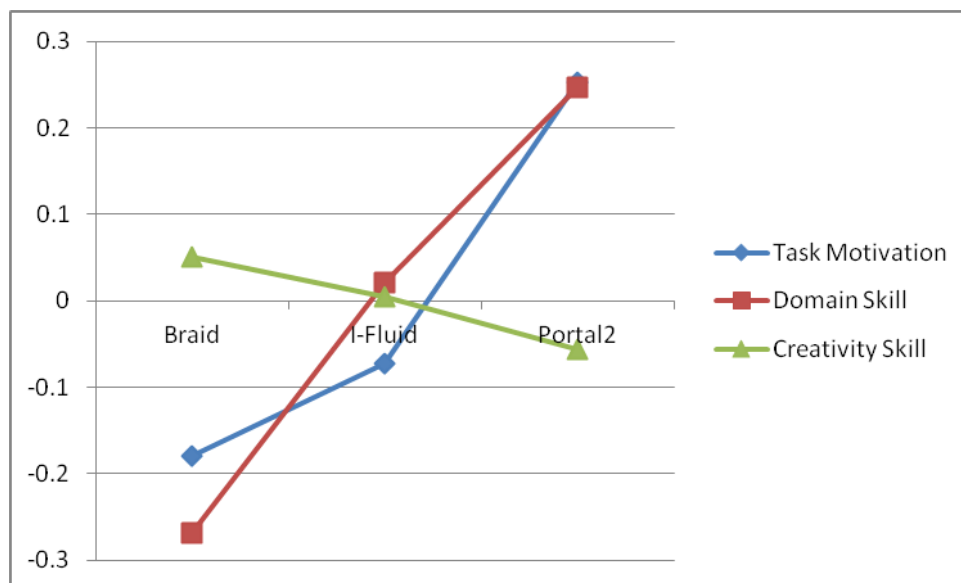


Figure 1. Creative potential components for each game

7.1 Behavior Analysis of Task Motivation

According to means difference (Figure 1), the coding results show the example of puzzle game play activities influence the high level of task motivation in Portal 2. Conversely, in Braid gameplay activities engage low in comparison.

7.1.1 Involvement Activities

Both games allow participants high works on solving the problem within the game activities. In Portal 2, the player works to solve a wider variety of portal puzzles and expansive story to escape from the room ($M=5.79$, $SD=0.71$). In Braid, the player progresses by finding and assembling jigsaw puzzle pieces ($M=5.47$, $SD=0.67$).

7.1.2 Stability Activities

These activities of both games show high refining the integrity or stability of a problem solution. In Portal 2, the player can move one to one, rotate objects in real time such as "...get the box across gaps through holes in the walls and around obstacles" ($M=5.68$, $SD=1.00$). In Braid, the player can read some sort of information from words. After a few seconds or minutes of reading his/her amassed a bit of knowledge and can find ways to apply it ($M=5.11$, $SD=0.85$).

7.1.3 Set Breaking Activities

These activities allow participants to use objects and materials in different ways. In Portal 2, the player can use the portal gun to get in and use the cube to open the door ($M=5.16$, $SD=1.30$). In Braid, the player can use a shift button to complete some task such as pick the key form the enemy in the cave ($M=4.74$, $SD=0.91$).

7.1.4 Pace Activities

These activities required more high speed within Portal 2 progresses from a slow to fast than Braid activities. In Portal 2, the player spends a lot of time tangling with spatial reasoning puzzles in test chambers form slowly to fast ($M=5.00$, $SD=1.15$). In Braid, the clock has always ticked down for bonus point, but only 15 minutes, the player cannot achieve a bonus point ($M=4.53$, $SD=1.04$).

7.1.5 Planning Activities

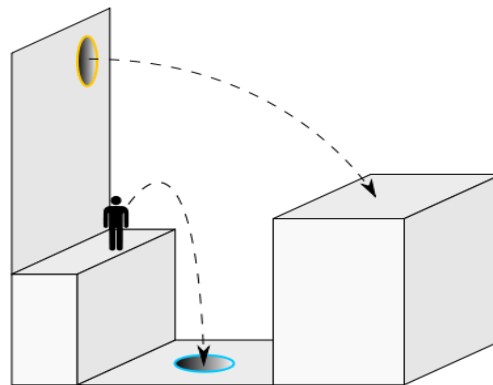


Figure 2. Portal 2 Planning Activities

Planning activities that participants can organize materials in both games are high. In Portal 2, the game challenges player to use portals to traverse rooms in unusual ways such as a player-character executing the "flinging" manoeuvre gains speed by falling into the blue portal to shoot across a wide gap upon exiting the orange portal in Figure 2 ($M=5.42$, $SD=1.30$). In Braid, the payer can use enemies to complete his/her task such as use the enemies to jump higher ($M=5.05$, $SD=1.05$).

7.1.6 Playfulness Activities

In Portal 2, participants can engage more in game tasks than Braid. The game needs the player to find a way to add an element to the puzzle, which the player will have to ponder before they can take

action ($M=5.42$, $SD=1.02$). In Braid, the player got trapped in the Jigsaw Bridge and tries to find out what the meaning of whole puzzle ($M=4.84$, $SD=0.81$).

7.1.7 Exploration Activities

In Portal 2, encourages more playful testing out of ideas than braid. The player can use portal gun to get the idea of get in or get out ($M=5.37$, $SD=1.12$). In Braid, the game allows the player test his/her ideas how to get the key in Fig. 3. ($M=4.84$, $SD=0.67$).

7.1.8 Enjoyment Activities

The gameplay tasks are higher positive enjoyment activities in Portal 2 than Braid. In Portal 2, the player follows a logical sequence that is satisfying to discover the puzzle ($M=5.37$, $SD=1.26$). In Braid, the player said cute and smile when saw the animal at the castle ($M=4.63$, $SD=0.74$).

7.1.9 Concentration Activities

Related to concentration in problem solving activities, both games provide minimal distraction the game tasks. In Portal 2, the game tasks provide the player to think and do the action without penalty of time ($M=5.37$, $SD=1.16$). In Braid, the player feels comfortable to complete the puzzle pieces ($M=5.21$, $SD=1.06$).

7.2 Behavior Analysis of Domain-Relevant Skills

The coding results show the example of puzzle game play activities influence average domain relevant skill in I-Fluid. While in Portal 2, player behavior indicative of domain-relevant skills was generally high in comparison.

7.2.1 Exhibited Uncertainty Activities

Both games provide participant can reverse or undo steps or action in the game activities. In I-Fluid, the player can reverse or undo all the time without penalty ($M=4.32$, $SD=1.56$). In Portal 2, the game allows players trial-and-error until they come upon the solution such as “It’s on to opening portals, jumping off ledges, and redirecting light in bouts” ($M=6.53$, $SD=1.26$).

7.2.2 Assuredness Activities

Assuredness activities allow players confidential in going about required tasks. In I-Fluid, the absorbent surfaces such as paper or biscuits will soak player up that make common sense ($M=4.74$, $SD=1.02$). In Portal 2, the puzzle rooms are incredibly well designed in there is no hard and fast rule with the game’s difficulty curve ($M=5.42$, $SD=1.43$).

7.2.3 Difficulty Activities

Both games allow participants feel uncertain completing tasks. In I-Fluid, the small objects to take control make player feel uncertain such as player said in Figure 3 “It too tiny for me” ($M=5.47$, $SD=1.64$). In Portal 2, the new player cannot get the ideas how to use the cube to open the gate ($M=6.16$, $SD=1.07$).



Figure 3. I-Fluid Difficulty Activities

7.3 Behavior Analysis of Creativity-Relevant Skills

The coding results show the example puzzle game play activities influence high creativity relevant skill in Braid. While in Portal 2, player behavior indicative of creativity-relevant skills was generally low in comparison.

7.3.1 Wide Focus Activities

Wide focus activities are composed of goal statement and irrelevant to tasks, for example the current problem that need to be solved more than one step. These activities both games are low. In Braid, the player has to solve jigsaw to create bridge and can go to solve next problem in Figure 4 ($M=2.26$, $SD=0.96$). In Portal 2, the Player have to get the cube from one room first and then get to the next room for leave the cube to open the gate and escape from the next door ($M=2.53$, $SD=1.47$).



Figure 4. Braid Wide Focus Activities

7.3.2 Striving Activities

Both games are high in striving activities that participants encountered obstacles while completing tasks in the game. In Braid, the player cannot get the key in the small place, because there is too small for Tim ($M=5.53$, $SD=0.68$). In Portal 2, the player dies from the enemies before find the way to escape from the portal ($M=5.05$, $SD=1.18$).

7.3.3 Concrete Focus Activities

While focused concretely on the task at hand, participants talk about the qualities of the materials, objects or attributes of the game world. In Braid, the player said about the qualities of the materials, objects or attributes of the game world “Shift button is very useful...” “The game is look like easy but not easy” ($M=5.37$, $SD=1.80$). In Portal 2, the player said “The game look like the movie” ($M=6.1$, $SD=1.24$).

7.3.4 Concept Identification Activities

Concept identification refers to the selections of problem solving solution, for example participants have an abrupt change in activity designed to help complete a game task. The result shows both game are low. In Braid, the player cannot solve the whole jigsaw then has an abrupt change in activity designed to help complete a task change by doing other action for getting ideas ($M=0.74$, $SD=1.02$). In Portal 2, the player cannot complete task then go to main menu and find the early level to play ($M=0.74$, $SD=1.09$).

8. Discussion and Conclusions

The research identified the key specific components of puzzle computer game experiences that may be measured to assess a game’s potential for supporting creative activity. The example activities in I-Fluid and Portal 2 show an important part in the generation of an acceptable solution in terms of domain-relevant skills through exhibited uncertainty, assuredness, and difficulty activities. Engaging in playful Braid and Portal 2 gameplay activities; including wide focus, striving, concrete focus and concept identification activities can have a positive effect that influences the active engagement of creativity-relevant processes. Task motivation influences the quantity of ideas through set breaking, pace, planning, playfulness, exploration, enjoyment and concentration activities as shown in Portal 2 and Braid activities. The creative potential prediction involves the relationship between task creativity within a knowledge domain and the effect of intrinsic motivation on the process.

The task motivation factor includes involvement, stability, set breaking, pace, planning, playfulness, exploration, enjoyment and concentration are high. These activities contributed to the practices that refer to participants are motivated by their feeling of positive challenge in problem solving. Domain skill activities in three games show high exhibited uncertainty, assuredness and difficulty activities. These skills refer to familiarity with factual knowledge for solving problems in the domain. Knowledge of a particular domain influences the evaluation process in creative potential processes. Creativity-relevant skill component includes wide focus, striving, concrete focus and concept identification that refer to ability to break set during problem solving. These activities are low which means puzzle gameplay that refer to ability to break set during problem solving are low. The activities may influence other gameplay genre. The puzzle gameplay integrated into strong story-lines that may not provide break set while completing the progressive game tasks.

The results show the significant domain skill difference between Portal 2 and Braid; these games have different mechanics, goals and setting. Portal 2 has a high mean of task motivation and domain-relevant skills and low creativity-relevant skills. Braid has a high mean of creativity-relevant skills and low task motivation and domain-relevant skills. The results will enable the relationship between games mechanics to be examined through creative components in the future work.

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