1. Exploring the Relationship Between Creative Potential, Playing the Game Minecraft, and Engaging in Its Player Community

MICHAEL D. PROCTOR AND JOHN J. AEDO

Abstract: Technology and by extension innovation have become cornerstones of modern life and key drivers of prosperity. Creativity is considered one of the foundational skills to the evolution of technology and innovation. How one measures the contribution of various approaches to creativity enhancement still faces challenges. A study was conducted with middle and high school STEM students to explore the relationship of creative potential, their experience with the game *Minecraft*, and use of social media related to the game. The TCT-DP creativity test was selected because of its fitness to task and institutional experience. While the results did not support a link between either experience in *Minecraft* or engagement in its online communities, there are patterns that could inform both game design and creativity curricula.

Purpose

The primary purpose of the research was to explore the relationship between creativity potential and individual time spent and/or expertise in *Minecraft*, the most popular builder game and one of the most popular video games ever (Gilbert, 2019). The secondary objective is to determine the effect (if any) of engaging in social media with regards to the game—posting comments, sharing works, contributing to player-generated content, and so forth.

Introduction

Steinkuehler (2016) reflected on the state of educational-game development, lamenting the top-down approach that has failed to consistently produce games that marry pedagogically effective content, engaging design, and accurate content. She proposes to "create an indie scene that marries these three domains (and cultures) to produce not just games but educational media more broadly that do not simply reify what we already do" (p. 177). We can start by understanding the engagement dynamics of the games children actively seek out to play and the social structures around those games, such as the best-seller game *Minecraft*. Aedo and Proctor (2016) found support in the literature that both playing video games and participating in affirmational communities may support creativity. Day (2019) suggests that learning within communities happens in a networked structure of inquiry among members: "This is why we think that the question is not how a certain technology helps in the diffusion of information, skills, or knowledge, but rather how the network functions when problem finding and solving are involved" (p. 67).

Techniques to assess the level to which behaviors of inquiry, presenting the creative work to the group, and critiquing the work contribute to creativity are important to the way forward. Related questions include: What is the level of acceptance of creativity in a community or network? To what level is creativity facilitated by a game? To what level does a social media system support sharing and collaboration?

The above research questions represent end goals of the "big picture," requiring much more extensive data gathering

than likely answered within the scope of this study. This research is limited to a quantitative case study aimed at exploring the nature of creativity among the player population of *Minecraft*.

Method

The study was conducted through the University of Central Florida's summer STEM camps for aspiring engineers and scientists. Students ranged in age from 11 to 17. IRB approval was obtained on May 3, 2019, expiring May 3, 2020.

Instruments

This study uses two instruments—a drawing-based Test for Creative Thinking-Drawing Production (TCT-DP) and a survey. The survey instrument is composed of two main sections. The first section is the game achievement inventory, which asks questions pertaining to activities and accomplishments inside the game *Minecraft*. The second is the social media engagement items, which ask questions about how often the participant posts in game forums or shares his or her in-game creations with others.

The TCT-DP. The TCT-DP is an easy-to-administer, drawing-based creativity test requiring no more than 15 minutes to complete, can be scored by trained laypeople (i.e., non-psychologists) with the guidance of the scoring manual, and can be administered to a wide age range (Urban, 2004). Thus, the TCT-DP enables transferability of creative behavior from games to a real-world setting by capturing creativity independent of setting, task, or other context-sensitive interactions with the subject.

The game achievement inventory and social media engagement survey. The survey instrument was designed, administered, and mostly scored within the Qualtrics web-based analytics software. In addition to the primary data of interest to the study, basic demographic data along with a unique identification number are prompted. The identification number is a randomly generated six-digit value, which is written at the top of the TCT-DP sheets. It is used to link the creativity test with the surveys.

Latham, Patston, and Tippett (2013) support the use of game-specific task completions and other measures of performance assigned by the game as valid constructs of video game expertise.

There are no established norms for what would differentiate a novice gamer from an expert gamer in *Minecraft*. The game achievement inventory collects three types of data: level of experience in combat, level of experience in resourcing, and experience in crafting and producing creative works in the game. Game achievement will be scored along two categories—Combat and Resourcing. The Combat score is a measure of the difficulty of enemies defeated in the game. Participants are presented a list of enemies in the game and asked to mark which ones they have defeated. The Resourcing score is a measure of how well they have mastered the environment. The various resources in the game (ores, wood, minerals, killed animals, and tamed animals) are presented in a similar checkbox list.

One gap in the *Minecraft* scoring system is its lack of a reward system for creative behavior or completing creative tasks. Most rewards regard combat and resourcing. In order to get a better picture of a player's creative achievement, supplementary questions inquire about structures crafted, the use of the redstone logic system, and the creation of custom player skins, maps, or game mods.

Combat scoring is based on a normalized point value system derived by a three-member panel of experts in *Minecraft*, with each member having a minimum of five years of experience in the game. While *Minecraft* features an experience-

point award system for defeating enemies, this scoring system is too skewed to provide any meaningful analysis. According to the *Minecraft Wiki* (iMakerB, 2020), in the original scoring system, common enemies such as Zombies, which can be defeated by novices, provide 6–9 experience points. Defeating the final enemy at the End, meanwhile, earns 12,000 experience points. This scale effectively buries any other combat achievements a player may have earned along the way, since their point values are far lower (5–20 experience points for most enemies) than that of the End boss. The new scoring system, on the other hand, normalizes the awarded points based on the actual difficulty of the enemies encountered. The panel considered factors such as enemy mobility and offensive capability (e.g., single-target versus area-effect attacks) or unique abilities that pose a significant tactical challenge. The resulting scale gives a maximum possible combat score of 500 for defeating every enemy type in the game.

Resourcing scoring is derived similarly. The original experience-point tables provided by the game serve as the basis for the scores. However, Combat and Resourcing need to be balanced in their total respective scores as they are equally important factors in the *Minecraft* experience. The expert panel reviewed the experience-point table and derived new values based on the existing baseline and setting the scoring upper boundary to 500 points to match the top Combat score. Several factors were considered in scoring, such as the difficulty of obtaining the prerequisite tool for gathering the material. For example, obsidian requires the most difficult-to-obtain material, diamond. It also requires managing a hazardous environment, since obsidian is found near sources of lava. Other factors include the depth underground at which the material can be found. Deeper depths are more dangerous as the difficulty of the monsters encountered increases. These circumstances merit a score of 60, which is the same as defeating a wither enemy. Scoring for taming and killing wildlife also considered the relative disposition of the animal (peaceful or aggressive), its speed, abundance or rarity in the game world, and availability of any food or material required in its maintenance and breeding.

Three questions comprise creative output. The first is a free-response question: "What kinds of things have you made *in the game*?" Responses earned points in accordance to the five stages of skill acquisition (Dreyfus, 2004): *novice*, *advanced beginner*, *competent*, *proficient*, and *expert*. Each level is assigned a discrete value, 1 through 5, according to its proficiency level (see Table 1).

Proficiency Level	Score	Qualities
Novice	1	Houses, static structures
Advanced Beginner	2	Structures with moving parts such as railroads, rollercoasters. Structures that span multiple levels/floors.
Competent	3	Structures that alter or define gameplay such as maps, arenas, mazes, obstacle courses
Proficient	4	Replicas of real-world places or objects (monuments, architecture) or complete maps
Expert	5	Dynamic creations that employ logic

Table 1. Scoring construction proficiency.

The second question is a checklist of devices and contraptions crafted in the game. These items account for the dynamic elements that extend the game's creative palette beyond static structures to include things that react to players or the environment. Activity in any of these items indicates a level of proficiency beyond casual play, as these elements require an understanding of the game's logic systems and core engine. Moreover, *Minecraft* can be a development platform. Its game engine is available for programmers to extend in various ways at different levels. Players can choose to play with

modifications to the game engine, which can significantly alter the play experience; mods could include adding utility to the user interface, adding new monsters, even creating entirely new and unique game rules/systems. Players can also choose to participate in modding by contributing their own game assets or code. Each activity is assigned a proficiency level (see Table 2).

Activity	Score
Used redstone to create simple devices like automatic doors or light-triggered lamps	1
Used redstone to create simple digital circuits (flip-flops, clock circuits)	3
Used redstone to control mine carts with switching tracks and/or routing	2
Used redstone to create advanced digital circuits and devices such as calculators and CPUs	5
Used command blocks to spawn monsters	1
Used command block chaining	3
Used command blocks with redstone	4
Used mods like Tinkers Constructs, Extra Utilities, RF Tools, or similar	2
Created a mod pack	3
Contributed art or code assets to a mod	5

Table 2. Scoring advanced dynamic play.

The third question relates to creative output outside of the game about the game—for example, drawing pictures of the game enemies, writing stories set in the game or about the game, or making videos about the game. As above, an activity checklist is presented, and the participants select those items that are true about them (see Table 3).

Activity	Score
I have created custom maps for Minecraft.	3
I have draw pictures or paintings about Minecraft.	1
I have written poems or stories about Minecraft	2
I have made sculptures or models out of Legos/building blocks about Minecraft*	3
I have made videos about Minecraft	3
I have written songs or made music about Minecraft	2
I have written player guides, tutorials or other kinds of articles about Minecraft	4
I have created a custom player skin for Minecraft	1
I have made or helped make code or art for a Minecraft mod.	5

Table 3. Scoring out-of-game creativity.

The social media engagement survey measures motivation for play, online play and discussions, collaborative creation, or sharing of creations. These questions are mostly free response; this is due to a goal of avoiding Likert-scale items as the survey targets children. Responses were interpreted on a five-point Likert frequency scale from 1 (nonresponse) to 5 ("More than two or three times per week").

Frequency of sharing game experiences online is composed of three Likert frequency questions: "How often do you

record or stream your *Minecraft* games?", "How often do you post/write about the game online?", and "Mark all of the following activities that you've done." The same rubric used for "How often do you play with others?" is used for frequency of streaming or sharing.

Sampling

Volunteer-based sampling is nonprobabilistic and therefore there is no formula for computing the required sample size (Ritter & Sue, 2007). Per Ritter and Sue (2007), the traditional N = 30 should suffice. For correlation analysis, Bujang and Baharum (2016) recommend N = 46 with an R0 = 0.0, R1 = 0.4 for inequality tests with a power of 80% and alpha of 0.05.

The population was sampled from participants in a series of summer camps hosted by the University of Central Florida to promote STEM enrollment among potential students from middle and high schools throughout the United States. The selection of the camps was based on schedule availability and consent of the instructors. Two camps were used: The Physical Sciences Summer Institute and the Computer Science Institute. The physical science camp hosted rising sixth through eighth graders and presented material across multiple disciplines, including earth and life sciences, engineering, computer science, and digital media. Although there were no skill or academic prerequisites, the students must have been recommended by a teacher to attend the camp. The computer science camp hosted older students, from rising ninth through 12th grade with a minimum age of 13 at the time of application.

Administration Procedure

The camp facilitator introduced the principal investigator (PI) to the class and provided a brief explanation of the activity and its purpose, clearly identifying the investigator as a doctoral student in the Modeling and Simulation program at the university. The PI handed out the test sheets and pen while explaining the activity. In both camps, computers were available with Internet access through which to access the Qualtrics survey. Instructions for the creativity test were read directly from the TCT-DP manual. Students were given a maximum of 15 minutes to complete the test but were not informed of this to avoid adding unnecessary stress, which can affect creativity. Turn-in times were recorded on the test sheet as they were turned in.

Data and Analysis

Correlation Analysis

Simple correlation with the TCT-DP scores was calculated independently for time spent in game, game achievement, and social media engagement to directly answer the research questions. In all cases, correlation was statistically insignificant.

Every other measured attribute was also cross-correlated with all the others and with the TCT-DP scores. In Table 4, the negative correlations all correspond to the TCT-DP against each individual dimension of the survey. However, within this matrix, there are some correlations not related to the TCT-DP that merit further inspection. Combat and Resourcing are correlated at 0.79, suggesting confirmation that these two factors align with game achievement. The creative behavior

dimensions show moderate correlation with Combat and Resourcing as well (between 0.54 and 0.63). This may be an indicator of the gamer profile represented by the students sampled in this study.

	Combat	Resourcing	Cr - In Game	Cr - Out Game	Cr - Total	Social	Construction	TCT-DP
Combat		0.79	0.63	0.61	0.69	0.56	0.44	-0.19
Resourcing	0.79		0.54	0.58	0.62	0.49	0.44	-0.14
Cr - In Game	0.63	0.54		0.57	0.95	0.36	0.45	-0.11
Cr - Out Game	0.61	0.58	0.57		0.8	0.57	0.41	-0.19
Cr - Total	0.69	0.62	0.95	0.8		0.48	0.49	-0.15
Social	0.56	0.49	0.36	0.57	0.48		0.41	-0.08
Construction	0.44	0.44	0.45	0.41	0.49	0.41		0.07
TCT-DP	-0.19	-0.14	-0.11	-0.19	-0.15	-0.08	0.07	

Table 4. Correlation matrix.

Combat and Resourcing Scores

Combat and Resourcing scores show an interesting pattern in their distribution and skew. Neither Combat nor Resourcing are normally distributed. Combat score is binormal in its distribution with a mean score of 253 (out of a maximum of 500) and a skewness of -0.03. However, half of the players scored more than 240 points, which is possible only by defeating some of the game's most difficult enemies, such as withers, elder guardians, and the Ender Dragon final boss. Resourcing shows a similar, but more pronounced, pattern. Resourcing is a more linear progression in the game. While it may be possible for a player to defeat more difficult enemies relatively early on, this is not the case with Resourcing. It is not possible to skip forward and gather the more difficult and rare resources. Resourcing is gated by the tool-progression system. This means that Resourcing is a good indicator of a player's true progress in the game. The distribution of Resourcing scores is skewed left with a skew parameter of -0.65. Much of the student population clustered at the far-right end, with many achieving close to the top score.

Creative Behavior

Conversely, all three creative behavior measures clustered near the low end. In-game Creativity, an indication of the player's use and mastery of advanced dynamic game elements, skewed the most with a right skew of 1.02. Out-of-Game Creativity and Construction exhibited similar skews at 0.72 and 0.61, respectively.

Analysis

The creative behavior scores are the first hint at what may be happening with our participants' scores within *Minecraft* and why there may not be any correlation with actual creative potential. These students were playing *Minecraft* to win at *Minecraft*. In any other game context, that would be a tautology. Most games are solely concerned with reaching the end state—defeating an opponent, beating the high score, or completing the story. *Minecraft* is not like that. *Minecraft* has very strong creative components, including a play mode, aptly titled "Creative Mode," in which all the combat elements

and resource acquisition elements are effectively disabled. Enemies either do not appear in the game or are docile and all construction materials are available in infinite quantity from a menu. Even within "Survival Mode," the creative component is still offered through the game's building-block nature. Once the materials have been gathered, it is still possible to build freely with those materials. The Resourcing progression is the only limiter to creativity within Survival Mode. Many players craft their creations within Survival Mode because they enjoy the challenge of building under pressure. This study's cohorts, however, clearly did not engage the creative facilities offered by the game.

The reason is simply because they did not need to. These players played to win. The Combat scores leaned to the right with most players (52%) engaging the game's more difficult enemies. The Resourcing right skew likewise shows that these players advanced through the mining and gathering progression ladder. It is not possible to defeat the stronger enemies without strong weapons and for that, players must dig through the increasingly difficult materials to get to materials with which to fashion adequate weapons for the tougher enemies. Meanwhile, they opted not to use the advanced interactive dynamics. Defeating enemies does not require redstone gadgets or mastery of the game engine. Likewise, surviving in *Minecraft* does not require elaborate constructions. The only structure a player needs to build in the game is a strong walled structure big enough to house the crafting tools required to create and enhance his or her weapons and armor. Long-term security can be established by torching the perimeter of the structure far enough out to prevent monsters from spawning close enough to be a threat. Once the structure is built and the perimeter lit with torches, a player can be done with construction. If players opt to explore extensively, they can simply repeat that process at their new location.

Without their engaging in much creativity, then, there is not much reason to expect to see any differences in their creativity test scores.

Conclusion

Personal experience and the literature suggested that creativity, especially among young adults, is on a decline (Kim, 2012). This research is motivated by a glimmer of hope that the author discovered on YouTube—a thriving microcosm of creativity all centered around *Minecraft.* Players are creating fantastic landscapes of every imaginable shape and size—personal castles intricately decorated with furniture and detailed appointments, sprawling roller coasters with dynamically triggered animations and special effects, complete scaled re-creations of real-world items and places. The magnitude of skill being demonstrated seems to suggest that perhaps there is something special about *Minecraft* that elicits such player engagement.

It seems that for many children, *Minecraft* may be just another monster-hunting adventure. While the game certainly affords the player a great deal of creative power, these cohorts apparently did not avail themselves of it. While the literature does seem to suggest that playing video games, in a generic sense, may offer cognitive benefits (Hutton & Sundar, 2010), we also know that many children play video games (ESA, 2019) and so therefore may already be enjoying their benefit.

Therefore, if a powerful platform such as *Minecraft* is to be exploited for any creative advantage, the learner must be guided and encouraged to use its features for self-expression. One possible way forward can be found in Microsoft's sample Computer Science Curriculum for Minecraft (Mojang, 2020). This curriculum takes a traditional introductory computer science course and implements it entirely inside of *Minecraft.* The Education Edition of the game includes development tools that allow learners to manipulate entities in the game, either directly using the JavaScript language or through a visual interface such as Code.org, in which logic flow is graphically represented with interactive blocks. Assignments allow and encourage learners to engage the virtual world not only using their own avatars as they would with regular *Minecraft*, but through the programming interface. The final project is not only a test of their earned

programming skills, but also an open canvas in which they can create whatever they want. The goal of that final assignment is simple: Use what you have learned to create something interesting and novel. That is the core of creativity, harnessed in a structured curriculum that happens to take place in *Minecraft*.

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