CHILDREN'S CONCEPTS OF CREATIVITY IN VIDEO GAMES: THE IMPACT OF DIFFERENT GAME TYPES

by

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Children's Concepts of Creativity in Video Games: The Impact of Different Game Types

A Thesis submitted in partial fulfillment of the requirements for the degree of Master of Arts at George Mason University

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DEDICATION

I dedicate this work to my cats, Mackerel and Cocoa, who have provided endless emotional support and stress relief as I worked through this project.

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ABSTRACT

CHILDREN'S CONCEPTS OF CREATIVITY IN VIDEO GAMES: THE IMPACT OF DIFFERENT GAME TYPES

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Research on video games typically focuses on adolescents and young adults, and on the possible negative effects of gaming. However, ever younger children are given access to video games, making research with these younger age groups necessary, particularly as games may start to replace activities such as pretend play. Our study approaches the question of how video games for younger children may prime cognitive creativity after playing, as well as how children conceptualize creativity within video games. In study 1, children played one of two video games (Minecraft, with no plot or mission, or Dragon Quest Builders, which contains both) and provided several open-ended responses about their creativity in the game. Participants then completed a cognitive creativity task. In study 2, shortened video clips of children's outputs in Minecraft from study 1 were shown to a separate group of children, ages 7 – 15 online. Children were asked about their prior experiences with video games, they rated the creativity of the Minecraft videos, and they explained each of their ratings. Results show

that children with more gaming experience rated gameplay significantly lower for creativity than those with less experience, and that gameplay focused on building something was rated significantly higher for creativity than other types of gameplay. These studies allow us to evaluate how video games could train children to be creative, in an age group typically excluded from video game research, to gather information on what creativity might look like in video games, and to understand how children of various ages conceptualize creativity within video games.

INTRODUCTION

Ever advancing technology has become increasingly more accessible in recent years, including availability and engagement in popular video games. Children as young as age five spend a surprisingly large portion of their time interacting with digital media, playing video games an average of 40 minutes per day (Rideout & Robb, 2020). Despite this rapidly growing younger audience, most video game related research focuses on adolescents and adults, and little is known about the different effects video games, especially popular games designed for entertainment, have on young children; Research that does exist focuses primarily on serious games intended for education (Alves et al., 2013; Enz et al., 2008; Harrington & O'Connell, 2016).

As children start to reach the age of six and the development of and interest in pretend play begins to dwindle (Thompson & Goldstein, 2019), video games may take the place of time previously spent on pretend play. This is especially possible as toys used in pretense are replaced by a market of robotic toys and computer games (Balci & Ahi, 2017; Kardefelt-Winther, 2017; Sauerwein & Rees, 2020). The shift to video games becomes particularly meaningful when considering the development of creativity, which is often related to pretend play in young children, and may have a critical period before the age of ten (Hoffmann & Russ, 2012; Leggett, 2017; Russ, 2016; Russ et al., 1999). Creativity is a desirable skill both for children in schools and adults in the workforce, especially with the need to be able to work with the adaptive new technologies as the tools used by society for various professions continue to change at expedited rates (Barczak et al., 2010; Gabe et al., 2007; McWilliam, 2008). It is therefore important to identify possible activities children can engage in from ages six to ten to help promote creativity, after pretend play has stopped but while still in the critical period. One such activity could be video games.

Video Game Research

As video games grow in popularity, the psychological research surrounding them also continues to grow, especially on the topics of violence, aggression, and gaming disorders. Similarly, just as video game technology continues to rapidly advance and change, so do findings on stereotypically negative associations with gaming, with several contradictions in the published literature (Anderson et al., 2010; Ferguson & Rueda, 2010; Kuss, 2013; Prescott et al., 2018). Some reviews have found null results for the relationship between violent video games and aggression, but more stringent inclusion criteria, such as used by Prescott et al. (2018), lead to a small correlation found between violent games and aggressive behaviors. One possible explanation for this relationship is hostile attribution bias, which proposes that video games prime players to scan the environment for threats and then players begin to assume real world stimuli in their environment that would normally be neutral are hostile and react defensively (Gentile et al., 2014).

Another well studied avenue of video game research is the possible application of games to train various skills in a variety of populations, by allowing for safe and controlled exposure to different situations and environments. These include skills such as wellbeing, prosocial abilities, and other positive outcomes. A review by Halbrook et al. (2019), focused on the effects of video games on well-being in adults, looking at violent games and aggression, social activity in games, and exercise games, found that different features of games, such as online multi-player (versus single player), can induce positive effects on well-being and provide the ability to exercise social skills while immersed in the game. Not only does this review propose skills that could be trained within the world of a video game, it also notes the importance of specific game features for how effective the game is at skill training in the real world.

Another study that looked at the use of video games to increase empathy and prosocial behavior with adolescents aged nine to fifteen years old found the use of prosocial video games led to increased empathy, cooperation, and the tendency to maintain positive relationships across socio-economic groups (Harrington & O'Connell, 2016). Video games, specifically serious games, defined as non-entertainment games designed for education, have also been used as possible interventions for social skills (e.g., empathy and theory of mind) in children with developmental delays and disabilities. These interventions have shown significant results, especially among children with autism spectrum disorder (Tang et al., 2019). A review of studies that looked at both entertainment and serious games and their effects on emotion regulation in adults found that across studies games seemed to be linked with positive effects on emotion regulation strategies and emotional intelligence, but excessive gaming may hinder these positive effects (Villani et al., 2018).

Video game research has also focused on cognitive skills. Another review looking at the applications of computer games for various skills found that not only were there several studies linking games and emotion skills, with specific skills impacted by different types of games, but also several cognitive skills such as processing speed, memory, task switching, and mental rotation were improved from playing games, especially action and puzzle games (Pallavicini et al., 2018). Another review looking specifically at spatial cognition found that action and first-person shooter games have been shown to improve sensory, perceptual, and spatial skills outside of the world of game expertise and that these benefits occur more frequently than the negative effects such as aggression typically associated with these games (Spence & Feng, 2010). Another review, focusing on visual processing, found that while visual skills are often hard to train and test, action video games in particular have consistently produced positive and generalizable effects on visual processing (Achtman et al., 2008). Active video games, specific type of video games with the primary mechanic of the game involving players completing physical exercises, has continuously been linked to positive outcomes in youths' body composition and physical activity levels across studies (Gao et al., 2020).

Bringing these various effects and skills together, a review of the application of video games in therapeutic settings for physical rehabilitation, developmental delays, and mental illness found that video games have evidence supporting their use as effective interventions, and in some cases as measures of improvements, because of their wide array of applications depending on game type (Griffiths et al., 2017). An emphasis in all of these findings on video game effects and uses for skill training is the variation based on specific types of games. While studies on aggression and cognitive skills often focus on popular action and shooter games, many studies on social and emotional skills focus on “serious” games designed for education and teaching purposes. The larger array of entertainment video games, therefore, is ignored by most research. In general, there seems to be a lack of connection between the mainstream gaming industry and psychological research, as many studies that involve actual intervention with video games do not focus on the games that are most popular and successful outside of notoriously violent action games and serious games.

Game Structure. As noted in the previous reviews, not all video games produce the same effects, with genre as a common differentiating factor. In a review of the different components of video games that may impact how a game affects the player, Douglas Gentile (2011), a psychologist that specializes on video game related research, urged readers to push past the dichotomy of positives and negatives within games and look at the smaller features and what they uniquely contribute to the gaming experience. Different parts highlighted in the review include time spent on the game, mechanics, content, structure, and the context in which the games are played.

Another important factor to consider for effective training of generalizable skills is the prior experience a participant has with video games. Smith et al. (2020), found gaming experience predicted players’ success for learning a novel strategy game, and specifically identifying as a “gamer” predicted more successful learning of a novel action game. It is possible that not only is the learning of a new game easier for experienced gamers, but there may also be a difference in how experienced gamers learn other skills from games. In a review of the use of video games to train surgeons in medical school, it was found that experienced gamers had better outcomes as a result of the game-based training (Gupta et al., 2021).

Creativity Research

In analyzing the relationship between video games and creativity, it is important to have a clear definition of what creativity is and how it will be measured. In their review of various definitions of creativity, Slavich & Svejenova (2016) highlight the importance of the creative process in defining creativity, looking past evaluating a final product in creativity measures. A common way creativity is described in the field of psychology is the generation of a novel and task appropriate idea. Divergent thinking, the ability to come up with many responses to one prompt, has been identified as part of creativity and takes the definition further to include the components of flexibility, fluency, originality, and elaboration (Sawyer, 2012). The components of creativity go hand in hand with the idea that the process is just as important as a final product by breaking down the cognition behind the creation. For our studies, creativity is defined as a process by which solutions that are flexible, fluent, original, and elaborate are generated for various situations encountered in the video game world.

Creativity frameworks often also include the social component of creativity, with social pressures influencing the motivation to complete tasks and in turn the amount of effort that is put into creativity (Amabile, 1983). Video games have a unique ability to offer constant sources of social motivations, either by online multiplayer abilities built into the game, ways to share creations online built into the game, or just from the non-player characters programmed into the game that frequently evaluate the player and provide quests or missions (Ferguson & Olson, 2013; Przybylski et al., 2010; Westwood & Griffiths, 2010; Yee, 2006). Considering these components, video games have the potential to be an ideal place for training creativity with constant sources of motivation.

Taking these definitions and frameworks of creativity into account, video games offer several avenues for creative expression. There are limitless chances to restart different projects allowing players to try as many solutions as they want with no monetary consequences. Open worlds allow players to interact with, and adapt appearance and function of, various game components as they please. Most games having some form of customization through either avatars, personal rooms, fighting style, or complete control of the world design. Game designers sometimes force players to come up with new and sometimes inconspicuous ways to solve puzzles within the games, as the easiest method usually will not be the correct way to solve a puzzle or win a battle. Players have the opportunity to create intricate plans and designs and share online either directly through a platform built into the game or on social media, allowing social motivation from getting recognition on sharing platforms from other players. There are other ways players can be creative in video games, but these points help exemplify how creativity is applicable to video games.

Measuring Creativity. One of the most common ways to measure creativity is through divergent thinking, which is the ability to generate a variety of different solutions or ideas to one problem (Reiter-Palmon et al., 2019). Multiple divergent thinking tasks have been designed, the most commonly used being the Alternative Uses Task (AUT), among other verbal tasks also included in the Torrance Test of Creative Thinking and visual tasks from the Wallach and Kogan figural tests (Charles & Runco, 2001; Guo et al., 2021; Mouchiroud & Lubart, 2001; Vernon, 1971). An AUT often takes the form of presenting someone with an object and asking them to come up with as many uses for it as they can, which can either be done by just saying the name of the object or physically showing the object. The AUT is the scoring system for the components of creativity mentioned earlier by taking into consideration scores for fluency based on number of responses, originality based on the uniqueness of the responses compared to the sample, and flexibility based on how different the responses are from one another and from obvious uses of an item. Many creativity measures share this same coding scheme, making it a good measure for comparison to other creativity evaluations and other samples. While the AUT may not be applicable to measuring creativity in a video game, it can serve as a simple and quick task to add on to a study for comparing video game creativity to real-world cognitive creativity.

One study analyzed the performance of four-year-old children on the AUT and found that children were more likely to use bottom-up processing in their responses, and their responses became more original the further along in the list the response was generated (Bai et al., 2021). This study, along with all the other studies reviewed earlier using an AUT in children, provides evidence that children as young as four are able to provide acceptable answers to an AUT and that it can be an appropriate measure of real-world creativity for a young age group. The application of the AUT to younger samples is important when considering its use in video game research, considering how popular games are among children and the need for research in this age range.

Another popular method of measuring creativity is through asking others to rate creative products or processes, known as the consensual assessment technique (CAT) (Amabile, 1982; Cseh & Jeffries, 2019). Typically, experts in a field are asked to rate creative products under the assumption that the experts know how to recognize when something in their field is creative (Amabile, 1982). Judges typically go through some sort of training to make sure they understand the task and are familiar with the range of products in the sample they will be rating. The ratings of several judges are then compared to ensure that there is agreement for each product, and then the agreed upon score is used to compare between products in the sample. Judges score both the process and final products similarly, but knowing things such as the age of participants can change their ratings (Hennessey, 1994). Age is important not just in how creativity is rated, but also in what behaviors we choose to measure and interventions used to train creativity. The CAT can easily be adapted to a measure of video game creativity, given its flexibility to pull judges from any domain. One potential difficulty would be deciding who counts as an “expert” in video games, given that it does not have an established academic or career path.

The consensual assessment technique (CAT) has only been used a few times with children as judges with varying success. One study asked various groups of raters to evaluate children’s musical compositions to see which group was most reliable (Hickey, 2001). They found that music teachers were the most reliable group, and that while 7th grade children were fairly reliable, 2nd grade children had very poor reliability. Kaufman et al. (2016) asked elementary school students to rate their own creativity in several basic creativity tasks using a guided questionnaire and compared it to the ratings of expert judges. They found that for visual and verbal tasks, children's personal score was significantly correlated with the expert scores. In a study asking 10-13 year old children to pick the original idea out of a list, they found that children who were told they would have to later build the idea picked more feasible ideas and ignored more original ones that the control condition pick (van Broekhoven et al., 2022). The age and the nature of the task impact children's choices when deciding how creative something is, and so it is uncertain how the results of previous studies may carry over to a video game task where children have a range of experience with the game.

Manipulating Creativity. In addition to how real-world creativity is measured, variation in task instruction is important to consider for creativity measures. In some early research it was found that leaving tasks completely open ended with little to no instruction hindered creativity in adults, as responses became wildly unrelated or unfeasible to the task (Goldenberg et al., 1999). Another study found that when adults were given explicit instructions to come up with diverse ideas in an idea generation task, participants were able to come up with sufficiently different responses, but if they were not explicitly instructed to generate distinctly different ideas, they failed to incorporate any diversity or variation in their ideas (Johnson et al., 2021). In a sample of Chinese high-schoolers it was found that thorough task explanation was beneficial for creative outcomes, but simple instructions to just "be creative" were not (Niu & Liu, 2009). From this study, it is worth noting the reception to being told to be creative may differ between cultures. There seems to be a careful, culturally relevant balance required to optimize the creative performance in any given task that leans heavily towards clear instructions and guidelines being more effective.

Looking to the effect of instructions on general learning, in an engineering museum exhibit found that clear engineering instructions, as well as transfer instructions for the older group of children, produced the best performance on the engineering tasks as opposed to not receiving clear instructions from an attendant (Marcus et al., 2018). In another study based on museum exhibits, it was found that while verbal versus written prompts impacted parent involvement in an activity it did not change child involvement, showing that younger children may be more flexible in the way that they receive information for a task (Letourneau et al., 2021). It is possible that the relationship between video games and creativity may be moderated by the type of instruction given in the game and how much structure is provided. Some games have explicit stories with quests that must be completed in one way or another, while other games are open-world and allow players to essentially craft their own story and goals, so it is likely that one of these structures will yield more space and clarity for creativity than the other.

Creativity in Children. There have been several studies investigating cognitive creativity in young children and how it can be developed or trained. Leggett (2017) posited that children under the age of ten are in the optimal zone for training creativity, and as such measurement and training of children's creativity should be a priority for researchers and educators. One common form of creative expression that is studied in childhood is play and its various forms. In a study on child-initiated play with four-year old children, Craft et al. (2012) looked at how play specifically promotes the use of possibility thinking, which they claim is an early form of creativity as children begin to consider what potential different objects and situations have instead of just thinking about what exists in the moment, and how caregivers and practitioners view this skill. Though the study is on a smaller scale and primarily qualitative, it points out the importance of training different creative skills at a young age and finding ways to give children agency in this pursuit. In a review of the role classrooms and teachers play in the development of creativity, it was found that most educators struggled to articulate what creativity even is (Leggett, 2017). Leggett called for the need to provide environments that encourage creative expression, paying attention to what four- to six-year-old children might interpret as creative as opposed to just objective creativity, and the necessity of individual feedback and reinforcement. The concerns presented in these papers about the quality of creativity training children receive could be addressed by video game related training methods. Not only would games allow children to take an active role in deciding how they want to express themselves, they are also built to provide continuous reinforcement and encouragement to keep playing the game. The individualized support provided by video games can help supplement the areas in which classroom facilitated creative tasks may lack.

There are several studies that have looked at a variety of ways that interventions can be used to help promote creative cognition, defined as divergent thinking, in children. A group of education scholars conducted an experiment to see if playing with building blocks while imagining numbers increased a variety of outcomes related to mathematics achievement in six-year-old children (Pirrone et al., 2018). Divergent thinking was measured using drawing completion tasks then coded for fluency, flexibility, originality, and elaboration. The results showed that the group partaking in the building block intervention had significantly more growth on the divergent thinking measure between the pre and post-test than the control group.

Another one-time short intervention to improve general creative thinking skills was developed for children between the ages of seven and twelve including watching videos of other children creating bowl shaped bibs and detachable heels and figural arrangement exercises. Children were given a battery of divergent thinking tasks, including an AUT, drawing task, and guessing task both before and after the intervention to test effectiveness (Gu et al., 2019). The two-hour intervention session was found to lead to significant increases in all divergent thinking test scores.

A study on Chinese children, averaging around age ten, found that an intervention where classroom management was altered to be similar to a role-playing game led to higher scores on an AUT divergent thinking measure compared to a group with traditional classroom management (Chen et al., 2020). Not only do these studies support the idea that divergent thinking can be fostered in children through intervention, but also that game related interventions specifically can be effective. In a study of nine- to twelve-year-old children, another type of creativity intervention involving both verbal and figural components was tested (Fink et al., 2020). The intervention consisted of twelve game like tasks over the course of two school lessons and two days. The verbal training showed evidence of improving both verbal divergent thinking as measured by an AUT and figural measured by cued drawing task compared to a control, however the figural training was not able to significantly improve either type of divergent thinking. This finding shows there are some limitations to the types of intervention that can be used to train creative cognition in children.

In a slightly older sample of adolescents aged fifteen to sixteen, a study on a divergent thinking training intervention found that the intervention group showed stable performance pre and post-test measures (an AUT), while the control group that received no intervention performed worse on the post-test (Kleibeuker et al., 2017). Consistent with the differences seen in the AUT measures, fMRI revealed the brain areas associated with divergent thinking were more active in the intervention group compared to control group. This neurological evidence supports the idea that the AUT is actually measuring creative cognition, and not some other construct unrelated to cognitive efforts. Even so, in past research on tasks to improve creativity in children there have been concerns that using developmentally inappropriate creativity measures may cause inconsistent findings (Mottweiler & Taylor, 2014). Mottweiler & Taylor suggested the use of tasks focused on story completion and figural drawing, but other studies have also found ways to adapt other creativity tasks for children, including verbal tasks such as the AUT.

Video Games and Creativity

There are several reasons to believe video games are related to and can encourage the development of creativity. One of the most obvious is the ability of video games to recreate any kind of environment is one avenue through which they may encourage creativity. There are a plethora of video games with fictional settings, including science fiction and fantasy. Imaginative worlds and fantasy settings have been shown to increase creativity in adults, such as exposure to science fiction television increasing scores on an alternative uses task when there were high amounts of narrative transportation (Black & Barnes, 2021). Similarly, Guegan et al. (2021) exposed children between the ages of seven and eleven years old to several different virtual environments and then asked them to take a divergent thinking test, and found that children exposed to the fantasy dreamlike environment produced ideas higher in originality. The interactive nature of the games often induces a flow state (Cowley et al., 2008; Green & Kaufman, 2015; Klasen et al., 2012). The flow state experienced while playing video games, which is immersion due to active engagement in a challenging and rewarding task as opposed to the immersion due to an engaging narrative in transportation, has been found to be highly correlated to, and empirically indistinguishable from, transportation into those games (Sherrick, 2021). The similarities between video game flow and narrative transportation make video games an ideal medium to reproduce the effects on creativity found by Black & Barnes (2021), with the possibility to evoke it in an even wider audience due to the larger variety of content that can invoke flow and transportation in video games.

There is a small body of previous research on the relationship between video games and creativity. One book discusses the theoretical potential video games have to foster creativity based on creativity research, although it does not present much data on the matter (Green & Kaufman, 2015). One point made in this text to highlight the fundamental connection between gaming and creativity is that video games are designed to encourage creative solutions to a vast array of different kinds of problems and puzzles, making them a great place to practice creative flexibility. The definitions of creativity presented in this book also match the components of creativity considered for the present study, looking at fluency, flexibility, originality, and elaboration; as well as an emphasis on creativity being a combination of process and outcome, and the effect of social motivators being key, especially in video games.

While Green & Kaufman (2015) explain the theoretical perspective, there are several studies that deal with digital media, some including video games, and creativity. Jackson et al. (2012) surveyed children with an average age of twelve years on their use of a variety of different technologies, and then tested their cognitive creativity using a figural task from Torrance Test of Creative Thinking; they found video games, regardless of type, were associated with higher levels of cognitive creativity. Another study that looked specifically at very young children's technology use found that children between the ages of zero and five were using a variety of different apps, with 75% using tablets with a guardian and 35% using tablets on their own, many of which had features that allowed for creative expression through some form of designing (Marsh et al., 2018). Some of these apps were not even designed for children to play with, such as a slideshow app, but children were seeking out ways to use them creatively. The motivation of children to use technology creatively and the correlation between video games and high creativity levels support theoretical perspectives on why games would be good for fostering and studying creativity.

Studies focused purely on video games and creativity have found various differences in effects based on the genre and other specifications of games. One study that surveyed children ranging from age nine to eleven about the video games they played found that different games were using different learning strategies to help players progress (Hamlen, 2013). In this same study they also found that the most creative children, measured with the Torrance Test of Creative Thinking, spent less time playing video games on average, but that playing video games was not hindering creativity because more time spent playing video games had no relationship with creativity outside of the top percent of creative children. A possible explanation of this finding is that the most creative children often have other hobbies they spend time on, such as the arts, instead of playing video games; however, even if this finding holds true then video games can still be used to train the general population in creativity.

First person shooter (FPS) games are a common subject of video game research, although they are usually studied in the context of violence and aggression. Wright et al. (2002) looked at the potential for creative expression in these games, even though they do not typically have many design or customization options. Data was collected through the chat logs generated from playing seventy hours in fifty different online servers in the game. Their analysis showed that even in FPS games, players of undisclosed ages were being creative in the way they communicated with one another for multiplayer settings in the game. Players would often come up with unique lingo and ways to be humorous when talking to other players about the game, seen after reviewing thirty-nine types of communication in the chat logs, broken into five larger categories including: creative game talk, game conflict talk, insult/distancing talk, performance talk, and game technical/external talk. The prominence of creative talk shows that players are able to seek out different ways to be creative with all the possibilities that technology and gaming provides.

In-Game Creativity. Two studies have also found ways to evaluate creativity within the realm of the game itself as opposed to using a separate creativity measure afterwards (Ott & Pozzi, 2012; Shute & Rahimi, 2021). Both of these studies, however, were focused on puzzle and strategy games and so the creativity they measured was purely based on different ways a specific problem presented by the game was solved and had little to do with design or the type of creativity typically associated with different art forms. A study by Ott & Pozzi (2012) took all the solutions for any given level in a physics game, averaged the designed paths together and based creativity off of deviation from the average path created by eight- to ten-year-old children. Shute & Rahimi (2021) used fluency, flexibility, and originality guidelines to code for how many items were created for a problem solution, how many times an incorrect solution was repeated, and how similar solutions were, based on the average trajectory of all participants (aged thirteen to fifteen years old) solutions using game file coordinates. Both of these methods rely heavily on the presence of specific right and wrong answers to a problem, and everyone pursuing the same exact outcome in the game.

However, there is still a lack of measurement strategies and coding techniques for in-game creativity based on more free forms of expression that involves heavier design elements, instead of just problem solving. Shaw (2022) started to address this issue by developing a creativity measure using the game *Minecraft*. Participants were novices to the game and asked to build a creative house, then their builds were rated by experienced players for novelty and usefulness. These scores were significantly correlated with other divergent thinking measures and openness to experience. While this study is a step forward, limiting the players to only building houses severely limits the inherent freedom of open sandbox games like *Minecraft* and as a result could affect their potential for creativity in the game. More research is need on how to measure creativity in naturalistic gameplay to fully utilize the potential of video games as creativity tasks.

Game Choice. In the present studies, one of the games being used is the popular title *Minecraft*. This game spawns the player into a randomly generated world with a variety of resources available to collect and craft items in the game that can then be used to create any number of buildings, designs, puzzles, etc. at the will of the player, and other than basic survival (which can actually be turned off allowing the player to be invincible) there are no inherent objectives in the game. Minecraft has been used in research before, partly because it is so popular and widely available on every gaming platform, and also because it is a completely open world for the player to use as they please. This virtual sandbox game seems ideal for allowing creativity, as it allows for practically unlimited new and original creations, while having minimal requirements for play.

Blanco-Herrera er al. (2019) conducted an experiment comparing Minecraft to two other activities where adult participants did the activity and then took a series of creativity tests. The other activities included playing a racing video game and watching television, and only in the Minecraft condition participants were either instructed to be creative or given no instruction. An AUT and remote association test (RAT) as well as a creative production task based on drawing aliens were completed to compare creativity levels after partaking in the three activities. The results showed playing Minecraft without any instruction lead to the best performance on the creative production measure, coded based on how different the creature was from typical Earthly standards for living beings, in comparison to the other two conditions or playing Minecraft with the creative instruction. There was not a significant difference between the creative instruction in Minecraft condition and the other two activities, so the presence of instruction was important to the benefits of Minecraft for creative production.

Another study by Fan et al. (2022) looked at the importance of how open-ended an assigned task in Minecraft was for creativity transfer to other in-game performance and to creative cognition outside the game, with hopes to replicate findings in a similar study with Lego from Moreau & Engeset (2016). They asked undergraduate students to either build a house with only a picture to model it off of and large variety of supplied blocks to choose from, or asked them to build the same house following step-by-step instructions with only the exact materials provided. After completing the task, the participants completed an AUT and then were given an additional 15 minutes in Minecraft to make whatever they wanted, this free-play creation was then scored using the CAT. They found that being in the more open-ended task group lead to significantly higher CAT scores compared to the specific instruction group, but there were no differences between groups on the AUT. They also found that those who reported being more interested in Minecraft scored higher on the AUT and the CAT. Their results were similar to those found in the study with Lego from Moreau & Engeset (2016), suggesting that Minecraft is a good choice of game for influencing and assessing creativity.

Nebel et al. (2016) reviewed all the ways Minecraft has been used educational or experimental settings, providing evidence of the seemingly infinite amount of freedom the game offers to players to create what they want. The variety of tools and materials within the game has allowed it to be used to create resources to visually represent interactive information in multiple subjects including history and geology, and it has been used to create stimuli used in both gaming and non-gaming research alike. Rahimi et al. (2023) did a content analysis of Minecraft videos on YouTube that rank and evaluate other players' builds, looking for ways the game was discussed that related to a modified rubric for assessing creative products. This rubric included elaboration, originality, aesthetics, surprise, humor, complexity, and novel use of materials. Their transcript analysis revealed evidence for all aspects of the rubric except humor, they also found two new aspects of creativity in Minecraft that could be added to the rubric (realism and effort). This content analysis provides further evidence that Minecraft naturally applies to several aspects of creativity.

A small-scale qualitative study also looked at how a few groups of high school students used Minecraft for educational projects in the classroom and found preliminary evidence that the game allowed students to think critically, collaborate, create, and communicate (Hewett et al., 2020). Students were given six weeks to create a virtual world, most themed after historical or cultural references, as a group, before projects were graded. Common steps taken by the groups throughout the process included assessing problems they ran into, trying to consider various perspectives from which to solve it, and communicating about how to best apply a solution. Based on these prior use cases in both creative and learning conditions, Minecraft seems to be an ideal game to use as a basis for analyzing the full potential video games have to promote cognitive creativity training.

Current Studies

Given the literature reviewed thus far, there are several gaps that need addressed. There is limited research on what creativity in video games looks like, especially among children, and the studies that do exist give specific guidelines designed by the researcher for how to play. Commercial entertainment video games have the potential to elicit creativity naturally, and allowing natural play in a study would also provide a better idea of how children are being creative in a normal daily task at home. The current research on video games and creativity also does not sufficiently parse out what components of specific games are better or worse for creativity compared to other games. The ways children might conceptualize creativity in video games is also unclear, and knowing the capacities of children to think about creativity in a game is important for future intervention and measure development.

The present studies have been devised to test the impact video games can naturally have on creativity in children. Study 1 involved bringing children between the ages of seven and nine to the lab to play half an hour of either *Minecraft* or a game called *Dragon Quest Builders.* The participants were not given any instruction on how they should play the game besides being asked to be creative and being given a tutorial on controls, making the play as naturalistic as possible while still in a lab. While no previous research has been done using the game *Dragon Quest Builders*, the mechanics are very similar to *Minecraft*, including the freedom to build and design with a plethora of materials that can be gathered and crafted in the same building block style graphics. With the addition of an explicit story and quests to follow, *Dragon Quest Builders* is a good choice for comparison to *Minecraft* because the story structure (which essentially provides detailed information and prompts to follow) is the only major difference between the games, allowing us to isolate a specific game component that may influence creativity. Qualitative data on children's thoughts about creativity in the video games was gathered to better understand what might be considered creative within games built on open expression. The overarching themes in this data were gathered for the possibility of use in future measure development. Study 2 then asks a sample with a slightly larger age range to judge the creativity of the participants from Study 1, in order to see how children think about creativity of others in video games, and whether their experience levels matter at this age.

The young sample of the study is also rare to see in entertainment video game research, as most research on children involves serious games (especially for clinical interventions) and tech created for educational use (Halbrook et al., 2019; Holtz et al., 2018). Not only is this young age grouping getting more and more access to video games in their spare time, they are also at a critical period for training skills they will take into adulthood such as creativity (Leggett, 2017; Rideout & Robb, 2020).

STUDY 1

In Study 1, children were randomly assigned to one of two games and then completed an AUT after the gaming session. The primary comparisons to be made between games are based on whether there is high direction provided by the game for what to do (*Dragon Quest Builders*), or no direction provided (*Minecraft*). Based on previous research on the effects of instruction quality on creativity, having high in-game direction or no in-game direction will be key in identifying various influences on the video game and creativity relationship. These gameplay conditions were then compared based on the AUT scores to see which structure allowed for the most priming of creative cognition outside of the game, connecting video games to the priming of cognitive creativity. The AUT will be scored by incorporating all responses into originality ratings and comparing answers to the sample for uniqueness, as has been done in the past with children (Mouchiroud & Lubart, 2001).

While the present study is exploratory in nature because of the unique sample, stimuli, and measures, there were still a few hypothesized outcomes based on the video game and creativity bodies of literature:

1. Based on previous research on the effect of clear and explicit instructions on learning and engagement in adults and children, children in the condition where they have high in-game direction will score higher on cognitive creativity

measures (Blanco-Herrera et al., 2019; Johnson et al., 2021; Marcus et al., 2018; Niu & Liu, 2009).

2. Regardless of game, children with more experience playing video games prior to the study will have higher cognitive creativity scores. Both games are very similar in their function and in general gaming experience has been shown to improve learning abilities with new games, so there should be no difference in this effect by game structure condition (Smith et al., 2020).

METHODS

Participants

There were 27 children who began participation in the study but 5 did not complete the protocol or were missing data due technical difficulties, so the final sample $n = 22$. The sample was 60% male and 54% white, 13% Hispanic or Latino, 18% Asian, 13% African-American, and 2% didn't say. Children that have followed a normative developmental path between the ages of seven and nine years old were asked to participate in this study. The study was conducted at a public university in Northern Virginia, where the socioeconomic status of most families is assumed to be middle class or higher. The children all spoke and read English at a level that is appropriate for their age. Data collection took place in the psychology lab space.

As a reward for taking part in the study, children were allowed to choose a toy from a toy bin regardless of whether or not they fully completed the protocol. There were no risks involved with participation in this study. While the video games that were played contain some fighting mechanics, they are not the primary focus of the games, the imagery is not graphic, and the opponents are primarily fantasy creatures, so there is little concern about exposure to violence during gameplay. Gameplay and audio were recorded during every session, and these recordings were separated from any identifying information and stored in a password protected drive before being moved to a secure cloud storage system.

Participants for this study were recruited through a database of families interested in participating in research at the university. Flyers were also posted at community locations where families spend their time. IRB approval was given by George Mason University.

Measures

Parents were given a questionnaire asking basic demographic information including age, race, ethnicity, and gender. There were also questions regarding how much experience the children have with creative tasks and the arts in general, as well as the parent's opinion of video games. Children completed two questionnaires about gaming including a qualitative self-evaluation of creativity, and a divergent thinking task.

The *gaming experience questionnaire* was given to the child participants before they started the gaming session. Questions included how often they are able to either play or watch others play video games, whether they have played either of the games used in this study and to what extent, and a list of three games the children like to play in case they play a game similar to the games used. These questions provided a general overview of how much exposure the child had to gaming to account for in possible effects on in-game creativity evaluations.

There was also a follow-up questionnaire after the gaming session in the lab. The questions covered whether the child enjoyed the game, if they found it challenging, what their favorite and least favorite part was. There were also several questions about the child's creativity: whether they felt creative, what the most creative thing they made was and why, how this object compared to digital objects in the game they have made before, and the source of any ideas or plans they had while playing. Both questionnaires were answered verbally by the child and recorded with a microphone along with the gameplay recordings.

In-game creativity was analyzed qualitatively. Due to the lack of research on children's creative expression in video games, more information is needed about how children conceptualize creativity in a game. Children were asked about what they thought was the most creative things they made and why it is creative. They were also asked to compare it to previous things they have made if they have experience playing the game on their own. Themes gathered from these open-ended responses as well as conversation had during the actual gameplay recording were then used to conceptualize what children deemed as creative in the game and compare any salient differences between the games.

We used an emic (i.e., inductive) coding approach due to the exploratory nature of the data (Ravitch & Mittenfelner Carl, 2020). A codebook was developed with emergent themes pulled from the participant responses. All coding was done by one person, the first author, so no reliability testing was necessary. A single coder was deemed appropriate due to the brevity of the responses and the basic nature of the coding. No specific themes were identified a priori, but we approached the data with a few goals in mind. We looked for trends in whether children focus on the process or product as creative, the specificity with which they identified what was creative (e.g. claiming the pink bed is creative versus claiming the whole room is creative), and thematic trends of what kinds of things were deemed creative (e.g. buildings, traps, methods of travel, fighting technique, mine digging, etc.).

A divergent thinking task was also used to compare in-game creativity to cognitive creativity. The alternative uses task (AUT) is a very common measure of divergent thinking and a version adapted for young children was used with previously validated coding instructions (Benedek et al., 2013). For this task, the children were shown a simple object and asked to list as many ways it can be used as they can think of. Children were prompted to provide more answers if they got distracted, but after two prompts the trial ended and the next item was introduced for a total of three trials. Only the second two trials were actually coded, as the first trial acted as a warm up to make sure the children understood the task instructions. The research assistant wrote down all answers children gave, as they said them, to prevent slowness or frustrations based on writing ability. Responses were coded for originality, fluency, and flexibility by one researcher. *Originality* was coded on a Likert scale ranging from 1 to 5 that focused on three aspects: being uncommon in the sample, being distinctly different from obvious or everyday uses related to the object, and cleverness. *Fluency* was coded as the total number of responses the child gave. *Flexibility* was coded as the number of distinct categories their responses could be grouped into (e.g., all responses that involved holding liquids counted as one category). The individual response ratings were totaled together for an overall AUT score.

Procedures

After children were recruited and confirmed to participate in the study, they were invited to come into the lab space at a time that worked for them. Once the family arrived a few minutes were taken for introductions and to allow the child to become comfortable with the research assistant. During this time, parents were given the consent paperwork and the parent questionnaire via an online survey. After the child seemed comfortable with the situation, the parent was asked to leave the room.

The child was then taken over to the portion of the room set up with the Nintendo Switch and recording equipment, and after they got situated the recording of audio and the video game screen began. Before the child started to play the game they went through the gaming experience questionnaire, which lasted around five minutes. A brief tutorial on the controls and basic functions of the game was given where the child was asked to repeat every function shown to them, this took ten minutes. The game was randomly assigned for each child. Once the tutorial was completed, children were given a minimum competency task to ensure they were able to utilize the games functions on their own. This task took between ten and fifteen minutes and was uniform across all participants in either condition. The task involved gathering the materials and building a basic square structure with a door, windows, a torch, and a bed.

The timer for the free-play gaming session began once the child completed the minimum competency task and began playing the game again. Throughout thirty minutes, the child received reminders of the instructions every five minutes, or if they seemed frustrated or confused the research assistant prompted them with questions of what they were working on to help them recalibrate what they wanted to be doing. After the thirty minutes passed, the child was asked to find a good place to stop playing. While the gaming session recording was still going, children went through the follow-up questionnaire about their time in the game and what they thought was creative, which took about five minutes. The game was left on, but the recording was stopped at this point. The child was moved to another table away from the game to complete the Alternative Uses Task (AUT), which took about five minutes. Once the AUT was finished the child was taken back to their parent and allowed to choose a toy as a reward for participating. If at any point the child expressed that they were uncomfortable or wanted to stop, data collection for that participant ended and they were allowed to pick a toy before leaving (this only happened once).

RESULTS

Quantitative Results

Descriptive statistics of the cognitive creativity measure are included in Table 1. In order to evaluate the hypotheses presented in this study, we ran an ANCOVA including game structure as a predictor, cognitive creativity as an outcome, and gaming experience as a covariate. This model assessed the main effect of game structure on creativity when accounting for gaming experience. We found no significant differences between the game structure conditions for cognitive creativity scores when accounting for game experience, $F(1,19) = 0.805$, $p = 0.38$. Models were also run for each component of the AUT separately including originality, $F(1,19) = 1.13$, $p = 0.30$; flexibility, $F(1,19) = 0.14$, $p = 0.71$; and fluency, $F(1,19) = 0.36$, $p = 0.56$; there was no significant difference between groups.

A linear regression model was then run to test the relationship between overall gaming experience and cognitive creativity scores. Gaming experience did not account for a significant portion of the variance in cognitive creativity scores, $F(1,20) = 0.33$, $b = 2.21$, $t = 0.58$, $p = 0.57$.

Table 0: Means and standard deviations for AUT by condition

	No Narrative		Narrative	
AUT Component	Mean	SD	Mean	SD
Overall	47.41	27.71	48.50	37.23
Originality	29.00	17.84	29.60	24.46
Flexibility	7.58	3.68	6.60	2.50
Fluency	10.83	6.83	12.30	11.36

Note: N = 22; no scores were transformed; overall score was calculated by summing the three components.

Qualitative Results

Qualitative analysis was based on the children's responses to the post-game creativity questions to better understand how children think about creativity in video games. Using an inductive emic approach, a total of seven themes were identified: *responding to the game world, prior game knowledge, novel idea generation, adapting others' ideas, building capabilities, identifying specific building parts or actions,* and *arbitrary valuations unrelated to creativity*. Additional quotes for the various themes are available in Appendix A.

The first theme that recurred in the children's responses was behaving in response to events happening in the game. This involved actions used as a means to solve problems such as protecting against monsters and accessing new areas. These responses did not indicate trying to be creative in the problem-solving process, but focused on just accomplishing the goal. Example quotes include:

"Well, I need somewhere to stay so that monsters can't get me so I decided to make one." (1003)

"I was tired of seeing these ghosts in my house." (1021)

"Because you need a house so the mobs don't get you." (1023)

The second theme was experienced players relying on their previous knowledge of the game. This included remaking objects and buildings they have built in the past, making something they don't normally make when they had played in the past, or referencing understood rules of how to play the game known by the larger player base but not explicitly stated by the game. It can be inferred from these responses that some of the children understood creativity to mean being different form the typical game experience, however not all of them tried to be different from previous experiences. Example quotes include:

"Usually I put mine in a square like however the roof is shaped, instead of putting them everywhere in the roof." (1008)

"I used to make cars and now I made a house." (1022)

"Because it is the number one rule in Minecraft to not dig straight down…because you never know if you are in survival you could fall directly in lava…you don't know what is directly under your feet." (1025)

The third theme that emerged was generating their own ideas and making decisions on the spot. This included getting ideas from their own head or thinking that other people would not do the same thing. It can be inferred that children making statements with this theme understand that creativity involves an element of your own original thinking. Examples of this theme include:

> *"Probably just because I think, you know most people don't do that. The idea…I just actually thought of it." (1017)*
>
> *"Because I needed to picture the house in my head as a plan." (1014)*
>
> *"Because not most people know that sea pickles give off light, and also if they did know that they probably wouldn't do it." (1012)*

The fourth theme was adapting ideas from other people or experiences. This included replicating builds they saw other players do in guides and videos, taking inspiration from non-video game projects, or changing builds they had seen done in the game before. Some of the game creations that initially seemed very impressive were actually just pulling from outside ideas, and as such experience would play an important role in determining the creativity of something in a game. Example quotes include:

> *"[I go the idea from] this Native American project we did at school." (1014)*
>
> *"I watch videos and just curious to see if it would be good to do." (1010)*
>
> *"It's actually a thing [that others have done] but I just made it a miniature version of it." (1001)*

The fifth theme that we identified was the capability to build in the game. This theme included references to the pure skill or accomplishment of building, regardless of what was built. These statements tended to be very general and did not mention the idea generation process, just the actual act of building. Instances of this theme seem to be associated with the common misconception that creativity is just the act of creating, as opposed to the typical academic definition that focuses on ideas. Example quotes include:

"Making my new house." (1015)

"Building the things and building the houses." (1019)

"The most creative thing I did was making the house." (1022)

The sixth theme was specifying actions or parts of a building in the description of what was creative. This included stating a specific behavior or piece of a build that they considered key in their creativity. The presence of this theme would indicate the ability of some of the children to think deeply about what exactly would make their gameplay creative, although not all these responses corresponded with actual creativity. Example quotes include:

"I dug straight down, that's how I got myself stuck." (1025)

"Building the house the way I did it, using carpet, instead of using torches and lanterns for lights using sea pickles." (1012)

"I spawned a bunch of wolves." (1016)

The seventh and final theme was arbitrarily assigning value to builds or behaviors that were unrelated to creativity. These statements included saying something was fun or visually appealing, or just stating it was good without saying why. These statements may indicate a lack of understanding what creativity is and just associating it with high value outputs. Example quotes include:

"Because I don't think that I can build anything else that good." (1003)

"Because it was really fun and was way bigger than the other one so it was prettier." (1011)

"Because it looks creative and it has good stuff inside it." (1015)

There were differences in themes by game condition. Children in the *Minecraft* condition most frequently discussed having their own ideas or making things up (8 children) or compared gameplay to previous experiences (6 children) when asked how they were creative compared to the *Dragon Quest Builders* condition. Children in the *Dragon Quest Builders* condition more frequently talked about just being able to build something as being creative (8 children) or talked about responding to events in the game (5 children) compared to the *Minecraft* condition.

DISCUSSION

In study 1, we sought to test whether narrative in a game would make a difference in creativity transfer to the real-world and in how children discuss creativity in video games. We hypothesized that the presence of narrative in a game would lead to higher cognitive creativity scores and that those with more experience with video games would have higher cognitive creativity scores. Our results showed no difference between groups assigned to a game with a narrative (*Dragon Quest Builders*) versus a totally open sandbox game (*Minecraft*) in subsequent AUT scores. There was also no significant relationship between video game experience and AUT scores. In our qualitative analysis of how children discussed their creativity in the game, we found a total of seven recurring themes, and there were differences in what themes were most common between the two groups. The group in the narrative game condition talked more about just being able to build and responding to in-game events most often, while the group in the sandbox game condition talked more about coming up with their own ideas and comparing their gameplay to past experiences.

The lack of difference between groups in the AUT scores lines up with previous research done by Yan et al. (2022) mentioned earlier with the game *Minecraft*. While our narrative condition more closely matches their open-ended task, there is no match for our completely open-sandbox group or their clear instruction group. Despite this, the similarity in our findings suggests that instruction from the experimenter or the game narrative at any level of specificity is not important in how a game prime creative cognition as measured by the AUT in either children or adults. While Blanco-Herrera et al. (2019) did find differences between their *Minecraft* groups based on instruction, the only instruction difference was whether or not they were told to be creative, which is a different type of instruction than the task clarity emphasized in our study and Yan et al.'s. It is possible that some other component of these building and exploration-based games is what could prime creativity that is unrelated to narrative instruction. While we did not see a significant effect of game experience on AUT scores in our child sample, Yan et al. did find an effect of game interest on AUT scores in adults. The children in our sample may not have had enough experience in the games to foster improved creative cognition, whereas some of the adults in the Yan et al. study had been playing the game longer than the years our sample was even alive. Future research should focus on isolating a different component of the game *Minecraft* in comparison to other games to find out what could drive its relationship with creativity.

The differences found in our qualitative results could be because of the presence of narrative, but it could also be because more children in our study were experienced with *Minecraft* than with *Dragon Quest Builders*. On the other hand, the two games were so similar on all aspects besides the narrative that experience in one should easily be applied to the other, as has been seen with less similar games in the past (Smith et al., 2020). The responses children gave in the qualitative questionnaire tended to be brief, so it is difficult to parse out the true extent of their thinking. Based on the responses we got, we also cannot make clear distinctions as to what types of gameplay children consider to be creative in the games. It is worth noting that none of the children said they were not creative while playing, this could be in part because the experimenter repeatedly told them to be creative and so they conformed to the experimenter's expectations. The children may not have been able to accurately judge their own work in this situation. More research is needed to know how children think about creativity in these games more generally, and to try and understand how children come to the conclusions that they do.

Often times in developmental research and child interventions, we focus on optimizing learning for children and helping them advance in as many skills as possible. Children being able to have fun while accomplishing these goals is often left out of the conversation. While we did not find significant results in this specific study to act as evidence that video games can train creativity, the pursuit of how to utilize video games to this end may still be worthwhile purely based on the amount of enjoyment participants experienced in the study. Almost every child that participated indicated they had fun, and many of them were excited coming into and leaving our lab space just from the thought of being able to play video games for science. If children are having fun while completing a task, they will be more motivated to continue engaging with it. The power of fun is also applicable to the use of video games as measures for various cognitive functions like creativity, as children who are having fun may put more effort into their performance than they would a standard lab task.

There are some limitations to study 1, the most obvious being the small sample size. A power analysis was performed using the application G Power, and it was estimated that for an effect size of .22 (Marcus et al., 2018) and a power level of .8, a sample size of 165 would be necessary to compare two conditions for main effects only. Our sample was well below this, at only 22 children. Recruitment for the study was ongoing for nine months with the bulk of the data being collected in the first three months. The decision was made to end the study after several months with no new participants being recruited. Our small sample size may contribute to the lack of significant results, and a replication with a large sample would be necessary to make any definitive conclusions from our quantitative results.

Additionally, we did not have a control group or pre-test scores to compare the AUT to. We cannot make any causal claims about whether the video games improved creative cognition in general, we can only discuss whether game narrative made a difference in creative cognitions and whether those who had more past experience with video games were more creative. We made the decision to not include a pre-test bearing in mind that children in our range would have a limited ability to stay focused on the tasks at hand, and we wanted to prioritize giving them more time in the game since our research questions focused more on game differences.

We are also limited by the fact that each participant only evaluated their own gameplay, and so we do not know how they would consider different play styles as creative. More detail on how children think about creativity in video games may come to light when children are asked to directly compare one gameplay session to another. To address this concern, we developed study 2, where children evaluated the gameplay footage of several participants in study 1's *Minecraft* condition. Videos were selected to show a variety of play styles so comparisons can be drawn from each participant's responses. Study 2 also eliminates the issues surrounding the bias potentially caused by the experimenter asking the participants in study 1 to be creative before then asking them to evaluate creativity. The data collected from study 2 can be used to build on study 1 towards the goal of being able to quantify what creativity in video games such as *Minecraft* looks like for future studies.

STUDY 2

Due to the limited research on video games and creativity, we do not know how children might conceptualize what creativity is within a video game. Once there is more information on how children conceptualize creativity within a video game, it may become easier to quantify creativity in video games with a scale, allowing for comparisons between children's in-game creativity and their broader creative cognition. Study 1 provided preliminary information about how children think about creativity in video games, but most responses were very brief. There also did not seem to be a connection between in-game creativity instructions and openness and post-game creative scores on the AUT. Due to the experience differences between the two games it is still uncertain what aspect of the game may change creative thinking. Study 2 addressed this by focusing only on one game and asking for children's thoughts and creativity ratings on several versions of gameplay recorded in Study 1. The method used is a bit different from the standard CAT, with many participants rating the same few products, but the general guidelines for the CAT still apply, including not providing specific guidance on how to rate things and preventing raters from discussing their scores with each other (Amabile, 1982). Keeping the effects of task information on creativity judgements in mind, the raters in the present study were made fully aware of the task parameters, given a tutorial on the game to make sure they understood how it worked, and told the age range of the children who created the stimuli.

In study 2, therefore, we asked children aged 7 – 15 to rate the gameplay of other children in *Minecraft* on creativity and then explain their reasoning. To keep with study 1's goal, understanding how different types of video games impact children's creativity, we will categorize gameplay videos based on play style to observe any differences in ratings related to specific elements of the game. Even if gameplay ratings are not consistent between children, open ended questions about rating justification may provide insight on whether the rating scale is the issue or their conceptualizations of video game creativity. Seeing how children rate gameplay and comparing these ratings to existing creativity measures will provide information on children's understanding of creativity and ability to apply it to video game experiences. This baseline evidence of children's creative thought surrounding video games is necessary in building future creativity measures and interventions with video games. While this study is again exploratory in nature, we have some hypotheses based on related literature:

1. We hypothesize that children with more experience in the game will provide more reliable ratings, similar to the experts and older children in typical CAT measures (Hickey, 2001).
2. While there isn't any evidence to suggest which play style may be rated more creatively, we expect to see a significant difference in creativity ratings between play styles similar to how children rate creativity in different artistic domains separately (Kaufman et al., 2016).

METHODS

Participants

The sample contains 52 children ages 7-15. The sample is 77% male and 62% white, 1% African-American, 1% Hispanic, and 23% Asian. The children all spoke and read English at a level that is appropriate for their age. Children were recruited for the online study through social media, online forums, email lists, and word of mouth. There were no risks associated with completing the study and children were allowed to exit the survey at any time. Families were offered a $5 gift card as a token of appreciation for participating. The entire study was conducted asynchronously through an online survey so any child age 7-15 in the United States was able to participate with parent consent. Recruitment was conducted online, first through posts on various social media websites and online parenting groups, and then through the Children Helping Science platform that is powered by Lookit. Children Helping Science is a website where families can register an account and complete various developmental research studies appropriate for their child's age. All studies posted on Children Helping Science are reviewed by administrators to ensure they follow the platform's guidelines before being released to families. A majority of our sample came from the Children Helping Science website.

Measures

Before children began, parents were asked to complete a demographic questionnaire that asked about the child's age, gender, race, and ethnicity through open ended questions and parent education level through a multiple choice. Parents also completed the first half of the child's gaming experience questionnaire by entering how many hours their child spends playing video games in a week. The child then completed the rest of the gaming questionnaire, which was the same as the experience questionnaire from study 1.

The *creativity judgement questionnaire* was designed for this experiment based on the guidelines for using the CAT with children in previous literature (Hickey, 2001; Kaufman et al., 2016). Children were presented with six videos of *Minecraft* gameplay from participants in study 1. The videos were sped up and edited so that they were only a minute and thirty seconds each. Each video was classified by the first author, based on their experience with the game and familiarity with all available data from study 1, as one of three play styles: building, exploration, or manipulating game mechanics. The children were not aware the play styles in each video were being classified. After each video the participant was asked whether they liked what player made and whether they thought the player was good at the game using a 1 – 5 Likert scale; this was to help determine whether children were able to separate creativity from something being good. Children also rated the creativity of each video using a 1 – 5 Likert scale.

After giving each creativity rating, children recorded a video of them explaining why they gave that score for creativity. The qualitative data was analyzed using an inductive emic approach, generating emergent themes after seeing the data (Ravitch & Mittenfelner Carl, 2020). We chose not to use themes from the first study because discussing other children's creativity may be different than discussing the child's own creativity. To ensure reliable interpretation of the responses, all responses were double coded by two trained research assistants, and the IRR was calculated based on the presence of code in each rating explanation. The raters agreed 73% of the time, and a majority of these disagreements were related to whether the child described a norm for the game. These disagreements can be attributed to the difference in game experience between the two raters, where one had a basic knowledge of the game and the other was a veteran player. When disagreements in codes occurred, the first author acted as a third coder to decide what the final code would be.

Procedures

After a family was recruited to participate in the study, they used a link provided in the recruitment posting to access the online survey. The survey began with parent consent, and was followed by the parent demographic questionnaire and the parent portion of the video game experience questionnaire. Then the parent was asked to enter an email address for a gift card to be sent to upon completion of the study. Parents were then instructed to pass the survey to the child who would complete the rest of the study independently. Children were shown a video going through the assent form, and were asked to press a button if they wanted to participate in the study. If the child agreed to the study, they were then given the rest of the gaming experience questionnaire. Any open-ended questions for the child portion of the survey prompted the child to record a video of themselves verbally answering the questions. Videos were later transcribed and deleted, only storing the transcription.

After the gaming experience questionnaire, children who had indicated they had not played *Minecraft* before were given a brief tutorial on the game to make sure they understood what kinds of things were possible when playing. Once the child indicated they understood the game *Minecraft*, they were shown another brief video explaining what creativity is and the instructions for the rest of the survey. Children then watched each gameplay video and answered the questions for the creativity judgement questionnaire. After answering the last question, they were prompted with that the survey was over and given contact information in case the family had any questions or concerns about the study. Payment gift cards were sent to the parents at the provided email address after all data had been collected.

RESULTS

Quantitative Results

Descriptive statistics for creativity ratings and experience levels can be found in Table 2. In order to test the first hypothesis, that more experienced children would provide more reliable ratings, a series of two-way random effects intra-class correlations were run to determine group reliability using absolute agreement between raters on single measurements. Scores were calculated with participants clustered within the stimuli being rated, to determine agreement between all raters on each stimuli video. The resulting ICC score indicates how much of the variance in ratings is attributable to the stimuli themselves as opposed to other individual level factors. In general, children were not in agreement on how to rate the game play regardless of play style or experience level, the ICC was .07 with a 95% confidence interval from .02 to .35 ($F(5,189) = 6.85$, $p < 0.001$). To account for gaming experience and the fact that an ICC cannot be calculated based on a continuous variable describing the raters, the raters were split into three groups (low experience, average experience, high experience) and an ICC was run for each group. Group cutoffs were determined based on the spread of scores to get equal numbers of raters in each group, such that the range of scores in the average experience group is smaller than the range of scores in the low or high experience group. The most experienced raters still only had an ICC of 0.344 with a 95% confidence interval from 0.098 to 0.891 ($F(3,51.8) = 7.9.02$, $p < 0.001$); the average experienced players had an ICC of 0.06 with a 95% confidence interval from -0.009 to 0.801 ($F(2,53.6) = 2.98$, $p =$

0.059); the lowest experienced players had an ICC of -0.002 with a 95% confidence interval from -0.03 to 0.307 ($F(4,62.5) = 1.18$, $p = 0.327$). While the reliability was higher in the most experienced players, it was still poor (Koo & Li, 2016).

To determine if the rater's experience was correlated with their creativity ratings, a basic regression model was run with experience as the predictor and each rater's average creativity score as the outcome. Gaming experience accounted for a significant portion of the variance in creativity ratings, $F(1,50) = 7.73$, $b = -0.02$, $t = -2.781$, $p = 0.008$. Figure 1 shows a plot of the relationship between creativity ratings and experience. Additionally, multiple linear regression model was run with rater's average liking and average skill ratings as the predictors and the average creativity rating as the outcome. Liking scores ($b = 0.28$, $t = 2.20$, $p = 0.03$) and skills scores ($b = 0.83$, $t = 5.98$, $p < 0.001$) accounted for a significant amount of the variance in creativity ratings, $F(2,49) = 90.3$. A one-way repeated measures ANOVA was used to determine whether creativity ratings were different between the different play styles presented in the stimuli. There was a significant difference in the ratings of the different play styles, $F(2,100) = 5.94$, $p = 0.004$. Follow-up pairwise comparisons revealed that scores for the building style were significantly different from the exploration style ($p = 0.03$) and the mechanics style ($p = 0.01$), but the exploration style and mechanics style did not significantly differ from each other ($p = 1.00$). Figure 2 is a box and whisker plot displaying the mean differences between ratings of each play style. The complete R code used to run all analyses is available in Appendix C.

Table 2: Means and standard deviations for rater experience and creativity ratings by play style.

Variable	Mean	SD
Overall Creativity	3.46	0.92
Mechanics Style	3.23	0.95
Exploration Style	3.38	1.24
Building Style	3.77	1.17
Experience	19.80	7.86

Note: N = 52; all creativity averages are based on the average score each rater gave per category

Figure 1

Average Creativity Ratings Predicted by Gaming Experience

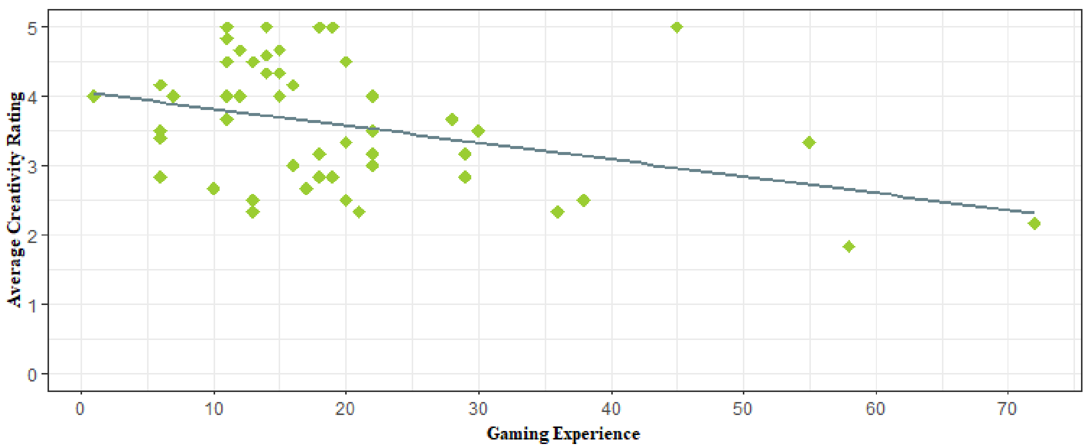

Figure 1: Average creativity ratings predicted by gaming experience. N = 52; all creativity averages are based on the average score each rater gave.

Figure 2

Creativity Ratings by Gameplay Style

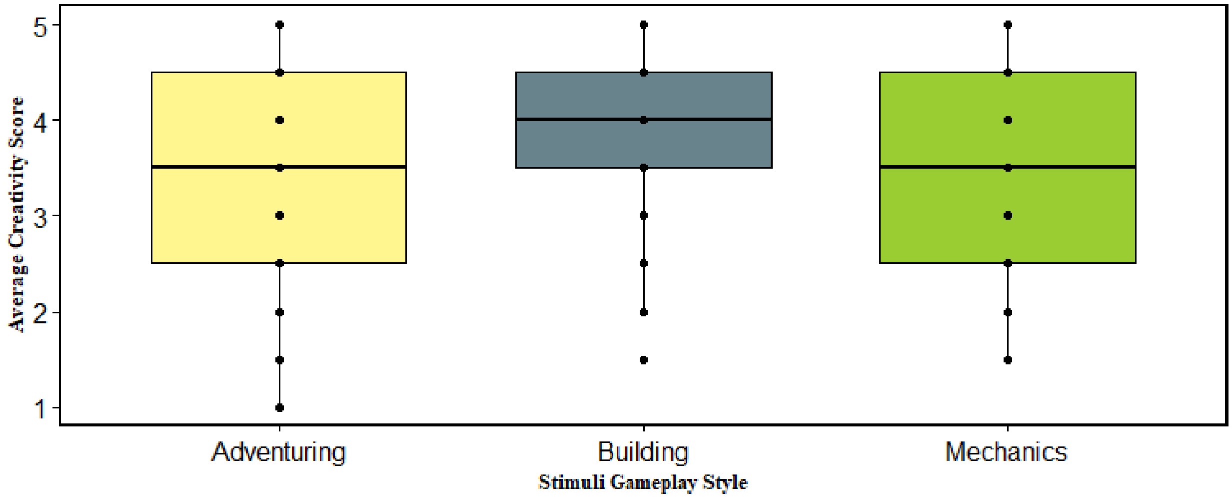

Figure 2: Creativity ratings by gameplay style. N = 52; all creativity averages are based on the average score each rater gave per category.

Qualitative Results

Qualitative analysis was based on the children's responses to the open-ended question asking them to explain their creativity rating for each stimulus to better understand how children think about creativity in video games. Using an inductive emic approach, a total of four themes were identified: goal orientation and usefulness, making an item or doing an action that follows game norms, personal preference, and differing from the game norm. Additional quotes for each theme can be found in Appendix B.

The first theme recurring theme was describing the player's goal orientation and usefulness of their builds or actions. This included describing why a player did something, or noting whether or not they thought the player was being effective in how they played the game. From this theme, it can be inferred that at least some of the children were able to keep in mind that utility is important for creativity when making their ratings. Some quotes that represent this theme are as follows:

> *"They were doing stuff that helped them make the mobs learn different moves." (1001)*
>
> *"He made his house out of ice and it served as a home." (1018)*
>
> *"They had TNT blowing up everything. It didn't serve a special purpose." (1034)*

The second and most frequent recurring theme was describing the player's actions or creation but not indicating that it differs from the norms of the game. This most often included very specific descriptions of what the player did without any explanation of how or why it might be linked to creativity, but in rare cases it was accompanied by direct statements that the player was following a tutorial or norm of the game, or claims that there was nothing innovative or novel about the player's actions. The presence of this theme indicates that children may be fixated on the common idea that creativity is just the process of making something, and are not readily able to consider the novelty or usefulness of the creation without further training. Some example quotes of this theme include:

> *"He used many different blocks and spawned many different mobs. He even knew how to spawn iron golems." (1040)*
>
> *"They had an underground thing with dogs and wolves." (1009)*

"They just didn't do anything new or interesting. Just like normal. Like you're just trying to build a portal trying to, no, you're just placing spawners down and just spawning wolves." (1033)

The third recurring theme was attributing rating decisions to personal preference that was unrelated to creativity. This included statements about just liking something or thinking the player's technical skill was good or bad. This theme aligns with the quantitative results that children's liking ratings and skill ratings were correlated with their ratings of creativity, and indicates that children struggle to separate creativity from other value judgements. Example quotes of this theme include:

"They built a house and it was pretty good and they built a pen for that wolf dog thing and it was pretty good and they looked pretty experienced." (1035)

"I don't know why I like it. It is cool." (1038)

The final theme that was recurrent was statements about how the player did something that differed from the norms of the game. This included mentioning whether they had seen anyone else do the same thing or describing how what the player did was unique. This theme indicates that at least some of the children were able to articulate why they thought something was creative in a way that matches the definition they were given at the start of the study. Some example quotes for this theme include:

"Why I think video one was really creative was because I don't think I would have thought of that before in Minecraft." (1041)

"They made their house slash fortress out of unusual materials, which I thought was creative. And they also used an unusual sort of lighting sequence." (1034)

"You get to see 2 animals that you usually wouldn't see in this world fight." (1010)

While they were not common enough to consider them recurring themes, some children did express confusion with trying to track what the player was doing or frustration with the study itself. The most frequent theme was making an item or doing an action that follows game norms (135 instances), followed by personal preference (89 instances), goal orientation and usefulness (54 instances), and differing from the game norm (36 instances).

DISCUSSION

In study 2, our goal was to determine how children rate creativity within the game *Minecraft* and whether this is impacted by their prior experience with the game. We hypothesized that children with more experience in the game would be more reliable in their creativity ratings, and that there would be differences in the average creativity rating by video play style (building, exploration, or mechanic manipulation). Our results showed that while children with more experience were more reliable in their creativity ratings, all children still had poor reliability. However, there was a significant negative correlation between experience and creativity ratings, where more experienced children gave lower creativity ratings to other children's gameplay. There was also a significant difference in creativity ratings between the different play styles shown in the videos, where gameplay focused on building was rated higher than gameplay focused on exploration or manipulating game mechanics.

The poor reliability in ratings is consistent with previous work where children were used as raters for the CAT (Hickey, 2001). One potential reason is that children do not fully understand what it means to *be creative* in a given task. However, Kaufmann et al.'s (2016) study found that children's self-assessments of their creativity were correlated with their actual creativity scores, so it seems unlikely that children are fully unaware of what creativity means. Another possibility is that children struggled to keep their standards for creativity in mind as they progressed through the video stimuli, and as a result their standards changed. There were no floor or ceiling effects in the creativity ratings either, so the lack of consistent ratings indicates that children may have been assigning scores at random without thinking too deeply as to why they chose the score. The qualitative explanations for each creativity score were generally very short, and children most frequently just described that the player was building or doing something without necessarily explaining how it was creative. In the future it would be beneficial to ask children to explain if and how something is creative through a back-and-forth interview to encourage them to think more deeply before asking them to assign the numerical score, this could bring the more experienced children up to an acceptable level of reliability just like novice adults can be trained to be reliable judges for the CAT (Barbot et al., 2019; Runco et al., 1994).

The correlation between gaming experience and creativity ratings matches results of other studies, where more experienced raters gave consistently low scores to novice products (Hickey, 2001; Runco et al., 1994). While these results are not surprising, knowing that the effects of experience also apply to children's creativity judgements can inform future studies comparing children and adult ratings and studies looking to train children to be effective raters of creativity. The preference for gameplay focused on building also aligns with research in the field of aesthetics, where children prefer realism and focus on the content of artwork when making evaluations of aesthetic preference as opposed to abstraction or technique (Kuscevic et al., 2014; Machotka, 1966). Videos showing the construction of a building show a specific goal and end product for the children to rate that aligns with the commonplace layperson's idea that creativity is the act of making something. Videos showing mechanics manipulation and adventuring may be more abstract in that they do not depict a clear end product, and as a result children have a harder time evaluating their creativity leading to lower scores. To further our understanding of what types of gameplay children find creative, future studies should select videos that are matched on creativity ratings by adults but are from different categories so that any differences in scores are based solely on the preferences of the child and not just the amount of creativity displayed. It is likely differences in children's ratings would still be present in this situation, given the high correlation between children's ratings of liking each gameplay video and their creativity ratings.

Limitations of study 2 include the large age range and the small number of stimuli children were asked to rate. Normally when using a CAT raters evaluate a much larger number of creative products. Only six videos were used in study 2 in order to keep the time it takes to complete the study low. Initially there were eleven videos in the online survey, but children were not completing the full survey and so we chose six videos to reduce attention demands. This may also be a side effect of using an online asynchronous survey with children. If the ratings were collected in person or through a synchronous video call children may have been able to evaluate more stimuli. Additionally, the age range of the study was very large (7-15 years old) in order to combat problems with slow recruitment, but our sample was not large enough to calculate age effects. In future studies the age range should be constricted to eliminate age effects, and if other children's gameplay is being evaluated then the ages of the raters should match that of the creative products.

GENERAL DISCUSSION

To review, in study 1 we tested whether the presence of narrative in a video game would change whether the game primes creative cognition in the real-world by having children play one of two video games and taking an AUT afterwards. Children were also asked to explain how they were creative in the video game they played, and this was used in a qualitative analysis. Our results showed no difference in AUT scores between the two game conditions or by level of past experience with video games. There were differences in the themes that most commonly arose between the two games, with the narrative game leading to explanations centered around the ability to build and reacting to in-game events and the open sandbox game leading to explanations centered around generating their own ideas and comparing play to past experiences. In study 2, we tried to deepen our understanding of how children think about creativity in video games by using an online survey to ask children to rate and explain their ratings of some of the gameplay videos recorded in study 1. Our results indicated that children do not rate gameplay creativity consistently, regardless of prior experience with video games. But, children with more experience do give lower ratings of creativity compared to less experienced children. Taking the findings of study 1 and study 2 together, children do not give clear descriptions of how creativity works in video games without thorough prompting. It is unclear whether children just don’t understand creativity, even when given a definition, or if they are not able to keep their judgement criteria in mind and end up evaluating things randomly. Other work with children in grades K through 8 found that children's self-reported creativity was not correlated with their actual creative performance, indicating children just may not fully understand creativity (Evans et al., 2023). The evidence that more experienced children rate things differently suggests that training may be effective in getting children to understand domain specific creativity, in video games or other areas.

A major limitation of both studies is the small sample size, preventing us from making any substantial claims based on quantitative analysis in study 1 and from parsing out age effects in study 2. Study 1 also lacked a direct comparison for the AUT, either a pre-test or control group, to indicate whether the game increased creative cognitions in general across groups. Study 2 would benefit from a larger number of stimuli to rate, but due to the restrictions of maintaining children's attention in an asynchronous online study we chose to limit the stimuli to just six *Minecraft* videos.

There are several directions for future research based on our findings in these two studies. One possible direction is to replicate study 2, but done in-person so that the children can be prompted to elaborate on their rating explanations. Further elaboration in explanations would clarify whether the issue is a lack of understanding of creativity in video games or just a lack of focus on keeping judgement criteria consistent. Another direction for future research would be isolating a different characteristic of the game *Minecraft* that can be compare with another game. Isolating different characteristics of the game can inform us what components are most important for a game to elicit creativity, which in turn could inform the design of future video games and interventions with video games for creativity. Due to the lack of consistency from children's explanations, it would be beneficial to turn to adult players of video games to identify what is creative in video games for the development of in-game creativity measures. There has been some work on this already using content analysis of *Minecraft* YouTube videos (Rahimi et al., 2023) and having experts rate the creativity of novice adults in *Minecraft* (Shaw, 2022), but these studies focus on adult gameplay. Children's capacity to be creative in video games should be evaluated separately, with criteria developed based on a child's ability. Additionally, the use of a different game with a little less variety in play styles than *Minecraft* may be best for developing a clear and replicable measure of creativity using video games. In conclusion, more work is needed to understand children's creativity in video games, but video games continue to be an enticing possible pathway for creativity measurement and intervention in children because of their robust presence in children's daily lives and the motivating power of fun involved with video game-based tasks (Rideout & Robb, 2020).

APPENDICES

Appendix A

Theme	**Included Quotes**
Response to game world	"Well I need somewhere to stay so that monsters can't get me so I decided to make one." (1003); "Because I have an open space I guess." (1007); "Because I made stuff that I needed and wanted." (1009); "But I actually went out over the hills, like over those hills and yeah, I tried to build a bridge to another island that I saw but I couldn't." (1017); "I needed something to survive so I made a house." (1022); "Because you need a house so the mobs don't get you." (1023); "I was tied of seeing these ghosts in my house." (1021)
Prior game knowledge	"Because I made those a lot." (1001); "Something that I made in the past." (1001); "Because I've played this before I like digging tunnels a lot. " (1007);

	"Usually I put mine in a square like however the roof is shaped, instead of putting them everywhere in the roof." (1008); "I thought of Minecraft when I made a little house I thought I could maybe do that in this game and use a different block for the roof." (1011); "The Nether portal reminded me of something from the End portal." (1020); "I used to make cars, and now I made a house." (1022); "Because it is the #1 rule in Minecraft, to not dig straight down... because you never know if you are in survival you could fall directly in lava, etc...you don't know what is directly under your feet." (1025)
Having own idea	"Because it came from my mind." (1004); "I just thought about what I wanted to do in the game." (1004); "Because I didn't use any blueprints and I just made it." (1006); "I just thought of it" (1008); "No I didn't see build with an ice house before I

	built my house." (1008); "Because I think I like saw what I was going to do." (1010); "Because not most people know that sea pickles give off light, and also if they did know that they probably wouldn't do it." (1012); "[I got the idea from] My brain." (1012); "Because I got to make something without instructions." (1013); "Because, I needed to picture the house in my head as a plan." (1014); "I just made it up." (1015); "I've always wanted a pet wolf, especially in life, and that is where I got my idea from." (1016); "Probably just because I think most people don't do that and they probably just stay in this little area because it's a safe place but I went out..." (1017); "The idea...I just actually thought of it. I jsut wanted to know what's up there..." (1017); "I know most people wouldn't think about making a glass floor." (1018); "I didn't really get the ideas from anything." (1018); "[I did it] Just

	because." (1025); "Yes [I got the idea in my own head]." (1023); "Because I have a feeling no one else has done it." (1021); "[The idea] just popped in my head..." (1021)
Adapting others' ideas	"It is actually a thing but I just madde it a miniature version of it." (1001); "Because you kind of told me to make a room." (1006); "[I got the idea from] Basically the villagers." (1009); "Well I got the idea by village, villagers have 3x3 houses but not all of them." (1010); "I watch videos and just curious to see if it would be good to do." (1010); "This Native American project we did at school." (1014); "[I got the idea] From a regular house." (1019)
Building capability	"Building the armory." (1004); "I think me building a house." (1003); "Building a room." (1006); "Probably making the sick house. " (1011); "Building the house." (1010, 1014, 1022, 1023); "[The most creative thing was] Building." (1013);

	"Making my new house." (1015); "Building the things, and building the houses." (1019); "Starting this wall." (1021)
Specifying parts or actions	"The slime powers was the most creative thing." (1001); "I kind of made an area where you could stand there for hours since I can't lay down or sleep." (1007); "Putting lanterns all over the ceiling and putting them in an arranged line." (1008); "Well, like, making stuff with the table." (1009); "Building the house the way I did it, using carpet, instead of using torches and lanterns for lights, using sea pickles." (1012); "Spawned a bunch of wolves." (1016); "Trying to go to other islands even though there was no tutorial." (1017); "Every time I deleted a block from the floor, I just use that to make something else instead of the floor." (1018); "Trying to go to bed while I was in the Nether." (1020); "I dug straight

	down that's how I got myself stuck." (1025)
Arbitrary Valuations	"Because I don't think that I can build anything else that good." (1003); "Because it was really fun and was way bigger than the other one so it was prettier." (1011); "Because it looks creative and it has good stuff inside it." (1015); "Because the wolves are so cute." (1016); "Because it was fun and I was able to build the walls and make a kitchen in it...but that turned out a place to put the bed." (1019); "Because we are in a dimension that isn't real..." (1020)

Appendix B

Theme	**Included Quotes**
Goal orientation and usefulness	"Gave them the pillager outpost thing so that they could fight while using it normally to see the 2 enemies of the game fight." (1010); "Then when he was enchanting his gear, he, like, built like a roof of bookshelves to enchant his gear." (1023); "This person just made a house made out of ice and put torches and lanterns all in it. Good idea. No monsters will spawn." (1032); "They built a building very tall to stay away from the monsters." (1027); "I don't think it really served a purpose." (1018); "Looked like it was like a cave and it looked like a dungeon...but I just didn't see how it served a purpose at all." (1018)
Making an item or doing an action that follows game norms	"He built a small tower thing or it was she, I don't know if that kid was he or she whatever. But yeah, they put pillagers on it and then stuck iron golems around it,

	and the iron Golems, like they do, just smack smack smack." (1032); "He went actually in survival mode and putted TNT up and then he just floated up." (1012); "They were building with ice." (1022); "They put a fence in it and they made another house." (1042); "They had an underground thing with dogs and wolves." (1009); "They just started out building a base which wasn't creative. I was hoping they would be like the one who made this house and then it turned out to be creative, but it wasn't." (1033)
Personal preference	"They made a house and it's good." (1045); "What he was doing looked cool and interesting." (1029); "Because I think that this one's better than the last one." (1028); "They built a house and it was pretty good and they built a pen for that wolf dog thing and it was pretty good and they looked pretty experienced." (1035); "I liked what they were doing with the

	wolves and also in the beginning with the end portal in lava." (1001); "I like how the Fort looked." (1039)
Differing from game norms	"Because they did something that other people wouldn't think of doing." (1006); "It was creative to use TNT to get underwater." (1008); "They put a lot of work into it and then made it into a villagers house in one of the ice mountains, which we don't usually get to see in an ice biome." (1010); "I don't think other people would make a house and a garden like that." (1048); "I wouldn't have thought of mining a hole and putting lava in it." (1041); "There was some strange type of, I never heard of that, that type don't even know what it is." (1032)

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