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### Creating Worlds of Endless Variety: An Evaluation of Procedural Content Generation in Gaming

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Creating Worlds of Endless Variety: An Evaluation of Procedural Content Generation in Gaming

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**Senior Honors Project**

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**Abstract:**

Today, video games are more ingrained in American society than they have ever been before. This entertainment medium has become more profitable than all television streaming services combined as well as the entire film industry in Hollywood. Playing video games, which was once considered a pastime, has become a career for many, with websites such as YouTube and Twitch hosting thousands of “let’s play” channels and various esports tournaments boasting six- or even seven-figure prize pools.

With the evident popularity and financial success of video games, radical changes to the game development process can carry a massive impact on society, whether in the profitability of the gaming industry or the general attitude toward the medium; to ensure that this impact is positive, these processes should be analyzed meticulously. Therefore, this paper will evaluate one of the more recent alternatives to conventional game design known as “procedural generation,” which utilizes an algorithm to assemble parts of a game based on a set of parameters rather than having an artist or programmer design them.

To determine the viability of procedural generation in game design, this thesis examined several of the more well-known games that contain procedurally-generated content. It compared statistics of these games such as financial success, critical reception, and development costs, with the corresponding statistics of similar games that did not use procedural generation to reach a conclusion about whether or not this novel development technique benefits a game more than conventional design.

## Introduction

When examining the evolution of game design, the quantity of progress displayed over the last few decades is staggering. Modern video games are a far cry from early text-based adventure games, featuring stories told not merely through text but through fully-voiced narratives taking place in vast, explorable worlds. However, while these improvements have increased the potential for game developers to more vividly present their artistic visions, they have also raised the bar in terms of what players expect from their favorite game publishers. While major publishers might be able to invest the time and money necessary to fund large-scale games, smaller studios consisting of a handful of people will find the task too monumental.

However, rather than being forced to sacrifice their vision or take on debt to be able to create their games, some developers have turned to a relatively new method of creating in-game content: procedural generation. Rather than conventional content creation, which involves a person designing each asset of a game, procedural content is primarily designed using an algorithm. This does not necessarily mean that human designers are rendered obsolete by procedural algorithms since the latter are still incapable of creating completely original content. Typically, the algorithm takes individual assets created by designers and combines them according to rules set by the algorithm's programmers [Togelius et al. 2016].

While procedural generation cannot completely automate game design, it can relieve some of the burden of designing aspects of a game through the sheer quantity of combinations these algorithms can create. As a specific example, *Minecraft* dynamically generates its worlds using a procedural algorithm along with a sequence of integers called a "seed." The integers that

a seed contains are read by the algorithm and used to determine what type of features the generated world will have. Thus, a particular seed will always generate the same world unless the algorithm is modified, offering players the option to consistently generate any world that they find particularly interesting. Seeds can be either input by the player or pseudo-randomly generated, and if the player inputs a seed that contains letters or is longer than twenty characters, the seed is internally converted to a 32-bit integer using Java's `String.hashCode()` function. However, doing so restricts the number of possible worlds generated to  $2^{32}$ , and randomly generating the seed only allows access to  $2^{48}$  possible world combinations, though this many worlds is still impossible to explore in one's lifetime. The largest pool of possible world combinations is only accessible by manually inputting a seed of less than twenty-one integers, which gives the player access to a staggering  $2^{64}$ , over eighteen quintillion, worlds [Minecraft Wiki Contributors 2020].

Each world is not generated all at once, however, and is instead loaded in segments called "chunks." Each chunk is a collection of blocks that is 16 blocks long, 16 blocks wide, and 256 blocks deep, allowing for over fourteen trillion different chunks to be generated. When the player spawns into a world, the algorithm loads a limited number of chunks in all directions around the player's position to allow the player to explore the immediate area. When the player wanders far enough beyond their spawn point, the game loads new chunks into the area they enter.

Additionally, the chunks in the area that the player left are unloaded to free up memory and are reloaded when the player returns. This system of only loading chunks near the player allows the game to generate enormous worlds, with each one being fifty million blocks in every cardinal direction [Minecraft Wiki Contributors 2020]. Thus, through its utilization of procedural generation, *Minecraft* is able to provide its players with a virtually limitless quantity of

exploration and, when combined with the game's focus on player-created content, with enough space to bring virtually any construction idea to life.

Procedural algorithms are not limited to creating in-game environments, however, and are capable of creating a broad variety of assets for video games. However, procedurally-generated content can be divided into four main categories. The first type is "game bits," which are objects that the player interacts with while playing a game. This is perhaps the broadest category, encompassing everything from enormous mountains to a single blade of grass. The second type of content is game space, the way in which game bits are arranged to form a game's environment. The third type is game scenarios, the situations with which the game presents the player. These can include aspects of a game such as its narrative or enemies' behavior during combat. The final type of in-game content is game systems, which describe how in-game objects interact with each other [Korn et al. 2017]. For instance, if the player drinks a potion, game systems dictate the effects the potion will have.

There are two different applications of procedural generation when creating in-game content. The first of these methods, static generation, is used by game developers to create various assets prior to their game's release. The developers sort through the combinations created by the algorithm and place their favorites in the game. The second method was described in the previous example of *Minecraft's* world creation: dynamic generation. Rather than consisting of assets that were generated prior to release, games which use dynamic generation create their assets while they are being played. This leads to a less predictable experience for players since the assets generated each time the game is run will likely be different each time. However, static generation could also be argued to ensure that the player encounters more interesting combinations of assets, albeit with no variation between playthroughs of the game. Some games

have actually utilized a combination of both methods in an attempt to provide their worlds with the variety of dynamic generation as well as the consistent quality of static generation. Going back to the idea of designing in-game worlds procedurally, a game might use static generation to arrange rooms in a way that its developers find appealing while leaving the arrangement of the rooms' details (furniture, wallpaper, etc.) to dynamic generation. However, the question of how much each method should be relied upon is still debatable [Porter 2017].

While procedural algorithms' efficiency when compared to human designers is undeniable, the effects that their implementation has on aspects of a game other than its development time are considerably less clear. A game's overall success can be measured in a variety of factors, such as sales figures, average concurrent players, and critical reception. To determine the effects that procedural algorithms can have on these aspects of a game's success, this thesis examined several games that feature procedurally-generated content and compared their success-reflecting statistics to those of similar games that do not feature procedural generation.

The two series of games that this thesis examined were the *Borderlands* and *Destiny* franchises. Both game series belong to the "looter-shooter" genre, in which the primary goal of the player is to gradually acquire better weapons and other equipment, and both series have a strong focus on multiplayer, both competitive and cooperative. Each franchise has also been exceptionally successful, with the *Borderlands* series making over one billion dollars [Ballard 2019] and *Destiny* being the second-most profitable first-person shooter franchise of all-time behind *Call of Duty* [Bailey 2019]. However, each series has a different approach to providing its players with a vast array of powerful weaponry.

Each installment in the *Borderlands* series boasts millions of weapons through the use of a procedural algorithm to dynamically generate each weapon the player encounters. Each piece of each weapon is chosen by the algorithm from a list of possibilities, with each piece affecting the weapon's overall statistics [Borderlands Wiki Contributors 2020]. For instance, a sniper rifle might spawn with a barrel that grants it additional accuracy or one that offers higher damage. Some parts grant weapons far more distinct effects, such as the "Infinity" pistol barrel that allows the weapon to fire without consuming ammunition. When interviewed prior to the launch of *Borderlands 2*, the game's weapon designer, Kevin Duc, discussed his goal to balance the quantity and uniqueness of the game's staggering arsenal of weapons, stating that "eighty-seven million guns isn't really that interesting if they all look the same, if they all act the same." When discussing the benefits of creating the game's weapons procedurally, he cited the broad appeal of offering players so many weapons, with different weapons offering not only distinct effects but different visual aesthetics as well [Pitts 2012].

While *Borderlands* utilizes procedural algorithms to assemble its weapons dynamically, the *Destiny* series has employed conventional design methods to create gear for its players, with each piece of equipment being completely designed by human artists without assistance from procedural generation. When asked about why Bungie, the development team behind *Destiny*, had steered away from procedurally generating content, *Destiny's* lead designer Steve Cotton stated that "For us [Bungie], it's not good enough to just make a bunch of real estate. Real estate has to be really well thought-out, so you really try to create experiences.... [W]hen it's not done by someone by hand it's hard to get experiences that are memorable" [Joy 2016]. Viewing procedural generation as an impersonal means of content creation, Bungie chose to have more

creative control over the content their players experience by designing it more conventionally, with each level and item being created by a team of artists and programmers.

## **Materials and Methods**

The effectiveness of each of these content creation methods was evaluated based on several criteria. The first of these was how each franchise was received critically according to Metacritic.com. Both critic and user reviews were examined, specifically the average score of each series and common criticisms. However, not all user reviews were included when considering common criticisms since each series has thousands of user reviews across each game. Instead, for each game's user reviews, the criticisms of the twenty reviews that were voted most helpful were considered. Along with critical reception, each game's financial success was examined, with consideration to development costs and profits. Finally, each series' ability to maintain an active community of players was examined based on the average number of players on Steam. Specifically, *Borderlands Game of the Year Edition's*, *Borderlands 2's* and *Destiny 2's* average player counts were considered over the six months after their releases; this duration was chosen since *Destiny 2* has only been available on Steam for six months, releasing October of 2019. The original *Destiny* was not examined since it was never available on Steam; thus, its player numbers were unavailable. *Borderlands 3's* player numbers were also not considered since it had only been on Steam since March of 2020, offering insufficient data to determine whether or not it can maintain a long-term player base.

## Results

Overall, the *Borderlands* series was received favorably by critics, with the series holding an 83.6 average critic score across the three main entries in the franchise [Critics of Metacritic 2009, 2012, and 2019]. The most positively received aspect of the games among critics was the procedurally-generated weapons, with on average twelve critics praising the quantity and diversity available in each game. There were only two negative statements among all the games regarding the loot system: that having such a large quantity of weapons made only a select few actually worth picking up. The games' procedurally-generated items were also considered an overall positive aspect of the game because of how they tie in to the game's role-playing elements, which allow players to customize their character's abilities and statistics to create a variety of playstyles. These elements were considered a positive aspect of each game an average 5.3 times, with only 1.3 criticisms of their lack of depth. The series' combat, on the other hand, reveals a downside of its implementation of procedural generation. While it was favored by the majority of critics, with each game having 12 positive reviews of the combat and 1.3 negative [Table 1], three of the negative reviews across all the games cited excessive difficulty as the reason for disliking the combat. Although this difficulty could be due to a lack of player skill, the fact that players' acquisition of items is randomized could have also been a contributing factor. Each player's experience is highly dependent on what type of loot is created by the procedural generation algorithm; players that do not encounter any powerful items will be at a significant disadvantage when compared to players that do. However, based on the higher number of critics who had no issues with *Borderlands*' combat system and the somewhat ambiguous criticisms of those who did, it would seem that *Borderlands*' procedural generation algorithm is designed well enough to provide players with a fairly consistent stream of powerful items.

The games also scored relatively well with users, with the series holding an average user score of 7 [Users of Metacritic 2009, 2012, and 2019]. The games' procedurally-generated loot was reviewed fairly positively, with an average of 6.6 positive statements about the loot and 3 negative ones. While the positive reviews praised features of the weapons such as their quantity and diversity, the negative criticisms cited issues such as weapon balancing and the fact that most weapon differences boiled down to statistics rather than more interesting effects. The implementation of role-playing mechanics was evenly split, with each game having 1.3 positive and negative reviews, with all four complaints centering on the lack of depth in customizing one's playstyle. The games' combat was reviewed more favorably, with an average of 4.6 positive statements and 1.3 negative [Table 2]. Reviews mentioning specific aspects of the combat cited the games' difficulties, with two enjoying the challenge provided by the combat and two claiming that it was too easy. One particular criticism of the combat mentioned that the player had found an especially powerful weapon in their playthrough of the original *Borderlands* that had trivialized the combat for the rest of the game, highlighting a balancing issue regarding the game's procedural weapon generation [Users of Metacritic 2009]. Overall, while none of the user reviews criticized the games' quantity of weapons, some found issues with the quality and variety of the weapons that were generated.

Along with the *Borderlands* games, the *Destiny* franchise scored fairly well among critics, with the PlayStation 4 versions of both games holding an average critic score of 80.5 [Critics of Metacritic 2014 and 2017]. The in-game items, while still reviewed favorably, were brought up less frequently than those of *Borderlands*. Each game had 5.5 positive mentions of their items and 0.5 negatives, with the majority of critics enjoying the quantity and quality available and one critic of the second game disliking how the weapons felt to use. The

role-playing elements were also quite positively received. Each game had 5.5 critics who enjoyed them, though none cited a particular aspect of the role-playing mechanics that they enjoyed, and three critics disliking the shallowness of those in the first game. The series' combat was received immensely positively, with each game having twenty-six positive statements about the combat and only three negative ones. The aspect that was mentioned specifically was the player-versus-player combat, with eight total critics saying they enjoyed it overall, one saying they disliked it in general, and one saying that it was unbalanced [Table 3]. However, one particularly contentious issue was the amount of content in both games, which was split fairly evenly between 11.5 positive statements about each game's content and 13 negative ones. All twenty-three positive statements stated that the games offered players plenty to do while seventeen said the games did not provide enough. Additionally, eight said that the content provided was shallow or lackluster, and one found the first game's content derivative of other games [Table 4].

This overall lack of appealing content was echoed by the twenty most helpful user reviews for the *Destiny* series, which gave the series an average score of 5.5, a far less favorable response than that of critics [Users of Metacritic 2014 and 2017]. While one user defended *Destiny 2's* quantity of content, each game had an average of two criticisms about their general lack of content. Specific complaints about an underwhelming amount of content mentioned the quantity of planets to explore in the first game, the short campaign of the second game, and lack of endgame content in the second game. Criticisms of content from the first game being reused in the sequel were also quite prevalent, with eleven users stating that the latter did not have enough original content to be considered a true feature and additional criticisms of features such as playable classes, enemies, menus, and heads-up display remaining relatively unchanged from

the first game. Ultimately, there were an average of fifteen user criticisms about the amount of appealing, original content in each game [Table 4].

A large quantity of content, however, does not essentially equate to a consistently high player count, and each game's player numbers on Steam seem to dispel this correlation. Although *Destiny 2* was heavily criticized for its lack of original content, it maintained a fairly stable player base, retaining 46.9% of its average player count six months after the game's launch on Steam [Figure 1]. The first two *Borderlands* games, however, failed to retain nearly as many consistent players, with *Borderlands Game of the Year Edition* having only 13.2% of the player base it had at launch and *Borderlands 2* faring even worse with 11.6% [Figure 1]. The reason for this mass exodus of players from these two games was somewhat ambiguous since both were generally received positively on Metacritic. *Borderlands 2* had an 89 critic score and 8.2 user score [critics and users of Metacritic 2012], and while *Borderlands Game of the Year Edition* did not have any critic reviews, it also held an 8.2 user score [Users of Metacritic 2010]. However, the lack of correlation between procedurally-generated content and consistent player numbers demonstrated that games cannot rely solely on large quantities of content to maintain a stable player base.

Although a consistent player count can be beneficial for a game's future developments, particularly when considering the financial viability of potential sequels and expansions, measuring how much money a game made against how much time and money it cost to produce can be just as significant when measuring a game's financial success. After all, even if a game has a relatively high player count, it would still be a financial failure if the profits earned from sales are insufficient to cover development costs.

While information regarding the development of the first *Borderlands* game was scarce, the development periods of the second and third entries were relatively well-documented. *Borderlands 2* began development in 2008 and released on September 18, 2012, and according to the president of Gearbox Software, Randy Pitchford, the game cost between thirty and thirty-five million dollars to develop [Pitts 2012]. These costs, however, were abundantly covered by the game's sales figures, which totaled over twenty-two million copies after its release [Tassi 2019]. The game's sequel, *Borderlands 3*, boasted impressive sales figures as well, selling over five million copies within its first five days of release, making it the fastest-selling game owned by 2K, the game's publisher [Ballard 2019]. Its development time was also comparable to its predecessor's, with development beginning in 2015 and the game releasing on September 13, 2019 [Borderlands Wiki contributors 2020]. However, while both games took about four years to develop, the costs of their respective developments were substantially different, with *Borderlands 3* dwarfing its predecessor with a \$140 million budget, though this did include the costs of content added to the game after its launch [Chalk 2020]. Randy Pitchford attributed the game's increased costs to an increase in staff, and while the game ultimately turned a profit, Gearbox Software employees did receive substantially smaller royalties than they had initially predicted [Chalk 2020]. The reason for taking on so many new employees was likely an increase in the game's scope. *Borderlands 3*'s senior producer Anthony Nicholson stated that the game had far more missions, enemies, and areas for players to explore than its predecessor, and since the game only used procedural generation to create its equipment, it would have been necessary to hire more programmers and artists to add these features to the game [Fischer 2019]. Nevertheless, while the staff increase did take a toll on the game's profits, both games were

ultimately financial successes, and the *Borderlands* series as a whole has made over one billion dollars [Ballard 2019].

The *Destiny* series, on the other hand, has been somewhat mixed in terms of its financial success. The first *Destiny* game proved to be immensely successful, making over \$500 million within its first day of being released [Cooper 2015], more than tripling its \$140 million in development costs [Levy 2014]. These profits were bolstered by the game's exceptional pre-order numbers, which totaled over two million in the US across all consoles [VGChartz contributors 2014] and made the game the most pre-ordered entry in a new intellectual property ever [Cooper 2015]. The game took slightly longer to develop than the previously mentioned *Borderlands* games, with a five-year development time [Kato 2014], and while the development was troubled due to massive revisions to the game's story, the issue could not be realistically linked to the game's use of conventional design over procedural generation [Schreier 2015].

*Destiny 2*, though, was considered less successful than its predecessor. The game had less than twelve percent of the number of US pre-orders of the first *Destiny* game [VGChartz contributors 2017], and although it did ultimately sell more copies [Good 2017], Activision Blizzard, the series' publisher, reported that its sales had fallen below expectations [Makuch 2019]. The game's underperformance was also indicated by the fact that it was being given away for free between November 2<sup>nd</sup> and 18<sup>th</sup> in 2018 [Blizzard Entertainment 2018]. This was potentially an attempt by Bungie and Activision Blizzard to attract more players and increase investment in future paid expansions for the game [Schreier 2018]. In January of the following year, Bungie split from their publisher, taking the *Destiny* franchise with them, and when asked about the decision to part ways with Bungie, Activision Blizzard CEO Bobby Kotick commented that the *Destiny* series “was not meeting our financial expectations” [Frank 2019]. This

underperformance in spite of impressive sales could be a reflection of the same situation experienced by *Borderlands 3*: higher development costs due to a large staff, a financial symptom of using conventional design over procedural generation. Due to *Destiny*'s large scale and Bungie's insistence on using conventionally-created assets, the company would have needed to hire a significant number of artists and programmers to make these assets, cutting into the profits of the game. This possibility of overstaffing cutting into Activision Blizzard's profits is supported by the mass layoffs on February 12 of the same year, when the game publisher laid off eight hundred of its employees, approximately eight percent of its total staff. Despite making an impressive \$1.8 billion that year, a record-breaking amount for the company, managers at Activision Blizzard felt that the company was unsustainable given its current size [Futter 2019]. The demand for staff created by *Destiny 2* is also evident in Activision Blizzard's assignment of studios other than Bungie to create content for the game, namely High Moon Studios and Vicarious Visions. Collister Johnson, president and Chief Operating Officer of Activision Blizzard, stated that "[Bungie was] tying up one of our scarcest resources- developer talent" and that splitting with Bungie was the "right path forward" [Makuch 2019].

Even with a fairly large staff of around six hundred in 2019 [gameslice 2019] and the support of additional studios, members of Bungie still expressed concerns about not being able to produce enough content to keep the game consistently updated. Bungie's Creative Director Luke Smith stated in August 2019 that "working on the game was starting to wear people down" and that the amount of content they had been tasked with creating "put the team into an unsustainable development cycle" [Orland 2019]. Although Bungie had generally delayed content for the sake of "preserving work-life balance" for their developers, they had occasionally resorted to "crunch," an increasingly prevalent practice in the video game industry that forces employees to

work upwards of one hundred hours per week to ship content on time [Semuels 2019]. However, Smith asserted that “it’s something we don’t like to do very often. We just did it recently..., so to ask a team to do that back-to-back? Full disclosure, that’s just not a thing we want to do” [Handrahan 2019]. While Bungie’s prioritization of its employees’ well-being is certainly commendable, it created issues with delivering content consistently to players, with Smith stating that “not relying on crunch to ship is now hard.... It requires changes to planning and culture, which takes a long time to do” [Handrahan 2019].

Given the vast arsenal of gear boasted by the *Borderlands* games or how many immense worlds *Minecraft* can offer its players, it is clear that procedural generation algorithms are capable of creating more content more efficiently than any team of designers ever could. However, while these algorithms can alleviate player criticisms of a game lacking content, it does not guarantee that the content generated will be appealing to players. For instance, while the *Borderlands* games were widely praised for their abundance of different weapons, some players found issues with the weapons themselves, such as their performance in combat or their functional similarity to one another. Large amounts of content cannot guarantee a consistently high player base, either, as evidenced by the first two *Borderlands* games’ dwindling player numbers in spite of each game’s vast numbers of procedurally-generated weapons.

The randomized nature of procedural generation can also be detrimental to players’ experiences when considering a game’s difficulty. When procedurally-generated content is tied directly to the player’s ability to survive, players are effectively at the mercy of the algorithm. Players who receive less powerful gear based on the whims of a procedural algorithm will find the game considerably more difficult because of elements of the game beyond their control, which makes the game seem unfairly difficult to the player. Conversely, if a procedural

algorithm gives players weapons that are too powerful, the game will become too easy, and players will lose interest. Both of these possible issues with procedurally-generated content are visible among the Metacritic reviews for the *Borderlands* series.

Additionally, the financial downsides of not using procedural generation can be seen in both the *Borderlands* and *Destiny* franchises. Due to *Borderlands 3*'s increase in content that was not procedurally generated, Gearbox had to hire additional staff to create assets for the game. According to the studio's president, the need to hire more content creators for the game resulted in lower profits than anticipated despite the game's impressive sales figures. The *Destiny* franchise's overreliance on handcrafted content also forced Bungie to take on so many staff members that despite being the second most-profitable first-person shooter franchise of all time, the series still underperformed financially.

As well as reducing a game's development costs, procedural generation can also allow for efficient content creation, resulting in shorter hours for development teams and less incentive to resort to crunch. As evidenced by the difficulty in creating content for *Destiny 2*, Bungie struggled to consistently keep the game updated despite having a staff of over six hundred, delaying patches and updates to the game for the sake of maintaining its employees' well-being. Allowing some aspects of a game to be created by procedural generation would allow content to be created more frequently and would alleviate some of the stress placed on game developers tasked with updating their game.

## **Discussion**

While most of the issues raised on Metacritic regarding the *Borderlands* series' procedurally-generated items were fairly specific, there was one particular criticism that was

somewhat ambiguous, specifically regarding the games' difficulty. While the games' procedural generation algorithm might have been responsible for these players' issues with the games' level of difficulty, whether they considered it too easy or too difficult, the players' differences in skill could have also been the variable that created these players' different opinions regarding the games' difficulty.

However, while the *Borderlands* series' procedural generation algorithm did not necessarily negatively impact these players' experiences, there were Metacritic users reporting that procedural generation had been detrimental to a different game's difficulty. This game, which was being considered for this study before *Borderlands* and *Destiny* were ultimately chosen, was *Spelunky*, a game that uses procedural generation to dynamically create its levels. Three of the twenty most-helpful user reviews expressed their dislike of the game's level generation, stating that the player's survival was too heavily dependent on what type of level was generated. Specifically, the game's randomized placement of helpful items and deadly traps was criticized due to the occasionally infrequent generation of the former and sometimes excessive placement of the latter [Users of Metacritic 2013]. The fact that a player's death could be the result of the level generation algorithm randomly creating excessively punishing levels would be made even more irritating by the fact that *Spelunky* is a rogue-like game, in which a player's death results in restarting from the beginning with none of the items acquired on the previous playthrough. Thus, in spite of the ambiguous nature of most criticisms regarding the *Borderlands* series' difficulty, there have been issues raised against games heavily tying player survival to a procedural algorithm.

One potential point of ambiguity regarding the player counts of each examined game was the fact that the statistics for the 2009 original release of *Borderlands* were unavailable on

Steam. Instead, the player counts of the 2010 *Game of the Year Edition*, which was virtually unchanged save for the inclusion of the game’s post-launch downloadable content [Gilbert 2010], were examined. This version of the game is not to be confused with the *Game of the Year Enhanced Edition*, which was released in 2019. This version was not examined because the 2012 version was closer to the original 2009 release of the game, with the 2019 *Enhanced Edition* containing new weapons and updated graphics that were not found in the original. While it is unfortunate that the original release’s player numbers were unavailable on Steam, those of the original release of *Borderlands 2* were, and they sufficiently disproved an essential correlation between a game’s possession of large quantities of procedurally-generated content and its ability to retain a larger portion of its player base than games without procedural content generation.

**Table 1: Critic reviews from Metacritic that mention aspects of the *Borderlands* series relating to its usage of procedural item generation; displays how many critic reviews considered each element a positive or negative aspect of each game as well as the average positive and negative reviews for each game in the series.**

	Border-lands 1 Positive	Border-lands 1 Negative	Border-lands 2 Positive	Border-lands 2 Negative	Border-lands 3 Positive	Border-lands 3 Negative	Average Positive	Average Negative
Items	14	0	7	1	16	1	12.3	0.6
RPG Elements	11	3	2	1	3	0	5.3	1.3
Combat	18	1	4	2	14	1	12	1.3

**Table 2: User reviews from Metacritic; follows the same format as Table 1.**

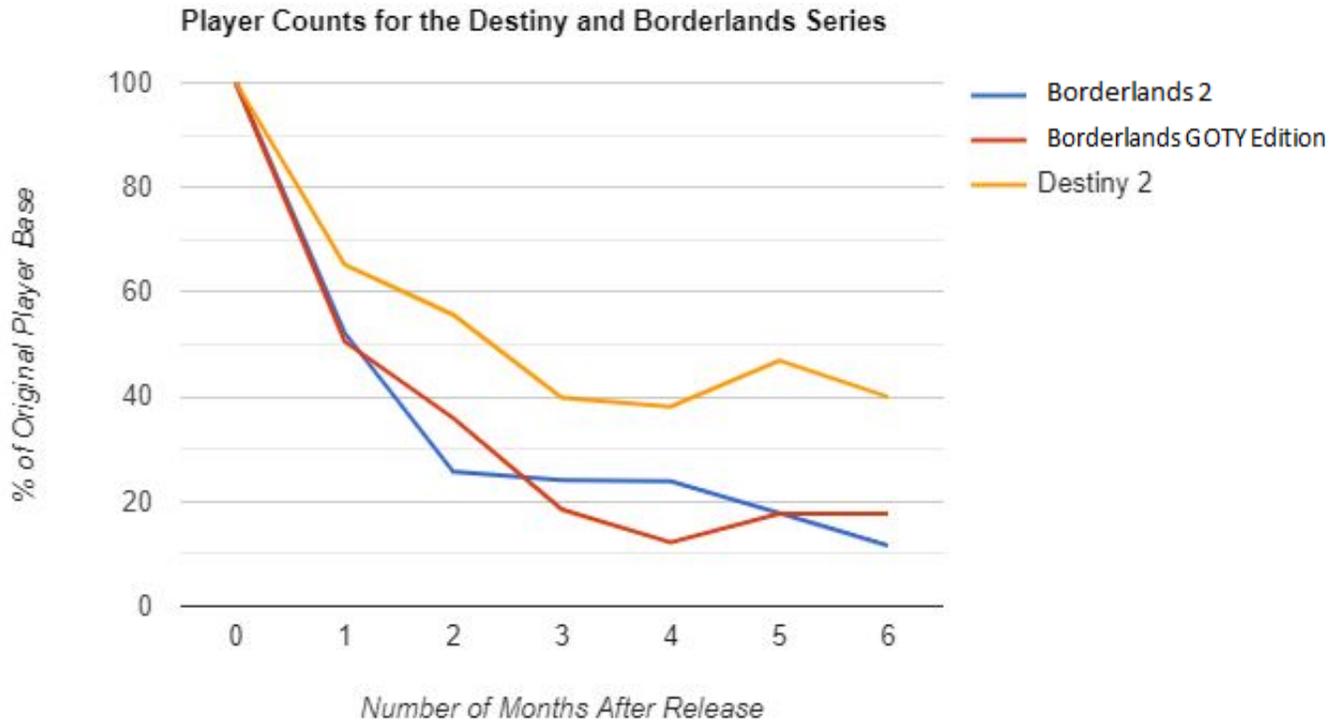
	Border-lands 1 Positive	Border-lands 1 Negative	Border-lands 2 Positive	Border-lands 2 Negative	Border-lands 3 Positive	Border-lands 3 Negative	Average Positive	Average Negative
Items	11	3	6	6	3	0	6.6	3
RPG Elements	3	3	1	1	0	0	1.3	1.3
Combat	8	4	4	0	2	0	4.6	1.3

**Table 3: Critic reviews from Metacritic that mention the *Destiny* series' aspects related to its conventionally-designed items.**

	<b>Destiny 1 Positive</b>	<b>Destiny 1 Negative</b>	<b>Destiny 2 Positive</b>	<b>Destiny 2 Negative</b>	<b>Average Positive</b>	<b>Average Positive</b>
<b>Items</b>	3	0	8	2	5.5	0.5
<b>RPG Elements</b>	6	3	5	0	5.5	1.5
<b>Combat</b>	35	4	17	2	26	3

**Table 4: Critic and user reviews from Metacritic that mention the *Destiny* series' amount of content, either in a positive or negative way.**

	<b>Destiny 1 Positive</b>	<b>Destiny 1 Negative</b>	<b>Destiny 2 Positive</b>	<b>Destiny 2 Negative</b>	<b>Average Positive</b>	<b>Average Negative</b>
<b>Critics</b>	3	22	20	4	11.5	13
<b>Users</b>	0	5	0	25	0	15



**Figure 1: Average player counts for Borderlands Game of the Year Edition, Borderlands 2, and Destiny 2 taken from Steam Charts; shows how much of their original player bases these games were able to retain after release.**

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