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RESEARCH ARTICLE

# Reward Types in Popular Recreational and Educational Mobile Games

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**ABSTRACT** The increase in the number of smart mobile devices has led the explosion of a variety of educational and recreational game applications. This study's purpose is to find common themes in the reward types of the cumulatively most-installed educational and recreational mobile games. The video games were observed by researchers from previously recorded footage available online. The most frequently occurring reward types in the most installed game applications in descending order are sensory feedback, glory, access, sustenance, facility and praise. Educational and recreational games appear to have differences in reward types present, recreational games having significantly higher median of total reward types. In the most installed game applications data set, the occurrence of every individual reward system, except praise and sensory, are significantly different between educational and recreational games. In-game rewards which seem to fit into multiple reward types are highlighted. In conclusion reward types differ in occurrence in addition to popular educational games appearing to have less reward types present than games made purely for entertainment purposes.

**INDEX TERMS** Reward types, rewards, mobile video game, educational games, mobile learning.

## I. INTRODUCTION

The number of smart devices such as phones and tablets is continuously increasing [1], [2], [3], so it is only natural that the number of applications available for these devices has both increased and diversified [4]. The education technologies global market has simultaneously seen significant growth and was estimated at 186 billion dollars during 2020 [5]. Serious and educational games have shown trends [6], [7] like the massive increase in mobile games [8].

Reference [9] suggests that the users are not divided equally between the applications, even though the game industry as a whole is growing. The vast majority of the users in application stores focus their attention on the already popular applications [9]. The data provided by [10] shows that the most installed application in the ''Paid Apps'' category has more than 10.0 million installations. The number of installations drops by 90% when moving to rank 12, and the last position on the list (500) holds only more than 50 000 installations. Similarly the ''Games Educational'' category's most installed game application has more than 100 million installations, the number of installations drops by 90% at rank 34, while the last position (500) holds more than 500 000 installations.

Educational games, according to [11], are a combination of playing and education whose end goal is to improve users' knowledge and capabilities. Reference [12] describes the term ''educational game'' as an loosely used term for any game that is built to educate and entertain. Most of the popular educational mobile games are made for children [3]. The educational games available from the Google Play Store have been shown to be lacking in quality [1], even though many studies suggest that educational games can improve learning outcomes [13], [14], [15]. Most evaluation tools created for this purpose produce results of poor quality that may contribute to the failures in educational software [16].

An educational mobile game that is perceived positively by teachers increases the chances of it being adopted into wider

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use [17]. Enjoyment of the learning process is suggested to be an essential part of any successful learning experience [18] and [19] suggests that having more rewards in the video game increases player enjoyment of recreational games. The body of literature regarding the elements that produce enjoyment needs more research [20], [21].

Providing different reward types in games has been suggested to increase the duration of the gaming session [22] and to positively affect player interest and enjoyment [23], benefit both attention span and memory retention and guide behavior [24]. The users report experiencing more autonomy and being more immersed in the game even when a ''placebo'' power-up is introduced in a video game [25]. The most effective application of reward systems in games is in environments where the users are not very motivated to begin with [24].

### A. REWARD TYPES

A study was conducted in 2015 to redefine the previously vague taxonomy of video game rewards [26]. In the study, 915 reward instances from 60 different games were observed. The most frequently occurring reward types were (in descending order) facility, glory, sensory feedback, access, sustenance and praise.

We will have to understand the history behind the monetization methods of video games in general to understand the need for assessment of different types of rewards and how the reward systems in games have progressed. Different rewards for money that are offered to the users can be used to monetize. The main source of revenue generation revenue during the video game industry's early years was selling complete games. This has changed in the past fifteen years as the so-called microtransactions (purchasable additional in-game content) have entered the business [27]. The ''freemium'' model of offering a free game with microtransactions has become popular in the video game industry [27], [28].

The rise of the ''freemium'' model has led to different types of rewards being applied to popular video games such as Apex's Legends (2019) and Epic's Fortnite (2017) behind various layers of monetization mechanics, such as battle passes, loot boxes and in-game currencies. These layers have been suggested to be obscuring users from seeing both how much money they are spending and what they are spending it on [27], [29]. An exploratory set of analyses of the battle pass system in the popular video game Dota 2 (2013) suggests that even though play of the battle pass has decreased, the spending on that system has increased [30].

Research has also been performed in the field of individual reward systems, such as achievements, in addition to monetization. Achievements, as described by [31], require a signifier (name), completion logic (condition) and a reward. Microsoft's Xbox and Sony's PlayStation overlay achievement and trophy systems were observed, and [32], in addition to [33] in a separate study, found that a segment of gamers felt compelled to complete every achievement. Other players found achievements to be intrinsically motivating, because they sometimes challenge the player to play the game in a completely different way to achieve the completion logic. The system interrupted some participants' engagement with the game. The players were divided about whether or not the achievements were an indication of excess time or individual skill in the game [32].

Gamification is the most popular segment of research in the field of reward systems [7]. Most rewards used in gamification studies are badges, tangible rewards, currency, unspecified rewards, likes, animated feedback and kudos [34]. More research needs to be performed in the field reward type design [35]. This can be used to provide guidelines and insight for educational and recreational game development and to advance the understanding of how reward types affect the motivation, popularity and likeability in addition to the overall impact of a game [36]. Thus, this study will focus on four key research questions:

- Does the number of reward types in the individual game correlate with the games position on the list in the cumulatively most-installed games data set during the time period 2012 - 2020?
- Is there a difference between the number of total reward types in educational and recreational games in the cumulatively most installed mobile games as of 2022?
- Is there a difference between the number of individual reward types in educational and recreational games as of 2022?
- Is there a difference between the number of individual reward types within most installed and randomly sampled educational and recreational games data sets as of 2022?

This study presents an overview of how the reward types have changed in the cumulatively most-installed mobile games between 2012 and 2020. The reward types in the fifteen cumulatively most-installed, paid game applications and educational games (as of 2022) are compared between each other and between a random sample from the same category of games. The data sets collected were available from Androidrank [10]. This study contributes information about the growth of reward types during data set and insight on the most- and least-appearing reward types. The taxonomy of rewards presented in [26] (access, facility, sustenance, glory, praise and sensory feedback, Table 1) is tested in the context of mobile applications, and possible additions are presented.

## II. METHODOLOGY

The data set for the cumulatively most-installed Android games from the year 2012 to 2020 was collected [10], and the fifteen most-installed games that were present during each year were taken into the study, because, as [9] suggests, most users are attracted to the most-installed applications.

The fifteen cumulatively most-in stalled games from the ''Game Educational'' section were selected from the same source. The fifteen most-installed games were selected for the study from the ''Paid Apps'' category. Two items were

removed from the list of ''Paid Apps'' because they were found to be applications and not games. The next two most-installed games in the same category were selected to take their spots in the data set.

Twenty randomly selected samples were also taken from both ''Game Educational'' and ''Paid Apps'' categories. The samples were selected randomly from the remaining positions in the 500 listed games after removing the 15 most installed game applications. The selection was done through a random number generation algorithm.

Reference [26] used a method in the study that produced the typology in which the video game rewards were reviewed from 10-15 minutes of gameplay footage. This study applies a similar method. A search query was formed to find each footage, and the Google search engine was used to find gameplay footage from YouTube for each individual year. The query was formed as follows: ''name of the game AND android gameplay AND site:youtube.com''. The time limitation tool of the Google search engine was also used to limit the date of the results between January 1st and December 31st each year. For example, the results from the year 2016 would begin from January 1st 2016 and end on December 31st 2016.

Difficulties were encountered in the gathering of footage for the cumulatively most-installed games from 2012 to 2020. Some games were platforms for user-generated content that held endless possibilities for the users to create gaming experiences and rewards at will. These games were marked as having all the possible reward types. Some games lost popularity during the years, and no footage was found. These individual cases were excluded from the data set.

### A. EVALUATING REWARD TYPES

Two of this paper's authors (evaluators) were given instructions to watch footage and type the rewards. The evaluators observed the gameplay footage until they concluded that most of the content available in the footage was seen (approximately 10 to 30 minutes was spent per game, depending on the availability of the footage and the complexity of the game) and listed the six different reward types found in the mobile games. The definitions of reward types quoted to the examiners were similar to how [26] explained them (see Table 1).

The data collection resulted in several tables containing the year, names of the games and the individual reward types found in the data set. These data were then compared between the researchers and analyzed further.

### B. ANALYSIS

Non-parametric Mann Whitney U test (MW) by using R-software (version 4.1.3) was used to test whether the fifteen most-installed, paid game applications differed from the fifteen most-installed educational games in terms of reward types present (research question two). The same procedure was done for the two data sets which contained the twenty randomly selected data sets from each category (research question four).

Mann Whitney U test was selected due to its robustness to test ordinal data and compare statistical difference between two groups [37]. For testing individual reward system presence in paid applications and educational games, chi-square test ($X^2$) was used to compare dichotomous measures (present/absent) of reward type presence in two groups of games (educational/recreational) in R-software (version 4.1.3). Chi-square test was selected due to its robustness and performance with dichotomous variables [38].

The relation between the number of reward systems and the order of the games in the top 15 cumulatively most-installed games were examined for individual years from 2012 to 2020 by using the Kendall Tau-b correlation coefficient. The results from the Kendall Tau-b correlation coefficient were then calculated with Bonferroni correction to relieve possible bias caused by multiple testing. Kendall tau was selected due to its suitability and performance for comparing ordinal association of two variables [39]. Kendall tau b was performed using kendall R package [40].

## III. RESULTS

Using the search query, over 160 videos were found, and the reward types were analyzed following the [26] typology. The most popular reward type found in the data set was sensory feedback (Table 2). Sensory feedback was found in every game, usually in the form of a sound or a visual effect after a player action was performed. The second popular reward type was glory, which came in the form of points or achievement systems. This was closely followed by access, because most of the games had various levels to play. The number of sustenance rewards was found to be steadily increasing in the data set. Praise was usually given to the player in the form of verbal and written praise after successfully completing a task or a level, but it still did not see much appearance in the data set when compared to other reward types.

The Cohen's kappa values were calculated to assess the agreement of researchers on different reward types. The value produced by Cohen's kappa was found to be in the range of almost perfect agreement; however, it turned out after a discussion that some vagueness was still apparent in the data set; a common conclusion was reached after more discussion, changing the value of the Cohen's kappa to 1, which suggests perfect agreement [41].

Figure 1 shows a steady increase in the number of individ ual reward types found when the range of years is increased in the data set. The number of reward systems found during the year 2012 was, on average, a little over three per game. This number rises to, on average, near five individual reward types per game when moving forward to the year 2020.

### A. POSITION ON THE LIST OF MOST-INSTALLED GAMES

The Kendall's Tau values (Table 3) represent the correlation between the number of reward types found in an individual game and the positioning on the fifteen most-installed games list. This test was repeated for each year from 2012 to 2020. A Tau value of 0 means no relationship between the number

**TABLE 1.** The reward typology presented in [26] including examples.

| Type of Reward | Definition | Example |
|---|---|---|
| Access | Players gain access to otherwise inaccessible environments, environmental objects or game modes (cutscenes included). | Opening a door to a new area. |
| Facility | Increasing player performance in current state of play. | Unlocking a new spell or a sword. |
| Sustenance | Alleviate burden, for example removing a hindrance. | Preventing losing all health; receiving health potions. |
| Glory | Measurable in game or meta-game environment through points, achievements, badges and victory conditions. | A badge that represents mastery of the game. |
| Praise | Applauding or flattering the player via game systems. | "Great job!" when finishing a round in game. |
| Sensory Feedback | Overt aesthetic or tactile feedback with the intention of promoting positive affect in the player. | Beams of light that emanate when player opens a chest. |

**TABLE 2.** The percentage of each reward type found in the range of years from 2012 to 2020.

| Year | Access | Facility | Sustenance | Glory | Praise | Sensory Feedback |
|---|---|---|---|---|---|---|
| 2012 | 60.0% | 20.0% | 13.3% | 86.7% | 20.0% | 100.0% |
| 2013 | 93.3% | 66.7% | 60.0% | 93.3% | 20.0% | 100.0% |
| 2014 | 100.0% | 57.1% | 57.1% | 100.0% | 0.0% | 100.0% |
| 2015 | 100.0% | 71.4% | 71.4% | 100.0% | 7.1% | 100.0% |
| 2016 | 100.0% | 66.7% | 73.3% | 100.0% | 20.0% | 100.0% |
| 2017 | 100.0% | 69.2% | 84.6% | 100.0% | 7.7% | 100.0% |
| 2018 | 100.0% | 66.7% | 80.0% | 100.0% | 13.3% | 100.0% |
| 2019 | 100.0% | 66.7% | 80.0% | 100.0% | 20.0% | 100.0% |
| 2020 | 100.0% | 73.3% | 86.7% | 100.0% | 26.7% | 100.0% |
| **Average occurrence** | **94.7%** | **61.8%** | **67.2%** | **97.7%** | **15.3%** | **100.0%** |

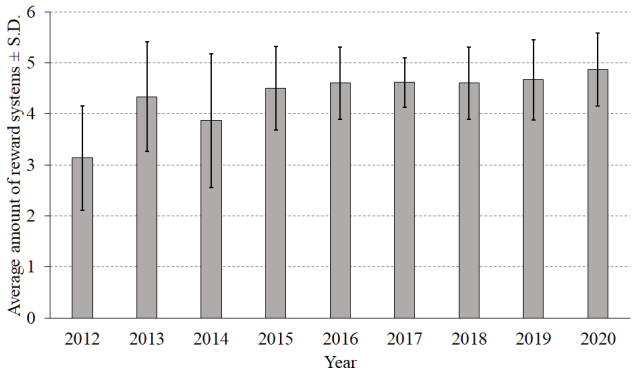


**FIGURE 1.** The average number of individual reward types found in the range of years from 2012 to 2020. The average number of reward types can be seen to be steadily increasing from three to nearly five per game.

**TABLE 3.** Calculating the correlation between the number of individual reward types and the position in the most-installed games during the data set from 2012 to 2020. The P-value is after Bonferroni correction.

| Year | Tau | P-Value |
|---|---|---|
| 2012 | -0.539 | 0.098964 |
| 2013 | -0.375 | 0.704979 |
| 2014 | -0.619 | 0.034884 |
| 2015 | -0.436 | 0.501147 |
| 2016 | -0.441 | 0.416511 |
| 2017 | -0.215 | 1 |
| 2018 | -0.298 | 1 |
| 2019 | -0.331 | 1 |
| 2020 | -0.197 | 1 |

of reward types in a game and the position on the most-installed list; a value of 1 is a perfect relationship between the values.

### B. RECREATIONAL AND EDUCATIONAL GAMES

Distribution of the amount of rewards between randomly chosen paid game applications (n = 20) and educational games (n = 20) had significantly different distribution (MW, W = 101.5, P = 0.007), recreational games having significantly larger mean (MW, W = 101.5, F = 0.003).

The data show that there is a significant difference between the types of individual reward types found between randomly chosen paid game applications and educational games. Figure 3 shows that paid game applications have more (significantly different number) access (Chi-square, $x^2 = 7.03$, df = 1, P = 0.008), facility (Chi-square, $x^2 = 10.99$, df = 1, P = 0.0009), sustenance (Chi-square, $x^2 = 6.14$, df = 1, P = 0.013). Reward types with no statistical difference between presence in paid game applications and educational games were glory (Chi-square, $x^2 = 1.6$, df = 1, P = 0.206), praise (Chi-square, $x^2 = 0.53$, df = 1, P = 0.465) and sensory (Chi-square, $x^2 = 2.105$, df = 1, P = 0.147).

Paid game applications in the fifteen cumulatively most installed games data set sported 64 counts of various reward

types (Figure 2) while educational games from the same data set had 33 in comparison. The difference between the number of total reward types in the two data sets is 51%, with game applications having more rewards present. Distribution of rewards between the fifteen cumulatively most installed recreational games and educational games from the same data set had significantly different distribution (MW, $W = 199.5$, $P = 0.0002$), recreational games having significantly larger mean (MW, $W = 199.5$, $F = 0.0001$).

The data show that there is a significant difference in the types of individual reward types found between the data set of the cumulatively most-installed paid mobile game applications and the most-installed mobile educational applications. Figure 2 shows that recreational games have more (significant difference between recreational games) access (Chi-square, $x^2 = 7.5$, $df = 1$, $F = 0.006$), facility (Chi-square, $x^2 = 16.0$, $df = 1$, $F < 0.0001$), sustenance (Chi-square, $x^2 = 110$, $df = 1$, $F = 0.0009$) and glory (Chi-square, $x^2 = 5$, $df = 1$, $F = 0.025$) type rewards However, educational games seem to have more rewards of praise, but not significantly (Chi-square, $x^2 = 1.0$, $df = 1$, $F = 0.309$), in addition to sensory rewards being equal in both data sets.

When examining the amount of rewards present in the 15 most installed educational games to the randomly selected games from the same data set there is no significant difference ($W = 169.5$, $p = 0.5127$) in regards to the number of reward types versus the position on the data set. There appears to be a similar direction when comparing the fifteen most popular paid game applications to a random set of twenty paid game applications ($W = 110.5$, $p = 0.1674$).

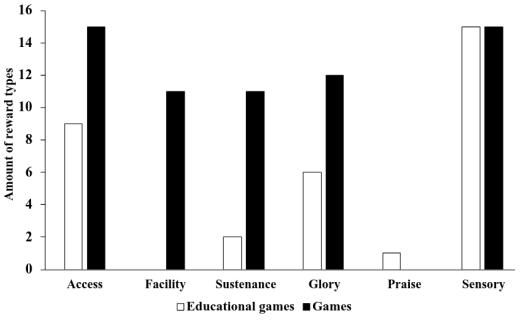


**FIGURE 2.** The number of different reward types found in the 15 cumulatively most-installed mobile educational games and paid mobile game applications 2022 data set.

## IV. DISCUSSION

As shown in the figure 3 the educational games and paid game applications appear to have different amount of reward types present when comparing the randomly selected data sets of each category.

When comparing the random sample of either recreational game or paid game application data set to its corresponding top 15 list it appears that the number of reward types does not seem to affect the popularity of the game within the data sets.

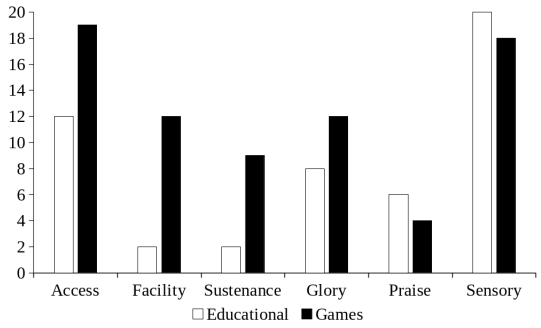


**FIGURE 3.** The number of different reward types found in randomly selected 20 mobile educational games and paid mobile game applications data sets.

Information was collected for this study about different reward types found in the most-installed Android game applications in the Google Play Store. Fifteen applications were selected because most of the users tend to predominantly choose the most popular applications [9]. The rewards that were categorized into six different categories found in [26] are access, facility, sustenance, glory, praise and sensory feedback. Cohen's kappa value was found to be 1, which suggests perfect agreement among the evaluators [41].

The results suggest that in the cumulatively most installed games data set the most popular reward types in descending order are sensory feedback, glory, access, sustenance, facility and praise (Table 2). The dataset shows that some reward types are more popular than others. The occurrences in reward types do not seem to follow the same pattern as in [26], which reported, in descending order, facility, glory and sensory feedback as its most popular reward types in game applications. Access, sustenance and praise were the least popular in the same study.

As to why the results differ from the ones gathered from [26], one possibility is that the definitions of the reward types can be interpreted in various ways. One explanation might simply be that the current trends in mobile gaming have come to these types of games and reward types because of random happenstance. It is also plausible that the mobile platform provides some affordabilities and restrictions that have made the games designed in a different way. for example it could be that sensory feedback is the most popular reward type because the mobile devices and game engines usually support the affordability of sound and visual effects, in addition to the target audience being mostly children in educational contexts [3]. This study also supports this view in the context of recreational games. Most of the games available in the market produce overt sounds and display visual effects when actions are taken. It would be considered odd and not user friendly if users were not visually and audibly informed of their game actions, such as picking up a coin or completing a level in the game. However, when the sound or visual effect for picking up a coin becomes "overt," it seems to be subjective when comparing the level of sensory feedback present in this study to the findings of [26]. It could be that

mobile games are more suited for sensory feedback, but it seems that differences in the definition of sensory feedback is a more likely explanation.

Access or unlockable content was found to be among the most popular reward types in the examined games. Unlock able content, such as levels or different outfits for characters, has been a part of the video game reward selection for a long time and can be seen as a quite popular solution; levels were in older and newer games, different outfits are in modern games. Perhaps unlockable content was included in most games because unlocking content can provide structure and motivation to the users or create the feeling of progression.

It is interesting to note that, even though [26] reported that they were unable to find a reward that would fit into multiple categories at once, this study's evaluators found some that appear to do so. For example, in some ''auto runner'' games such as Subway Surfers and the Minion Rush: Despicable Me Official game, there is an item on the track that can be picked up. The player is flung into the air for a short while when it is picked up, which gains access to an otherwise inaccessible environment (access) while avoiding a negative game state by being unable to lose the game (sustenance) and collecting coins without any obstacles in the way (increasing the player's effectiveness, facility). Therefore, it can be assumed that the typology, as is, possibly includes rewards that match multiple reward types at once.

Glory or point systems were found in most games in the cumulatively most installed games data set, similar to [34] who found that badges were the most popular reward in the data set used in that study. Many of the glory rewards found in the games, according to the evaluators, were point systems inside the game to signify progress or collect rewards and in-game currency to spend somewhere for unlockable content rewards. The evaluators noted that the more modern the games they were looking at, the more likely it was that the glory systems included achievements like those described by [31].

The reward-type praise was found to be missing from most of the games. Reference [26] defines praise as ''praise'' or ''flattery to the player'' via game systems, so defining this reward type generated some discussion between the evaluators. A clear definition between praise or flattery and stating the situation in the game was formed. For example, if the game states that the player has received a ''double kill,'' a ''strike,'' or has completed a level, this was treated as simply information about the state of the game. However, it was counted as praise if the player was directly praised, such as ''You are such a fast learner!''. With this in mind, the researchers suggest that future studies take into account the difference between stating the state of the game and praise or flattery, as the authors found this could quite easily confuse users.

The facility and sustenance reward types were less popular in the cumulatively most installed games dataset (Table 2). This might be because the idea of improving your character's performance or having sustenance mechanics such as health potions (avoiding negative game state) often assume that the player has a character or that a negative game state can be achieved. The evaluators discussed the very definition of ''negative game state'' as mentioned by [26] in the definition of rewards of sustenance. For example, in the My Talking Tom games, it might be seen as funny by juveniles to see the character hungry or dirty if the character is not taken to the bathroom, because the sounds and gestures can be seen as entertaining in a fictional character.

It is interesting to note that, even though [19] suggests that having more rewards improves the user experience, a game can be popular with only one or two reward types, although several different reward types are often found together among the most popular ones.

The evaluators discussed in which reward-type category customization of ''skins'' or different visual materials for game objects would belong. A process of elimination decided that skins were rewards of access because they were similar to ''inaccessible environments or environmental objects.'' It might be worth investigating the possible addition of a separate reward type, ''rewards of customization,'' due to the popularity of ''skins'' present in the data set. This would increase the accuracy of reward type research. It was also noted that points and achievement systems that were together in the ''rewards of glory'' were often present separately, and it would be interesting to further separate rewards of glory into its own sub categories. such as ''points,'' ''achievements or badges'' and ''other''.

During the assessment of different reward systems in the cumulatively most-installed educational games as of 2022, the evaluators found that some games in this category were questionable in educational quality, because the end goal of learning (as defined by [11]) was unclear, a finding that supports the view in [1], in addition to having very aggressive monetization schemes. The researchers noted that the games based on popular franchises were often more focused on entertainment, and games funded by less known organizations appeared to promote learning more than the previously mentioned games.

The evaluators noted that the diversification of applications mentioned in [4] was not apparent in the game applications, because there were numerous games that would be indistinguishable from each other if the models were swapped, such as ''auto runner'' games. The evaluators were unable to see any serious or educational video games present in the most-installed games data sets other than the 2022 cumulatively most-installed educational games data set, even though the number of serious and educational video games has increased during the years [6].

### A. RESEARCH QUESTIONS AND LIMITATIONS

The answers to the research questions presented in the introduction to this study can be seen from the analyzed data. Figure 2 shows that the fifteen cumulatively most-installed, paid game applications and educational games for mobile have significant differences in reward types present in the

individual games, in addition to recreational games having 51% more counts of reward types found. The average number of individual reward types found in the 15 most cumulatively installed games in both paid game applications and the educational game application data sets showed no significant difference when compared against the 20 randomly selected games from the same category. In comparison, the 20 randomly selected games from each categories had significant differences in the number of reward types present. Recreational game applications have more rewards of access, facility, sustenance and glory while being equal in the sensory feedback rewards to the educational game counterparts. Praise was not found in the game applications but was present in some of the educational games.

An individual game was found, on average, in four data sets with each data set representing one year of games.

Table 3 shows that the number of reward types present in the individual game does not significantly correlate with the positioning of the game in the data set because the data varies from year to year. The years 2012 and 2014 show a statistically significant correlation with the number of individual reward types present and the position on the list. This may warrant more research into mobile game reward types from 2000 to 2010 to see if the trend started or existed during these years. There is a possibility that the game companies realized during the early 2010s that more rewards yield more profits and started to implement more reward types afterwards.

The ''freemium'' monetization model as presented in [27] was seen as a popular choice in the 2012-2020 cumulative data set. A game that did not have some reward types when it first appeared in the data set or that had some added often had glory or access type rewards that were directly tied to monetization schemes. Many of these mechanics were often included in the starting experience of the game for free and were then turned into purchasable benefits later on in the game. Achievement systems as described by [31], battle passes similar to the ones examined in [30], loot boxes and in-game currencies, all started to spread in the data set as time progressed from 2012 to 2020. Various methods of obscuring from the player what they are buying and how much they are buying it for (as seen in [29] and [27]) were noted. The evaluators found that, in addition to reward types, the number of penalty mechanics for monetization schemes gained popularity from 2012 to 2020 as various ''wait $\times$ time to play, build or hatch'' mechanics emerged.

This study's findings support the view presented in [42] and [36] that suggests that more reward types increase the player enjoyment in recreational games. More research is needed on player engagement in educational [20] and recreational contexts. The games that were evaluated for this study rarely showed signs of overlay achievement and trophy systems, as were seen on other platforms [32]. The games that had achievement systems added to them were popular even before achievement systems were added. This suggests that, even though reward systems can be most effective when applied in environments where the users are not very motivated [24], this does not mean that they are not applied to activities that are already enjoyed by many. Many of the achievements that were seen by the evaluators were randomly awarded for doing very basic tasks necessary for the games and not many people viewed in the footage seemed to notice or care about the achievements. Had the players in the footage looked at the achievements more closely or aimed to complete some more complicated ones on purpose, it could have, in theory, increased the players' interest and enjoyment [23] and guided player behavior [24]. This is similar to [25] some players who were noticed being visibly more immersed in the game after picking up rewards.

This study is limited to the fifteen most-installed applications shown in Androidrank's ''Game Educational'' and ''Paid Apps'' category selections and cumulative game installation data. Whether or not these games are educational or not is out of this study's scope. The category selection for each reward type found in the selection of games is prone to human error. The data from the year 2022 was currently not available for the research team so it was not presented in this study. Other mobile platforms were not included in this study, because the same data sets were unavailable for this research from the Apple, Windows or other alternatives.

## V. CONCLUSION

As the competition in the recreational video games industry grows and every game company wants to maximize the revenue generated, research into reward systems is necessary in order to understand and guide player motivation. Similarly the field of educational games hopes to grasp similar levels of enthusiasm and enjoyment to their products for serious purposes. Understanding the motivation behind the application of various reward systems and their popularity is key to guiding the future of video game reward systems research.

In this study it was found that the average number of individual reward types in recreational games has steadily increased in the range of years from 2012 to 2020. The average number of reward types in the beginning of the data set (2012) was three per game. When looking at the data from the year 2020 the number had risen to on average near five different reward types per game. There appears to be no direct correlation with the number of reward types present and the position on the list.

The same can be said when comparing a random sample of 20 games from the top 500 most cumulatively installed game applications lists to each other. Paid game applications appear to have significantly more reward types present when comparing the 15 most installed paid game applications to the educational game applications. However no significant difference can be found when comparing the 15 most installed game applications to the 20 randomly selected game applications in either paid game application or educational game data sets.

The impact of this research can be achieved with the novel findings that the number of individual reward types has

steadily risen over the years and that there is no direct correlation with the number of individual reward types present to the popularity of the game. This research has also shown support to the idea that educational games have individual reward types present when comparing to games made for purely recreational purposes. As this study suggests that the number of individual reward types does not correlate with the popularity of the game in the data sets it suggests that the efforts of game designers are better spent in the quality of reward types present over the quantity. However as the games in the longitudinal data set grew with age the number of reward types added had also increased. Many of these newly introduced reward types were directly associated with monetization schemes. With this knowledge it is possible to start further researching the field of reward types in video games in more specific scenarios and practical applications.

## VI. FUTURE RESEARCH

Research in the field of reward types and application of said types in educational, serious and recreational games appears to be lacking in depth and variety. Answers to questions such as which reward types are the most common on platforms other than mobile or various genres and, even more importantly, why they were chosen to be included in said games remain unclear. The authors hope to see more applications and games reviewed for different reward types in the future. Understanding why and when reward types work is key to building more engaging educational and recreational games and to help increase the popularity of educational applications [17]. An increasing number of various mobile devices, such as tablets [2], educational technology [5] and mobile games [8] are gaining in popularity. Thus, it is important to avoid poor quality results from evaluation tools [16] and to focus more on the enjoyment of the learning process (shown to increase the possibility of a successful learning experience [18]) to produce more data that shows that educational games can improve learning outcomes [13], [14], [15].

Regarding future research in the field of reward systems, the researchers suggest adding data points by explaining how the rewards were obtained, in addition to expanding the reward typology presented in [26] into relevant subcategories. The researchers encourage research in the field of reward types and systems in contexts other than gamification (as it appears to be the most popular one [7]). The duration of gaming sessions in the different games could be taken as a data point for comparison with [22]. The interaction of the player and the reward system could be observed with eye-tracking technology or more traditional methods, such as recording footage, to gather evidence on the effects of various reward types in games.

The presence of individual reward types and the longevity of the game on the list of the most-installed games would also be an interesting comparison for future research. Using different application stores, countries, more data points from Androidrank [10] or similar sources, game popularity can be analyzed to further improve the body of literature on reward types in games for entertainment and education, which can then be taken as additional data points for future research.

## REFERENCES


[1] S. Papadakis, M. Kalogiannakis, and N. Zaranis, "Educational apps from the Android Google play for Greek preschoolers: A systematic review," *Comput. Educ.*, vol. 116, pp. 139–160, Jan. 2018.

[2] J. L. Miller and C. A. Kocurek, "Principles for educational game development for young children," *J. Children Media*, vol. 11, no. 3, pp. 314–329, Jul. 2017.

[3] S. Papadakis and M. Kalogiannakis, "Mobile educational applications for children: What educators and parents need to know," *Int. J. Mobile Learn. Organisation*, vol. 11, no. 3, pp. 256–277, 2017.

[4] B. Kim, "The popularity of gamification in the mobile and social era," *Library Technol. Rep.*, vol. 51, no. 2, pp. 5–9 2015.

[5] V. V. Timchenko, S. Y. Trapitsin, and Z. V. Apevalova, "Educational technology market analysis," in *Proc. Int. Conf. Quality Manage., Transp. Inf. Secur., Inf. Technol. (ITQMIS)*, Sep. 2020, pp. 612–617.

[6] F. Laamarti, M. Eid, and A. El Saddik, "An overview of serious games," *Int. J. Comput. Games Technol.*, vol. 2014, pp. 1–15, Oct. 2014.

[7] J. Tyni, A. Tarkiainen, S. López-Pernas, M. Saqr, J. Kahila, R. Bednarik, and M. Tedre, "Games and rewards: A scientometric study of rewards in educational and serious games," *IEEE Access*, vol. 10, pp. 31578–31585, 2022.

[8] B. DaCosta, S. Seok, and C. Kinsell, "Mobile game-based learning," in *Advanced Methodologies and Technologies in Modern Education Delivery*. Hershey, PA, USA: IGI Global, 2019, pp. 809–824.

[9] N. Zhong and F. Michahelles, "Google play is not a long tail market: An empirical analysis of app adoption on the Google play app market," in *Proc. 28th Annu. ACM Symp. Appl. Comput.*, 2013, pp. 499–504.

[10] *Free Android Market Data, History, Ranking*. Accessed: Mar. 19, 2022. [Online]. Available: https://androidrank.org/

[11] D. Furió, S. González-Gancedo, M.-C. Juan, I. Seguí, and M. Costa, "The effects of the size and weight of a mobile device on an educational game," *Comput. Educ.*, vol. 64, pp. 24–41, May 2013.

[12] N. Holbert and U. Wilensky, "Designing educational video games to be objects-to-think-With," *J. Learn. Sci.*, vol. 28, no. 1, pp. 32–72, Jan. 2019.

[13] G. L. Y. Ping, C. Lok, T. W. Yeat, T. J. Y. Cherynn, and E. S. Q. Tan, "'Are chemistry educational apps useful?'—A quantitative study with three in-house apps," *Chem. Educ. Res. Pract.*, vol. 19, no. 1, pp. 15–23, 2018.

[14] G.-J. Hwang, P.-H. Wu, C.-C. Chen, and N.-T. Tu, "Effects of an augmented reality-based educational game on students' learning achievements and attitudes in real-world observations," *Interact. Learn. Environments*, vol. 24, no. 8, pp. 1895–1906, Nov. 2016.

[15] A. Drigas and M. Pappas, "A review of mobile learning applications for mathematics," *Int. J. Interact. Mobile Technol.*, vol. 9, no. 3, p. 18, Jul. 2015.

[16] R. Bednarik, P. Gerdt, R. Miraftabi, and M. Tukiainen, "Development of the TUP model–evaluating educational software," in *Proc. IEEE Int. Conf. Adv. Learn. Technol.*, 2004, pp. 699–701.

[17] J. C. Huizenga, G. T. M. ten Dam, J. M. Voogt, and W. F. Admiraal, "Teacher perceptions of the value of game-based learning in secondary education," *Comput. Educ.*, vol. 110, pp. 105–115, Jul. 2017.

[18] P. Felicia, *Handbook of Research on Improving Learning and Motivation Through Educational Games: Multidisciplinary Approaches: Multidisciplinary Approaches*. Hershey, PA, USA: IGI Global, 2011.

[19] D. Johnson, M. Klarkowski, K. Vella, C. Phillips, M. McEwan, and C. N. Watling, "Greater rewards in videogames lead to more presence, enjoyment and effort," *Comput. Hum. Behav.*, vol. 87, pp. 66–74, Oct. 2018.

[20] A. I. A. Jabbar and P. Felicia, "Gameplay engagement and learning in game-based learning: A systematic review," *Rev. Educ. Res.*, vol. 85, no. 4, pp. 740–779, 2015.

[21] V. Shute, S. Rahimi, and X. Lu, "Supporting learning in educational games: Promises and challenges," in *Learning in a Digital World*. Springer, 2019, pp. 59–81.

[22] M. Ronimus, J. Kujala, A. Tolvanen, and H. Lyytinen, "Children's engagement during digital game-based learning of reading: The effects of time, rewards, and challenge," *Comput. Educ.*, vol. 71, pp. 237–246, Feb. 2014.

[23] C. Phillips, D. Johnson, M. Klarkowski, M. J. White, and L. Hides, "The impact of rewards and trait reward responsiveness on player motivation," in *Proc. Annu. Symp. Comput.-Hum. Interact. Play*, 2018, pp. 393–404.
[24] S. Hidi, "Revisiting the role of rewards in motivation and learning: Implications of neuroscientific research," *Educ. Psychol. Rev.*, vol. 28, no. 1, pp. 61–93, Mar. 2016.
[25] A. Denisova and E. Cook, "Power-ups in digital games: The rewarding effect of phantom game elements on player experience," in *Proc. Annu. Symp. Computer-Human Interact. Play*, Oct. 2019, pp. 161–168.
[26] C. Phillips, D. Johnson, P. Wyeth, L. Hides, and M. Klarkowski, "Redefining videogame reward types," in *Proc. Annu. Meeting Austral. Special Interest Group Comput. Human Interact.*, Dec. 2015, pp. 83–91.
[27] N. Tomic, "Effects of micro transactions on video games industry," *Megatrend Revija*, vol. 14, no. 3, pp. 239–257, 2017.
[28] A. S. Firdaus and R. A. Rahadi, "Conceptual model for factors that influence purchase intention of in-game purchase in freemium mobile game," *Int. J. Accounting*, vol. 6, no. 32, pp. 74–87, 2021.
[29] D. Joseph, "Battle pass capitalism," *J. Consum. Culture*, vol. 21, no. 1, pp. 68–83, Feb. 2021.
[30] E. Petrovskaya and D. Zendle, "The battle pass: A mixed-methods investigation into a growing type of video game monetisation," OSF Preprints, Sep. 2020.
[31] J. Hamari and V. Eranti, "Framework for designing and evaluating game achievements," in *Proc. Digra Conf.* Princeton, NJ, USA: Citeseer, vol. 10, no. 1, 2011, p. 9966.
[32] C. Cruz, M. D. Hanus, and J. Fox, "The need to achieve: Players' perceptions and uses of extrinsic meta-game reward systems for video game consoles," *Comput. Hum. Behav.*, vol. 71, pp. 516–524, Jun. 2017.
[33] T. Apperley and E. Gandolfi, "Evaluating gamer achievements to understand player behavior," in *Data Analytics Applications in Gaming and Entertainment*. Boca Raton, FL, USA: Auerbach, 2019, pp. 15–32.
[34] Z. H. Lewis, M. C. Swartz, and E. J. Lyons, "What's the point?: A review of reward systems implemented in gamification interventions," *Games Health J.*, vol. 5, no. 2, pp. 93–99, Apr. 2016.
[35] M. M. M. van Dooren, V. T. Visch, and R. Spijkerman, "Rewards that make you play: The distinct effect of monetary rewards, virtual points and social rewards on play persistence in substance dependent and non-dependent adolescents," in *Proc. IEEE 6th Int. Conf. Serious Games Appl. Health (SeGAH)*, May 2018, pp. 1–7.
[36] C. Phillips, D. Johnson, M. Klarkowski, M. J. White, and L. Hides, "The impact of rewards and trait reward responsiveness on player motivation," in *Proc. Annu. Symp. Comput.-Hum. Interact. Play* New York, NY, USA: Association for Computing Machinery, 2018, pp. 393–404, doi: 10.1145/3242671.3242713.
[37] T. W. MacFarland and J. M. Yates, "Mann–Whitney u test," in *Introduction to Nonparametric Statistics for the Biological Sciences Using R*. Springer, 2016, pp. 103–132.
[38] M. L. McHugh, "The chi-square test of independence," *Biochemia Medica*, vol. 23, no. 2, pp. 143–149, 2013.
[39] R. Newson, "Parameters behind 'nonparametric' statistics: Kendall's tau, Somers' D and median differences," *Stata J.*, vol. 2, no. 1, pp. 45–64, 2002.
[40] A. McLeod. (2022). *Kendall: Kendall Rank Correlation Mann-Kendall Trend Test*. R Package Version 2.2.1. [Online]. Available: https://CRAN.R-project.org/package=Kendall
[41] A. J. Viera and J. M. Garrett, "Understanding interobserver agreement: The Kappa statistic," *Family Med.*, vol. 37, no. 5, pp. 360–363, 2005.
[42] D. Johnson, S. Deterding, K.-A. Kuhn, A. Staneva, S. Stoyanov, and L. Hides, "Gamification for health and wellbeing: A systematic review of the literature," *Internet Interventions*, vol. 6, pp. 89–106, Nov. 2016.

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