

Avoiding Failure in Modern Game Design with Academic Content *A Recipe, an Anti-Pattern and Applications Thereof*

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Abstract: Educational Games tend not to be designed by game engineers. They usually do not compare either in graphics or in addictiveness to small games that people have installed on their mobile devices. In order to understand why people play today, a survey was conducted to determine players' explicit and implicit knowledge about motivators in addictive games. Based on the results of the questionnaire, we studied demographic preferences and commonalities in order to develop a recipe for the design that fits the general current market. An anti-pattern was a by-product of this process. Both are then applied towards an analysis of existing games and the design of a new one.

1 INTRODUCTION

Playing games can be addictive and fun. In contrast, learning in the official context of education is often stressful or perceived as a duty (Few, if any, studies look at the academic stress caused by educational methods in schools today). Rare are the students who cannot wait to get up in the morning to continue their learning from last night, more frequent in first grade than the later years. To improve the learning experience, researchers and educators have introduced games into the classroom in different ways: By using existing games in class or adding gamification mechanics to educational content. Due to the large number of publications in this area, we focus on literature overview papers to establish the current status-quo in this field of study.

1.1 Gamification

Gamification pertains to the analysis of mechanics that make games fun and then applying these to situations outside of gaming in order to recreate the feeling of fun or addiction to new applications such as learning or marketing or the solving of mundane tasks (rephrased from Oxford Dictionary).

According to (de Sousa Borges et al., 2014), there have been a number of papers on various topics relating to gamification in education. Very few, however, deal with actual game design for experience, solution proposal, and validation with respect to master-

ing skills.

Dicheva (Dicheva et al., 2015) lists the papers that have studied various features in gamification usage for education. The most frequently studied mechanics in order of popularity are: 'Status', 'Social Engagement', 'Freedom of Choice', 'Freedom to Fail', 'Rapid Feedback' and 'Goals and Challenges'. Researchers have studied gamification of educational material and shown that there is a strong interest in using game mechanics for education.

We believe that there remains a significant gap in actually designing and validating the use of games with academic content, going beyond gamification.

1.2 Games

Game-based learning (GBL) builds on existing games, such as *Civilizations*, and re-uses it for an educational purpose, like economics or history (Squire, 2006; Wiggins, 2016). Games are only starting to make a very slow move into schools (Dickey, 2013; Salen, 2011). The idea of using games in education is sometimes treated differently in the literature and called Educational Games or Serious Games (for example, (Vaz de Carvalho et al., 2016)). These are designed specifically with academic content in mind. For the purpose of this paper, we prefer not to distinguish between games and serious games (this is not unusual and seems to agree with the findings in the literature overview on the subject (Boyle et al., 2016)). According to Merriam Webster, a game is defined as:

a) A form of competitive activity or sport played according to rules. b) An activity that one engages in for amusement. c) (adj) eager or willing to do something new or challenging. In this sense, there is no need to give a special name to a game that has academic content. The key is instead on how the content is designed as a game (for example pure game design (Egenfeldt-Nielsen et al., 2016), and it's effect on children's learning outcome (Suarez Caraballo, 2014) and (Berkling et al., 2015)).

1.3 Extrinsic vs Intrinsic

The difference between extrinsic and intrinsic motivation has been sufficiently described (Ryan and Deci, 2000). The negative effects of extrinsic motivators on intrinsic motivation and performance have been discussed repeatedly. Lately, Hanus (Hanus and Fox, 2015) has shown the effects of gamification in the classroom in a longitudinal study:

- "Over time, gamified students were less motivated, empowered, and satisfied.
- Gamified course negatively affected final exam grades through intrinsic motivation.
- Gamified systems strongly featuring rewards may have negative effects."

With "Educational" Games and gamification we often obtain, as a result, exactly this sort of extrinsic motivation by providing unrelated rewards. In contrast, popular games themselves seem to tend more towards the intrinsic motivation and working with the provided content to learn something. In this paper we would like to contribute towards moving education into the direction of understanding how to design and use games with academic content.

It is known that content design is an integral part of a good game and there is no reason that it cannot contain the same information that would be studied in an educational setting.

1.4 Demographic Dependence

Using game mechanics to design an addictive educational experience has been studied in detail. It is well known that personas, typical user profiles of a known demographic, are necessary for good design. Koivisto and Hamari (Koivisto and Hamari, 2014) have shown that age and gender play a major role when designing gamification mechanics for their respective demographics. The work presented here incorporates demographics but looks at common themes across demographics for general audiences in education.

1.5 Relationship between Education and Games

Vallerand (Vallerand et al., 1986) explains in a very valuable summary the key to seeing education as a game: It is important to identify the intrinsic rewards relative to the culture and build game-like interactions on top of these by focusing on mechanics like "Freedom to Fail, Rapid Feedback, Progression and Storytelling" - note that these overlap with those studied in the gamification literature (Section 1.1). Stott (Stott and Neustaedter, 2013) then makes the connection with existing terminology in education. "The Freedom to Fail" is analogous to formative assessment using "Rapid Feedback", "Progression" relates to scaffolded learning and "Storytelling" is equally recognized as a powerful tool in the classroom.

What we can learn about the current culture of games and what engages our time in gaming? Subject of this paper is a more detailed recipe-like mapping between these two areas.

1.6 Current Cultural Framework

This paper presents an update of the analysis of a list of games as a function of their demographics. Looking at the most popular games, a framework of features (motivation factors) is developed. This framework forms the basis for a survey of over 800 people across different age ranges. With the newly gained knowledge about gamers, we proceed to formulate a recipe and an anti-pattern as a by-product. This in turn is used to analyze a finished educational game that has been released in the market and to show how these steps generalize to a second game design.

This paper contributes to the general knowledge in this area by providing an updated analysis on why gamers play today. A survey is designed to find out more about players in indirect and direct ways and use this information to create a recipe for designing games that happen to have academic content.

Section 2 explains the framework that was developed through detailed study of 27 popular games. Based on this framework, a survey (see Appendix A2) of over 800 participants was conducted and the results are described in more detail in Section 3. Section 4 discusses what not to do in a game design and analyzes the current situation in standard schools and Universities. Since there is room for improvement in the 'game of learning', a subsequent step writes up a recipe for game design with educational content in Section 5. Given the recipe, an existing, successful (with respect to skills improvement and fun) educational game is analyzed (Section 5.1) and a new game

designed (Section 5.2). Finally, Section 6 summarizes and refers to future work.

2 ANALYSIS OF GAMES

A list of popular games from Google Play Store charts and from subjective Experience of Bachelor students is compiled. This list forms the basis of the questionnaire to analyze these games with respect to their features in relation to the demographics of the players.

Four main categories of distinguishing features evolved out of an iterative analysis of the games list (see Appendix A1 for a comprehensive listing and usage statistics): Game-mode, Motivation, Emotion, Simplicity and other features not categorized. These are each explained below (with examples):

2.1 Game Mode

Games can be distinguished by game mode. These usually fall into one of these categories:

- One-level/infinity (Pineapple Pen, Piano Tiles)
- Level (Candy Crush, Angry Birds)
- Story (Clash of Clans)

2.2 Motivation

Motivation for games are simple game mechanics that create extrinsic motivation such as listed below. We distinguish between rewards and currency, that serves as a mechanism to acquire new tools to help the player progress. Goals define specific "work" that has to be accomplished irrespective of levels. Come-back motivations are types of appointments. High-score is a form of competition with self or others and a progress bar shows the path towards a goal or level.

- Rewards (Cut the Rope)
- "Currency" (Subway)
- Goals (Angry Birds)
- Come back motivations (FIFA, Block Hexa Puzzle)
- Confrontation with high-score (Pineapple Pen, Flappy Bird)
- Progress bar (Clash of Clans, Temple Run)

2.3 Emotion

A major factor in games are emotions that can be supported with emotional faces, sound or graphics. Furthermore, fun, humor and spectacular death can support the creation of strong emotions for the player.

- Faces (Pineapple Pen, Pou)
- Sound-FX (all)
- Emotional Music (not for 2048)
- Humor (Angry Birds)
- Fun Death (Temple Run)

2.4 Simplicity

Simplification is important for on-boarding and ease of movement across levels of difficulty. It should be easy to start and proceed. The menu has to be quick, direct and easy to understand:

- Fast proceeding (not Temple Run)
- Fast start (not Clash of Clans)
- Simple menu (Pou, Candy Crush)

2.5 Other

Other factors that do not fit into the above categories have been determined as important aspects of a number of games that are currently popular: Their relation to reality, patterns that are learned to improve performance, social behavior (like feeding the animals in a friends' zoo) or competitions with self or others.

- Relation to reality (FIFA)
- Patterns (Roll the Ball)
- Social (Pou)
- Competitive (Flappy Bird)

Appendix A1 lists the games and gives detailed analysis of these factors.

3 SURVEY: DESIGN AND RESULTS

In order to gain a deeper understanding of how we can use games in education and generalize their design across populations, a current survey was conducted. The survey builds on the features that we have defined in the previous section.

3.1 Survey Construction

The survey includes three sections (see Appendix A2).

- Demographic data
- Gaming Habits
- Games Installed and general Motivators

- Favorite Game and specific Motivators
- Emotions and their initiators

The evaluation of the survey should increase insight into the motivators based on three methods of eliciting information:

1. Installed games indicate interests indirectly through framework,
2. Explicit motivation to play a favorite game, and
3. Indirect indicators of motivators that create favorite emotion as reason for playing.

These three insights allow us to understand how games can be designed with academic content.

3.2 Demographics of Participants

The survey, using Google forms, was announced via facebook games website and through university networks as well as employers. The result is a healthy mix of people from industry and university, as well as a good spread across age groups and gender. Figure 1 depicts an overview of the population that answered the survey. In total 893 people responded to the survey within two weeks of posting it. Table 1 gives the number of people who took the survey and fall into each of the four categories of interest to us.

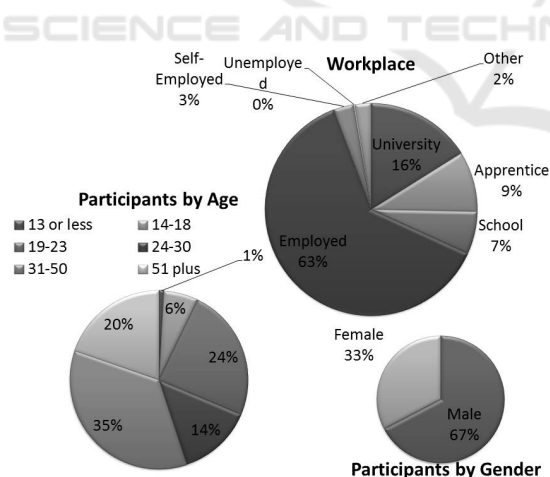


Figure 1: Survey Demographics.

Table 1: Participant numbers by Male/Female and Age bracket (< 23 vs. > 31).

Subgroups	< 23	> 31
Male	173	347
Female	107	145

Table 2: Significance in differences between subgroups by % of chance that the two queried groups will differ in their response. (YM, YF, OM, OF = Younger/Older Male/Female).

	Goals	Rewards	Competition	Friends	Emotions
YF vs. OF	0,47	0,32	0,19	0,50	0,28
YM vs. OM	0,99	0,73	0,61	0,75	0,99
YF vs. YM	0,84	0,37	0,99	0,84	0,96
OF vs. OM	0,02	0,08	0,89	0,74	0,22

3.3 Results of Motivators in Favorite Game

Specific questions regarding motivators were asked with the favorite game in mind. In particular distinguishing features of games were queried: Goals, Rewards, Competition, Friends, and Emotions. These points are compared across the four above defined demographic groups. With the likert scale from 1-6 (1=not at all and 6=very much), groups 1-3 and groups 5-6 are joined. The values in Table 2 represent the chance¹ that the resulting two queried subgroups respond differently to each motivator.

It shows that competition is of different importance for male than female, regardless of age. Goals and Emotions have different importance for younger vs. older males, Emotions differing also between male and female when young. Regarding Goals and Rewards male and female have assimilated with age.

Figures 2 and 3 show the difference between the % of females minus % of males who selected a particular rating for a category. (Similar graphics can be seen for the other two comparisons in Figures 5 and 4.) A higher positive bar shows preference by female or older demographic when compared to male or younger demographic. When there is a large change from "very little" on the likert scale to "very strong" then it can be seen that there is a large difference between the two groups. For example, older males pay little attention to emotion, while younger males feel very strongly about this motivator. Younger females differ most strongly in competition when compared to young male. Changes from young to older females are not so pronounced. Changes between older male and females are also less pronounced, except for the competition factor.

In order to understand more closely, which emotions are important in playing and how these are cre-

¹This calculation is based on N-1 Chi-Square test as recommended by (Campbell, 2007), using the 2-tailed p-value.

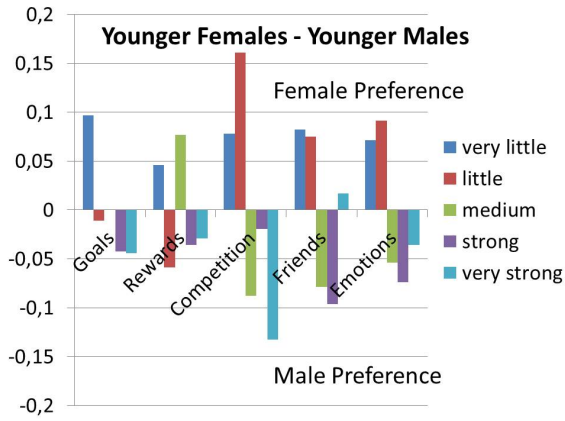


Figure 2: Difference between younger males and females.

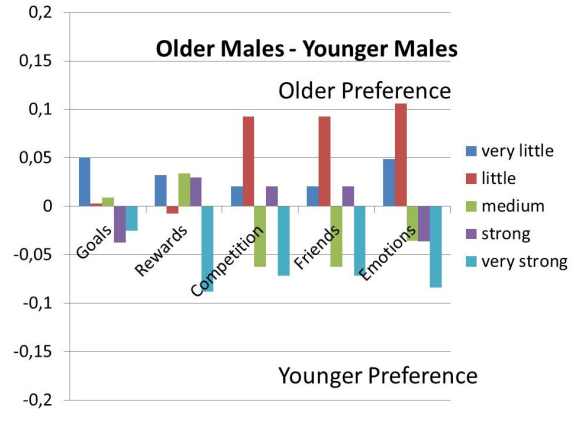


Figure 4: Difference between older and younger males.

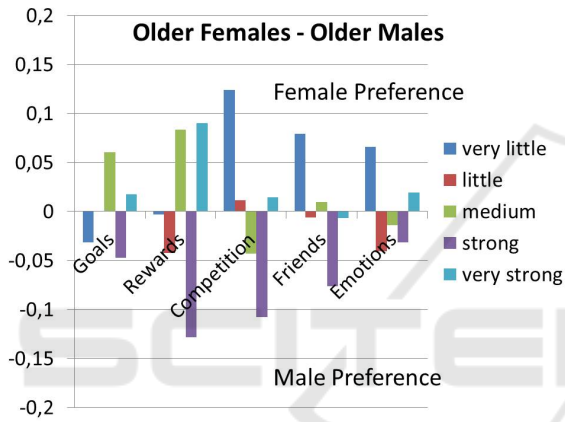


Figure 3: Difference between older males and females.

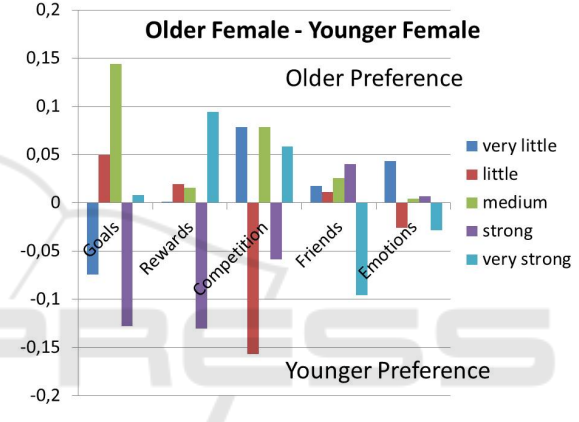


Figure 5: Difference between older and younger females.

ated, one question relates to this regarding the specific favorite game. Namely, which emotion is produced by the game and how this emotion is established. An interesting commonality is found here. Either gender and age group plays for fun and enjoyment. And each group has mostly minor differences in opinion on how this fun factor is established. Namely excellent graphics, the ability to improve oneself and the increasing difficulty. The astonishingly similar distribution is shown in Figure 6. These results corroborates findings from game design and Psychology (for example, (Koster, 2014; Bianco et al., 2003)).

3.4 Results of Motivators in General

Based on the installed games on people's devices, a profile can be established that compares a tendency of games and their features that are preferred by gender or age group. (More analysis can of course be done on various other parameters.) Equation 1 defines how the representative number for each group and each feature (see appendix) was calculated. The cross product between the number of people within the subgroup

who have installed a particular game on their computer with the feature vector across these same games is normalized as given in Equation 1. This value represents a preference for a given motivator within the selected group of respondents to the survey.

$$Value_{(Subgroup \wedge Feature)} = \frac{\sum_i^{games} (X_i Y_i)}{\sum_i^{games} X_i \sum_i^{games} Y_i}, \quad (1)$$

where X is the vector of persons in a particular subgroup who have this game installed given the subgroup and Y is the analysis vector for a particular game feature across all games. This Vector has a 1 if the feature exists and a 0 if the feature does not exist. (The feature vectors are referenced in Appendix A1)

The resulting values can then be compared across subgroups as shown in Figures 7 and 8. Looking at these, we can determine the following trends (among others):

- Differences between females and males get more pronounced as they get older.
- Males like faces, humor and fun death.

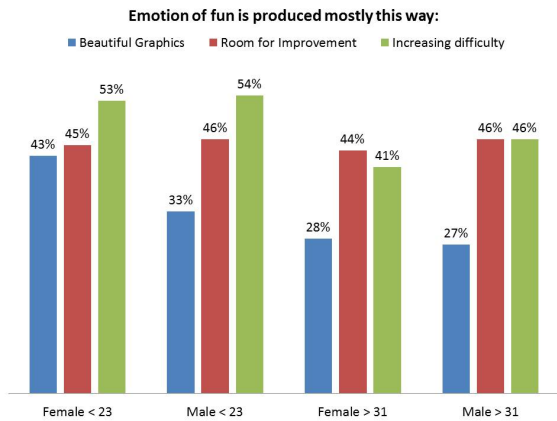


Figure 6: Commonalities on most important emotion and how this emotion is created.

- Older people need more goals.
- Females like a come-back incentive.
- Females tend to be more interested in levels than males. This is less pronounced in younger ages.
- Some differences between gender are more pronounced in the older demographic.
- Figure 9 shows items that are most sensitive to gender specific demographics. Among these are also levels, rewards and competition that will be discussed in more detail later.

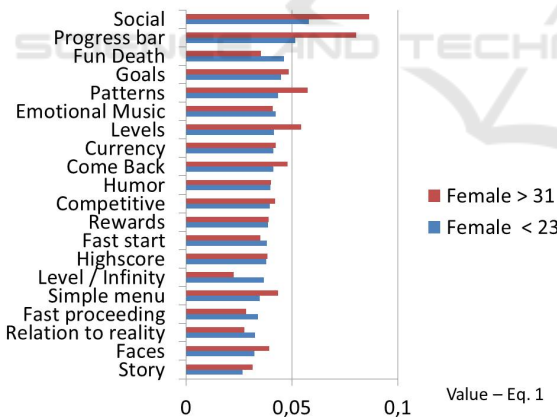


Figure 7: Values (Equation 1) for female demographics sorted by younger females (implicit feature preference).

Based on the features preferences across the games we can establish that there are indeed differences when looking across all the various features that games have. While this information shows implicitly which features are preferred through the games that are installed, it is not guaranteed that all installed games become favorites. So, they do not necessarily represent a true picture of favorite games choices. However, they may serve as an indicator given the

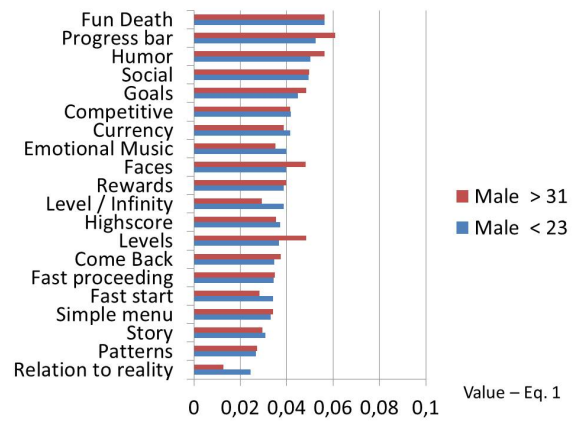


Figure 8: Values (Equation 1) for male demographics, sorted by younger males. (implicit feature preference).

Differences in Preference by Age

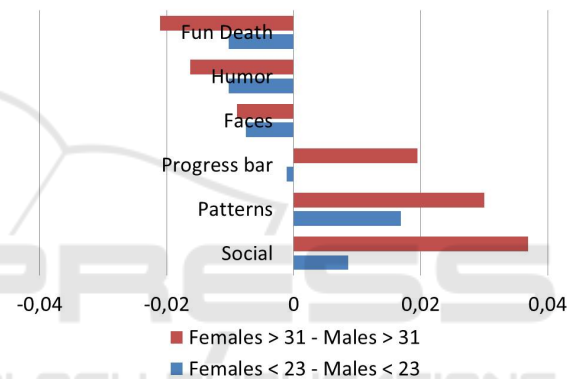


Figure 9: Selected motivators showing differences in gender for younger and older demographic groups. The younger demographic tends to have less pronounced differences.

large set of data. The next step is to compare features specific to the favorite game.

3.5 Results of Direct Questions about General Motivators

Questions, looking more specifically and detailed at the motivators of Levels, Rewards and Competition, were asked. While they seem to be favored in different ways by demographic groups, a more detailed examination shows commonalities.

Figure 10 depicts the relative importance of levels in games for both males and females in general and in their favorite game. All demographics, whether in general or for their favorite game, favor levels.

Figure 11 depicts preferences for several different types of competitions that can be used in games. It shows that certain types of competition are more interesting than others. While there are gender differences, there is some agreement across demograph-

ics that competition with self is more preferred than global competition.

Figure 12 shows that there are different types of rewards. In general rewards may not be important to players. However, looking in more detail at different types of rewards, there are differences. If the reward pertains to gaining more power or skills in the game, they are of interest to a larger number of people than simple rewards that do not enable the player. This finding holds true across all demographics.

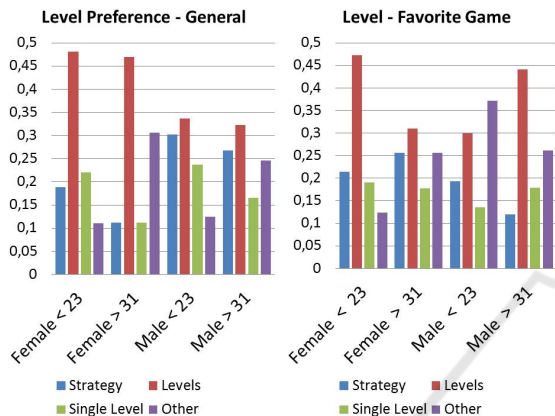


Figure 10: How important are levels?

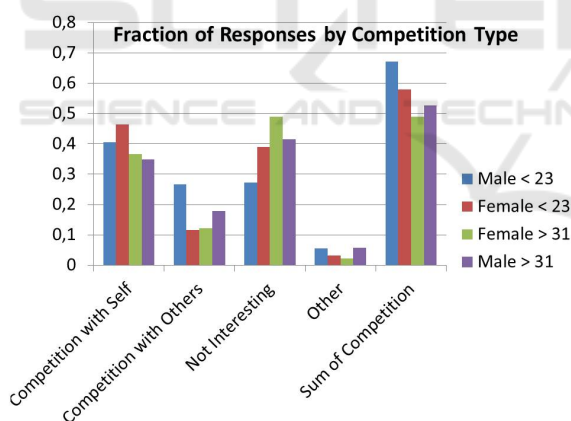


Figure 11: Which types of Competition are Preferred?

3.6 Summary and Conclusion of Survey Results

Looking at implicit and explicit preferences in motivators, we have shown differences in demographic subgroups. But more importantly, we have gained insights into commonalities that are necessary to design a game for the general public, regarding motivators for academic content learning. The survey shows how levels, competition and rewards have to be carefully used within a good design. With the gained

General - Importance of Rewards (by Type)

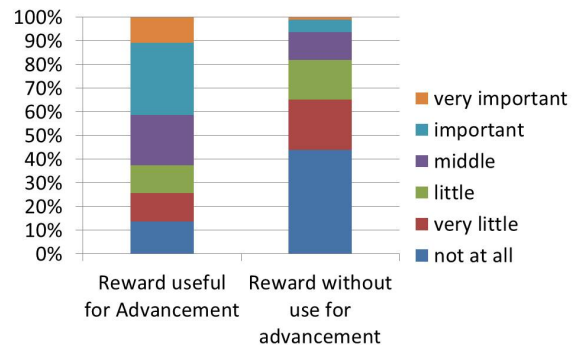


Figure 12: How important are Rewards?

knowledge, we can define anti-patterns, how not to use a game in the classroom or how to design a game with academic content. Similarly, we can define good practice on how to present content to users. With these patterns, we analyze existing games and create new designs. People enjoy playing for fun. This fun is created with three major points regardless of demographic: Learning is fun if it increases without boundaries in difficulty. As long as the graphics are good. The survey has re-confirmed that educational content is even a necessity for a fun game.

4 GAME DESIGN: ANTI-PATTERN

Game design can be done badly and it is of interest to define an anti-pattern, a pattern for bad design (when designed for the general crowd) and is deducible from the survey results.

4.1 Anti-Pattern

- Single Level (fits fewer demographics)
- Bad Graphics (Crowded, low quality (unless funny), unrelated to content): For example, too many icons, graphic elements and texts.
- No rewards or unrelated rewards (that do not contribute directly to increased skill)
- Little self-awareness of skill increase
- Too complex on-boarding or advancement
- Long units of play necessary
- No view of own high-score to compete with
- No replay of level - ie. no chance to improve
- Too much material at the same time (unleveled)

- Path to restrictive (no choices)

Levels can be designed badly as follows:

- Few levels
- Too many repetitions, no new elements
- No individual speed
- Competition with others
- No improvement in finished levels possible

4.2 Analysis of Generic Educational System

Analyzing the generic learning environments, that still pervade most of the education system, in terms of this anti-pattern one can see some design issues from the point of view of enjoying learning in schools or universities today. While schools have levels (first grade, second grade, ...), there is no individual speed. In fact, there often is competition with others and after a level is finished, no improvement is possible. A bad grade not only can not be improved, but can permanently hold students back in future levels.

While grades can be seen as rewards (for those who do well), they do not represent new tools for solving more complex problem sets. They may not even reflect skills accurately by themselves (Schuler et al., 1990; Trapmann et al., 2007b; Trapmann et al., 2007a). Students tend to have little knowledge of their own skills since there is no progress bar during the course of one class (with respect to skills - there are progress bars in terms of time and exam dates). The learning path is also very restricted with few electives and no control over the speed at which the content will be mastered.

Furthermore, the on-boarding process and further progression is not always easy, "I have no time to learn, I need to prepare for the exam next week" - is a typical anti-pattern in the game of learning.

Finally, the units of the game are often quite long, if we can measure them by time between exams. In school, there are weeks, at University there can be whole semesters between exams and level-unlocks. The number of levels with respect to the content are additionally too few. So learning, in our society has not yet matched the pattern of good game design for the general population. It remains to be proven quantitatively whether good game design in education improves the skills outcome.

5 GAME DESIGN: RECIPE

Based on the findings of the survey of 2016 on how games are played explicitly as well as implicitly, one can establish a checklist of important design elements when building a game around academic content for the general public, that is, they hold mostly true across demographics.

In general, the following points are absolutely essential and can not be bypassed:

- Graphics (Consistent and Simple)
- Rewards (Must relate to capabilities)
- Increasing Difficulty
- Increased Knowledge
- Easy to start and stop playing
- Competition with Self
- Leave out everything else

Design steps should include the usage of levels in the following way:

- Many Levels (Consistent and Simple)
- Frequent new elements
- Levels can be infinite (level-based improvements)
- Don't use single level

5.1 Analysis: Phontasia

Phontasia is a game that has educational content and is on the market (Berkling and Pflaumer, 2014; Berkling et al., 2015). It has been successfully deployed in schools and has demonstrated an increase in skill level for the academic content presented within the game. The content of the game relates to phonics for German orthography and allows children to proceed from simple patterns to more complex patterns in the same way phonics does that for English. The game is set up as a magician's lab where the player mixes potions of letters into words. The potions become increasingly complex. Observation of game use has shown that it is highly addictive in addition to improving the skills. In fact, becoming expert at the skill is the central learning goal that children are pursuing because the skill is gained and the new level of difficulty is the reward, as new potitions become available.

- Graphics (Consistent and Simple)

Graphics are beautiful and supported with sounds that match the underlying theme and the task.
- Rewards (Must relate to capabilities)

There are negative rewards, a heart can be lost three times to catapult players back to the start

(similar to the game of Ludo). The reward is indirect in that correctness of the work results in the ability to reach the next level. The next level has a larger number of potions that come with increase in power to work with, resulting in new patterns to discover.

- **Increasing Difficulty**
Each level offers new opportunities to explore and with that new difficulties and new potions to mix in. Letters in new positions are rewards and gifts that give new power. With this power comes difficulty of words to be spelled.
- **Increased Knowledge**
The students learn to spell words that they had been previously denied because the necessary potions were not yet acquired.
- **Easy to start and stop playing**
It is easy to start and stop playing at any time. Stopping in the middle of the most successful streak is even a good idea because kids cannot wait to come back and play again to prove, they can reach the next level.
- **Competition with Self**
There is intense competition with self in order to reach the next level, without losing a heart, faster than last time, improving automaticity and proficiency in the player (learner).
- **Leave out everything else**
Nothing else happens in this game except word spelling and the sounds of the magic mix.

Design steps should include the usage of levels in the following way:

- **Many Levels (Consistent and Simple)**
There are 12 levels, a lot to a second grader. Each level adds only one small additional potion.
- **Frequent new elements**
Each level offers new elements and challenges. They look and feel like rewards because the kids can finally spell new words that they had been waiting for and prevented previously (Mostly due to orthographic misconceptions by the player that are now being learned correctly).
- **Levels can be infinite (level-based improvements)**
Each level can be played again. In fact, many children go back to replay the lower levels because they enjoy feeling comfortable with already mastered skills.

5.2 Design: Drum Stix

Drum Stix is a game designed to teach rhythm. It has gone through three iterations of design, successively using more of the information gained from the survey and its analysis.

5.2.1 First Design

The original game design consisted of a single-level game containing small mini-games that were triggered when certain levels were reached in the game.

5.2.2 Revision

According to the survey, levels are important to a larger demographic. The new design contains a strategy game (build up a village) as basis with levels in form of missions (or goals) to be achieved to level up. There are still mini-games as in the original design but the levels are now more visible to the student. There is a dependency between missions and rewards of currency type (this currency can be used to buy material for the village). A well-built village improves the depth of the missions until the game becomes increasingly complex. This elaborate reward system bypasses the original content of rhythm learning. The survey strongly indicated little interest in such rewards that are not content or learning progress related.

5.2.3 Final Version

The game should have easy on-boarding and progression with constant improvement. Therefore, the complex original design was rejected for a simplified level design. Maximally simple and dedicated only to the content in question, the app is opened and a play button leads directly to the drums, which are the center of learning. In the first level, 2 drums are visible: 'Kick' and 'Snare'.

Each level consists of one task. A song is played in the background. Each drum is marked with a color and number. The progress-bar (for the song) indicates which drum should be played (Karaoke style). Missing a drum-beat results in a mark-down. Correct performance results in a mark-up of points. As the player repeats this rhythm, the karaoke support is removed. The level ends with the first mistake the user commits. As the levels ends, the user is shown his own current and his highest score. Played levels can be repeated any time, even as new levels open up.

Gamers can individually adjust the drums according to their needs. They can be placed differently or new drums can be purchased with the collected coins.

In buying a new drum, the next level starts. Any open level can be played with the purchased drums. With the increasing number of drums, the game becomes more difficult. More coins can be won and bigger, additional instruments bought. Rhythms are growing faster and more complex. While the first purchase is easy to obtain, further advancement is based on improved skill. There are a large number of levels and care will be taken to create fun graphics.

6 CONCLUSION AND FUTURE WORK

We have aligned current cultural motivators for the general audience with a design recipe and an anti-pattern. Based on the responses of a large number of participants, it was shown that different demographics may differ in certain aspects of game features; there are nonetheless several very important commonalities. Namely, what constitutes fun, that rewards need to make sense to improve learning and that competition is relevant mostly with respect to self. We have shown how the use of levels is constructive for users. By providing a recipe and showing how this is applied during design, a generalizable contribution to the field of study has been provided. An anti-pattern furthers understanding of mistakes to avoid during design. While there are studies providing recipes in gamification (Nicholson, 2015) or blended learning (Naaji et al., 2015), these are not based on large numbers of participants, nor are they focusing on generic vs. specific motivators as a function of demographics. The elaboration of current literature in the field of games in education, the analysis of responses from gamers and the ensuing detailed analysis of game design and its generalization has led the authors once more to believe that game design is necessary to put the enjoyment back into learning while improving learner skills. Regarding future work, there are at least two areas of work. Given the learning from the survey, a new design of the survey and re-run would be important. In order to show the relevance of game design in academic content, there must be more focus on measuring learning impact. There are too few studies according to the literature (Boyle et al., 2016), for example (Novak et al., 2016). Even if there are smaller studies, these are often not general enough because they are generated in a specific environment without quantitatively motivated framework nor performed on a large number of participants. More research effort is needed regarding generalizability and outcomes assessment.

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APPENDIX

A1. Games

The list of games that are chosen for the study is as follows: Figure 13 shows the distribution of games as they are installed on devices.

FIFA, Pineapple Pen, Block! Hexa Puzzle, Piano Tiles 2, Rolling Sky, Subway Surfers, Clash of Clans, Flippy Bottle Extreme, Color Switch, Roll the Ball, Temple Run, Pou, Hill Climbing Racing, Candy Crush, Angry Birds, Fruit Ninja, Geometry Dash, Cut the rope, 2048, Doodle Jump, Plants vs. Zombies, Jetpack Joyride, Stack, Dumb ways to die, Flappy Bird, Minesweeper, Tetris

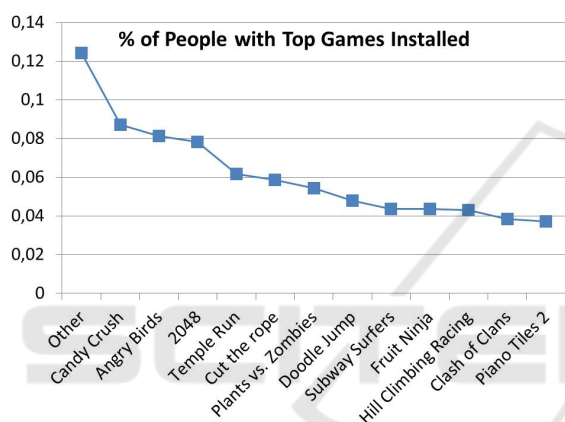


Figure 13: Popularity of Games.

Figure 13 depicts the distribution of users that selected this game as installed on their mobile device. The games are analyzed by their features as discussed in Section 2. The Table of features by game can be found on the github project page ².

A2. Survey

The links to the survey and the analysis page are online ³.

6.1 Gameplay on Smartphones

6.1.1 Demographics

- Age (<13;14-18;19-23;24-30;31-50;>51)
- Gender
- Job/University/School form

²<https://github.com/heikofa/StudienarbeitWebanalyse>

³<https://goo.gl/forms/qoLenhj9mhzeHoMR2>

<http://www.heiko-faller.de/studienarbeit>

- Type of University (list)

6.1.2 Playhabits

- (mark one) How many times do you play (several times a day, daily, several times a week, once a week, rarely, never)
- (mark one) How long do you play (minutes, ; 30 minutes, longer)
- (check all) Where do you play? (home, commute, at work/school)

6.1.3 Questions Regarding General Games

- (check all) What type of game do you like? (strategy, level, single-level, other)
- (check all) Which competition motivates you? (competition with self, with others, does not motivate, other)
- (mark one) How strongly are you motivated by these types of rewards (not at all, very little, little, medium, strongly, very strongly):
 - Reward for daily play
 - Rewards that are useful in the game
 - Rewards that embellish
 - Other

6.1.4 Which Games do You Have Installed?

- (check all) see list of games above
- other

6.1.5 Favorite Game

- Which one
- (mark one) What level modus (single level, multiple level, strategy, other)
- (mark one) How strongly are you motivated by these types of rewards (doesnt exist, very little, little, medium, strongly, very strongly)
 - goals
 - rewards
 - competition
 - friends
 - emotions
- (check all) Which emotions do you have during this game? (Fun, fear, stress, tension, nervousness, frustration, other)
- (check all) Which motivators create this emotion? (graphics, sound, humor, fatal death, open end to improvement, competition, rewards, increasing difficulty, clear path, other)