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Principles for Engineering Social Interaction in Asynchronous Mobile Games: Featuring Idle-ability

ABSTRACT

Since their first appearance, mobile devices have had exponential technological growth and have gained other functionalities besides standard calls and messaging services. With the advent of smartphones, the mobile gaming market has grown enormously to become one of the most widespread forms of gaming. This paper devises guidelines for engineering online multiplayer asynchronous mobile games. The findings emerge from the launch of a new game where, alternately, players try to guess the answers given by other players to a given set of questions. Departing from the meaning of usability in ISO 9241-11, we define Idle-ability as the capacity of a product to realize operational and satisfaction goals in a specified context of sociotechnical idleness. Moreover, design principles are proposed to improve Idle-ability in the selected genre of mobile games. Asynchronous games are traditionally integrated into social platforms and online communities. Our work offers recommendations for its separate deployment in the market, exploring the potential of invisible social bonds among its players.

Keywords: Mobile game, Asynchronous gameplay, Game design, Engineering interaction, Social interaction, Idleness, Idle-ability.

INTRODUCTION

Mobile games are having tremendous growth in the game market. Among its multiple possible forms, asynchronous games (Bogost, 2004; Saarenpää et al., 2009), evolve in a sequence of interactions similar to traditional board games (e.g., chess). Mobile technologies allow interactions to occur remotely, producing an invisible tie between the players (Bogost, 2004), that can "*leave the game running in the background while doing something else*" (Saarenpää et al., 2009). There are interesting examples in the social network market (Baabdullah, 2020; Shin & Shin, 2011) where asynchronous social games like Farmville allow personal entertainment. As we explore in this paper, there are other cases where interaction with other users is the main goal, raising new challenges to keep the players interested and willing to pay for the game experience.

The study of social interaction in mobile games is a growing area of research. For example, articles evaluating end-users awareness for "*collaboration and understanding each other in order to avoid the risk of dissenting which is crucial in social games*" (Baabdullah, 2020). Other authors found positive results in the learning outcomes of asynchronous games, exploring the

continuous online and offline tasks (Fan et al., 2017), and exploring the emerging pervasiveness of this genre of mobile games (Valente et al., 2017). However, these essential studies address the runtime phases of adoption and use, lacking studies focusing on the design-time of social interaction in asynchronous mobile games.

Our work extends past contributions on guidelines for game design (e.g., for older adults as presented by Kawamoto, Martins and Da Silva (2014) or wireless application protocol games introduced by Shchiglik, Barnes, Scornavacca and Tate (2004)) focusing the aspects of commercial mobile games with an asynchronous mechanics. Intermittent idleness is another characteristic of asynchronous games that we address in this paper. Therefore, there are opportunities for more intelligent (Sun et al., 2020) and collective interaction during the game and also outside of the game, including the interface, reflection after a move, discussion before a move, or about the game and related topics (Stenros et al., 2009).

This research has started with a game producer introducing their second asynchronous mobile game in the market. The company planned to create a commercial game that explores telepathy as the central concept, where players must match their answer to a common question. Game producers make significant investments in mobile game development, but the return is uncertain, particularly when a social network is not the main target of the game. Playfulness, price, and user reward are essential to capture the interest of paying players (Hsiao & Chen, 2016), but what are the leading engineering principles that promote social interaction in asynchronous mobile games? This is the central question addressed in this work.

The rest of the paper is structured as follows. The following section presents background concepts about the mobile game market and the particularities of asynchronous mobile games. Next, the design science research approach is presented, aiming to propose engineering guidelines for commercial asynchronous mobile games. Afterwards, it is included a comparison of different asynchronous mobile games to extract their key features. Subsequently, the design and development are detailed in a tutorial style that includes the technical infrastructure and design rationale. The discussion follows, highlighting the key lessons learned and design principles. The paper closes by summarizing the conclusions, the study limitations, and the opportunities for future work.

BACKGROUND

Mobile Games and Asynchronous Gameplay

Since the appearance of smartphones and their respective system (e.g., Android, IOS, and Windows), anyone that owns such a device can easily download apps from a vast collection available in their specific app market. For example, Android and IOS - that own nearly 99 % of the Mobile Operating System Market Share Worldwide - have an app market available for multiple purposes, including games. A significant part of these games is free, and typically, revenues come from the advertisement or in-game purchases. This has opened a whole new market opportunity for games, and as phones become even more innovative and more powerful, so do mobile games. As a result, the mobile gaming market is growing enormously and has been

the largest segment of gaming since 2017 (Wijman, 2019), reaching more corners than any PC, console, or handheld has ever gone before. In 2019 mobile games are reported to own 45% of the global games market, generating 68.5 billion dollars, and by 2022 it is predicted to reach 95.4 billion dollars, 49 % of the international games market (Wijman, 2019).

Mobile game research now addresses emergent topics like player loyalty and purchase intention (Cheung et al., 2021), or user awareness (Baabdullah, 2020). Synchrony is also a determinant characteristic of this type of product, and recent research is exploring the potential of asynchronous mobile games for multiple purposes. For example, collecting and labeling data for the growing needs of machine learning, taking "*advantage of small units of available time to contribute and have fun*" (Bragg et al., 2021). Although synchronous games may offer a more direct sense of connection between players, there are alternatives to promote social interaction of players "*from different time zones, under the format of asynchronous play, as a way to maintain connections during the quarantine*" (Yuan et al., 2021). Nevertheless, despite the important design principles now emerging to improve social interaction in serious games (Fonseca et al., 2021) and the pioneer recommendations for asynchronous game design that include contextual information presented by Korhonen et al. (2008), additional examples and guidelines are necessary to maximize the value of game breaks.

There are different perspectives on asynchronous gameplay. For example, the concept can be seen as the different player experiences occurring in the same game, as Luigi's Ghose Mansion published by Nintendo, or when "*participants cannot know when their collaborators will next contribute to the game*" (Hammer, 2018). Our study adheres to the four characteristics of asynchronous gameplay presented by Bogost (2004): 1) asynchronous play supports multiple players playing in sequence, not in tandem, 2) asynchronous play requires some kind of persistent state which all players affect, and which in turn affects all players, 3) breaks between players are the organizing principle of asynchronous play, and 4) asynchronous play need not be the defining characteristic of a game.

Asynchronous or turn-based gameplay is defined for having its game flow divided into individual phases, in which the game is paused, called turns. Like synchronous play, the number of players can go from two to a lot more, depending on the game. However, in asynchronous mode, players never play at the same time. Instead, they play in turns, one after another (Boudreau & Consalvo, 2016). In some cases, they might even have time limits. Depending on the asynchronous variant used, the game progression may vary but turns typically are used to give players more time to think about their actions and not focus so much on keeping track and controlling several things at once in real-time. This means that asynchronous gameplay allows more flexibility for individual players and demands fewer time synchronies, making it more casual (Bogost, 2004).

Despite the vast potential of asynchronous games and their adoption for learning purposes (Romero et al., 2012; Shamsudin et al., 2019), contributions aiming at commercial solutions are still emerging in the literature. Many publications found about asynchronous gameplay focus on the context of social network platforms. New contributions are necessary for engineering this

genre of products and increasing its viability in the market. Social interaction is vital in a product line that minimizes direct contact periods and aims to improve game adherence over time.

Balancing Interaction and Idle-ability

Time and space do not need to be (and usually are not) shared by the players in asynchronous mobile games. In fact, the "use" of the game artifact alternates between moments of "work" and "break". For example, when accessing the system and making changes to the database, when automatic identification and recognition of human gestures and actions is implemented (Duan et al., 2021; Jiang, Li, et al., 2019; Jiang, Zheng, et al., 2019), or when the players are waiting for the next turn.

The factors leading to mobile game use have already been addressed in usability research. For example, to understand the reasons leading users not to use the game and memorability issues (Sagar & Saha, 2017). The standard approach to usability thinking is how the user interacts with a system (e.g., interface, response time). However, ISO 9241-11 definition of usability, namely, "*the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use*" (ISO, 2018) and user-centered design (Jokela et al., 2003) do not exclude the value of inactive periods.

Idle games are a paradigmatic example of continuous use with minimum interaction (Alharthi et al., 2018). In this case, the game evolves while the user is waiting (e.g., resource accumulation), ranging "*from games that require constant interaction to no interaction at all*" (Alharthi et al., 2018). Game engagement in this type of game is particularly challenging, and the interesting title "*Busy doing nothing? What do players do in idle games?*" (Cutting et al., 2019), can also be applied to humans' idleness (Humphreys, 2018).. Many valuable and important things can continue to happen in both the virtual (Alharthi et al., 2018; Cutting et al., 2019) and the social (Russell, 2004) realms of idleness. Therefore, our project contributes to the body of knowledge of user-centered design guidelines (Moschini, 2006) and the adaptation of idle games characteristics (Spiel et al., 2019) for the case of asynchronous mobile games.

Idle-ability in the context of turn-based, asynchronous game design can be defined as the capacity of a product to "*achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of*" (ISO, 2018)sociotechnical idleness. We argue that both moments of interaction and idle are essential to engineering social interaction in this category of solutions.

RESEARCH APPROACH

The proposal of engineering guidelines follows the design science research (DSR) paradigm (Hevner et al., 2004). Having its foundations in the sciences of the artificial (Simon, 1996), DSR is particularly suited for information technology development, studying artifacts in real situations, and producing innovative design theory (March & Smith, 1995). There are influential guidelines to conduct DSR (Gregor & Hevner, 2013; Hevner et al., 2004; March & Smith, 1995), recognizing the outputs of the research (e.g., methods or instantiations) and the activities of artifact production, namely, build, evaluate, theorize, and justify. Principles of implementation

are important components of design theory (Gregor & Jones, 2007; vom Brocke & Maedche, 2019).

Our year-long project started in September 2019 in cooperation with an IT company that develops mobile games. The case company started their asynchronous product line with a game for guessing songs, and ensued their second release for guessing words that a friend would pick for a specific theme and question. A review of related literature and a comparison of available games preceded the design of their new product. Our contribution is in the form of guidelines, devised according to the principles proposed by Hevner et al. (2004) and evaluated with the strategy of technical risk and efficacy (Venable et al., 2016).

Engineering guidelines are crucial to our case company. First, the success of their products is heavily dependent on the capacity to create social interactions between the players. Second, few guidelines exist to support the team of game designers during the development and testing of the selected genre of mobile games. Our project contributes to both goals and offers an opportunity to contribute to the body of knowledge with (1) a real example of deploying a commercial asynchronous mobile game and (2) the lessons learned in the process that may assist future developments in this area.

The structure of this paper is inspired by the six core dimensions of DSR projects (vom Brocke & Maedche, 2019): *(1) problem description, (2) input knowledge, (3) research process, (4) key concepts, (5) solution description, and (6) output knowledge*. The initial four dimensions of the grid are stated in the previous sections. Subsequently, the market review and the design of the asynchronous game solution are described. The most relevant output knowledge is summarized in the discussion.

MARKET REVIEW: KEY FEATURES OF ASYNCHRONOUS MOBILE GAMES

In this section, different asynchronous mobile games are reviewed. The selection was made according to the connection with the topic of telepathy and/or the possibility of asynchronous gameplay. The list is not exhaustive but allows to extract some standard features to this market niche. The explored mobile games were the following:

App1 - Words with Friends 2. A two-player mobile game developed by Newtoy - a video games development company, for both IOS and Android Operating Systems, released in July 2009. In this game, both players take turns forming words either vertically or horizontally on the board with the letters presented on the screen. Depending on the word and where the player places it, they win a certain number of points.

App2 - Draw Something. A two-player turn-based mobile app developed by OMGPop, launched on February 6, 2012, is available for IOS, Android, and Windows Phone. A player chooses one word out of three displayed words, where the most challenging words to draw give the most coins. Then, they draw the word they chose, whereas they can change the thickness of the pencil and its color to draw it. In the end, they send the drawing for the other player to guess.

App3 - Ruzzle. A mobile game developed by a company named MAG Interactive was firstly published in the Apple Store in March 2012 and then a month later in Android. The game is divided into three rounds. In each round, a player must form the maximum number of words from a 4x4 grid on the screen within two minutes. The winner is the player awarded the higher number of points at the end of the three rounds.

App4 - Lalaoke. A two-player turn-based multiplayer mobile game developed by HYP, which is available for Android and IOS. In this game, a player selects a song out of three, hum the chosen theme and submit what they sang. Afterward, the other player receives a notification and must guess which song was hummed by the other player. Then, roles are inverted.

App5 - Trivia Crack. A mobile game developed by Etermax and released in March 2013, available for Android, iOS, Facebook, and Windows Phone. In this game, a player must answer questions regarding specific categories (Entertainment, Art, Sports, among others). When this player gets a question wrong, then it is the other player's turn to answer questions. The first player to respond correctly to a question from each category wins the game.

Table 1 shows the main features from the previous asynchronous mobile games.

Table 1. Game Features Comparison

Feature \ Game	App1	App2	App3	App4	App5
Game History	✓	✓	✓	✓	✓
Notifications	✓	✓	✓	✓	✓
Daily Challenges	✓	✓	✓	✗	✓
Daily Bonus	✓	✓	✓	✗	✓
Shop	✓	✓	✓	✓	✓
Game Statistics	✓	✓	✓	✓	✓
Facebook	✓	✓	✓	✓	✓
Tutorial	✓	✗	✗	✓	✓

Some of the features that prevail in the studied asynchronous mobile games are identified below.

- Game history. This corresponds to the presence of a list where players can keep track of their games. This feature is essential because players want to see their ongoing games, know their turn to play, and the results.
- Notifications. The identified mobile games that have messages, use them to warn the players when it is their turn to play, about new game features or daily challenges.
- Shop. Players can spend the coins they won playing the game. It is a way of keeping users playing the game so they can buy new features and a way of making them spend real money.

- Facebook. Many of the apps that require a login have Facebook integration. Facebook login allows users to login into the apps without having to lose time in registering first. They can also invite Facebook friends.
- Tutorial. Some mobile games include tutorials that can guide players throughout different aspects of the game.
- Game statistics. All mobile games provided game statistics, such as the current game results or in-between round statistics. This way, players can see how well they are performing against their opponents.
- Daily bonuses and challenges. Essential for players to get back in the game, stay entertained, and possibly win prizes.

The characteristics of asynchronous mobile games and the market comparison served as a base for the design and development presented in the next section.

DESIGN OF A COMMERCIAL ASYNCHRONOUS MOBILE GAME

According to March and Smith (1995) "[b]*uilding is the process of constructing an artifact for a specific purpose".* Therefore, artifact instantiations are important research outputs and usually precede the proposal of guidelines (March & Smith, 1995). While building the artifact in a natural environment, researchers can learn its utility to a specific class of problems (Hevner et al., 2004). In a second phase, evaluation "*requires the development of metrics and the measurement of artifacts according to those metrics*" (March & Smith, 1995) to understand the advances made. This section presents the details of the instantiation, followed by an evaluation.

The system architecture is presented in Figure 1. The architecture is composed of a mobile app and a server, developed in React Native and Ruby on Rails, respectively. The server comprises an Application Programming Interface (API) that uses the Controller and Model components to communicate with the mobile game. The MVC (Model – View – Controller) is a popular architectural pattern for web and mobile software development that divides the user interface and the information representation in the system (Cui et al., 2017). There is also an administration console (on the bottom-left of Figure 1) that can be accessed through a specific URL.

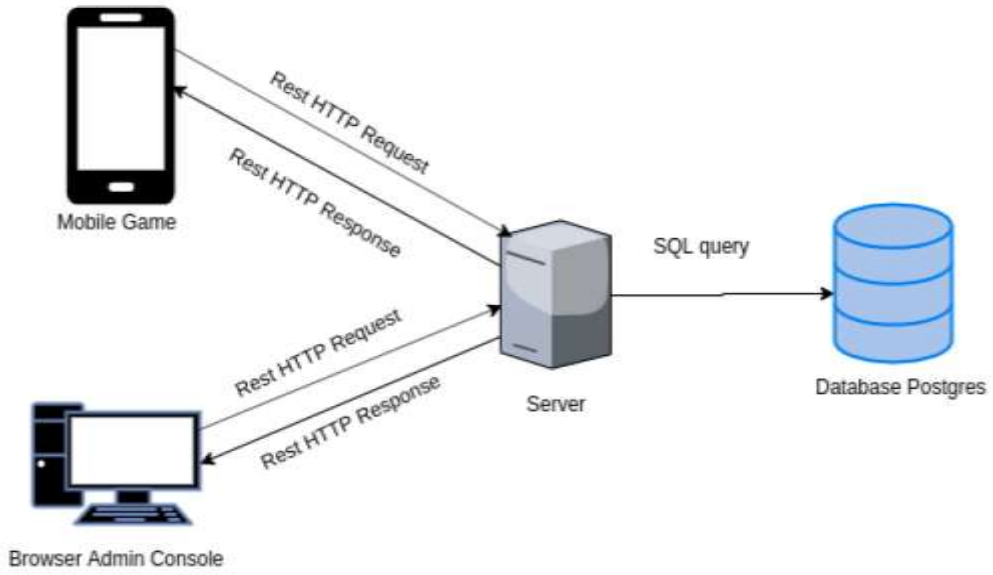

Figure 1: System Architecture (Source: Own)

Visual communication in mobile app development projects is key. For example, detailing the technical elements of the solution, the messages, or the interfaces with external applications (e.g., Facebook). The C4 model (Brown, 2018) is a possible solution to assist the architectural efforts of the team. A containers diagram zooms into the software system, showing the containers (applications, data stores, microservices, etc.) and their respective responsibilities. The containers diagram for the mobile game is presented in Figure 2.

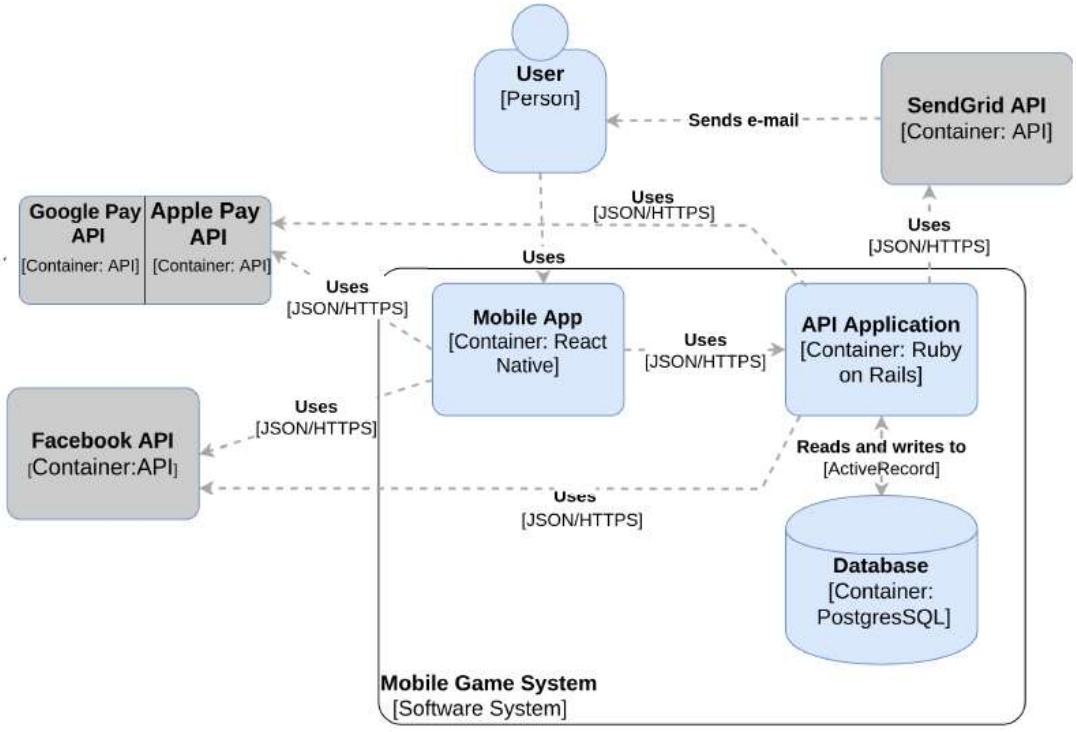

Figure 2: Containers Diagram (Source: Own)

As illustrated in Figure 2, other than the mobile game system already described in Figure 1, composed by the mobile app, the API, and the database, additional software systems are integrated, specifically: (1) SendGrid API to send e-mails in case a user wants to recover their password; (2) Google Pay API and Apple Pay API for payment purposes if a user wants to buy coins in the game; and (3) Facebook API to retrieve users' Facebook information in case they choose to login with Facebook.

Planning navigation between game windows is another important step. The navigation diagram of the mobile application is presented in Figure 3, which shows the application screen flow from the player's perspective. Each element represents a specific screen of the mobile app, and the arrows identify the possible sequences between screens.

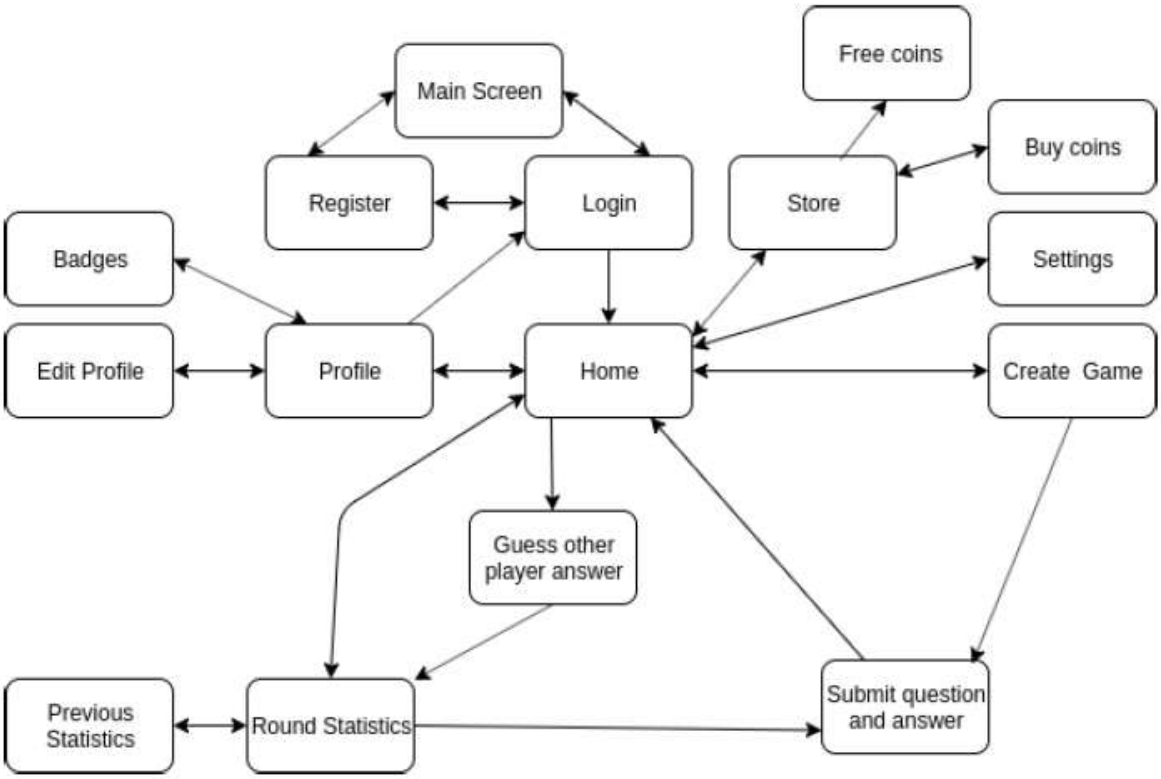

Figure 3: Navigation Diagram (Source: Own)

There are many features on this particular mobile game, such as a shop, where players can buy items to use in game and win free coins by watching an ad; a profile, where players can see their personal information and achievements, among others.

Figures 4 and 5 illustrate some of the core functionalities of this mobile game which are creating a new game and answering the questions.

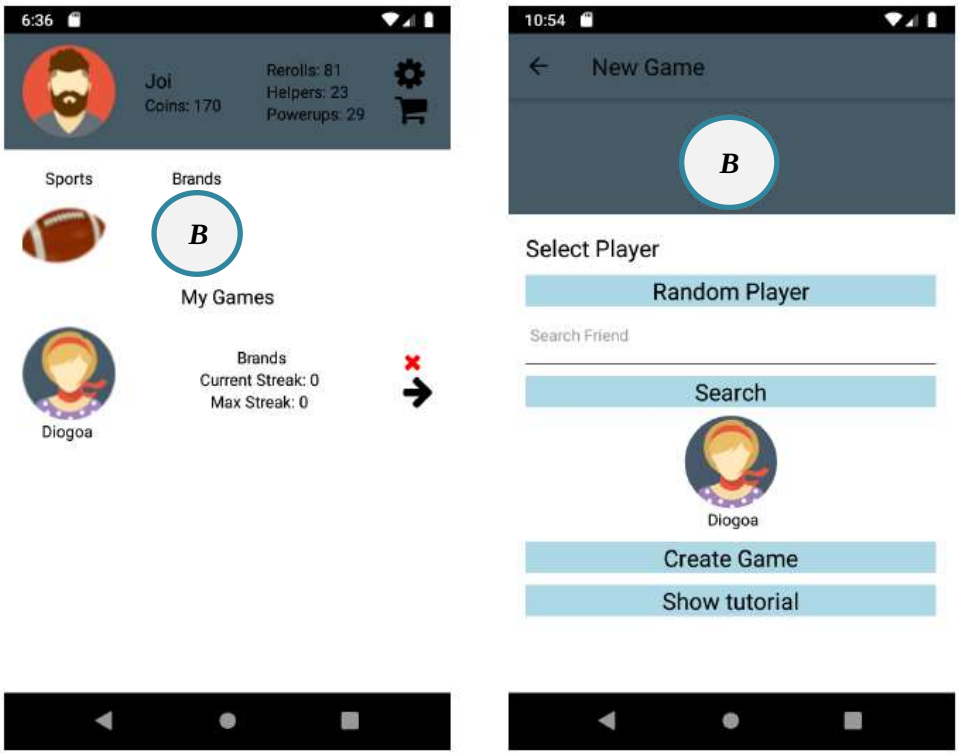

Figure 4: Home Screen (left) and Create Game (right) Layout (Source: Own)

On the Home screen, a user can select a game type (for example, "Brands" or "Sports") to play with another user. Afterward, they navigate to a new screen where they can choose to play either with a random player or search for a specific one. Subsequently, they can create the new game and navigate the "Answer Question" screen (Figure 5).

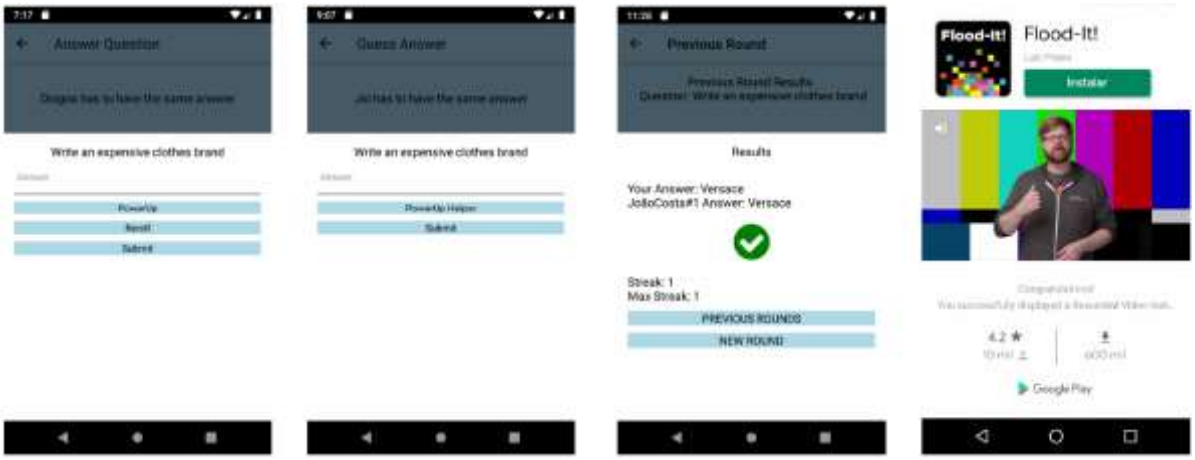

Figure 5: Submit Question, Guess Answer Layouts, Last Round Statistics and Free Coins Layouts (Source: Own; Online content in the rightmost image to test coin reward)

In this screen (leftmost image in Figure 5), a player must answer a random question from the selected game type. Before doing so, they may use a "Reroll", which allows the player to switch the question, or use "Powerup coins" that increases the number of coins earned if the players win the round. After answering the question, a notification is sent to the other player who must answer the same question according to what they think the other player answered (second image counting from the left of Figure 5). Before submitting an answer, the user may use "Helper" to obtain letters included in the word(s) of the other player' response. After clicking "Submit" they navigate to the last round statistics (third image). This screen shows each player's answers, displays if they won that round, and the current and max streak reached within that game type. Accessing the shop allows users to watch an ad to win 20 coins (rightmost image). "Rewarded video ads" were used since the goal is for the user to be rewarded after seeing an ad video.

Evaluation

There are different methods available to test and improve the quality of software products (ISO, 2011). Different testing techniques were used in this project including unit, integration, and end-to-end testing, load testing, and usability testing.

The first stage included unit and integration tests to ensure that all components perform as expected, integration seeks to identify problems in the interactions of different components. The end-to-end tests follow to guarantee that the application flow behaves as expected, simulating real scenarios. After ensuring that the app was as bug-free as possible and compliant to the requirements (functional tests), and load performance, a usability test plan was prepared. Even though the app's design can make it impossible to draw definite conclusions (first version), the team believes that conducting usability testing at this stage of the project can provide useful user feedback, positively contributing to future development stages.

Unit, Integration, and End-to-end Testing

Unit testing was executed during the project development and at the end through the command line of Rails console – used to debug and make experiments with the application. Integration tests were performed using the RSpec tool (Matsinopoulos, 2020) in different actions (endpoints) of the user controllers in the server-side of the project, ensuring that each request receives the correct response. Figure 6 presents an example of this type of test.

```
21  describe "PUT #reward_free_coins" do
22    it "returns a status message" do
23      before_coins = User.first.coins
24      random_coins = rand(1..100)
25      put :reward_free_coins, params: {coins: random_coins}, as: :json
26      json = JSON.parse(response.body)
27      expect(json['success']).to eq(true)
28      expect(json['data']).to eq(before_coins+random_coins)
29      expect(User.first.coins).to eq(before_coins+random_coins)
30    end
31  end
```

Figure 6: Example of RSpec Test (on the top) and Results (on the bottom) (Source: Own)

Figure 6 tests the scenario of advertising visualization ("reward_free_coins" endpoint). Line 23 identifies the number of existing coins. Then, a random number of coins is generated to simulate the request on line 25 (offer thar number of coins to the user). Lines 27-29 confirms if the execution occurs as expected: line 27 checks if the response was sent to the user, line 28 confirms the correct number of coins, and line 29 evaluates the correct database update. This is a simple example. However, in more complex cases (e.g., update endpoint – update username, password and avatar) multiple error messages can occur such as “existing username” or “password requires a number”, requiring an analysis of possible paths. Another tool named SimpleCov (Olszowka, 2010) was used to check the percentage of code covered during the tests. An example of the results is presented in Figure 7.

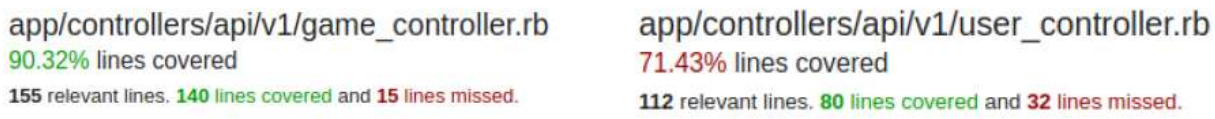

Figure 7: Example of Code coverage for “game controller” (on the left) and “user controller” (on the right) (Source: Own)

All the tests passed successfully in the final version of the game.

Load Testing

Load testing is a type of non-functional testing to understand the behavior of the application under a specific load to determine the system’s behavior under both normal and at peak conditions. It is essential to ensure the normal functioning of the mobile game when handling a high number of requests. In multiplayer games, some users may be idle and others not, requiring testing the solution in different situations. In the final stages of development, the server-side code was deployed to the Amazon Web Services (AWS) cloud to ensure that users could test the app freely as soon as it was released in the app store in testing mode. The tests were performed to one of the API endpoints that requires a higher computation effort (user index), querying the database.

Table 2 presents the test outputs when dealing with a certain number of simultaneous requests (concurrency).

Table 2. Load Testing to Endpoint Test Outputs

Requests	20	80	200	350	400	450
Concurrency	1	4	10	20	25	30
Requests p/s	3.9	11	14.6	15	14.7	14.4
Avg. latency (ms)	255	364	685	1335	1696	2087
Max latency (ms)	271	478	881	2057	2494	3155

The maximum number of requests that the server can serve (third line of Table 2) never overtakes the 15 requests per second. As Table 2 demonstrates, the maximum latency (3 seconds) is reached when the server is dealing with 30 requests simultaneously. For the server to be dealing with 30 concurrent requests at any time, the app would need to have a considerable number of users. Nevertheless, the number of users required to reach this value is unpredictable since users will interact with the app differently (some will use it more often, others less). Therefore, the current AWS cloud characteristics may be enough for the initial app deployment but require request monitoring techniques. For example, ensuring close control of the number of simultaneous requests so that admins get notified when these rises unexpectedly. In a scenario where the server starts receiving nearly 30 concurrent requests, the cloud should be upgraded through vertical scaling (upgrading hardware) and/or by increasing the number of instances.

Usability Testing

The usability test participants were selected considering if they matched the target audience for the mobile game. The target audience considered the people who usually play mobile games between fifteen and thirty years old and were selected from our contacts in academia and past development projects. The tests were performed in an undisturbed environment to ensure that there would be no distractions and that all interactions would only take place between the team and the tester. Each participant was asked to perform nine different tasks.

Table 3 below shows, for each task, the expected number of clicks and the average clicks among all participants.

Table 3. Usability Testing Metrics Expectation

Task	1	2	3	4	5	6	7	8	9
Clicks	6	6	4	2	3	2	3	3	3
Avg. clicks	6.6	6.3	4	3	4	2	4	3	4.3

Task descriptions legend: 1 - Registering; 2 - Edit username and avatar; 3 - Explore a badge; 4 - Buy re-rolls; 5 - Buy 100 coins (incomplete transaction); 6 - Obtain free coins; 7 - Deactivate and activate notifications; 8 - Game creation (random player); 9- Game creation (specific player).

Overall, the participants were able to perform the tasks efficiently and effectively, with some exceptions. Regarding task 9, for example, it became apparent that it would be preferable for the user to navigate to the respective game after clicking the notification since there was some hesitation on the participants' side. The participants understood the game objective, and the majority enjoyed the game thematic. However, all of them shared the understanding that more

work should be put on the user interface look and provided suggestions for improvement that will be important to implement before public release.

DISCUSSION

This section presents a "*summary of what was learned*" (Gregor & Hevner, 2013). Design science research is helpful to extract knowledge from design projects, usually summarized as a set of "*design principles and technological rules*" (vom Brocke & Maedche, 2019). These fundamental principles are presented below, explaining its origin and how it was implemented in the commercial mobile game. It is the result of a joint reflection made by the project participants.

Design Principle 1: ***Create a vision for the entire game lifecycle in stages of use(ability) and idle(ability).*** A strategy is necessary for the phases of pregame engagement, gameplay, and post-game interaction. In the proposed solution, the players want to reinforce the bonds with their friends, assessing how well they know each other and, eventually, strengthen their relationship. The gameplay experience should be intuitive and promote reflection. Both the wrong answer and the correct answer can fit in the purpose of "knowing the other and assessing that knowledge".

Design Principle 2: ***Prepare for the expected problems and define quality attributes for pregame engagement, gameplay, and post-game interaction.*** Asynchronous games have essential quality attributes such as usability, scalability, availability, and security. Not complying with these attributes can jeopardize the mobile game's success. Like in the asynchronous game developed, the usability of the mobile game should be validated through usability testing with possible end-users to identify user interface errors. Surveys about idle moments can be complementarily used.

Design Principle 3: ***Notifications are crucial in asynchronous gameplay but must be carefully planned.*** Distance and alternate attention require notifications as soon as one player finishes their answer. However, misuse of messages can damage the player experience and therefore must be limited. A user must be able to disable notifications.

Design Principle 4: ***Interruptions are part of the game.*** Moreover, it is possible to have IT interruptions. At the same time, humans continue to be involved, or the reverse (idle players while the IT layer performs actions) and thus require balancing sociotechnical idle states. Bonds between players can be maximized with both standard and uncommon interests. Therefore, the contents may promote a deeper reflection. Some answers may be immediate (something simple that the player should know), while others may require additional search.

Design Principle 5: ***A question can stimulate actions during the game interaction or in idle moments.*** One of the most innovative aspects found in the asynchronous gameplay design is the potential to promote activity from the other user. Some questions may demand actions (e.g., "did I like the movie Z"?), extending the interaction from mere reflection to promote interesting idleness moments.

Design Principle 6: ***Explore the creativity of the players in both questions and answers, extending reflection after direct interaction.*** The content will be critical to keep the players involved in the game. Therefore, players may be rewarded by sharing interesting questions (reactive - requiring a mere action or proactive - requiring an experience to understand what the other player would think) - a reflection that is expected to occur out of the game.

Design Principle 7: ***Extract knowledge from the content to produce personalized ads.*** Return on investment is not an option for the proposed asynchronous mobile game. The main advantage of a game that creates new knowledge from the players' interaction is the possibility to tune the ads according to the player profile. Taking advantage of the player's answers and the game content can minimize potential negative impacts of advertising on user experience. Data analytics processing can be done while the game is idle to improve the response time when interactions occur. Therefore, the company should come up with tactics that can take advantage of these aspects. For example, questions about brands can be used to select related ads, which may increase efficacy.

Design Principle 8: ***The user must have control of each interaction round.*** One of the main benefits of asynchronous games is that a player can use different actions during their turn to play, which they probably could not if the game was synchronous. For example, in our project, we provided different types of interaction with the round to the user. A user can use rerolls to change questions, helpers to obtain letters from the other player's answer, and a powerup that can increase the number of coins if both players get the same response.

Design Principle 9: ***Obtaining value from the idleness of the artifact and humans should be a central concern for entertainment designers.*** Particularly, when minimum interaction with the game interface is required. Idle-ability by design must anticipate scenarios (not only the opportunities but also threats, for example, security, privacy, and addiction) when interactions are not occurring between humans and machines, integrating this concept in the portfolio of tools and tests for user-centered design (Abras et al., 2004).

CONCLUSION

This paper presented engineering guidelines for commercial asynchronous mobile games. Our work has followed the design science research paradigm (March & Smith, 1995; vom Brocke & Maedche, 2019) in cooperation with a mobile game producer. A significant number of papers have addressed mobile game design and a few, the particularities of asynchronous or idle social games. However, we could not find engineering guidelines for asynchronous mobile games with a commercial purpose. Our work fills this gap and presents details of the engineering process that explored the value of interaction and idleness.

There are several limitations that must be stated. First, although we gathered interesting feedback from the testing phase, the game is not yet released in the market. Therefore, we cannot measure the direct benefits (e.g., ROI) in the proposed guidelines or the game's social impact. Second, the game focused on the concept of telepathy, where distance and reflection are a core concern of the players. Other types of games may reveal additional guidelines. Third, we could not test the

efficacy of advertisement based on the user-generated content, which is crucial for commercial purposes of this type of product. Finally, despite unfolding an inspiring concept of idle-ability, adopting it for requirements analysis and extracting design guidelines, our DSR evaluation used traditional user-centered design techniques. Additional work is necessary to understand the role of idle-ability at this phase. For example, selecting a specific sample of users to follow in a longitudinal study.

The following steps will be the market release and market evaluation. However, the development of asynchronous mobile games opens opportunities for future research in branded apps and a possible game variant for this segment. The proposed system may be interesting to increase the bounds of multiple players around specific brands, rewarding the most interested customers and obtaining valuable information from the content generated by their interactions. It will also be interesting to study the value of game idleness at social and technical levels. For example, proposing questionnaires or maturity models to evaluate idle-ability of different types of IT systems and promote studies that increase the value of IT in intermittent states of interaction and idleness.

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