

MASARYK UNIVERSITY
FACULTY OF INFORMATICS



Quality Assurance in Game Development

Master's Thesis

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Declaration

I declare that I have worked on this thesis independently using only the sources listed in the bibliography. All resources, sources, and literature, which I used in preparing or I drew on them, I quote in the thesis properly with stating the full reference to the source.

Matej Komár

Supervisor: Mgr. Jiří Chmelík, Ph.D.

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Resume

The aim of this work is to study and describe Quality Assurance. Mostly specified in the game industry and introduce methods used in this process. Afterwards use the knowledge of these method to analyse chosen games with additional personal testing. Describe stages of analysis and present the found results.

Key words

Quality Assurance, Game Development, game evaluation, testing, bug

Content

1 Introduction	3
2 Quality Assurance	5
2.1. Software Quality Assurance	5
3 Quality Assurance in Game development.....	7
3.1 Game development process.....	7
3.2 Bug and Issues categorization	9
3.3 Testing.....	11
3.3.1 External Quality Assurance	12
3.3.2 Internal Quality Assurance	12
3.3.3 QA Tester	14
3.4 Skill Requirements for QA.....	16
3.4.1 Communication	16
3.4.2 Understanding of game mechanics	16
4 Evaluation techniques and principles	19
4.1 Evaluation by Heuristics	19
4.1.1 Playability Heuristics	19
4.1.2 Heuristics Evaluation process	21
4.2.1 PLEX framework	21
4.2.2 PLEX framework Evaluation process	23
4.3.1 User Testing	24
4.3.1 Selected User Testing process	25
5 Game Analysis	26
5.1 SurvivAnt	26
5.1.1 Heuristics Evaluation.....	26
5.1.2 PLEX	27
5.1.3 User Testing.....	28
5.2 Blind Man's Buff.....	29
5.2.1 Heuristics Evaluation.....	29
5.2.2 PLEX	30

5.2.3 User Testing.....	30
5.3 SwordMaster.....	31
5.3.1 Heuristics Evaluation.....	31
5.3.2 PLEX.....	32
5.3.3 User Testing.....	33
6 Conclusion	35
Literature	37
Appendix	40
Glossary	45

1 Introduction

Field of computer science has been evolving remarkable since the first computer has been build. In the present there are countless companies in software development industry. Creating a software is not an easy way. However making sure that final product is working according to the requirements of the consumer and respect all constraints is even more challanging. Control of quality also known as Quality Assurance has been introduced exactly for this purpose

In my master's thesis I am describing what Quality Assurance is in general in Chapter 2. Afterwards in Chapter 3 I narrow it into Quality Assurance in Game Development including stages of Game Development itself. Followed by explanation of possible issues related to the game development and video games, what are the different approaches in testing as well as description of work, QA tester as a role need to do. Furthermore in Chapter 4 I am introducing three different techniques (principles) of Game Analysis including Playability Heuristics, PLEX framework and User Testing. Practical part of my work covered in Chapter 5 is analysis and evaluation of three student games of different genre and platform using the introduced evaluation techniques as well as my personal gameplay testing. Analysis includes found issues and bugs as well as what are the good (positive) aspects of each game. In Chapter 6 I suggest improvements on game mechanics, design and other aspects based on the found results.

This master's work is based on my experiences and knowledge I have got during studying at the University of Tampere as part of my Erasmus+ study program. I have had many courses from Game Studies, including Game Development process and also Quality Assurance in Software Engineering. Further I was working in the game studio Reborn (former Fragment Production) for almost three months internship Tester and afterwards Internal Quality Assurance Tester for additional five months. During this period I got more familiar with the development process of video game. What kind of issues can be found and how to reproduce them, which is the most crucial part of the and later even fixing several data or design related issues. I realized that processs of Quality Assurance is not easy to understand for everyone and some parts sounds way easier than they actually are. It's not just simply

playing and enjoying game for the whole day as many people think that's the main point.

2 Quality Assurance

The definition of Quality Assurance taken from [12]:

“Often used interchangeably with quality control (QC), it is a wider concept that covers all policies and systematic activities implemented within a quality system. QA frameworks include:

- (1) determination of adequate technical requirement of inputs and outputs,*
- (2) certification and rating of suppliers,*
- (3) testing of procured material for its conformance to established quality, performance, safety, and reliability standards,*
- (4) proper receipt, storage, and issue of material,*
- (5) audit of the process quality,*
- (6) evaluation of the process to establish required corrective response, and*
- (7) audit of the final output for conformance to (a) technical (b) reliability, (c) maintainability, and (d) performance requirements.”*

Definition of Quality Assurance is very obscure as it covers all fields of interest where we could call process of control as a part of whole Quality Assurance process. Further we will focus only in Software Quality Assurance (SQA) and in next chapter even more specifically to Quality Assurance in Game Development in more detail.

2.1. Software Quality Assurance

In software development where result is a final product or service, Quality Assurance is any standardized process of control which makes certain that product or service that is in development is satisfying all specified requirements. Companies start to use SQA as separate unit in company or as part of the development departure to increase the possibilities to find all defects. Nowadays SQA is more important than in past as it's used even throughout the development and a deployment process as a way of preventing mistakes before the final product or service has been made. Allowing to detect many issues during the development process saves huge amounts of financial, human and time resources. Usually correcting issues in early stages is much cheaper than when development process of product or service is close to the end.

Companies uses SQA also as a system how to improve their credibility and work process with better scheduling and efficiency as well as increasing customer confidence. Additionally increasing potential of company to compete with others. [13]

3 Quality Assurance in Game development

In this chapter, we define process of game development, what are the main requirements, issues and stages. Also, who the participants and roles in this process are. To establish good understating and further use all this information in introducing Quality Assurance integrated in the process of development in all stages of game development. Further what are the main problems related to the Quality Assurance, how QA can be divided based on different perspective and approaches.

3.1 Game development process

Let us introduce all relevant roles in Game development process which help us understand their responsibilities in further stages of this process.

General roles in most of the games are Developers, Publisher/Distributor and Consumer. Besides these basic roles there can be many others involved as can be seen in Figure 1 and even more. For the purpose of this work we need to focus mainly on the Developers roles within the development team.

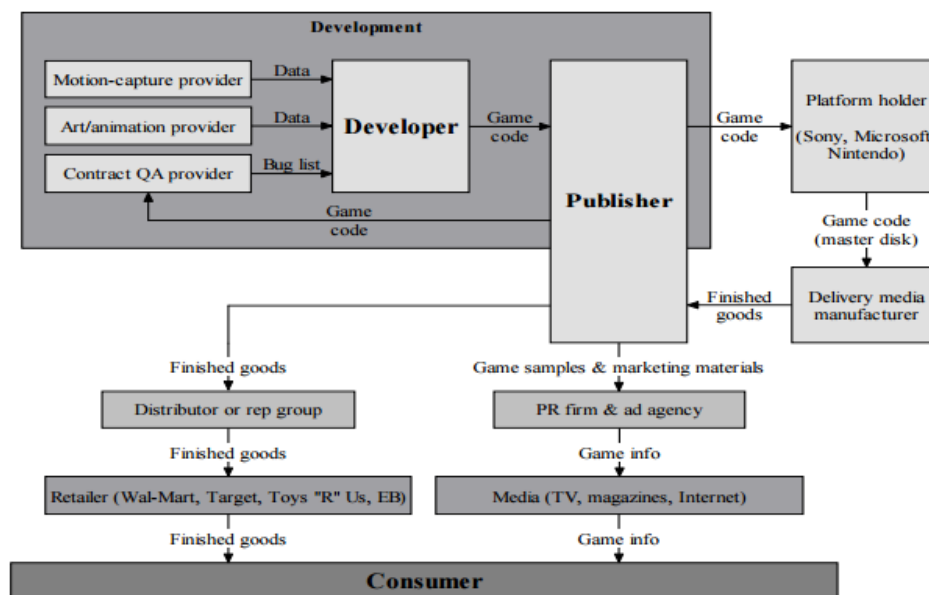


Figure 1 Game Development Roles. [15]

Development team size also varies on game scale however even small team can be behind bigger such as AA¹ games.

Let us further briefly introduce all stages of the game development process. Not all the companies have to follow this structure or scheme but commonly known stages are Concept, Pre-production, Production and Post-production (Post-Launch phase).

Concept as the starting point for the game is the idea what the game is about. Nowadays many games are sort of duplicates of existing concepts but with small changes in graphical or visual aspects of the games or small twin in mechanics. Besides this duplicates many developers are trying come up with completely new concepts and genres of games. Concept should contain genre, platform of the game, what will be the core of the game and what mechanics are supported. Additionally also marketing, business model, monetization plan and target audience. Follow up are three main phases as seen in Figure 2.

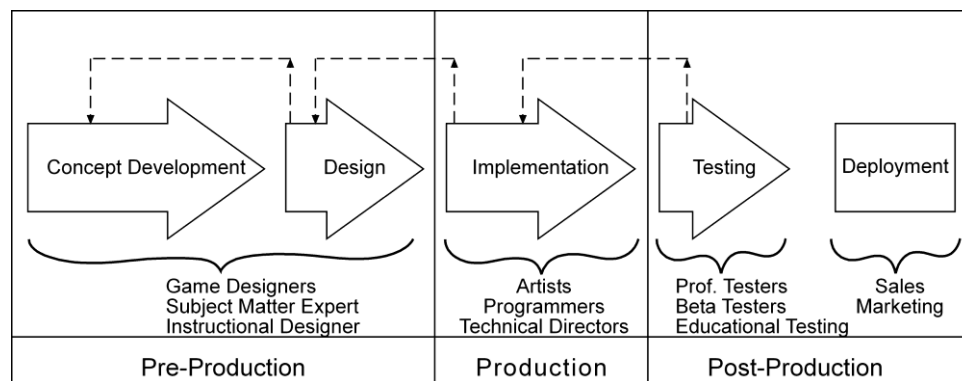


Figure 2 Game Development Process. [16]

Pre-production is phase where all the fun begins. Also, it is very important phase as mostly it's about planning. Changes in this phase are crucial as in later phases performing critical changes in core of game is very expensive or time consuming. Proper Pre-production contains of Prototyping which can be performed as paper prototypes or any toys or demo versions of game. Assuring that all mechanics and gameplay works as intended even with temporary graphics or messy code. Also Game Design Document² and Technical Design Document (TDD) – identifying technical challenges and plan of solutions. Both documents are written to describe gameplay, visual, technical, workflow, pipelines and other aspects of game in detail

¹ The scale of games according to budget, goals set and final metacritic score. [14]

² Document containing description of all elements of game. [17]

which are afterwards used in next phase as guidelines. On top of these documents team selection and work scheduling. [15][18]

Production phase can be followed by different development approaches such as waterfall or agile. As main task in this phase is to have First-Playable game which assures that all designed mechanics and gameplay works as intended as a proof of concept. Together with creating of all visual, graphical and audio assets and components. Achieving this first milestone allow us to focus on next one. Different conferences or events can be followed by the milestone. Common milestones are Alpha and Beta version of the game containing all features and content preferably already tested to avoid critical bugs and issues (further explained in follow section) finalized with Gold-Master (GM) version as complete game product. GM version is ready to be sent to press for reviews, to platform holders and distribution. [15][18] For purpose of my thesis this is the crucial phase where Quality Assurance takes the most important part to detect all possible issues early enough.

Post-production as a final phase of game development is about marketing, optimization, polishing visual aspects of game such as user-interface and performance. After the game has been launched wider information from consumers are usually posted in the game forums and discussions which gives developers feedback on issues overlooked during the testing.[15] Many companies are working on corrections and patches/updates with fixes. Current trend is that even after launch game is further developed and cycling back on previous phases creating additional content providing replayability. Best example are online games or MMORPGs where new content is constantly delivered to players. (World of Warcraft, League of Legends, etc.) [19]

3.2 Bug and Issues categorization

In this chapter, we describe what a bug is, general categorization of issues, what types can be found with the certain approach to testing and how impactful the issues can be.

Definitions of a bug related to the game industry can vary based on the different sights of view. Let's define it as *"any behaviour of the game that was not intended by the design or developers of the game."* General

categorization of bugs can be described depending on what the cause of certain bug is or what effect it has on the gameplay.

Ruuska [20] has divided bugs into two main categories: Functional and Localization issues. Each of these categories is split into subcategories:

Functional – Performance, Graphics, Collision, Artificial Intelligence (AI), Audio, Text, Camera, Balance and Design

Localization – Implementation, Linguistic, Audio and Other.

Detailed description related to each subcategory with possible causes and detailed explanation of issues further in [20].

Other approach in categorization of issues is based on what role in the team is responsible for its correction as followed: Design, Code, Art, User Interface (UI) Design and Localization. This is the distribution we used in Reborn. See Figures 3 to 5 for examples of suchs issues found in the game Urban Empire with the classification of the issues.



Figure 3 Localisation Issue - Missing character. Image courtesy of Reborn Interactive. Used with permission.



Figure 4 Code Issue - Missing pre-made roads on the loading of map. Image courtesy of Reborn Interactive. Used with permission.



Figure 5 Art Issues - Missing model of building. Image courtesy of Reborn Interactive. Used with permission.

3.3 Testing

Testing is key activity of the Game Development. Hence testing needs to be performed early enough and repetitively to prevent expensive refactoring at the later stages. Despite all its positives on the final product testing is overlooked by many companies or just done in small scale. In case of software and game development can be carried out utilizing two main types of testing: automation and manual testing. [21]

Automated testing is based on customized scripts and frameworks for quick testing of simulations or Unit Testing – where we run a specifically made script to test behaviour of some type of AI to detect problems related to it. Use of appropriate frameworks allow to construct tests following parts of code, creating visual reports to display outcomes as pass or fail. The potential of automated testing being more efficient and faster is great. Nevertheless a transition from manual to automated testing is not genuine as it seems on the first sight. Because many observations, done by human testers, simply can't be replaced by automated tests. [22]

Our focus is on manual also known as playtesting in which testing can be performed by simply playing the game however also certain pattern and scenarios are followed. As the main part of playtesting is Quality Assurance which can be further branched into Internal and External Quality Assurance testing. [21]

3.3.1 External Quality Assurance

Not always a company have to have their own Quality Assurance department – instead, they can use an independent QA company. This sort of testing always include planning of what tests are going to be performed with a primary specified goal. Such a testing can be focus on hardware compatibility, performance evaluation or general search for bugs and issues. External Quality Assurance usually have fresh view on a game which is more beneficial allowing to find usability issues as well. External testing is usually done in sprints or pre-defined periods of time and final results report is delivered afterwards, containing list of all found issues with severity assigned to them. Additionally, not every single version of game can be tested as the distribution and communication between developing studio and external company might overcome the budget.

3.3.2 Internal Quality Assurance

Internal QA tester is a member within the development team who have access to the most recent version of game if not decided otherwise. Giving QA tester ability to react to the actual state of the game with changes done on the way by developers. Purpose of QA tester is not only to find and report found issues but also to make sure that applied fixes works as intended and doesn't create even more issues.

Workflow for Internal QA is commonly defined within the company itself and can be very different from others. Despite this fact some similarities can be found between them. Tester is responsible for looking for issues, creating reports eventually assuring that issues will be assigned to responsible person to making it correct.

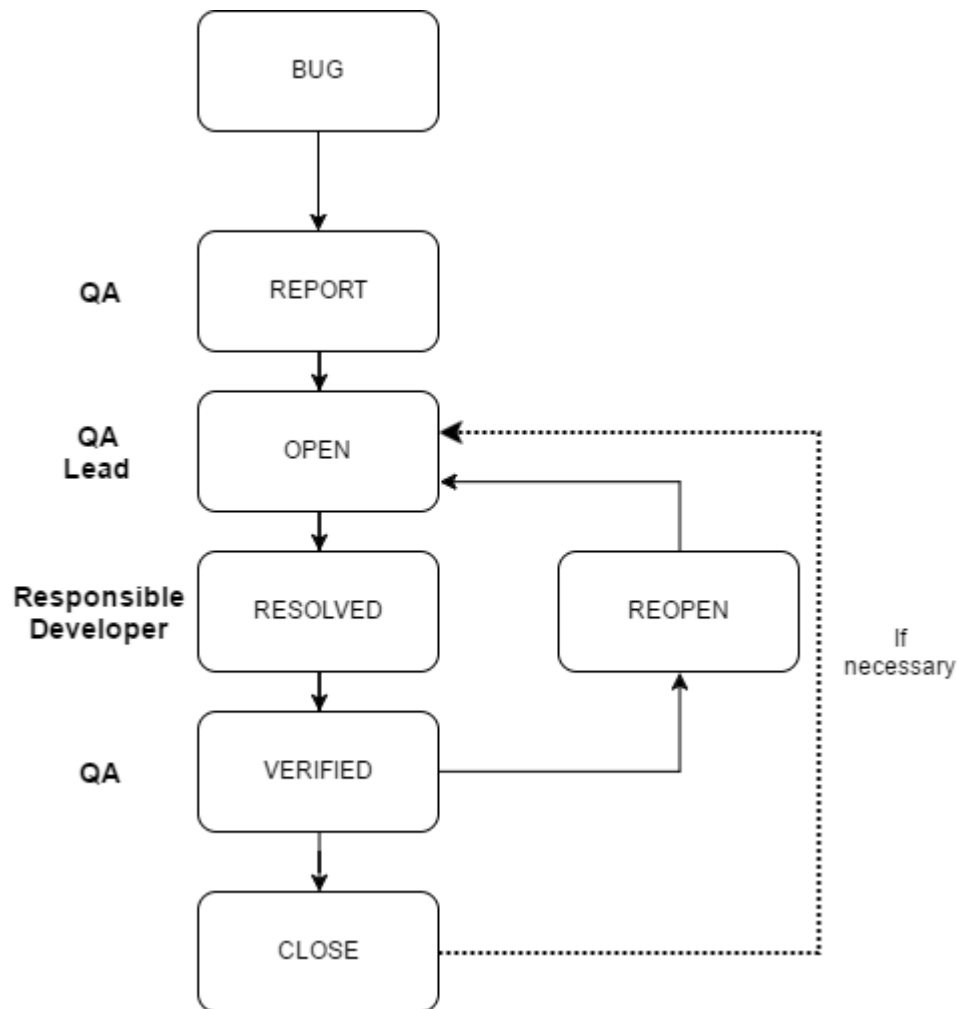


Figure 6 Example of bug life cycle.

Above is example how can be stated bug lifecycle - workflow decided in company how to proceed after discovering an issue.

1. QA tester finds a bug and create report
2. QA leader assigns report to leader of department responsible for fixing bug or directly to responsible person
3. After developer fix issue, QA tester confirms correctness of fix
4. If issue still persists tester assign issues back to QA leader
5. Otherwise close the issue

Above present workflow could be counted as ideal although in practice it's not that simple. Problems related to the actual workflow in the company depends on many factors. In case QA leader is not dedicated person within the team QA tester might struggle with assigning reports to responsible developer especially if tester is new in

company or didn't get proper instructions. On the other hand, problem can occur on the site of the developer leader who gets overwhelmed with amount of reports and those will stagnate, gets lost in tracking system or never reach person responsible for fixing issue.

3.3.3 QA Tester

Mentioned in the previous section one of main tasks of QA tester is to look for issues and bugs. According to [23] we can determine two leading manners how to detect bugs is positive and negative testing. Positive approach looks at the game and confirms the basic functionality of various game aspects: doors opens correctly as well as responsibility of UI elements and their actions. On the other side, negative testing is being mean and trying to break game mechanics with inappropriate behaviour: trying to walk through solid objects, spamming keys. Both ways are very important and tester should not only focus on one of them. Avoiding negative testing may allow consumers to find exploits – glitch allowing player to get advantage over intended gameplay also known as exploiting.

Second step is creating a report containing information of the bug in most viable detail with attributes such as: Description, Priority/Severity, Reproducibility, Reproduction steps, Game version and possibly others.

Description – detailed explanation of wrong behaviour of found bug as well as what the expected behaviour usually is. Additionally attachment with screenshots capturing the area of bug in-game, if possible.

Priority/ Severity – usually specified in the company guidelines or TDD as a certain prioritization list with explanation of each level.

Priority	Explanation
Blocker	Prevents player from progression during gameplay (crash, hang, blocked elements).
Critical	Issue has big impact on gameplay even though progression is still possible (missing textures, game elements).
Major	Has low impact on gameplay and doesn't prevent player from progression but still can cause confusion or annoy player (unimportant NPC glitching in walls or disappearing, wrong values are displayed in UI).

Minor	Small bug with no impact on gameplay, but still can be spotted and frustrating player (NPC mount not moving, overlapping objects).
Cosmetic	Commonly connected to level design or graphics (texture errors, misplaced textures).

Table 1 Example of priority table.

Reproduction steps – precise steps how to achieve reported bug, containing all necessary moves or actions to reach exact same state of game as when the bug was discovered. Allowing developer responsible for fixing to accomplish bug in need to fix it.

Reproducibility – How often reported bug occurs follow the reproduction steps. Taking into account that not always bug has to occur every single time following steps. Usually marked as: Always, Rare, Not reproducible.

Game Version – using version control and to assure that reported bug is still relevant to the currently used game version.

Others – may alter according to company needs, using tags for easier sorting of reported bugs, labels, etc.

As finding bug is usually the easy part as well as writing down the description and expected behaviour, real challenge of the QA tester comes to finding proper Reproduction steps and Reproducibility of bug as without this information developer would have hard time finding possible fix even in case of smaller game where code size is still notable. Furthermore, when fix is applied and QA tester need to verify correctness of fix. Usually first by following the Reproduction steps. However the tester should try to reproduce the bug couple of times because as mentioned before the bug doesn't have to always occur. Only after QA tester is sure that the found bug is fixed without any other side effects a report should be closed.

Along with previously mention tasks, one of the most important responsibilities of QA tester is to assure that fixing one bug doesn't create many others – in this case trying to figure out better way how to fix issues is preferable if cost for it is less than fixing all newly found issues.

3.4 Skill Requirements for QA

Even though many issues and glitches are very easy to spot, certain type of them is usually hard discover and even harder to reproduce. That's why QA tester requires a particular skill set to be able to detect even the smallest bugs. Every person has different interests, skills and all of their life experiences may be useful. In this section, different skills essential for QA are explained.

3.4.1 Communication

As one of the most important skills QA tester needs to have in his skill set to communicate within the team and being the connecting part between artist, designers and coders. In comparison with designers whose priority skill lays upon listening as written in [24], QA testers needs to be able to express and talk about issues found. To be able to communicate and understand what's going on in game the connection between designers and QA testers is very tight. Especially great communication within the team helps to avoid reporting of issues which may be seen as bugs at the first sight by the QA tester, but they are actually intended by the designer.

3.4.2 Understanding of game mechanics

To fully understand the meaning of this particular skill, first we need to have understanding of what game mechanics are.

Game mechanics can be seen as a skeleton underneath the skin of the game as core to interpret what a game truly is. *"Game mechanics are the core of what a game truly is. They are the interactions and relationships that remain when all of the aesthetics, technology, and story are stripped away"*[24]. There isn't one general taxonomy of them as even in very simple and straightforward games, they tend to be considerably complex. On one hand they are strictly defined set of rules for game objects but on the other one they sort of contain something more mysterious inside. And various researches can choose different taxonomies. However, I took categorization from [24] where game mechanics are split into six large categories: 1. Space, 2. Objects, Attributes, and States, 3. Actions, 4. Rules, 5. Skill, 6. Chance

Space – is a determined area where gameplay of game is taking place. This game mechanic defines individual places of game and relations between them and can be seen as abstract contains of game without any visuals or aesthetics.

Objects, Attributes, and States – space in the game cannot be empty, that's why we need to place various objects into it such as characters, props, buildings. Each of these objects have set of attributes as some sort of information of the object and every attribute has a present state. For example, an object "House" can have attribute colour and state would be blue. Different attributes have distinct amount of states related to them.

Actions – are a set of rules what player can do within the game divided into two branches as operative actions - simple actions, driving car left or right. And resultant actions – meaning of these actions is related to the bigger picture of the game and related to how player wants to achieve a goal.

Rules – creating a connection between all previously mentioned mechanics and are the most viable one. Set of constrains on the game space, objects and actions allowing us to set the main part of the game – the goals. There are many categories of rules based on specific game, objects or even related to gameplay (Operational rules, Behavioural rules, Laws, etc.)

Skill – This mechanic is taking the player as a target and not the game itself. Different level of skill is required from the player to allow him to play the game. Also, we can categorize skills into physical, mental and social skills. Skill of the player should match the difficulty of the game for the best experience. Many games are easy to learn but hard to master. Player acquires better skill to follow the increase of difficulty.

Chance – considering interactions between all previously mentioned game mechanics, chance is giving uncertainty into the game. Might be understood as the part of fun. Defining what are the probabilities and expected values of other mechanics.

Discovering localization and visual bugs is easier and doesn't require understanding of game mechanics too much. On the other hand, this skill is most crucial to discover and be able to detect most of the func-

tional and design issues. A QA tester needs to have general understanding of the game mechanics outlined above and how they are represented in the tested game. Furthermore, the tester needs to have a knowledge of each game mechanic category and their specifications. For example to detect not working button, tester needs to know what are the constraints of button and what action is expected for this button. In short understanding of game mechanics is ability of tester to determine what the mechanics of the game are and what the desired behaviour of them is.

4 Evaluation techniques and principles

In this chapter I introduce expert evaluation techniques such as Playability Heuristics, PLEX-framework where in both certain pattern of evaluation is followed. Another technique which is not expert is User Testing. Each of them will be further used in next chapter for game analysis.

4.1 Evaluation by Heuristics

Is widely used expert technique for evaluation of Usability and Playability of given software/games. But we focus on those used in Game Development.

These Heuristics are specifically designed rules of what aspects should be included in the game design as a simple method for evaluation. Expert with experience in game compare and evaluate various parts of game or a whole game with these heuristics. Results are listed in a table of Heuristic Violations. A violation of any heuristics can be also intentional when there is a good reason or design feature for it.

Besides evaluation, heuristics can be used as a great tool while in the process of designing a game to avoid problems in later stages of development.

There are several different Heuristics that can be used for expert evaluation but I have chosen *Playability Heuristics* [1] even though these are specified for mobile games, I have experience with their use and authors say we can use these specific heuristics for other platforms as well.

4.1.1 Playability Heuristics

Heuristics are divided into three groups Usability, Mobility and Gameplay. Besides these main categories we also added Multiplayer category. See Tables 2 to 5. Since my analysis contains different genre and platform games we need to establish all categories even though we use specific ones for each game. Detailed explanation of these heuristics can be found in [1].

No.	Game Usability Heuristics
GU1	Audio-visual representation supports the game.

GU2	Screen layout is efficient and visually pleasing.
GU3	Device UI and game UI are used for their own purpose.
GU4	Indicators are visible.
GU5	The player understands the terminology.
GU6	Navigation is consistent, logical, and minimalist.
GU7	Control keys are consistent and follow standard conventions.
GU8	Game controls are convenient and flexible.
GU9	The game gives feedback on the player's actions.
GU10	The player cannot make irreversible errors.
GU11	The player does not have to memorize things unnecessarily.
GU12	The game contains help.

Table 2 The heuristics for evaluating game usability. [1]

No.	Mobility Heuristics
MO1	The game and play sessions can be started quickly.
MO2	The game accommodates with the surroundings.
MO3	Interruptions are handled reasonably.

Table 3 The heuristics for evaluating mobility. [1]

No.	Gameplay Heuristics
GP1	The game provides clear goals or supports player-created goals.
GP2	The player sees the progress in the game and can compare the results.
GP3	The players are rewarded and rewards are meaningful.
GP4	The player is in control.
GP5	Challenge, strategy, and pace are in balance.
GP6	The first-time experience is encouraging.
GP7	The game story supports the gameplay and is meaningful.
GP8	There are no repetitive or boring tasks.
GP9	The players can express themselves.
GP10	The game supports different playing styles.
GP11	The game does not stagnate.
GP12	The game is consistent.
GP13	The game uses orthogonal unit differentiation.
GP14	The player does not lose any hard-won possessions.

Table 4 The heuristics for evaluating gameplay. [1]

No.	Multi-player Heuristics
MP1	The game supports communication.
MP2	There are reasons to communicate.
MP3	The game helps the player to find other players and game instances.
MP4	The game supports groups and communities.
MP5	The design minimizes deviant behaviour.
MP6	The design hides the effects of network.

Table 5 The heuristics for evaluating multi-player aspects.[3]

4.1.2 Heuristics Evaluation process

To use such evaluation technique expert need to have knowledge about evaluated game. My evaluation process includes short period of gameplay for each of selected games. Immediately writing down notes when I saw any violation of any of introduced Playability Heuristics.

As a final result of this evaluation method is Heuristics Violation table which contain what heuristic was violated, what is a reason of violation and severity rating, see Table 6.

Critical	Crashes the game or makes it unplayable in some way.
Major	Severely affects negatively on the play experience.
Minor	Minor nuisance which has a small effect on the play experience.
Cosmetic	Small mishap or similar, no effect on the play experience but stands out.

Table 6 Problem severity ratings.

4.2.1 PLEX framework

Playful experiences (PLEX) framework is another expert evaluation technique. This framework is built as a follow up from others theoretical work on game experiences, emotions, elements of play and argumentation why people play games. [4]

With „Playful Experience“ we mean experiences that are mostly non-goal-oriented and mainly evoked by fun or the pleasurable aspects of using a product. Playfulness may also include temporary negative experiences as part of the overall experience. This paper presents an overview of the Playful Experience (PLEX) framework, which defines 22 experience categories as the components of Playful Experience.[5]

Based on PLEX framework other researches come up with practical use, such as in design and evaluation related activities not only for video games but even other fields of development to design for playfulness.

For easier transmission of understanding 22 PLEX categories to stakeholders and designers who want to design for playfulness, Lucero and Arrasvuori had made [6] and evaluated [7] PLEX-cards.

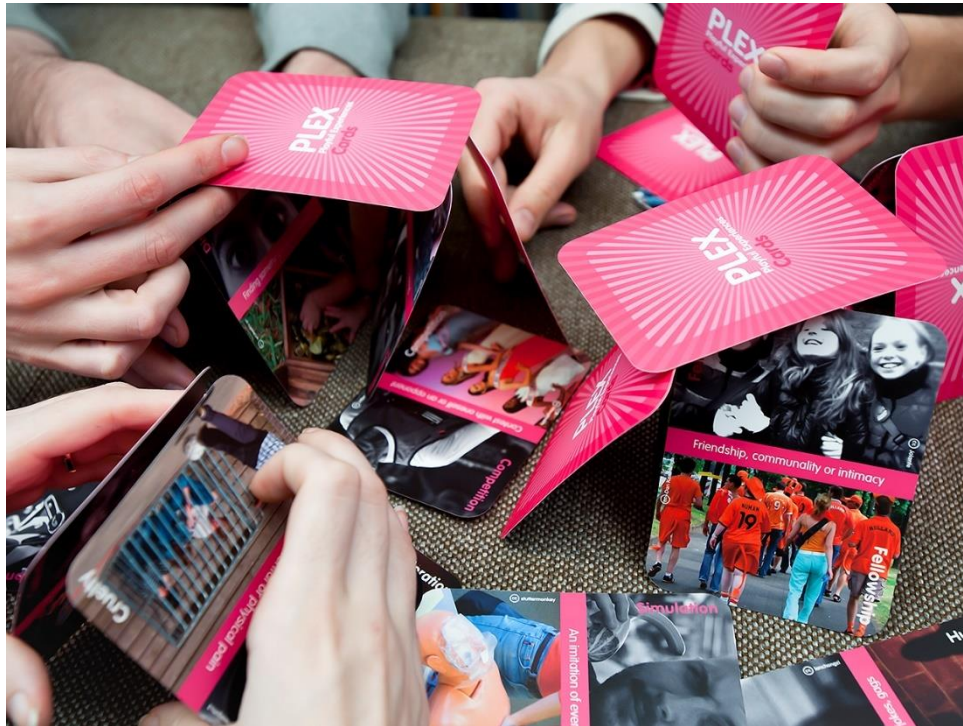


Figure 7 Photo of PLEX cards – Photo author: John Paul Bichard–
<http://www.funkydesignspaces.com/plex/>

All of the 22 PLEX categories can be seen below in Table 7 with brief description.

Experience	Description
Captivation	Forgetting one's surroundings.
Challenge	Testing abilities in a demanding task.
Competition	Contest with oneself or an opponent.
Completion	Finishing a major task, closure.
Control	Dominating, commanding, regulating.

Cruelty	Causing mental or physical pain.
Discovery	Finding something new or unknown
Eroticism	A sexually arousing experience.
Exploration	Investigating an object or situation.
Expression	Manifesting oneself creatively.
Fantasy	An imagined experience.
Fellowship	Friendship, communality or intimacy.
Humour	Fun, joy, amusement, jokes, gags.
Nurture	Taking care of oneself or others.
Relaxation	Relief from bodily or mental work.
Sensation	Excitement by stimulating senses.
Simulation	An imitation of everyday life.
Submission	Being part of a larger structure.
Subversion	Breaking social rules and norms.
Suffering	Experience of loss, frustration, anger.
Sympathy	Sharing emotional feelings.
Thrill	Excitement derived from risk, danger.

Table 7 PLEX framework consisting of 22 categories. [5]

4.2.2 PLEX framework Evaluation process

For PLEX-category testing, I played the games for a while again to confirm or bust some memories about possible PLEX-functions, that came to my mind while working on Heuristics Evaluation. Base idea is to determine which PLEX categories are invoked in player while playing game to get the most of playfulness.

To display results I will construct another table containing all PLEX categories found in each of the played game. Table also includes explanation where and why or what aspects of game are responsible for certain experience.

As a human nature and personality results of this evaluation depends on subjective experiences found by tester. That's why this type of evaluation is better as a group of experts rather than done individually. Still it's interesting evaluation technique and further can be used as framework for designing games . That's why I choose it.

4.3.1 User Testing

Definition of Usability: *"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."* [9]

User Testing or also known as Usability Testing is another method how to evaluate games to find possible usability issues. It's the most fundamental usability method where, players (testers) are representing the target group or the final consumer. Similar to previously introduced techniques User Testing narrows down the issues and challenges within game itself, that were not directly intended by game developers. [8] Additionally User Testing helps in Game Development to game designers and developers see game from other perspective as they can't think of all possible ways player will play their final product as well as they suffer "Developers blindness". That means that no matter how hard developers try there always will be issues or bugs they can't see simply because they know too much about the design of game itself.

General requirements for User Testing are: Test Users, Determined plan for play session, Session Evaluators, Evaluation of results. Let's take a look how to proceed in the setting up User Testing evaluation. [11]

Important aspect before User Testing can be started is to state what are the outcomes we expect and think about what we want to test. Different approaches we can take are for example: what user like or dislike, what they think after first-time experience, what are critical points, crucial mechanics and design issues. After we establish research questions we can proceed to selection of correct methodology to get proper answers. [10] There are several methodologies that we could choose from. Questionnaire and interviews are the most common methods to gather results after play session. Subsequently we need to determine the plan for Play Session

– which can be settled as laboratory session with strict rules for session evaluators and for tester. Next step is to collect responses from the Test User with already mentioned methodologies and last step is to evaluate and consider the difference between each of Test Users and see results.

As testers are selected individuals each of Test Users should be from different demographic group as well as with various game experiences so we are sure we covered all potential end users and consumers into consideration of results.

4.3.1 Selected User Testing process

My selected methodology for user testing was individual Play Session 1 on 1 with the Test User with duration around 30 minutes – throughout the gameplay I was observing reactions and making notes when different aspects of game were introduced to Test User or when he faced certain issues. Play session was followed up by interview where I was asking different questions depending on each of selected games to get most of the information and responses from Test User. Selection of Test Users was focus on diversity based on users experience with games – stated as level of gamer (depending on how often they play games), males and females as well as test users from various age groups.

5 Game Analysis

As practical part I have used above introduced techniques of Playability Heuristics, PLEX framework, User Testing and my personal QA testing. Games has been made by students of Masaryk University as part of the course *PV255 Digital games*. I have pick three very different games to see how analysis depends on genre and platform of each game. Each game have short introduction and description of game followed with analysis itself.

Chosen games are:

- SurvivAnt – PC, RTS game
- Blind Man's Buff – PC, Online Multiplayer game
- SwordMaster – Android, RPG game

5.1 SurvivAnt

Authors: Ľuboš Hyžák, Pavel Kouřil, Jakub Medvecký-Heretik

Platform: PC

About: SurvivAnt provides a spin on traditional RTS games, based on the idea of having indirect control of your units while also combining different phases of a gameplay - gathering resources and improving your units during daytime, and defending the anthill from waves of enemies each night. [2]

5.1.1 Heuristics Evaluation

#	Playability Problem Description	Violated Heuristic	Problem Severity
1	Screen layout should be in displayed with more contrast color.	GU2	Cosmetic
2	Queen abilities are lacking indicators when it's possible to use them and when they are on cooldowns.	GU4	Major
3	Indicator of ants carrying resources is never explained.	GU4	Minor

4	Indicators – should be explained immediately and not require player to see Help.	GU4	Minor
5	Lack of information of possibility to click on anthill to show ant statistics and description.	GU4	Major
6	Placing pheromones above anthill is not possible without any indication. Also indicator of radius behaves a bit strange around anthill.	GU4	Minor
7	Game is too easy at the beginning. Leaving game just run without any interaction you can easily survive 2 nights.	GP5	Major
8	Game is about repeating the same action of gathering resource – but this was violation on purpose of design.	GP8	Minor
9	Player can't customize or express himself other than way how he selects bonus points.	GP9	Minor
10	Attacking enemies can get stuck around anthill and just stay there without any further actions. Makes game very easy if this happens.	GP12	Major
11	Game supports only win or lose end conditions. After lose all upgrades are lost and new game needs to be started.	GP14	Minor

Table 8 Table of violated heuristics for game *SurvivAnt*.

5.1.2 PLEX

#	Category	Explanation
1	Challenge	Possible end of game is to win when surviving throughout three nights or lose.
2	Completion	Each day trying to gather as many resources as possible.
3	Exploration	As amount of resources is limited for each food found, player needs to explore whole map.
4	Nurture	Being a queen of anthill and taking care of the rest of ants as their leader.

Table 9 Table of found playful experiences from game *SurvivAnt*.

5.1.3 User Testing

Interview questions:

1. Was tutorial explanation of main goal and how to achieve it adequate?
2. What was the first that you got interested in or got your attention? And why? (confusion of the game at the start, because the lack of information in comparison of other games)
3. Which boost category did you selected first? Did you balance the boosts or focus in specific category?
4. Have you discovered something that was wrong or you don't like about the game? (bugs, mechanics, anything) (nothing special)

Observations from interviews:

Players without experience in the game had a problem with understanding the basic gameplay mechanics such as controlling ants with the use of pheromones. Tutorial was text based with more text than necessary and players intend to just quickly read through it which was possible cause of confusion. However, explanation of range indicator for pheromones is only in Help section, even though it supposed to be in tutorial as one of main points. After proper explanation or read through the Help, players were mostly focus on upgrades which allowed them better resource gathering. However main target were night shouts as every tester picked them to increase chance to survive the night. Every tester had besides understanding of pheromones mechanic, problem with different aspects of the game. Such as responsiveness of the UI elements, UI feedback to player and indicators explanation should be definitely prior objective for improvements. Furthermore, players liked the simplified look and changes in audio to invoke danger throughout the night but calm background music during day time. Also, the autonomy of ants moving around on their own and ability to remember where are the resources even after night. Players' progression in the game increased significantly with more experience they got. With full understanding of game, it seems to be too easy to achieve the main goal.

5.2 Blind Man's Buff

Authors: Jan Krejsa, Matouš Procházka, Adam Tuček

Platform: PC

About: Multi-player game based on traditional similarly named game. Full of action and funny moments with catchy graphics, chasing, and giving buff to others and various power ups. Collect more point than the others to win. [2]

5.2.1 Heuristics Evaluation

#	Playability Problem Description	Violated Heuristic	Problem Severity
1	Missing indicator for the duration of power-up effects.	GU4	Major
2	Missing indicator when player can use clapping to get points.	GU4	Minor
3	Player can't clearly understand characters' models' name while customizing it.	GU5	Cosmetic
4	Jumping isn't allowed when standing on the spot.	GU7	Minor
5	Missing description of power-ups and explanation what are their effects.	GU11	Major
6	Help isn't included in the game but delivered as external document which is not lacking a lot of information.	GU12	Major
7	Game requires all players in same network or 3 rd party programs for launching, which requires time to start the game.	MO1	Major
8	No message is displayed when any of the player is disconnected or when host disconnects and game is disbanded.	MO3	Major
9	Chat could be available before the game has started or even during the game session.	MP1	Major
10	Game is connected to the direct IP adress so all players needs to	MP3	Major

	connect to specific one while in same network.		
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Table 10 Table of violated heuristics for game Blind Man's Buff.

5.2.2 PLEX

#	Category	Explanation
1	Challenge	Give buff to others or trying to avoid getting it.
2	Competition	Main principle of the game is to be the winner, trying to earn more points than others.
3	Humour	Graphical aspect of the game is very joyful and characters' models are also amusing.
4	Relaxation	Game doesn't require too much of thinking and short game sessions are good for relief.
5	Simulation	Game is based on actual similar game that can be played outside with friends.
6	Suffering	Not being able to give buff or catch other players can lead to frustration.
7	Thrill	Getting closer to the player with buff is rewarded with more points per second.

Table 11 Table of found playful experiences from game Blind Man's Buff.

5.2.3 User Testing

Interview questions:

1. What was the first think that got your attention when playing?
2. How you feel about gameplay mechanics of the game such as movement and control of characters?
3. How useful would be the ability to communicate with players?
4. How was the graphical representation of power-ups useful for understanding of their effects?
5. Have you discovered something that was wrong or you don't like about the game? Perhaps do you have ideas for improvements?

Observations from interviews:

Graphics and audio nicely fit into the theme of the game. Fun and humour as main emotions are highly encouraged with colourful map, customization of players' character and sound effects during gameplay. For players with less experience in video games had prob-

lems with camera and character movement however those more experienced didn't. Nevertheless, all players agreed on lack of indicator or aiming tool for passing the buff to the others or any explanation how this mechanic works. Insufficient graphical representation of a power-ups and missing description of them discourage players to use them even though they are crucial part for the gameplay. Every player got interested in the game and come up with ideas for the improvements as they would like to play this game again. Adding map for better orientation, various indicators for the incoming noise direction or communication tool. Additionally, the main focus should be to improve the set up for starting a game, better match-making tool as it is online game to find other players easily. Simple emotes could be nice feature if they cannot be used for the harassment or violated against players.

5.3 SwordMaster

Authors: David Osička, Martin Příborský, Pavol Valovič

Platform: Android

About: RPG with interactive battles for mobile phone. Help Lancelot clear castle of enemies and save the imprisoned king. During journey search for hidden rooms implemented with dynamic lightning collect items to defeat your enemies. Enjoy battle aspects such as attack and blocking is simulated with finger movement on the touch screen of your phone. [2]

5.3.1 Heuristics Evaluation

#	Playability Problem Description	Violated Heuristic	Problem Severity
1	Small glitches with dynamic light and alignment of visual aspect.	GU2	Cosmetic
2	Indicators in combat mode includes not usable ones. Areas in which player should interact should be highlighted.	GU4	Major
3	Indicator of current damage taken from enemy and attack power should be visible when different power ups affect this attributes.	GU4	Minor

4	Missing Pause menu option in Battle screen, player cannot pause, reset or leave to main menu until battle is over.	GU6	Major
5	Bloking attacks coming from the corners is a bit inonvenient and player have to remember to swipe only vertically or horizontally even though sword graphics would suggest a diagonal swipe.	GU8	Minor
6	While in Pause Menu, confirmation should be displayed if player clicks on Main Menu option. Which can be hit by accident.	GU10	Minor
7	“Game characters” is not proper name of UI element and it’s not intuitive that this element contains Help and description of power ups.	GU12	Minor
8	Help is available only from the main menu and not when pausing the game. Player needs to quit current progression to be able to see the Help.	GU12	Major
9	Customized battle system is repetitive but this is done by design.	GP8	Minor
10	Customization or personalization is not available to player.	GP9	Minor
11	Playing game by progression order of levels gives player higher attack and bonuses collected in previous levels. However starting on specific level doesn’t give player equal strenght according to power ups. So after returning to Main Menu, Reseting level or dying all bonuses collected are lost – to get same state player needs to play from start again.	GP14	Major

Table 12 Table of violated heuristics for game SwordMaster.

5.3.2 PLEX

#	Category	Explanation
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1	Challenge	Reaching the goal by battles with enemies, navigating throughout the various level and finding key and gate to next level.
2	Completion	Saving the king as master goal of game.
3	Cruelty	Fighting enemies in order to kill them. Walking through mouses and killing them.
4	Discovery	Finding main goal objects, hidden rooms and power ups.
5	Fantasy	Being prince in medieval castle trying to save the king and his kingdom.
6	Humour	Small jokes are visible throughout the whole gameplay.
7	Suffering	After dying and need to start from the beginning.

Table 13 Table of found playful experiences from game SwordMaster.

5.3.3 User Testing

Interview questions:

1. Was battle system explained accordingly to your needs and understanding
2. What was the first that you got interested in or draw your attention? And why?
3. Did you understand all game object and their effect in game?
4. What you think about movement mechanics in game?
5. Have you discovered something that was wrong or you don't like about the game? (bugs, mechanics, anything)

Observations from interviews:

Even though the game contains practical tutorial for the battle system, all players had a problem to understand how precisely they need to perform actions in any battle. Every player died on the first encounter with real enemy. Biggest issue was using the swipe movement other directions than vertical and horizontal. Tutorial could be simplified a bit more to give clear idea for the battle mechanics. Despite the fact every player got issues with battle system, they see it very interesting giving the potential of the game. The division between combat and roaming around is done well. Additionally, dynamic lightning adds the element of surprise and curiosity. Movement control didn't take a long time to master just players needed to get used to it. Background music helped the atmosphere and fit into the game genre. The critical part is loading between battles as well as

new map area. Loading indicator is not responsive and players thought the game froze. In couple of times the game crashed completely during the loading of new level. This should be prioritized to improve as well as the description of the effects of collectable objects is insufficient. Currently available only from Main Menu and even hard to find. In general, players were really excited at the beginning after mastering the combat mechanics, but some found fighting and running around as too repetitive without any twist after certain amount of time played.

6 Conclusion

The aim of my work was to introduce the area of Quality Assurance in the relation with the Game Development. To describe the main steps in QA process are and how we can use the knowledge and understanding in the testing and quality control of the video games. To fully understand the meaning of testing process I outline different approaches and type of issues we can face in this process. Additionally, I narrowed what are the crucial requirements for QA tester and how important acknowledgement of game mechanics is.

Furthermore I introduced two expert evaluation techniques (evaluation by Heuristics and PLEX framework) for the game analysis, the precise content of them and how to perform the evaluation based on these techniques. Moreover the introduction to User Testing process. Including the exact stages of this process used further in the practical part of the work.

Practical part of thesis was to evaluate three specific games with expert evaluation techniques and User Testing. To show how useful these methods are in detection of issues in the games. I evaluated each game with different set of testers with various skills and game experience level to achieve diversity in the results.

Game	Amount of violated heuristics	Amount of playful experiences
SurvivAnt	11	4
Blind Man's Buff	10	7
SwordMaster	11	7

Table 14 Result table for expert evaluations.

Based on the results from Table 14, we can see that each game had almost same amount of the violated heuristics which most of them were minor. However issues related to these violations could be fixed or at least understood if such evaluation would be used in earlier stages of the development allowing developers make changes. And allow them easier tool for setting focus on different aspects of game. Related to the amount of playful experiences the more game contains the higher is change for player to enjoy the game and increase the rate of replayability. Developers and especially designers should use these methods to design various aspects of the game to invoke specific playful experience. To better understand

what could player expect to feel while playing the game. Nevertheless a balance between negative and possitive experience should be kept.

User Testing results can be matched to the violated heuristics as with the similar elements of the game players had most troubles. All games had in general the lack of information to the player or insufficient interpretation of the information. Various issues related to feedback to player action or absence of indicators are suchs example. Despite that players always found certain aspect of game they like, supporting their excitment to the game. Furthermore this method is useful not only for detection the problematic aspects of game as feedback from players. But to allow players to propose various improvements which can be further managed with developers.

To wrap it up Quality Assurance is important part of software development and even more in game industry. Testing and evaluation allows to detect issues. If used early enough or throught the whole process of development it could prevent occurance of issues and bugs in final product and make sure all requirements of consumers are met. Being able to detect and work on issues in the early stages of development also saves the amount of resources required for these fixes. Additionally all mentioned techniques are good to use while designing a game as guidane tools and to prevent issues from occuring.

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Appendix

Full interviews for each game:

SurvivAnt:

Testee #	Gender	Gamer
1.	Male	3/10
2.	Female	3/10
3.	Male	10/10

Was tutorial explanation of main goal and how to achieve it adequate?

1. Yes and no, the goal explanation was straightforward but the way how achieve it was not. I needed to read help to fully understand how to use pheromones and control the ants.
2. Bit of confusion at the beginning of the game as I don't like a lot of text to read so I possibly skipped some relevant part about controlling the ants. I didn't know how to use pheromones.
3. I have played the game before so the understanding of goal and how to achieve it was simple for me.

What was the first that you got interested in or got your attention? And why?

1. I got confused how to even play the game, as there was a lack of information in comparison of other games I played. I needed to read help to fully understand how to use pheromones and control the ants.
2. I really liked the simplified look of the game and the background music that changed according to the day (relaxing) and night (more aggressive as it's attack time)
3. The autonomy of the ants, as they remember the found resource and return to it after the night pass.

Which boost category did you selected first? Did you balance the boosts or focus in specific category? (First improving ants to collect more resource

1. At first my focus was on improved collecting of resources and afterwards I spend most resource in the shouts for better defence during night.
2. I don't remember what my first category was but mostly I bought shouts to protect myself during the night fight.
3. First choice was production of resources, when I wanted to attack enemies during day I upgraded ants' attributes but also bought few shouts to secure surviving the night.

Have you discovered something that was confusing or you do not like about the game? (Bugs, mechanics, anything)

1. I didn't like that I needed to read help before I was able to understand how to play the game. Also I didn't know when I can use the shouts again as they had no visible cooldowns.
2. It took me a while to discover that I can move the camera and discover whole area to play.
3. The struggle with UI responsiveness when I bought some upgrade that didn't activate but I lost the resources according to its cost anyway.

Blind Man's Buff:

Testee #	Gender	Gamer
1.	Male	7/10
2.	Male	9.5/10
3.	Male	5/10
4.	Female	3/10

What was the first think that got your attention when playing?

1. Graphical aspects of the game are really nice.
2. Humorous and funny sound effects were really thematic.
3. Beautiful graphics as they nicely fit in the game. Furthermore I actually think game was really nice as I didn't expect much out of student game.
4. I really liked how colourful the game was. Graphics invoked the childhood times in me.

How you feel about gameplay mechanics of the game such as movement and control of characters?

1. Movement was good but giving buff to other players was pretty confusing.
2. Range indicator for giving buff to others as it's hard to aim without it.
3. I had no idea how to give the buff to other player so I was just running away.
4. I was confused with the camera control and movement especially when close to the objects and edges of map.

How useful would be the ability to communicate with players?

1. Chat in the lobby would be nice or simple emotes during the gameplay.
2. In my opinion it should contain chat or push to talk as game is online and we don't need to be in same room.
3. Only in the lobby and after the end of round as during game chat seems a bit useless to me.
4. I think it would be a really nice feature at least before the match starts otherwise players need to use other communication tools.

How was the graphical representation of power-ups useful for understanding of their effects?

1. Lightning was pretty clear and trap after a while as well but I had no idea what the last one does.
2. Besides the creature power up, I knew all of them.
3. No idea what's the red one but others were quite easy to understand.
4. For example the lightning was quite obvious but about the others I didn't understand their effect until many tries to figure it out.

Have you discovered something that was wrong or you don't like about the game? Perhaps do you have ideas for improvements?

1. As its online game I would like to have some kind of match-making or finding the nearby players. And when someone used clapping I needed to be already looking at his direction to be able to see him, possibly an arrow or indicator of direction from where the sound came.
2. Easier setting up would be nice as its online game and probably some stats and leader boards. Besides that a more maps

would be nice improvement. And I think it would be also nice idea to play it on mobile phone instead of the PC.

3. Mechanics of giving the buff to others was not really clear as well as the camera movement was a bit too fast. And good improvement would be a map with indicators or noise or clapping for better navigation.
4. Sometimes I got stuck under the bridges. In my opinion a map would be good feature. To know where I am as being close to the edges of arena, the camera behaviour is confusing.

SwordMaster:

Testee #	Gender	Gamer
1.	Male	6/10
2.	Female	8/10
3.	Female	5/10

What is your opinion on the battle system explanation according to your needs and understanding?

1. Not adequate, it could be because I just quickly read through the battle tutorial. But I didn't understand how the battle system works.
2. Understanding of tutorial was good but a bit confusing as it's just at the beginning and it was too much information at the same time with colouring of the areas where to attack.
3. Only that it should be mentioned that you can't swipe in the diagonal way even its intuitive especially for phone.

What was the first thing that got your interest or draw your attention? And why?

1. Battle system, as it was something new.
2. Graphical representation and dynamic lightning that was hiding the enemies and objects.
3. Battle system as it's personal and division between roaming around and battle.

Did you understand all game objects and their effect in game?

1. Not clearly, as there was no text in the game. Only key but others not at all.

2. I have seen few items but I had no idea what is their effect besides key.
3. I didn't understand and almost killed myself with the poison as it was red and I expected to heal me. However key was intuitive.

4. What you think about movement mechanics in game?

1. Was ok, I am used to play games with similar movements.
2. At the beginning I was not sure if I need to swipe or tap or simulate joystick movement, after a while I got it. But in general it was good and new.
3. For me it was quite intuitive and easy to control the movement.

5. Have you discovered something that was wrong or you don't like about the game? (bugs, mechanics, anything)

1. Game was quite same all the time and repetition of the same action was making it boring after a while. Just fight, find the key, move to other level.
2. The loading time of the battle was a bit too long and I didn't know if it's loading or just froze. As improvement when collecting a poison it would nice that screen flash red as when you are hurt in the battle.
3. My game crashed when it was loading the new level. I didn't even know there is a help to the items, it definitely need to be in the game not just hidden in the main menu.

Glossary

QA

Quality Assurance

PLEX

Playful Experience

UI

User Interface

NPC

Non-player character

RPG

Role Play Game

RTS

Real-time strategy

MMORPGs

Massively-Multiplayer Online

Role-Playing Games