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Evaluation of Mobile Games with Playability Heuristic Evaluation System

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Abstract—**Heuristics evaluation is proved to be an efficient and effective method for inspecting usability of application software and game. However, it is reported in literature that negative usability results may cause failure to the product. In large projects usability evaluation in time consuming and due to time constraints project may fail. There is a need of improving method of conducting heuristic evaluation. Therefore, a motivation is raised to improve the method of conducting heuristic evaluation by automation the process. An automated heuristics evaluation tool empower users to focus on inspecting more usability problems within time constraints and reduce manual efforts. In this study, a playability heuristic evaluation system (PHES) is designed and developed to automate the process of conducting heuristics evaluation for games. To ensure the functionality of this systems, several tests were conducted. The results of this study advocates that with the help of playability heuristic evaluation system (PHES) more playability problems can be identified with in short time.**

Keywords— *heuristics evaluation, playability, PHES, mobile games*

I. INTRODUCTION

Usability is an important factor in the field of HCI. Scholars define usability as "the capability to be used by human easily and effectively", and "the effectiveness, efficiency, and satisfaction with which specified user can achieve goals in a particular environment" [1]. The importance of usability is discussed and enlightened by many researchers and they have proposed different techniques of conducting usability [2] , [3] and [4]. One of the widely usability inspection method is "Heuristic Evaluation" proposed by [5]. In 1990's, heuristics evaluation method was only used to evaluate interfaces of software product, but in recent years, heuristic evaluation gained higher interest among researchers of various disciplines. In the last decade, heuristic evaluation is widely used for evaluating games with playability heuristics [6] and [7]. The approach of evaluating games is the same as software product, but generic usability heuristics are not applicable for evaluating games. This is because games are much more different than software, and involves other factors, such as fun, enjoyment, entertainment and learning. Therefore, playability heuristics were proposed to evaluate games with

heuristics evaluation. Several researcher have proposed heuristics for various types of games such as computer, mobile and web based social games, listed chronically in Table I.

Heuristics evaluation is proven to be more efficient to evaluate games with playability heuristics as compared to other methods such as playtesting [8] and [9]. With the increase in demand of mobile games, and rapid growth of mobile gaming platforms, it is difficult to produce good quality games within time constraints. The method of conducting heuristic evaluation manually is time consuming as observed during evaluation and also reported by other usability practitioners [10]. This condition has given rise to the development of usability assessment tools and available in market [11] , [12] , [13] , [14] and [15]. However, it is also a challenging task to determine which tool is good or bad. It is reviewed from literature that each tool has its pros and cons. So by simply purchasing a tool does not guarantee to produce accurate results [12]. The existing tools available in the market are specially designed for evaluating usability of application software and don't cover the aspect of evaluating games with playability heuristics. Therefore, this issues increases the motivation to develop an automatic system for conducting heuristic evaluation on games.

In this study, a playability heuristic evaluation system (PHES) is designed and developed to improve/enhance the process of heuristics evaluation for games. PHES is a web based system, developed to evaluate games using incorporated playability heuristics. This system is very much flexible in such a manner that a multiple set of heuristics can be used in one study. Being a web based system, it facilitates a remote evaluation as well.

This papers is structured as follows: section two covers the published heuristics for video games and available usability tools for evaluation. Section three presents the methodology of conducting evaluation using PHES on games. Section four presents the results on evaluation of PHES. The paper ends with a conclusion and future works.

II. LITERATURE REVIEW

In this section, methods of evaluating games and published heuristics for game are discussed.

A. Playtestin on Games

Playtesting method has been introduced and commonly used for evaluating games. This method is being used by game developing companies but it is only applicable on fully functional prototype of a game. Playtesting method consumes more time to evaluate a game as compared to heuristics evaluation method. Using this method, users need to spend much time on playing game. In playtesting method users need to learn the game first. Once they are much familiar with the game, they need to report the real problem they faced during playing the game. The impression of using playtesting method is to gather real time data on what problems users faced during playing game [16] , [17] , [18] and [19].

B. Heuristic Evaluation on Games

Heuristic evaluation was first introduced by Nielsen and Molich [5] with a set of first 10 usability heuristics. Heuristics evaluation is a usability inspection method in which group of experts test the interface against the heuristics or also known as rule of thumb [5] , [20] and [8]. The first heuristics was introduced to inspect the interfaces of software products. Moreover, heuristics can also be used as design guideline rules in the development phase of a software product. This will results in effective and efficient software product [21].

As heuristic evaluation proved to be efficient, researchers from various discipline are attracted towards this usability inspection method. Nowadays, heuristics evaluation is very much common method of conducting usability tests on various products, such as application software, game, mobile user interfaces, and websites.

Heuristics evaluation presented a potential evaluation method for games, since the first heuristics for video games published [22]. Later in 1998, Clanton [23] published a set of game design principles, in which he conducted formal and informal inspection of games. The main focus on Clanton study is on, how computer game can be designed to engage users. Later on, in 2004, Desurvire et al. [24] proposed "The Heuristics for Evaluating Playability ". Later in 2006, Hannu Korhonen [6], proposed heuristics for mobile games. More heuristics are listed in chronological manner in Table 1.

TABLE I. HEURISTIC FOR GAMES

Author	Description
Federoff [25]	Federoff compiled a list of playability heuristics can be considered as first specific heuristics for video games due to its structure and modeling. The study was based on area of computer games; game interface, game mechanics and game playability and compiled a list of game heuristics that consist the three areas.
Desurvire et al.,[24]	Developed Heuristics for Evaluating Playability (HEP).
Korhonen [6] and [7]	Proposed a set of heuristics for mobile games based three categories: game mobility, game usability and gameplay. Later in 2007, Korhonen proposed 8 more heuristics for multiplayer mobile games.
Song and Lee [26]	Compiled key factors of heuristics evaluation for game design and categorized game heuristics on four areas; game interface, game play, game narrative and game mechanic.
Schaffer [27]	Heuristics for usability in games. These heuristics were based on literate and authors experience in the area of HCI. Schaffer divided these heuristics into five categories: general, graphical user interface, gameplay, control mapping and level design.
Pinelle [28]	Developed heuristics evaluation for video game design that adapts usability inspections for games. His heuristics is specifically focused on game usability and it was based on a structured analysis of usability problem from a large number of games.
Paavilainen [21]	Proposed first heuristics for social games. This list was consist on 10 heuristics.
Soomro et al., [10]	Presented additional 10 heuristics for mobile games to fulfill the gaps in heuristics proposed by Korhonen.

Each author in Table 1 proposed heuristics and classified in different aspect, and each models is proposed and validated in a different manner [21]. However, it is still a challenge to choose the appropriate and efficient in order to solve playability issues. Although, the selection of heuristics can vary with domain of choice i.e. computer games, mobile games, web-based social games. For each domain different heuristic sets are available with respect to their nature. Since, it is reviewed from literature and experienced from past studies that heuristics evaluation is efficient in such a manner that maximum number playability problems can be identified with a set of specific heuristics.

C. Automation of heuristic evaluation on games

From the last two decades heuristics evaluation plays an important role to measure the usability of software, games and websites. However, it is reported and observed that heuristics evaluation seems to be time consuming with manual approach of conducting evaluation. Therefore, to overcome this challenge, several usability assessment tools are available in market but it is still difficult to choose which tool is more suitable. This statement is supported by [12], claiming that 8 of 10 usability practitioners state the difficulty to justifying which tool better along with its cost. Comparison of benefits of several tools are listed in Table 2.

TABLE II. COMPARISON OF BENEFITS OF USABILITY ASSESMENT TOOLS (SOURCE. [12])

Features	Morea	Tobii	Userfeel	Loop11	Uranus
Software or website testing	✓	✓	✓	✓	✓
Mobile device testing	✓	✓	✗	✗	✗
Game testing	✗	✗	✗	✗	✗
Protocol setup (task, questions)	✓	✓	✓	✓	✓
User recruitment	✗	✗	✓	✗	✗

Subject Ratings	✓	✓	✓	✓	✓
Voice and screen recording	✓	✓	✓	✓	✓
Face recording	✓	✓	✗	✗	✗
Eye tracking analysis	✗	✓	✗	✗	✗
Task time measure	✓	✓	✓	✓	✓
Results exporting	✓	✓	✗	✓	✓
Reporting and analysis	✓	✓	✓	✓	✓
Moderators rating	✓	✗	✗	✗	✓
Open Source Support	✗	✗	✗	✗	✓

Despite the existence of these usability assessment tool, they are specially designed for evaluating the usability of software product and do not cover the features of games. Thus motivates the effort to develop a tool to automate the process of heuristics evaluation for evaluating games.

III. METHODOLOGY

To achieve the objectives of this study, a methodology is designed as followed. This study is divided into two phases. The first phase is the design and development of PHES and testing on interface. The second phase is testing of mobile games using heuristic evaluation method.

Finally, complete content and organizational editing before formatting. Please take note of the following items when proofreading spelling and grammar:

A. Development of Playability Heuristic Evaluation System (PHES)

Before starting the design and development of PHES, several usability assessment tools are reviewed to replicate the design and workflow of existing usability tools. Other related works are reviewed in the context of hardware and software requirements. The development of PHES is based on software development life cycle (SLDC). Iterative waterfall model implemented during the development of system to meet requirements within time frame.

From the requirement gathered, PHP / HTML5 /CSS /Ajax are selected for development of system and MySQL taken as basic database tool for creating and storing necessary records. All the development process planned to under Microsoft windows operating system.

Additionally, several interviews were conducted from usability practitioners. They were questioned about their past experience of conducting evaluation on mobile games.

B. Usability tests on Playability Heuristic Evaluation System

In order to validate the usability of PHES, several tests are conducted to ensure that the system is working properly. Six usability participants participated in the testing of the system, all of the participants are working in software developing companies and have good expertise of testing web based systems. All participants were invited to gone through the interface of the system to detect usability problem. Participants were also asked to give further suggestions for improvement of system. Once the usability of systems is fully tested and system is operational, the actual heuristics evaluation is planned to be conducted using PHES.

1) Test I: Heuristic Evaluation on Mobile Games.

In test I, heuristic evaluation is carried out using manually. Five participants were involved in this study. Each participant was provided a mobile phone, on which mobile games were installed. Problem report sheets and a list of playability heuristic are also given to the participants. At the beginning and end of each session, researcher noted the time of each participant, to measure the total time spent on one game.

2) Test II: Heuristic Evaluation using (PHES) on mobile games.

Before conducting heuristics evaluation on playability heuristic evaluations system, PHES meant to be ready to conduct evaluation, so the necessary activities are carried out. The games to be used in evaluation with all details i.e. (game genre, mode, platform, and description), are stored in PHES. The playability heuristics to be used in evaluation are stored with respect to their categorized.

From the requirement gathered, PHP / HTML5 /CSS /Ajax are selected for development of system and MySQL taken as basic database tool for creating and storing necessary records. All the development process planned to under Microsoft windows operating system.

Five participants were recruited to participate in heuristics evaluations using PHES. All these participants are involved in manual heuristics evaluation during case study I. Before starting evaluation, all the participants are briefly introduced with the functionality and the purpose of developing this system. Moreover, they were briefly presented to the basic operations of the system, i.e.

The evaluation is carried out in Usability lab, Department of Computer & Information Sciences, University Teknologi PETRONAS, Malaysia. The usability lab is well settled to conduct evaluation in a controlled and undisturbed environment. Each participant was provided, a mobile device on which games are installed, and a desktop computer on which PHES was online. Participants are advised to ask for assistance if any difficulty they face during evaluation. The evaluation is arranged in one day session, each participant are advised to evaluate two games.

At the end of the session mobile devices are collect from participants and each participant were asked some questions about their experience of using PHES. They were also asked to report any problem they faced during evaluation relating to ease of use or any usability problem with interface of PHES.

IV. RESULTS AND DISCUSSIONS

Playability heuristic evaluation system (PHES) is developed to improve the process of conducting heuristic evaluation. In this regards, using PHES, efficiency and effectiveness of heuristic evaluation is improved and took less time as compare to manual process. The idea of automation the process of heuristic evaluation was adopted from literature and suggestions of usability inspectors. Using PHES, the whole process is conducted using this system, participants stored each identified problem and assign severity to the problem. This system is very much flexible that the participant can review the reported problems and modify the problem if necessary. Moreover, the participant can only review and modify the problem which is reported by itself. The purpose of integrating this security technique is to avoid the biased results. If this system allows to review problems reported by other participants, there is a chance of duplication is results. The effect of duplication in results can lead to identical problems and many problems could remain unidentified. In this regards, maximum number of problems couldn't be explored.

Moreover, the design of this system is not only specific to evaluate mobile games with one set of heuristics. However, the system is very much flexible that different heuristics can be used, depend on the requirements of evaluation, i.e. different researchers have proposed heuristics for different type of games, so multiple or single set of heuristics can be used using this system. Additionally, the PHES is also capable of storing evaluation records, heuristics record, and games for future use.

A. Usability Tests on PHES

Usability study was conducted on playability heuristic evaluation system (PHES), in order to validate the functionality of the system. At the beginning of session, each participant was briefly presented the purpose of developing this system and its importance in context of research. Each participant was asked to go through the system to find out the usability problems. They were advised to inspect the following factors, website navigation, accessibility, flexibility, ease of use, website design & layout, website functionality. Participants reported and wrote down each problem and at the end of session each participant was asked several questions regarding possible improvements in system.

Usability practitioners generally liked the objective and concept of developing the PHES. They reported that the navigation of the system is very simple and understandable. Participants didn't faced any difficulty to navigate from one menu to other. However, they have reported that the navigation can be improved by placing the navigation tracking information. Moreover, it is reported the system is very much easy to use, the terminologies used in this system is very simple and understandable. However, usability practitioners found that some terminologies are technical and novice user may not understand.

It is also reported by usability practitioners that website layout and colors are well structured and elegant. Font size and colors are very much graceful that it can be easily readable and found no effect on eyes. Additionally, the system is fully functional and ready to use for heuristics evaluation.

B. Heuristic Evaluation using PHES

This study conducted a heuristic evaluation on mobile games using PHES. The objective of conducting this study is to measure the effect of automatizing the process of heuristic evaluation. Five game practitioners participated in this evaluation, all these participants are experienced and conducted traditional heuristic evaluation in previous studies. To ensure that PHES is effective method for evaluating games. In this regard, this research study conducted a comparative study of traditional heuristic evaluation and automate heuristic evaluation using PHES.

In Test I, five participants were asked to evaluate games using manual heuristic evaluation method. Table III shows the problem identified with manual heuristic evaluation. While participants were busy in evaluating games, their start and ending time of evaluation time was noted without knowing them. This approach is implemented to calculate the average time of each evaluator with respect to number of problems identified.

TABLE III.   PROBLEMS IDENTIFIED USING MANUAL HEURISTIC EVALUATION

Participant	No. games	Problems Identified	Problem mean	Time spent(minutes)	Time mean
A	2	14		51	
B	2	10		41	
C	2	12	11.2	39	46.8
D	2	9		44	
E	2	11		59	
Total		53		234	

TABLE IV.   PROBLEMS IDENTIFIED USING PHES

Participant	No. games	Problems Identified	Problem mean	Time spent(minutes)	Time mean
A	2	14		43	
B	2	11		39	
C	2	13	11.8	33	39
D	2	10		32	
E	2	11		48	
Total		59		195	

In Test II, same participants were asked to evaluate games using PHES. Results of evaluation are shown in Table IV. PHES has ability to calculate the time of each evaluation itself. So, the research does not need to note the time manually. The time calculating feature of the PHES is not visible to evaluator. Showing time to evaluators may affect the mind of evaluator and it may try to finish it quickly, which leads to unidentified problem. Following are the benefits of PHES observed in this study.

1) Time saving.

It is reported by participants that, it is easy to browse heuristic if needed during reporting a problem as compared to manual paperwork. Moreover, participants reported that reporting and assigning severity to problem is much more comfortable. Some participants express their personal opinions that, they no more prefer to write on paper, they feel easy and comfortable to type. In this regard, PHES facilities users to report more problems in short time. From table 1, the first case study has identified, the total 53 playability problems with mean of 11.2 per evaluator (Table 1). Total time spent on evaluation is 234 minutes with mean of 46.8 minutes per evaluator. In second case study, the total 59 playability problems are identified with mean of 11.8 per evaluator (Table 2). Total time spent on evaluation is 195 minutes with mean of 39 minutes per evaluator.

Based on this experimental study, this research has proved automate the process of heuristic evaluation is efficient. 39 minutes could be used by evaluators to identify new problems.

2) Flexibility

This PHES is very much flexible that it is not only designed for evaluating mobile games with one set of heuristics. Although, it is very much flexible that multiple set of heuristic can be used at same time. Moreover, this system can be used to evaluate other type of games, such as, computer games, console games, etc.

3) Reporting

In this regard, usability team doesn't need to compile and store the results of evaluation in any other software tool. PHES has its own database and data reporting form.

Development and Maintenance cost. This development and maintenance cost of this system is as part of MSc studies at University Teknologi PETRONAS, Malaysia.

4) Remote Heuristic Evaluation

This system is web based system, so it facilitate the evaluators located at different to conduct heuristics evaluation remotely. This approach enlighten the boundaries of heuristic evaluation to specific usability environment.

V. CONCLUSION

Based on the finding of this study, PHES is acceptable and proved to be efficient as compared to traditional heuristic evaluation. All the participants like the new method of conducting heuristic evaluation by automatizing it. By time saving feature of this system, evaluator can spend more time on identifying other playability problems. However, some participants given recommendations for future improvements of playability heuristic evaluations system. In future work, the method of evaluating user experience will be integrated in PHES.

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