Heuristic Evaluation of "PaPaYa PokPok": Case Study of a Mobile Game

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(Received: *April 19, 2019*; Revised: *August 7, 2019*; Accepted: *August 8, 2019*)

ABSTRACT

Usability of mobile games is vital for the $52 billion mobile gaming industry. It is critical to ensure game acceptance, which contributes to better player engagement and accomplishment. One successful method to ensure good usability is heuristic evaluation. Heuristic evaluation is the frequently used techniques for finding usability problems. Heuristic evaluation has been proven useful in game development. This paper presents the results of heuristic evaluation on the popular mobile game, PaPaYa PokPok as a case study. Six evaluators analyzed six objectives using 44 unique heuristics to identify usability issues. Results suggested that while it is an interesting game, it has room for improvement. The game was created to promote the importance of Thai cuisine. The game was once ranked number one in the top free apps on the App Store. The results of this study provide insights to mobile game developers in order to improve usability.

Keywords: Usability, Heuristic evaluation, Mobile game

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Introduction

Mobile game apps are ranked the fourth largest segment of the mobile app market in terms of time spent after social media, music, and multimedia. The mobile gaming industry is generated approximately $52 billion in revenues with a share of 45% of the global games market [1]. 3.3 billion mobile connections exist worldwide and the number is continued to rise [2]. Of these, 2.3 billion are smartphone users and 23 million are within Thailand [3]. A mobile game app can create revenues above and beyond the initial purchase unlike traditional games, by monetizing the ongoing engagement with users. These mobile game revenue models contrast with traditional revenue models of non-mobile games played on consoles where revenues come first and foremost from sales [1]. Accordingly, there has been an ongoing interest in the design of mobile games as a tool for training, health, socialization, especially for education [4]. Thus, playing mobile games may promote learning because of the interaction and intrinsic motivation these games provide [5].

The expand in mobile game industry led game developers and research scholars to discover the reasons behind games success. Mobile users get their first impression after interacting with the game thought its interface [6]. Like other apps, ensuring mobile game apps are usable; measuring usability is a crucial task. Usability is a key factor in mobile games. Usability is the extent to which a product can be used with “effectiveness”, “efficiency”, and “satisfaction” in a specified context of use [7]. Effectiveness and efficiency refer to a user’s ability and performance in completing tasks with the product and user satisfaction is a result of succeeding in task completion. A usable product is often easy to learn and easy to use [8]. However, games are most entertaining when they provide adequate challenge for a user, for example, in learning the game, solving problems, or discovering new things. A good gaming experience comes from the good user interfaces. Games should be convenient, reliable, and usable so that the user can concentrate on playing the game and enjoying it instead of having difficulties with the user interfaces. Playing a game is not straightforward. It is challenging, and the user needs to work towards goals. Mobile games have become more complex over the years [9]. Usability heuristics are designed for evaluating the user interface of the application. Both games and usability have long histories. Microsoft was the first to apply the usability evaluation techniques to game development in 1997 [4].

One successful of methods to ensure good usability is heuristic evaluation, which has been introduced in the game context [10]. Heuristic evaluation has been proven useful in game development [10]. It is an expert based inspection method on the investigation of the system according to design heuristics. Heuristic evaluation looks at the user interface and identifies the problems. The evaluators use a list of rules for identifying potential issues. They look at the screens one by one, trying to determine where the rules are violated. These rules identify potential issues that otherwise would have been overlooked. Nielsen and Molich [8] proposed a set of ten guidelines to be used as Heuristics for evaluating an interface after conducting a factor analysis of 249 usability problems. Heuristics means “rules of thumb”. Heuristics evaluation is s systematic process of inspection of a user interface for usability problems. It is both a “before design” and “after design” evaluation and rating method. It is an integral part of an iterative design processes.

Objectives of the study

The objectives of this study are: (1) to evaluate a popular mobile game, PaPaYa PokPok using heuristic evaluation; and (2) to provide insights to mobile game developers in order to improve usability.

PaPaYa PokPok

The game to be evaluated in this study is briefly introduced here. PaPaYa PokPok mobile game was selected as the case study subject (see Figure 1). The game was created by two undergraduate students and an advisor at the authors' university. The game was first released for iOS platforms on 10 November 2012 with approximately 400,000 downloads. The game was once ranked number one in the "top free apps" on the App Store and is currently rated at 4.1 out of 5 by 108 users. Added to this, the game had received the "Best Inventions Award" in 2011 from Rangsit University; and the development grant from the "Open House for Young Talents 2011" project, organized by the Software Industry Promotion Agency (SIPA). It is due for update. The latest version of the game is 1.5. The game has never been tested in a formal way by the developers. It is a cooking game according to the given ingredients and needed to put these ingredients correctly. The game is divided into ten stages and it is popular amongst many players. In each stage, players can win the game by successfully cooking and serving orders. Nonetheless, the game promotes the importance of Thai food known as "Papaya Salad". The game serves as a medium for players to think about Thailand.

Figure 1 Screenshots of PaPaYa PokPok

Methodology

This study conducted an exploratory study to examine usability problems of the mobile game, PaPaYa PokPok using heuristic evaluation method. In addition to this, the most well-known heuristics developed for "game design" are presented in the studies by Rutz, Aravindakshan and Rubel [1], Korhonen and Koivisto [9], Desurvire, Caplan, and Toth [11], Federoff [12], and Pinelle, Wong, and Stach [13]. The studies by Desurvire et al [11], Federoff [12], and Pinelle et al [13] were designed for a video game genre; and may not cover all aspects of mobile games. In particular, the studies by Desurvire et al [11], and Federoff [12] both focused on player fun and engagement. However, these studies did not comprehensively covered usability in detail. Pinelle et al [13] focused on usability and introduced heuristics for video games; while the study Korhonen et al [9] proposed a model designed for mobile games. However, there is no single set of heuristics from the mentioned studies was sufficiently

valid and completely comprehensive. In this study, the defined six objectives, 44 heuristics specifically tailored for mobile games were adopted from the studies by Alhaidary and Altammami [6] and Almeida, Mealha, and Veloso [14].

Participants

The study was conducted with six evaluators to identify usability problems following the studies by Nielsen and Molich [8], Almeida et al [14], Almarashdeh and Alsmadi [15], Bozyer and Durdu [16], and Perry, Kulpa, Pinheiro, and Eichler [17]. The evaluators are classified as double-experts. On average, each evaluator may discover about 20%, 40%, or 60% of usability problems depending on whether they were novices, single-experts or double-experts [15]. The evaluator was defined as a professional whom had professional knowledge and experiences in the Human-Computer Interaction (HCI), software engineering and mobile applications. Furthermore, three of the evaluators were familiar with the game (Eva_{1-3}) and other three evaluators have no experience with the game (Eva_{4-6}) [6, 18].

Instrument and heuristics used in analysis

This study has consolidated the heuristic evaluation models from the studies [6, 14] as follows: O_1 *the game should have mechanisms that facilitate the player's learning process and general gameplay* (facilitate learning) [6, 14]; O_2 *the game should be easy and enjoyable to play but have some complexity to engage the player* (easy and enjoyable) [6, 14]; O_3 *the player should be able to identify his actions in the game and respective feedback* (feedback) [6, 14]; O_4 *the game should be graphically appealing without overriding game play and be customizable* (graphically appealing) [6]; O_5 *the game should be accessible to any person or player* (accessibility) [6]; and O_6 *the game should be suited for mobility* (mobility) [6], see Figure 2. Once these objectives and supporting heuristics have been defined, evaluators are to undergo the study. Each evaluator spend time to test the game interface and produce a list of heuristic violations. In total, 44 heuristics in six objectives were used to evaluate the game.

O_1 consists of 12 heuristics as follows: H_1 tutorial provided at beginning of the game; H_2 tutorials are repeatable; H_3 help is clear and informative; H_4 match between system and real world; H_5 customizable controls; H_6 errors are prevented with warnings and messages; H_7 player is involved quickly and easily; H_8 game gives hints and suggestions; H_9 a game manual is not required to play; H_{10} non-playable content can be skipped; H_{11} information is displayed in various forms; and H_{12} player has full control over game [6, 14].

O_2 consists of 11 heuristics as follows: H_{13} game difficulty can be changed; H_{14} there are multiple game goals; H_{15} game is balanced: no definite way to win; H_{16} challenge, strategy, and pace are in balance; H_{17} game gives rewards; H_{18} the first-time experience is encouraging; H_{19} game is re-playable; H_{20} player does not rely on memory to play; H_{21} player experiences fairness of outcomes; H_{22} there are no repetitive or boring tasks; and H_{23} the player sees the progress in the game and can compare the results [6, 14].

O_3 consists of four heuristics as follows: H_{24} player score/status is identifiable; H_{25} feedback provided through sound; H_{26} all feedback is immediate; and H_{27} there are multiple forms of feedback [6, 14].

O_4 consists of nine heuristics as follows: H_{28} interface is consistent in color and typography; H_{29} screen layout is efficient and visually pleasing; H_{30} the player understands the terminology and art used in the game; H_{31} all relevant information is displayed; H_{32} the interface is non-intrusive; navigation is consistent; H_{33} logical, and minimalist; H_{34} the game story supports

the gameplay and is meaningful; H_{35} visual and audio effects arouse player interest; and H_{36} audio, video and graphics settings are customizable [6].

O_5 consists of four heuristics as follows: H_{37} icons size are adjustable; H_{38} game has accessible language; H_{39} game actions description can be turned on/off; and H_{40} the player cannot make irreversible errors [6].

O_6 consists of four heuristics as follows: H_{41} the game and play sessions can be started quickly; H_{42} the game accommodates with the surroundings; H_{43} interruptions are handled reasonably; and H_{44} the player can easily turn the game off and on and be able to save games in different states [6].

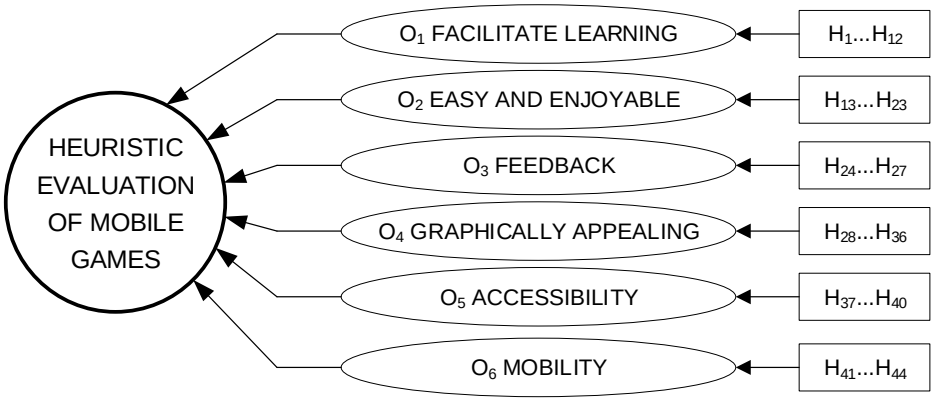

Figure 2 Heuristic evaluation models adopted from the studies [6, 14]

Procedures

Evaluators were asked to play the game while examining how it supported or violated each heuristic. The main objective of heuristic evaluation in this study is to identify possible difficulties with the game. In this study, heuristics were rated as "1 to 3" were considered as *having a usability problem* based on the severity of usability problems on a 1 to 5 rating scale [16]. The following 1 to 5 rating scale can be used to rate the severity of usability problems: "5" equals to there is no usability problem at all; "4" indicates that it is a cosmetic problem only; "3" is a minor usability problem; "2" is a major usability problem; and "1" is a usability catastrophe.

Results

The results of the evaluation reveal that 26 of the 44 heuristics (59%) were verified. These heuristics were H_1, H_2, H_4, H_8, H_9, H_{11}, H_{14}, H_{15}, H_{16}, H_{17}, H_{18}, H_{19}, H_{20}, H_{21}, H_{24}, H_{25}, H_{26}, H_{27}, H_{28}, H_{29}, H_{32}, H_{33}, H_{34}, H_{35}, H_{40}, and H_{42}. Based on the evaluations, the percentage of heuristics verified for each objective was calculated. O_3 (feedback) was fully verified at 100%. This is followed by O_2 (easy and enjoyable), 73%; O_4 (graphically appealing), 67%; and O_1 (facilitate learning), 50%, respectively. O_5 (accessibility) and O_6 (mobility) had the least heuristics verified, both at 25% (see Table 1).

Table 1 Percentage of heuristics verified for each objective

Objectives	% of Heuristics Verified
O_1 Facilitate learning	50%
O_2 Easy and enjoyable	73%
O_3 Feedback	100%
O_4 Graphically appealing	67%
O_5 Accessibility	25%
O_6 Mobility	25%

O_1 (facilitate learning) was evaluated with 12 heuristics, resulted in *six* heuristics being verified. The evaluators agreed upon: the game's tutorials at the start of the game (H_1); and the repeatable tutorials for the first-time player and those who return to the game (H_2), the match between system and real world (H_4), the hints and suggestions (H_8), a manual is not required to play the game (H_9), and information is displayed in various forms (H_{11}), see Figure 2. Similar procedures were performed to the rest of heuristics.

Figure 2 Screenshots from PaPaYa PokPok with the tutorial

O_2 (easy and enjoyable) was evaluated with 11 heuristics, resulted in *eight* heuristics being verified. Overall, the game was felt by the evaluators to be easy and enjoyable to play but had some complexity to engage the player. The evaluators agreed that the game difficulty cannot be changed by the player (H_{13}); and the game had some repetitive tasks (H_{22}). Five of six evaluators saw the progress in the game and were able compare the results (H_{23}).

O_3 (feedback) was evaluated with four heuristics, resulted in 100% verified by the evaluators. These heuristics were the player 's identifiable scores (H_{24}); the feedback provided through sound (H_{25}); all feedback was immediate (H_{26}); and there were multiple forms of feedback (H_{27}), see Figure 3.

Figure 3 Screenshots from PaPaYa PokPok with O_3 feedback

O_4 (graphically appealing) was evaluated with nine heuristics, resulted in *six* heuristics being verified. Overall, the evaluators agreed that the interfaces were logical, and minimalist (H_{33}). The game was visually pleasing with its colors and typography ($H_{28, 29}$). Its interfaces were non-intrusive; as well as the navigation was consistent (H_{32}). Not all evaluators agreed on the visual and audio effects would stimulate player interest (H_{35}). Two of the six evaluators did not believe that the game story supports the gameplay and is meaningful (H_{34}).

Table 2 Heuristics that were rates as having usability problems

$O_{1...6}$	ID	Heuristics	Evaluators (given rates)	Mean	S.D.
O_1	H_3	help is clear and informative	Eva_1 (1); Eva_3 (3)	3.5	1.378
	H_5	customizable controls	Eva_1 (2); Eva_3 (1); Eva_5 (2); Eva_6 (2)	2.5	1.225
	H_6	errors are prevented with warnings and messages	Eva_2 (2); Eva_3 (3)	3.5	.837
	H_7	player is involved quickly and easily	Eva_5 (3); Eva_6 (3)	3.67	.516
	H_{10}	non-playable content can be skipped	Eva_1 (3); Eva_3 (3); Eva_5 (3); Eva_6 (3)	3.33	.516
	H_{12}	player has full control over game	Eva_4 (3); Eva_6 (3)	4.00	.632
O_2	H_{13}	game difficulty can be changed	Eva_1 (2); Eva_3 (3); Eva_5 (3); Eva_6 (2)	3.33	1.366
	H_{22}	there are no repetitive or boring tasks	Eva_1 (3); Eva_2 (3); Eva_3 (3); Eva_4 (1); Eva_5 (3); Eva_6 (2)	2.5	.837
	H_{23}	the player sees the progress in the game and can compare the results.	Eva_4 (3)	3.83	.408

Table 2 Heuristics that were rates as having usability problems (Cont.)

$O_{1...6}$	ID	Heuristics	Evaluators (given rates)	Mean	S.D.
O_4	H_{30}	the player understands the terminology and art used in the game	Eva_5 (3); Eva_6 (3)	3.83	.753
	H_{31}	all relevant information is displayed	Eva_1 (3); Eva_5 (3)	3.67	.516
	H_{36}	audio, video and graphics settings are customizable	Eva_1 (2); Eva_3 (1); Eva_5 (3)	3.00	1.265
O_5	H_{37}	icon sizes are adjustable;	Eva_1 (2); Eva_2 (2); Eva_4 (3)	3.17	.983
	H_{38}	game has accessible language	Eva_1 (2); Eva_2 (3); Eva_3 (3)	3.33	.816
	H_{39}	game actions description can be turned on/off	Eva_1 (2); Eva_2 (3); Eva_3 (3); Eva_5 (3); Eva_6 (3)	3.00	.632
O_6	H_{41}	the game and play sessions can be started quickly	Eva_1 (3); Eva_2 (3); Eva_4 (3)	4.00	1.095
	H_{43}	interruptions are handled reasonably	Eva_2 (3)	3.83	.408
	H_{44}	the player can easily turn the game off and on and be able to save games in different states	Eva_1 (3); Eva_2 (3)	3.83	.408

O_5 (accessibility) consists of four heuristics to verify the game accessibility. Three of four heuristics received different opinions by the evaluators while only one heuristic was verified. There was a discrepancy among the evaluators on the icons size are adjustable (H_{37}), the accessible language (H_{38}), and the actions description (H_{39}).

O_6 (mobility) measures the game mobility with four heuristics. The game was to be able to play anywhere and anytime. Only, the game accommodates with the surroundings (H_{42}) was verified by the evaluators. The evaluators pointed out that the "shake" gesture with the game in public places that may cause embarrassment to the player.

Based on the above evaluation, usability problems found in the 18 of the 44 heuristics are presented in Table 2. Five of the 18 problems (28%) were identified by the experienced with the game evaluators while four (22%) were identified by the inexperienced with the game evaluators. In addition, nine problems (50%) were determined by both experienced and inexperienced with the game evaluators. The non-gamer experienced evaluators stated that it would be difficult for players to increase level without accomplishing tasks. Serious usability issues of the game were related to help (H_3), customizable controls (H_5), and the repetitive or boring tasks (H_{22}).

Discussion and Conclusions

This study reports on a heuristic evaluation of the mobile game, PaPaYa PokPok. 44 heuristics which were grouped in six objectives were used for the evaluation. Heuristics that were rated between *one* and *three* by the evaluators were considered as

having a usability problem. The results indicate that the game did not comply 18 of the heuristics. It is evident that the evaluators who have less experience with the game were not able to verify certain heuristics due to their lack of familiarity. This finding is consistent with the heuristic evaluation of "Guild Wars 2" by [16] that experienced players reveals more problems than inexperience players. Knowledge and experience about the game is essential during the heuristic evaluation. On the other hand, [16] also reported that inexperience players could revealed some problems which missed by experienced players. In this study, the inexperience with the game identified four issues of: player is involved quickly and easily (H_7), player has full control over game (H_{12}), the player sees the progress in the game and can compare the results (H_{23}), and the player understands the terminology and art used in the game (H_{30}).

Moreover, this finding is also in line with the works reported in "Hay Day" by [6]. One of visible flaws found is related to game input which is limited to the "shake" gesture. It is felt that implementing other controls such as "tap" gesture could be a valuable addition and expand the game. Furthermore, what a player does in the game is essentially final, as there is no possibility of undoing what a player does. This result is consistent with the study of "FarmVille" by [14].

While not all heuristics were verified, only *one* received consensus negative evaluation, while the rest 17 heuristics received diverse responses. This suggests that the game has addressed most heuristics to accomplish a positive player experience. Nevertheless, not complying with all heuristics does not necessarily lead to lower ratings [6]. This is reflected in the statistics showing the number of downloads that exceeds four hundred thousand and good user ratings (4.1 out of 5). However, heuristics evaluation presented in this study demonstrates that there is room for improvement specifically to enhance the experience of players.

One point needs to be noted in this study was the "language" used in the interfaces. This study also looked at options about word choices used in the labels and languages. In general, labels are used by players to understand the game's environment. Languages are used by the game to communicate with its players. Languages are more complicated than labels. Players lean on languages between "What is going on?" and "What should I do next?". Experienced players tend to skip instructions. This is because they assume, they know what they are doing. Inexperienced players are altering a huge amount of information as they move along the game stages in their mind and feeling overwhelmed; and hoping things will be okay if they go with it. Yet, the use of language is important when it comes to player experience. While English was used in the interfaces of the game, it is not comprehensive. For example, only Thai was used in the guidebook and tutorial's interfaces. There are no language options in the game. English should be included where appropriate. English is a good way to reach a global player. Thus, when evaluating the language used in an interface; it is not only the actual text on the interface. It is also the readability level of the text, the scannability of the text, the tone used, and the fonts used.

Limitations and Suggestions for Future Research

Whereas, this study adopted the heuristic evaluation method with the expert evaluation; as in all research, the research presented here does have its limitations. Heuristic evaluation is an easy and fast method in discovering usability issues. Expert evaluations conducted by utilizing proposed heuristics is the most common approach found in the

literature. There are other methods such as empirical evaluations, inspections and evaluations using mixed methodology. Empirical evaluation method includes studies conducted through user-testing methods such as surveys, interviews, focus groups and observations with a sample group of minimum 10 participants. Next, the inspection methods included articles which based on (1) review of existing literature to achieve a generic point-of-view towards heuristic evaluation; and (2) through the collection of information from common game reviews to offer a larger sample size. The final method involved mixed method modality, combining empirical research, expert evaluation and/or inspection methods.

Heuristic evaluation may vary according to the way the game is introduced to the evaluators, the way the evaluators look at the game, the evaluator's background, etc. Evaluators may work in isolation or may be asked to come up with a combined list where each problem is mentioned.

Another point to be noted here is that heuristic evaluation and usability testing are two different techniques for finding usability problems. With heuristic evaluation, an evaluator looks at the game interface and identifies the problems. With usability testing, potential players try out the game interface with real tasks. The problems found with heuristic evaluation are potential problems; while the problems found with usability testing are true problems in the sense that at least one player encountered each problem.

This study contributes to understand the game design and usability issues better, especially from the Thai context. the game designers must satisfy the needs of players to ensure a successful outcome. To achieve that, players needs should be reflected in the design not only by gathering the requirement. The future study should also emphasis on the existing domains of mobile interactions, mobile game evaluation under education aspect and formal game evaluation conducted.

Future work can be extended to other mobile game genres such as puzzle, arcade, action, family, educational, adventure, strategy, board, simulation, and trivia. The future study may also adopt the heuristic evaluation of the game from users' perspective, and the automated heuristic evaluation for usability. Finally, the localization of games should be considered. At least navigation elements and some content should be appeared in the local language and English.

Acknowledgements

The authors express the sincerest thanks to Mr. Montri Inthachot for his contributions to this research.

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