Heuristic Evaluation of Play4Fit Health and Fitness App: A Comparison Between Experts and Novices Evaluators

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Abstract. Heuristic evaluation (HE) can be used to effectively identify usability issues in various interfaces. However, it has not been widely used in evaluating smartphone apps, especially in the health and fitness domain. One reason is the lack of HCI experts, which makes incorporating HE into the design process difficult. This paper presents the results of a study that compared HE performed by three HCI experts and three novices in evaluating a gamification app for health and fitness on a smartphone. The study used Smartphone Mobile Application heuRisTics (SMART), which focuses on smartphone apps, and a severity rating scale to determine the severity of the usability issues. These issues were mapped to the SMART heuristic. The findings indicate that novices may identify usability issues that the experts overlooked. While the experts identified eighteen usability issues, the novices found only four; however, the novice's findings may be used as a substitute for HE when experts are unavailable. Both experts and novices identified two similar usability issues, but their severity ratings differed. One possible solution to address the lack of usability issues identified by novices in HE is to use more novices instead of experts in the evaluation process.

Keywords: *experts; gamification; heuristic evaluation; health and fitness; novices; smartphone app.*

1 Introduction

The advent of digital technology has significantly changed the way people interact with various devices as they spend significant amounts of time on computers, tablets, smartphones, and television. Unfortunately, the excessive use of technology has led to unhealthy habits, particularly among teenagers, such as excessive television time and uncontrollable extreme dieting [1]. In 2011, teenagers spent nearly two hours a day on online activities and approximately three hours watching TV [2]. Meanwhile, the average daily smartphone time was almost three hours in 2019 [3]. Consequently, their physical activity time has significantly reduced, leading to physical and mental issues [4]. Regular exercise can reduce stress, anxiety, depression, obesity, coronary heart disease, heart failure, and cancers, among other health issues [5], [6]. Therefore, it is essential

Received July 7th, 2021, Accepted for publication June 16th, 2023.
 ISSN: 2337-5795,
DOI: 10.5614/j.vad.2023.15.1.2

to encourage individuals, particularly teenagers, to engage in regular physical activity to maintain good health and wellbeing in the digital age.

Digital technologies have become increasingly important tools for promoting health and fitness activities [7], transforming how people seek help anonymously and autonomously and encouraging them to seek assistance on critical health issues such as alcohol consumption [8], to support consumer healthcare [9], and to promote changes in behavior interventions [10]. Wearable technology has also been used to promote health and fitness, revolutionizing the design and use of technology to enhance health and fitness [11], as exemplified by devices such as Fitbit Flex, Garmin Vivo Active, and Apple Watch. Smartphones and wearable technology have redefined the design of health and fitness improvements using gamification. Gamification is an emerging approach to instruction that uses game elements, game mechanics, and game-based thinking to facilitate learning and motivation [12]. It has been defined as using design elements useful in non-game contexts [13]. To be effective, gamified technology must be designed to outperform certain development models and influence people's beliefs, attitudes, or behaviors. For instance, in health and fitness activities, a developer may transform a non-game activity, such as exercising at home using different fitness styles, into a game that could potentially increase enjoyment and engagement by incorporating game elements, such as earning badges for fitness performance [14]. Designers must consider all factors, including input of users on how they think, feel, and behave, and use that information or knowledge in the design of technology [15]. Previous studies have demonstrated the positive impact of gamification on motivating behavioral changes in health. For example, it increases students' sense of recognition through success or failure and achievement [16]. Additionally, it enables users to experience different emotions, such as frustration and anxiety. Previous research has suggested that carefully designing tasks and activities with an appropriate level of challenge or difficulty is crucial in reducing anxiety or high frustration levels [17].

Heuristics evaluation (HE) is a method for determining the usability of a user interface. It involves multiple evaluators to ensure that all usability issues are identified. Research has shown that involving five evaluators can identify up to 75% of usability issues, compared to only 25% with just one evaluator [18]. Nielsen [19] suggested using three to five evaluators would identify 75% of usability issues. HE can be conducted by an expert with experience and understanding of interfaces [20]. However, it is not mandatory, and HE can be performed by domain knowledge experts, usability experts, or both [21]. HE has many advantages, such as being relatively inexpensive and fast, being conducted at any point in product development, identifying most issues, and providing an overview of the complete design [22]. This study used HE to identify usability issues in a health and fitness smartphone app, particularly focusing on the user

interface design. The aim was to provide valuable insights into improving the app's user experience (UX).

2 Rationale

A comprehensive analysis of 1,017 studies involving 10,449 participants has shown that remaining engaged in online programs is challenging, but gamification can increase engagement and enjoyment [23]. Gartner [24] revealed that up to 80% of failed gamification systems were poorly designed. In the health and application domain, the failure of gamification relies too much on motivating individuals and less on 'proper skill development', which can significantly impact behavioral changes [25]. Therefore, it is crucial to understand the concept of gamification, its mechanics, and how it can increase user motivation and engagement in physical activity [26]. Addressing the lack of HE integration in evaluating usability issues for health and fitness applications is also essential. For instance, studies [27], [28], and [29] only carried out usability evaluations without conducting HE for their developed app. Also, the lack of HE-integrating studies focusing on the gamification of health and fitness applications contributed to only 4% of 1,680 applications examined meeting the criteria [30]. Studies [31] and [32] incorporated the concept of gamification for their developed applications. Moreover, [33], [34] only used traditional Nielsen heuristics to assess the app's usability. Furthermore, there is a lack of research studies integrating HE between two different groups of experts and novices for health- and fitness-related applications. Therefore, this study aimed to (1) compare the usability issues of a health and fitness gamification application found by novices and experts; (2) determine whether novice evaluators are effective in identifying usability issues compared to experts; (3) use specific heuristics for smartphones in HE between the novice and expert groups.

3 Methodology

The Play4Fit app is a bespoke native Android-based application developed specifically for this study. Mobile Application Development Life Cycles [35] guided the smartphone app's design, development, and evaluation. This methodology comprised seven stages: identification, design, development, prototyping, testing, deployment, and maintenance. Only the first five stages will be highlighted here. During the first stage, the user requirements were analyzed by examining current issues with mobile gamification for health and fitness. Ideas from the current design of gamification applications were also considered. In addition, this study's target users, physical activity, and location were identified. The Play4Fit app focuses on physical activities such as running, walking, jogging, and kayaking, which takes place on university grounds, including stadiums, lakeside, and kayak recreation facilities. Finally, the Play4Fit app was designed

to address user engagement with the gamification app. The ideas from the first stage were then transformed into the initial design of the Play4Fit app by developing a storyboard user interface, which underwent three iterations. Subsequently, the storyboards were evaluated with targeted users to get feedback.

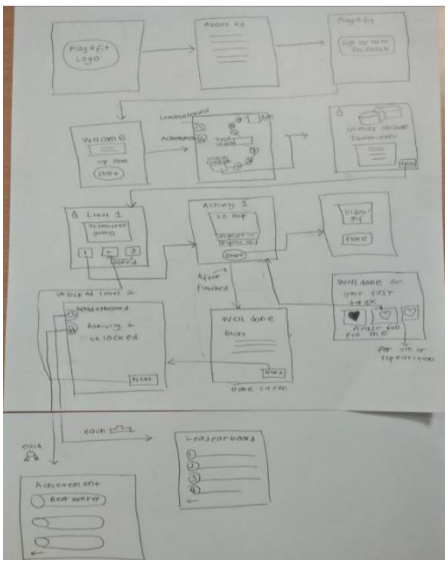

Figure 1 The first iteration of the storyboard.

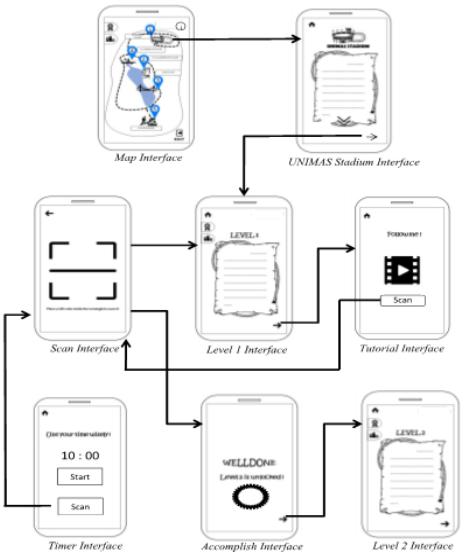

Figure 2 The final iteration of the storyboard for part of the activity of Play4Fit.

Figure 1 depicts the hand-drawn Play4Fit app storyboard. Later, the final version was developed using a wireframe tool to enhance its quality. Due to space limitations, only a portion of the final storyboard is displayed in Figure 2. The development of the Play4Fit app involved two distinct phases: (1) the app's core functionality was programmed, which included gamification elements such as badges, trophies, and leaderboards; (2) creating an intuitive user interface that would enhance the overall look and feel of the app. The Android SDK software was used for coding purposes, while the graphic design was created using the Adobe CS6 software. Figure 3 illustrates the final gameplay of the app. When users launch the app for the first time, they are redirected to the *Sign up* page and upon successful registration they are redirected to the *Sign in* page. After logging in, the users receive instructions and a map displaying the activity's location. The user is then guided through the app's usage and asked to complete various activities at specific locations. The activities and locations presented to the user are based on the game's elements of different levels, and the user must complete the activity within a given timeframe. After completing each activity, they can collect rewards and progress to the next level. The gameplay was designed using gamification elements such as levels, badges, trophies, and leaderboards to engage and motivate the user.

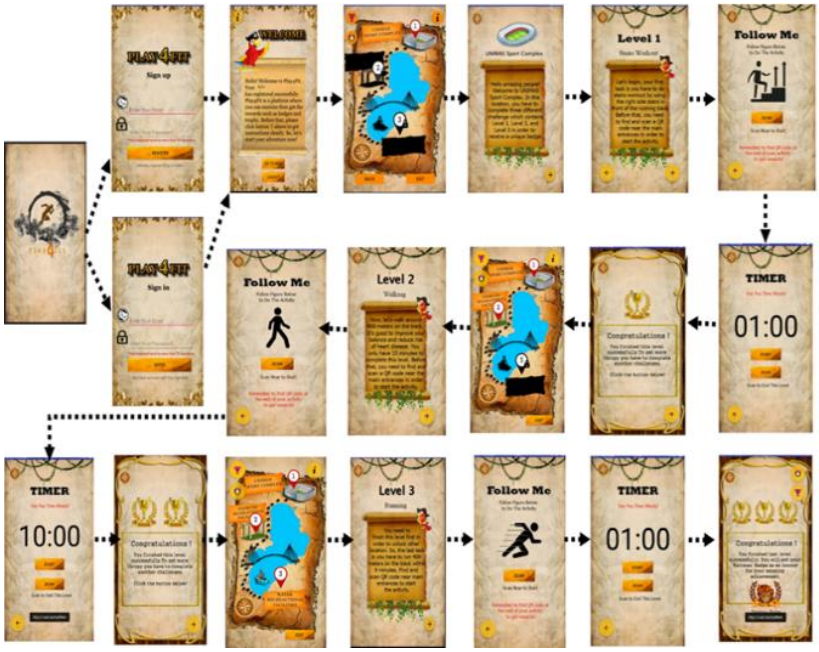

Figure 3 Final gameplay of Play4Fit.

This study employed the SMART heuristic developed by [36] to evaluate the usability of smartphone apps. The rationale for choosing the SMART heuristic in this study as specific heuristics was that it is well suited for a specific domain in detecting usability issues. While general heuristics are easy to use, they may not cover all usability issues for a specific domain. Other heuristics for smartphone apps are also available, as described in [37] and [38]. The Nielsen heuristic was not selected due to its weakness in addressing smartphone app usability issues, as highlighted by [37]. The mobile interface heuristic in [39] was not used because it does not focus on smartphone app icon usability. The TMD heuristics developed in [40] was not selected because it uses the same classification as Nielsen's heuristic. SMASH [38] and MATcH [41] were excluded due to similar problems identified in [36].

This study followed the standard procedure for HE. Six participants (three experts and three novices) were recruited to conduct the HE. The experts in this study were HCI lecturers aged 35 and 45 years, with extensive experience conducting various usability evaluations, well-versed with the process, and having conducted numerous HEs using different sets of heuristics. On the other hand, the novice evaluators were third-year undergraduate students pursuing Cognitive Science as their major. They had received relevant training, completed several courses in HCI, and had been exposed to various usability evaluation methods during their course. This study strictly followed all ethical procedures, as it involved human participants. The participants were briefed on the objectives and procedure of the HE evaluation and were assigned to two groups: experts and novices. Instructions sheets were provided as a guide. They were informed that their participation was voluntary, and they were asked to sign an informed consent form. The participants were told to take as much time as needed and were not rewarded for their participation. They were also informed they could withdraw from the evaluation process without prejudice. Participants were asked to familiarize themselves with the Play4Fit apps before conducting the HE. They were then asked to conduct HE individually and to browse the Play4Fit apps screen by screen before recording any usability issues on the provided sheets. Participants were asked to use severity rating scales: (0 – no usability issues at all, 1 – cosmetic usability issues, 2 – minor usability issues, 3 – major usability issues, 4 – usability catastrophe) [42] to rate the severity of the usability issues they found. After completing the evaluation, they were asked to discuss the usability issues and map them with the SMART heuristic. A SMART heuristic checklist was provided to guide the mapping. At the end of the HE, the researchers thanked the participants for their contribution and addressed their questions. After the HE was completed, the researchers consolidated the usability issues and compared the findings between the expert and novice groups.

4 Results

Table 1 summarizes the results of the HE conducted by the experts and novices, with the average severity rating being AVE and the corresponding SMART heuristic (#) for each usability issue identified. A total of 20 usability issues were found, with experts identifying 18 issues and novices identifying only 4. Two issues were found by both the experts and the novices, namely issue no. 3 and issue no. 10, but the experts and novices had different average severity ratings and disagreed on the SMART heuristic category for both issues. Issue no. 3 had a severity rating of 3.0 but with different SMART heuristic classifications, where the experts suggested #11 while the novices suggested #6. Similarly, for usability issue no. 10, the average severity ratings of experts and novices were 2.0 and 1.0, respectively.

Table 1 Average severity rating and SMART heuristics for experts and novices.

No.	**Usability Issues**	**Average Severity Rating**			
		Expert		**Novice**	
		AVE	**#**	**AVE**	**#**
1.	Too little information on the *trophy* interface to inform the user clearly about rewards.	2.00	#6		
2.	In each interface, the contrast icon and background do not match.	2.00	#6		
3	The pointer location icon on the *map* interface is not like an icon that can 'click.'	3.00	#11	3.00	#6
4.	There is no specific button (on the *map* interface) to return to the *welcome* interface.	3.00	#6		
5.	The home icon that navigates the user back to the *map* interface does not reflect the image.	3.00	#6		
6.	The start button on the *timer* interface has an unclear function.	2.00	#6		
7.	Information on the interface *badges* is not exactly accurate.	2.00	#5		
8.	The instructions for a certain level are too long.	2.00	#5		
9.	The button is not consistent across all interfaces.	2.00	#2		
10.	The app's background is not related to the fitness theme.	2.00	#2	1.00	#2
11.	The font is not consistent.	2.00	#2		
12.	The image for each *tutorial* interface did not match the activity.	2.00	#2		

13.	The icon makes it understandable.	2.00	#5		
14.	The back button in each instruction location interface is an intelligible and redundant function.	4.00	#6		
15.	The function of the exit button is not precise on a *well-done* interface.	3.00	#6		
16.	You do not need to *Sign up* & *Sign in*.	3.00	#5		
17.	No state completion when each level is finished.	3.00	#1		
18.	The alert sound on the *timer* interface during the activity session.	3.00	#1		
19.	The *interface login* should be on the first interface after the *splash screen* interface.			2.00	#5
20.	Button logout is supposed to be at the top of the *Welcome* interface.			1.00	#6

The expert group identified a highest rating of 4.0 for usability issue no. 14, while the novice group identified a highest rating of 3.0 for usability issue no. 3. The novice group identified only one major usability issue, accounting for 25% of the total issues, while the expert group identified 7 out of 18 usability issues, accounting for 39%.

After the HE, changes were made to Play4Fit. Examples of these changes can be seen in Figures 4 through 7. Specifically, Figure 4(a) and Figure (4b) demonstrate changes made to improve the visibility of reward information to address usability issue no. 1 as highlighted by the experts. In response to issue no. 7, also identified by the expert group, more information was added to each section to improve the user's understanding, as shown in Figures 5 (a) and 5(b). Finally, both the experts and the novices highlighted issue no. 3 regarding the map interface. Figures 6(a) and 6(b) demonstrate the changes. The evaluators found the location icon unclear, as it did not suggest tapping. Therefore, changes were made to the icon's affordance to enhance its function. Additionally, only the active level 1 location icon is displayed in white/red, while the inactive icon is in black. The expert group identified issue no. 14 concerning the 'back' button on the location 1 interface. They noted that this button had the same function as the compass icon on the top left of the screen in Figure 7(a). In response (Figure 7(b)), the 'back' button was removed from the interface to eliminate redundancy and enhance the UX.

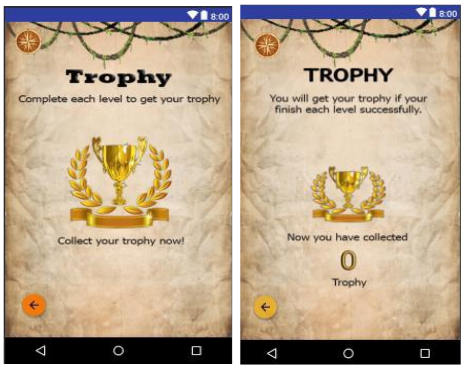

Figure 4 (a) left and (b) right: The trophy interface before and after HE.

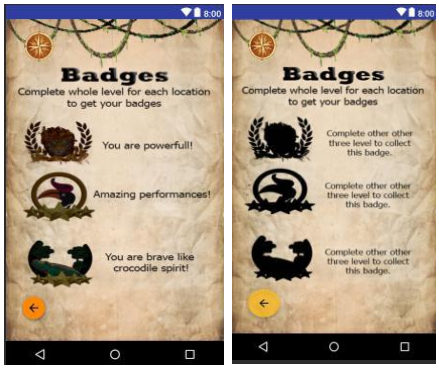

Figure 5 (a) left and (b) right: The badges interface before and after HE.

Figure 6 (a) left and (b) right: The map interface before and after HE.

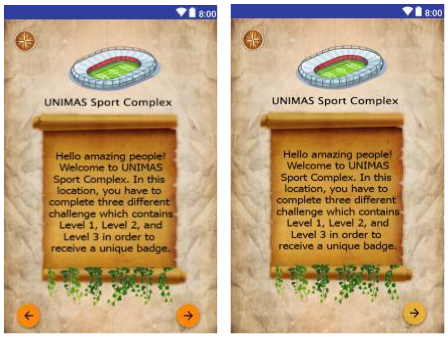

Figure 7 (a) left and (b) right: The location 1 interface before and after HE.

5 Discussion

Different types of usability evaluation have varying impacts on different stages of system development. User testing and expert evaluation are crucial in the system development lifecycle, allowing for identifying different issues at different stages. HE is a type of evaluation carried out during the early stages of system development and is usually conducted by an expert, although non-experts can carry it out as well. Perfetti [43] noted a growing trend of using non-usability experts in conducting HE due to its cost-effectiveness and ease of implementation. However, it is crucial to understand how individuals with varying levels of expertise assess the gamification of health and fitness, as experts and novices possess different knowledge and skills in usability. Furthermore, novices have limited knowledge of HCI design, lack experience, and may identify

only certain usability problems in a mobile interface. Conversely, experts can easily retrieve critical aspects of their expertise [44]. In our study, the experts identified there was too little information in the design of the trophic page and that only limited information was provided to the user on how to collect their reward (See Figure 4(a)). This issue was mapped with SMART #6, which suggests that a mobile interface should be designed with a simple navigable path and comprehensive information and instructions to enable users to accomplish their goals.

The experts also identified similar issues on different interfaces, indicating unclear information and instructions on collecting all badges were prevalent (see Figure 5(a)). A well-designed interface should provide clear and concise information and instructions for users to complete the tasks [45]. The expert evaluators used their knowledge and experience to assess the interface, while the novices drew from their past experiences with similar systems and limited knowledge from various courses. While this study confirms previous research that experts identify more usability issues than novices, as [46] suggested, it is important to note that the previous study used a different HE method, namely Collaborative Heuristic Evaluation.

Moreover, this study confirmed earlier findings that novices may also identify issues missed by experts across different HE methods using various heuristics and domain sets [47]. For instance, a prior study demonstrated that novice website users identified issues overlooked by experts [48]. Thus, this study reinforces the importance of including both expert and novice HE participants, given that they are future users of the app, which was designed based on feedback from university students. In this study, the novices identified two usability issues missed by the experts, emphasizing the significance of having both groups of evaluators. First, the novices recognized that the *Sign in* interface should be placed after the splash screen interface, drawing from their experience with various smartphone applications that placed it on the first page. This ensures clarity for users who already have an account and need to log in. As a result, it is easier to log into the first-page interface to prevent users from being confused and disrupting the UX and the quality of interaction with the app. The novice feedback corresponded to SMART #5, emphasizing the importance of using an intuitive interface to navigate the health and fitness app smoothly. Thus, novices may perform equally well or better than experts in identifying usability problems [49]. This study utilized SMART heuristics instead of traditional Nielsen heuristics, as not all usability issues can be mapped out with Nielsen's heuristic. Additionally, this study successfully mapped all usability issues to different SMART heuristics, unlike previous studies that showed Nielsen's heuristics fails to map all usability issues (i.e. [36,37,40]).

6 Conclusion

This study aimed to compare usability issues identified by experts and novices using heuristic evaluation (HE) on a health and fitness gamification application. The study identified 20 usability issues, with 18 identified by experts, four by novices, and two identical issues identified by both groups. However, it is important to acknowledge the perspective of novices, as they may identify usability issues that are overlooked by the experts, highlighting the importance of including both groups in evaluations. The study found that most usability issues identified by both groups were linked to SMART heuristic #6, which emphasizes designing a visually pleasing interface. A visually attractive interface enhances engagement and meaningful UX in health and fitness apps. Addressing usability issues before users can use them is crucial, as users often forgive a visually pleasing interface. This study revealed that two usability issues were identified by both groups and were rated differently in terms of their severity, indicating a potential disagreement between the two groups' views on the impact of such issues on users. Further research should explore the usability issues reported in the health and fitness gamification app literature and consider the consequences of not implementing HE in developing HE or other factors contributing to the UX.

Acknowledgements

We gratefully acknowledge the grant from the Ministry of Higher Education Malaysia (KPT) (FRGS/1/2020/SSI0/UNIMAS/02/4).

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