



# Evaluation of Mobile Applications User Interfaces: A Case Study of Children’s Mobile Applications

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**Abstract.** Phones developed from devices that provide simple service into more complex services providers where many application and opportunity are available to users such as taking pictures, playing games, editing videos and pictures, documents viewing etc. All of these enhancements lead to strong attachment between smartphones and people. Applications developed to meet users’ needs in different range of the society to hit high production and increase sales. Developer of these application taken under their consideration different characteristics that effect the performance and users adoption, where User Interfaces UI is one of the most critical part as it is the first interaction gate between users and the application. Evaluation of this part is necessary in order to get highly preferable application by the user, where evaluation is performed with users and without them. These two approaches used in this paper to evaluate children applications. Shneiderman’s golden rules used in usability measurement in addition to some criteria of the Software Usability Measurement Inventory SUMI by observing group of children while interacting with chosen application.

**Keywords.** User interfaces, Evaluation, Usability, Smartphones, Children application

**Mathematics Subject Classification (2020).** 90-04, 94-04

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## 1. Introduction

Phones evolution provide these devices with huge capability other than telephony stack such as games, calendars, browsing the web, checking emails, watching videos and many other tasks that fulfill users requirements that was available in PCs [19].

Development of application and download statistics increased rapidly, that enable users to integrate devices with services they want. Reported statistics shows high usage number of applications in each device where iPhone users reach 22 apps, additionally application categories such as games and music appeared as the most downloaded apps [23].

Applications offers different services for wide range of age group by different types of developers. Easiness of application user interface attract and achieve trust between users and application, where interface with critical points rejected by users [4]. Goodness of application and trust can be judged immediately by application's user interface, good design of interface encourage users to use this application and via versa badly designed user interface can collapse trust and limit application use [13].

Application interface that is easy to use and learn described as an intelligent interface where users performs task in sensible way to them, that imply designers to be aware of users where pre-knowledge of human strength should be maximized while minimizing their limitation [5]. Designing interfaces that satisfy users requirements is a challenging task[6], where designing process should respect users personality [1]. Users feedback and empirical measuring of interfaces should be frequently performed to understand users and make changing upon their needs [26].

Usability measure and evaluate goodness of interface design by evolving users or checking list of rules that must be taken by designers, these two viewpoints used in improving interface design [25]. As an attempt of providing information and communication technology services based on interfaces of computer and mobile devices to huge number of users universal usability expended by Human Computer Interface HCI and usability engineering [15]. In this paper usability of children applications evaluated by two methods, one with participating end users and without their participant.

Remaining parts of paper structured as follows: Section 2 discusses how user interfaces evaluated and developed guideline of designing process. Section 3 describe used methodology and work steps followed in this paper, while results are shown and briefly explanation maintained in Section 4. Finally, Section 5 conclude the paper with final thoughts.

## **2. Interfaces Evaluation Criteria and Related Work**

Developing a trust worthy software apply series of steps or processes that need to be followed by software makers. Measuring quality is an essential part that performed regularly during software development and after software maintenance where software investigated and quality calculated upon properties that need to be established [8]. Usability take a huge part of any software quality measurement. Usable software increases quality of this software, provide a productive environment to users, decrease cost of training, and increase user satisfaction [22].

User satisfaction mainly is the goal that application designer try to maintain, usually UI design affect user interest and satisfaction. Designing good and satisfactory UI present high challenge to designer and that lead some designer to write guidelines that makes designer work performed easily. Heuristic evaluation used as an evaluation technique for usability measuring as cost-effective usability techniques that is performed by following heuristic rules. Evaluation by heuristic can be evolved to develop new guideline of UI designing that can be performed fast and in affordable way [10].

Computer application design heuristics shows a lack of supporting mobile application evaluation, where these heuristics cannot be used directly as measurement guidelines. Heuristics of designing UI of mobile applications cover different properties such as: learnability, effectiveness, efficiency, and user satisfaction. Organization like Apples iPhone and Microsoft provides guidelines for designing human user interfaces [2, 16]. Framework of evaluation for IOS iPhone presented that declare guideline rules that need to be addressed by mobile application designers, set of originally pre-implemented heuristics used as a set of evaluation criteria. Framework evaluate each application based on properties like: user control and freedom, tolerance of errors, awareness of human limitation, linguistic clarity, accommodation, and Aesthetic integrity [17]. Another heuristic developed to be performed generally without boundaries such operating system or to be specified for certain platform by designer like Neilson's rules. Neilson represent 10 rules that evaluate mobile application, this approach used in [14] to assets android tablets native applications. Analysis of quality conduct some problems that may decrease usability of these applications.

Number of evaluation heuristics represented over the years such as: Spriestersbach and Springer, Constantine and Lockwood's, ISO9126, ISO9241-11, Zhang and Adipat, PACMAD, and Shneiderman's Golden Rules of Interface Design. Eight golden rules of Shneiderman that listed as follows:

- Strive for consistency
- Enable frequent users to use shortcuts
- Offer informative feedback
- Design dialog to yield closure
- Offer simple error handling
- Permit easy reversal of actions
- Support internal locus of control
- Reduce short-term memory load

Used in this study to evaluate usability considering these rules as usability principles [3, 18]. Evaluation principles may not be used for every application or specific platform, usage of these quality differentiate form one case to another. A guideline of M-learning application developed by author over 5 attributes that in analysis phase flexibility of UI assessed with high degree over other criteria, while other also conduct an excellent measure over the application [6, 9].

Methods of evaluation divided into two groups that works within or without end users participation. Involving software users performed through list of evaluation methods that each one can be suitable for a certain goal, thus using one of these methods depend on the situation and developer point views. Participation trough interacting directly with software with no scenarios that user need to perform or in other cases participant asked to perform some task that evaluator asked to see, generally a free interaction between user and application maintained by this technique. Interviewing users to evaluate application used as other methodology of evaluation where users interacted with specialist to address an reliable evaluation, answering interview questions give the user the opportunity to stand up with his/her own views freely on other hand a set of predefined questions asked by specialist to user where answer format are predefined and users answer need to be one of the available answers. Questioner performed

easily but users thoughts not expressed through that method, available standardization usability questioner like SUMI and WAMMI used to evaluate application. Observation to users interaction with applications can also be used to evaluate and shoot usability problems. Other techniques that used for assessment such as card soring, creativity method, and critical incident. Evaluation without users participant methods such as heuristics that discussed above, cognitive walkthrough, personas that study uses personality and design upon that, Algorithm based evaluation technique as known with automated evaluation, using expert knowledge to evaluate certain application, evaluation using models, analysis of software document and evaluate upon it, or creativity method [20].

An reliable comparison between multiple software products that is performed by internationally unified questioner SUMI (Software Usability Measurement Inventory). An powerful aspect of SUMI that it users are able to participate evaluation with detailed of future development areas in each software. Five sub-scales assessed by this measurement as affect, efficiency, helpfulness, control, and learnability [12]. Each scale assessed through 10 questions that is conducted by agree, disagree, or undecided [11].

Assessment of software declared using methods such as interviewing some participant, observing their behavior, or survey questioner such as SUMI. SUMI used as checklist for software evaluation based on interviewing and observation results, where participant are hearing impaired children between age 9 to 15. Nine quantities evaluated after development of JFakih that define usability such as learnability, help, navigate, efficiency, and user enjoyment these measurement shows that improvement are required [7].

An Arabic learning tool estimated using SUMI questioner that performed with help of 7 children between 4 to 6 years old to measure certain usability principles. Results demonstrate that application was effective to all users and feed backs was clear to children with problem of knowing which level they reach. Design also illustrate efficiency, user satisfaction, no error occurred and easiness of learning [21].

### 3. Methodology

Children applications evaluated by the integration of design guideline rules with Software Usability Measurement Inventory SUMI. Shneiderman's rules assessed these application by eight rules confirmed to be in these apps or not, while a group of seven children between age 5 to 13 invited to play with these applications and their reactions recorded to fill SUMI questioner. Questions asked to them also in how would you like this application to be improved ? and suggestions was on color changing beside that they don't have any other suggestion. Each one of them given 10 to 15 minutes to play with each app while they play games questions asked consequently about their opinion, suggestions, if they enjoy playing with this app or not and if they would play with it again. Some of the questions ignored by some of the children. Three out of four application are games that differentiate in level of easiness and one was an educational app installed freely from play store, apps played on smartphones that operated by Android operating systems. Selected applications are: Plants vs. Zombies<sup>1</sup>, Block Crush King<sup>2</sup>, Foot

<sup>1</sup>Electronic Arts, *Plants vs Zombies*<sup>TM</sup> 2, [https://play.google.com/store/apps/details?id=com.ea.game.pvz2\\_row](https://play.google.com/store/apps/details?id=com.ea.game.pvz2_row), Google Inc., USA.

<sup>2</sup>MB Software, *Mobirix*, <https://play.google.com/store/apps/details?id=com.mobirix.tenten>, Google Inc., USA.

Surgery Simulator<sup>3</sup>, and Adnan Quran teacher <sup>4</sup>. Two application were familiar by some of participants, additionally some refuse to play with some apps. Ignored apps evaluated using questioning children about their opinion on it.

SUMI questioner used to evaluate the degrees of some usability properties: easiness of use, learnability, help, user enjoyment. Each property given a brief explanation on Table 1. Additionally the eight golden rules listed and explained in Table 1.

**Table 1.** Usability Measurement Properties by SUMI and Shneiderman’s Rules

SUMI	
Usability Measurement properties	Explanation
Easy to use	Measure how children interact with apps, detection of harness ears and how that effect children interaction and satisfaction of apps. Asking evaluator help also reveal some problems.
Learnability	Measurement of children understand easily apps UIs without any help and for the first time and if they facing any problem with transaction from one UI to another.
Help	Help calculate if developers hints and feedbacks was understandable and acceptable to children.
User enjoyment	Reveal children satisfaction and interest in apps.
Shneiderman’s eight golden rules	
Strive for consistency	Evaluate consistency of application’s UI, commands identically in similar UI.
Enable frequent users to use shortcuts	Frequent users should have privileges more than others. Feedbacks that viewed by user should not be repeated again.
Offer informative feedback	Application that provide helpful hits increase user satisfaction, children in particular need an easy well formatted feedbacks that can be understood easily.
Design dialog to yield closure	Interaction with UI should be grouped into level of beginner, medium, and end. Children who play game for first time need an easy level of interaction until he understand UI very well.
Offer simple error handling	Serious errors need to be avoided, especially with children that may perform number of errors.
Permit easy reversal of actions	Entering unfamiliar options need to be handled easily, by reversing the action that children made.
Support internal locus of control	Gives the children the opportunity of making the action not responding to serial set of actions.
Reduce short-term memory load	Children forgive things very often, that imply simple design that can be unforgiving by users.

<sup>3</sup>Footsurgery TP, *Footsurgery*, <https://play.google.com/store/apps/details?id=com.tp.android.footsurgery>, Google Inc., USA.

<sup>4</sup>AQ Group, *Adnan Quran*, <https://play.google.com/store/apps/details?id=com.tagmedia.adnan>, Google Inc., USA.

## 4. Evaluation Results

Children given the control of using selected applications without any prepared scenarios, additionally questions were asked regularly about their opinion and suggestions. Easiness of use, learnability, satisfaction, and help measured as usability properties by observer with highlighting weakness and critical issues for end users in each application, results shown in Figure 1 with usability percentage to each application.

### 4.1 Easiness of Use

Children face troubles dealing with application such as Foot surgery simulator, entering surgery room for example was hard task to them. Finishing one level and proceeding to another not declared to children were they found it stressful to know what is happening when they finish level and how to proceed to the next one. These problem faced in Foot surgery simulator. Starting the game was uneasy in Plant vs. zombies to them, where most of them don't understand English and some of them are young to read.

### 4.2 Learnability

Applications were different in level of learnability. Learnable applications such as : Adnan Quran teacher and Block crush king were handled very easily by children, UI were very application applicable to them all. Where Plants vs. zombies and Foot surgery simulator were harder to learn by children, time of learning UI interaction higher than two past applications. Changes in UIs make children suffer for a little while.

### 4.3 User Enjoyment

Games were very enjoyable to all children, except Foot surgery simulator application, two children quit playing with it after a number of series trails. Adnan Quran teacher was familiar with three children and they respond to our questions as in other factors that it was very good to play with and that they like it especially when they want to memorize some of Quran's Surah.

### 4.4 Help

Ambiguous and not clear instructions lead children to ask help from observer. These not informative feedbacks faced in Foot surgery simulator and Plants vs. zombies. Block crush king have little number of feedbacks that was formatted in a way that is not understandable to children. Question in these three application asked to observer to translate it to way that they can understand.

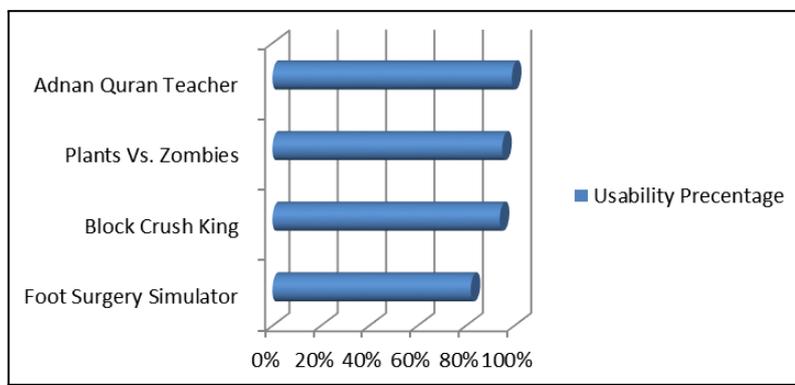


Figure 1. Usability percentage by SUMI

Another way of evaluation that performed by researcher with respect to well-known usability heuristics. Results shown in Table 2.

**Table 2.** Heuristic evaluation results

Rules	Adnan Quran Teacher	Foot surgery simulator	Block Crush King	Plants vs. Zombies
Strive for consistency	YES	YES	YES	YES
Enable frequent users to use shortcuts	YES	NO	YES	YES
Offer informative feedback	YES	YES	NO	YES
Design dialog to yield closure	YES	YES	YES	YES
Offer simple error handling	YES	YES	YES	YES
Permit easy reversal of actions	YES	YES	YES	YES
Support internal locus of control	YES	YES	YES	YES
Reduce short-term memory load	YES	NO	YES	YES

## 5. Conclusion

Application need to be evaluated to achieve high performance and user satisfaction. User interface considered as the main part of any software and mobile applications where interaction with users performed among it, that lead to the necessity to evaluate it regularly. In this paper evaluation performed by SUMI questioner within user participating and with usability heuristics that developed by many specialist. Shneiderman's rules and SUMI used to evaluate UI of children applications, results shows some weaknesses that can decrease usability. Users feedbacks form evaluation reveal a need to change for some application with high pressure for designer to establish. A contradiction between evaluation techniques that can be solved with adopting new evaluation technique that work as a median between designer point of view and users point of view. Finally, Shneiderman's rules that originally was developed to computer applications design proven that it can be used easily with mobile application evaluation.

### Competing Interests

The authors declare that they have no competing interests.

### Authors' Contributions

All the authors contributed significantly in writing this article. The authors read and approved the final manuscript.

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