Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 55 Issue: 11: 2022
DOI10.17605/OSF.IO/URSNJ

USABILITY EVALUATION OF MOBILE LEARNING APPS FOR SLOW LEARNERS

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Abstract

An application is considered "usable" if it is visually appealing, simple to use, and performs as expected. The majority of IT industries focus on the app's functional requirements while making only minor efforts to improve usability. Usability is an essential attribute that want more attention in determining the production of a successful mobile application. In recent years, different learning applications have been developed to help the effective learning and enhanced the IT expertise of the students but the usability of apps for slow learners is ignored during design process so that the slow learners are facing problem during learning process. In order for slow learners to learn effectively, learning apps must focus on usability so that they can learn effectively as learn others. Slow learners are students who have difficulty in learning due of their limited cognitive abilities. They face difficulties in understanding complex instructions and take longer to catch up. Smart phones can be used as complementary learning tools to support and enhance the learning experience of the slow learners. The touch screens to interact the applications on the smart phone gives the more confidence of slow learners to feel more encouraged to stay maximum period and to involve with the application. Using apps in learning activities with slow learners reaps benefits for their learning. In this work, we performed a participant-based usability evaluation of the 25 apps on HTML learning for iOS and Android. Slow learners between the ages of 16 to 55 years are selected for usability evaluation. Further participants are distributed into four main groups Group I, Group II, Group III and Group IV based on their age and 24 participants/slow learners are selected for usability testing under the supervision of moderator. As a result of usability testing of HTML learning apps, we discovered that HTML learning apps usability decrease as the age of the slow learners participants increase. Current HTML learning apps are not effective and efficient for slow learners learning.

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1. INTRODUCTION

Everyone owns a smart phone or other technological device in this time, whether they can afford it or not. People now own more cell phones than 93% of the general population [1]. The world of education has been significantly impacted by technology, which has the potential to increase educational opportunities. In the current context, m-learning [2],[3] is seen as the most recent kind of education brought about by the technological revolution, in which new educational opportunities are made accessible through mobile applications [4]. Smartphone users can learn by accessing the educational information on their devices because to a wireless and always-on learning system [5]. Such educational materials may take the shape of multimedia files or learning objects that are more visible, interactive, and efficient in improving the learning experience for students [6].

The number of software applications for mobile devices has increased dramatically over the last decade [7]. As a result of the increasing affordability, a large community of diverse mobile users has emerged. By 2020, there will be 5.65 billion smartphone users worldwide [8] and an Over the past few years, the financial market share has been around 15 billion USD annually. [9]. The development of apps helpful for personal use and covering other fields, such as health care management, business administration, electronic media, education service delivery etc., has drawn attention to the field of mobile application development. To create easy to usable and user-friendly applications, developers must pay closer attention to this broad application domain. Understanding the target users' needs, goals, and intelligence is also necessary for creating an intuitive application [10]. If these factors are carefully taken into account, then the usability in term of satisfaction, effectiveness and efficiency of these applications will result in great user acceptance from users and attract large number of users. It is an well-known fact that when visiting a search engine to find an application with a particular functionality, the applications are typically sorted in order taking into account the total number of downloads and good user ratings. Today's application users don't thoroughly scrutinise applications because of their hectic schedules and limited attention spans. Users look for apps that meet their needs, but they primarily rely their choice on the opinions of other users. The "Look and Feel" of the app, often known as usability, is one of the primary adaption factors after functionality [11]. Software usability is a step in the development of software that ensures the applications can be used by the intended users. Testing for usability is to make sure that an application can be used efficiently. Testing for usability is a technique used to make sure that anything can carried out one or more specific functions. In additional words, it states to calculating the easiness which employers can learn to use a programs/ apps and products [11]. There are two main approaches for executing usability testing of smart phone apps [12].

1: Testing for usability in the Labs

2: Testing Usability Remotely

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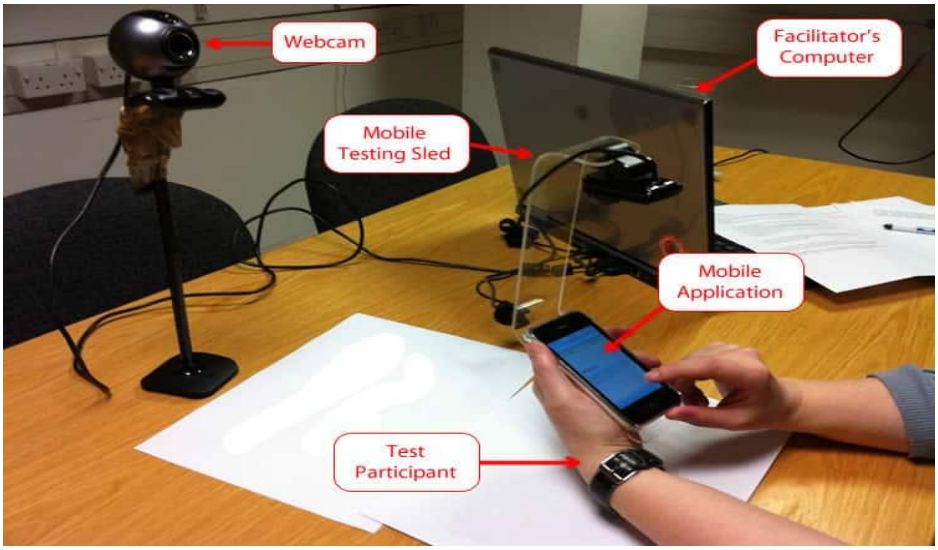
Testing for Usability in the Labs

Through the use of actual people and actual devices, this testing technique makes it possible to evaluate mobile applications. In this testing, the test is completely under the evaluator's control, and the tasks are simple to assign. Additionally, it has been discovered to produce findings that are clearer and more reliable [12].

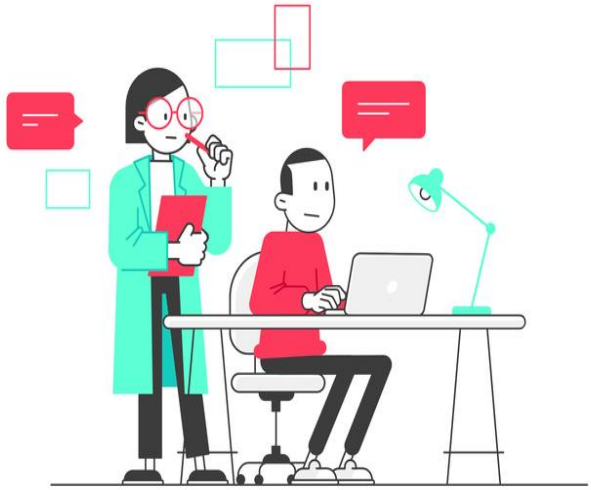
Figure 1: Usability testing on mobile [13]



Testing Usability Remotely

Remote usability testing permits you to perform user research with members in their natural settings by using screen or window sharing software [14]or virtual out-of-the-way usability seller facilities. Commonly, tests should be around 15–30 minutes lengthy made up of around 3-5 jobs.

Figure 2: Remote Based Usability Testing



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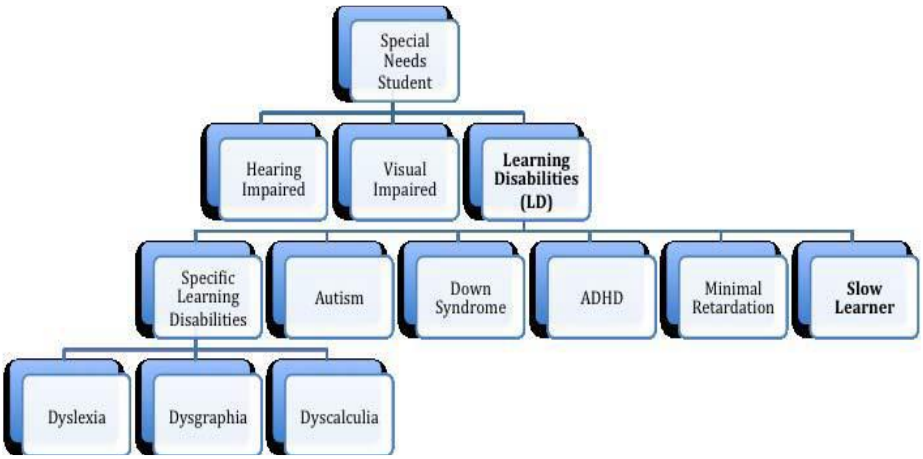
1.1 Learning Disability

Three categories are used to classify children with special needs, which are hearing impaired, learning disabilities (LD) and visually impaired. Learning disabilities include [15] intellectual disabilities, autism, Down syndrome, ADHD, specific learning disabilities (such as dyslexia, dysgraphia, and dyscalculia), and slow learners.

Figure 3: Hierarchy of Disabilities [15]



1.2 Slow Learners

Children with learning disabilities (LD) who struggle to learn are considered to as slow learners. These individuals have mild cognitive issues and are unable to pick up new information in the allocated time for learning. Slow learners are those who lack attention skills, have low intelligence quotients (IQs), weak information processing skills and poor short-term memory skills, lack concentration, and have short attention spans [16]. They also struggle with abstract thinking, which makes it difficult for them to express their ideas.

A child that is a slow learner typically has an IQ between 76 and 89, is slightly different from the rest, and has limited problem-solving skills. For instance, the average slow learner takes one year longer to understand the reading skill than the majority of pupils in the same grade. In general, they learn the skills and concepts more slowly as compared to other children's. Those who learn slowly usually have trouble understanding about specific situations and coping with abstract and symbolic material, such as words, numbers, and concepts [17]. Their learning limitations have also had a major impact on learning and solving complex problems. This enables slow learners to perform at a "backward" level in school and leaves them with very little cognitive capacity [18].

The slow learners are treated differently in the classroom, especially for children with disabilities. Their activities and qualities introduce them to different learning approaches. However, learning difficulties do not prevent them from improving their educational system. They should adopt any new instructional technology and cutting-edge

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technology, so as not to fall behind. They should therefore be exposed to and given experience using new technologies and how it might support in their learning. Various researches have shown how technology can help children with learning difficulties study more effectively [18].

The use of applications can increase the motivation of students with disabilities. Students with learning disabilities found the apps to be enjoyable and satisfying due to "the portability and social acceptability" [19]. Another research proved that using apps actually increased the learning motivation of people with learning difficulties. The touch screen and other features of the smart phone [16] has made the confidence for the slow learners to complete their task on the apps with the smart phone.

Our primary goal in this study is to conduct a comprehensive usability evaluation of the HTML learning apps on both the iOS and Android operating systems. The goal is to provide the research and development community with information about an essential type of apps that can enhance the mobile learning experience of slow learners with HTML learning apps. There is a need for this kind of research to discover the usability issues in mobile apps because there is so much effort being done on mobile application development. The rest of the research paper is organised as: Section II included the related work, section III is about usability testing structure and principles of matching various HTML learning apps. Section IV explain the analysis of the data of these HTML learning apps. Section V listed the identified usability problems. Finally, Section VI is about the conclusion of this research.

2. RELATED WORKS

This section discussed related work. The need for HTML learning apps for slow learners is not being addressed, it has been found. We therefore listed a few comparable works created for different applications along with some works relevant to technology or learning apps for slow learners.

Programming is a main subject to teach the students for software development. Students in higher education must build fundamental ideas for creating software applications that contribute to both the development of their knowledge of programming languages and their ability to think computationally. However, picking the right tool can be difficult. Especially given the wide range of options available on the internet. Additionally, not all of them meet the essential usability requirements[20]. In this study, researcher presented a set of platform that is very useful to develop programming skills based on video games. Finally, to determine optimal practice, we use a usability heuristic testing for a learner programming system.

In the development of a country, education is critical. Parents are adamant about fostering in their kids a love of learning. A teacher has the power to bring this about through effective instruction. However, for a variety of reasons, they may be unable to do so at times. There are several different types of learners, including fast learners, ordinary

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learners, and slow learners. Learning difficulties can be caused by a variety of factors, including poor memory, lack of understanding of the value of education, a lack of pertinent knowledge, and psychological factors. If the teacher can use diverse settings to bring out the students' inner potential, even slow learners will be more motivated to study. This article seeks to tackle this global dilemma by quoting Albert Einstein, the universal scientist, who said, "I never educate my students. I merely want to provide an environment in which kids can learn". The data was gathered using the case study method. Counselling was employed as a method to help them improve [21]. The main finding was that by giving slow learners with appropriate conditions and educational chances, they were more successful.

For children with learning difficulties, the introduction of smart phones and other technologies and apps has created a new learning environment. A study was undertaken with children with learning difficulties, specifically slow learners, in order to better understand the gap. They face difficulty in comprehending complex instructions and require more time to catch up. The use of multimodal features including animation, voice, images, and colours in combination with an intuitive touch-screen interface on smart phone and apps has helped slow learners learn a lot. In practice, smart phone, other technology and apps are complementary learning aids that help slow learners assist and enhance their learning process. Using apps in learning activities with slow learners has a positive impact on their learning. The voice, images, and ability to interact with screen have enhanced the motivation of the slow learners in their study, according to an observation and focus group discussion among teachers and slow learners. Slow learners showed involvement, enthusiasm, and excitement while completing the learning exercises. Learning and performing learning activities with smart devices/phones and applications has provided slow learners the chance, benefits, and new experience of interacting in their own style that is more relevant to them [22]. The findings are based on observations of a group of slow learners using tablet technology to aid their study in a suburban school. With ten selected slow learners, a six-week learning observation was done. The usage of smart devices/phone as complementary educational apps was found to have significantly increased the enthusiasm of slow learners to learn and cooperate with their peers. They have improved their attention, gained confidence, and had fun while learning using the smart phone and apps. This research suggests various suggestions for selecting and developing interactive tablet apps that could aid teachers, parents, developers, and policymakers in closing the digital divide among slow learners.

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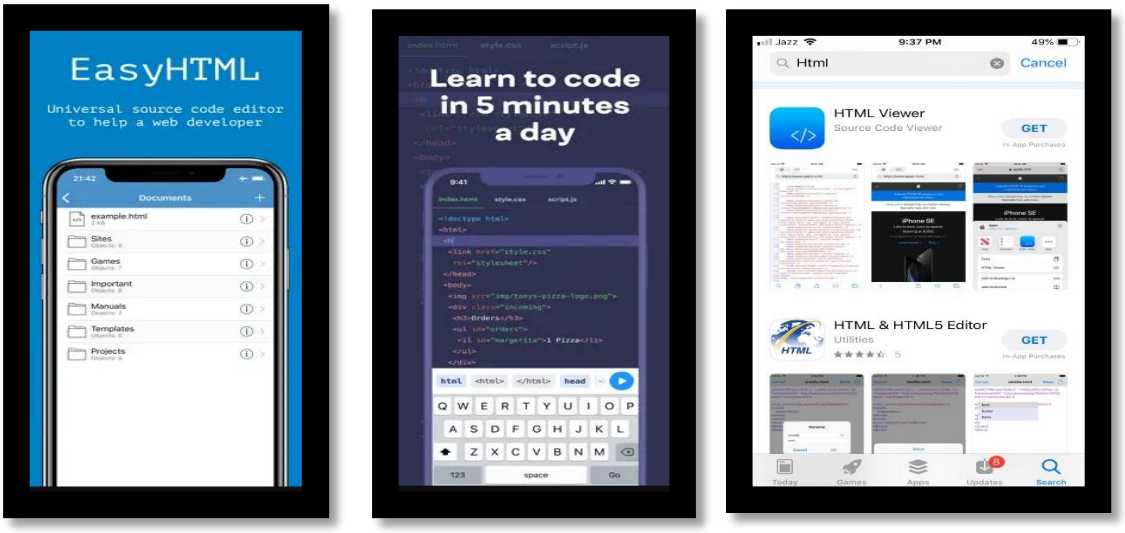
Figure 4: HTML Learning apps from iOS and Android Screenshots



3. USABILITY EVALUATION OF HTML LEARNING APPS

Usability evaluation with users is used to analyse the usability of the HTML learning apps. [23][24]. Usability evaluation is a time taken job, when we conducting a user-based laboratory evaluations [25].The following six phases have to be finished when directing a test as their guidelines:

- Test Creation
- Participants Selection
- Material for test
- Test Execution
- Review with the participants
- Convert figures into conclusion and recommendation.

3.1. Participant Choosing

The participant's selection is very important part for usability testing. It is a fact that slow learners are target audience for HTML learning apps but moderators also make a substantial user group for HTML learning apps. So, moderator as a part of the participant member would be a balanced judgement. Therefore, our choice of test members comprises of slow learners and moderator. All nominated members are supposed to have understanding about the usage of smart phones and apps.

Preferred age for slow learner's participants is fixed at 16–55 years. Total 24 participants are nominated from groups as (16-25) G1, (26 to 35) G2, (36 to 45) G3 and (46 to 55) G4

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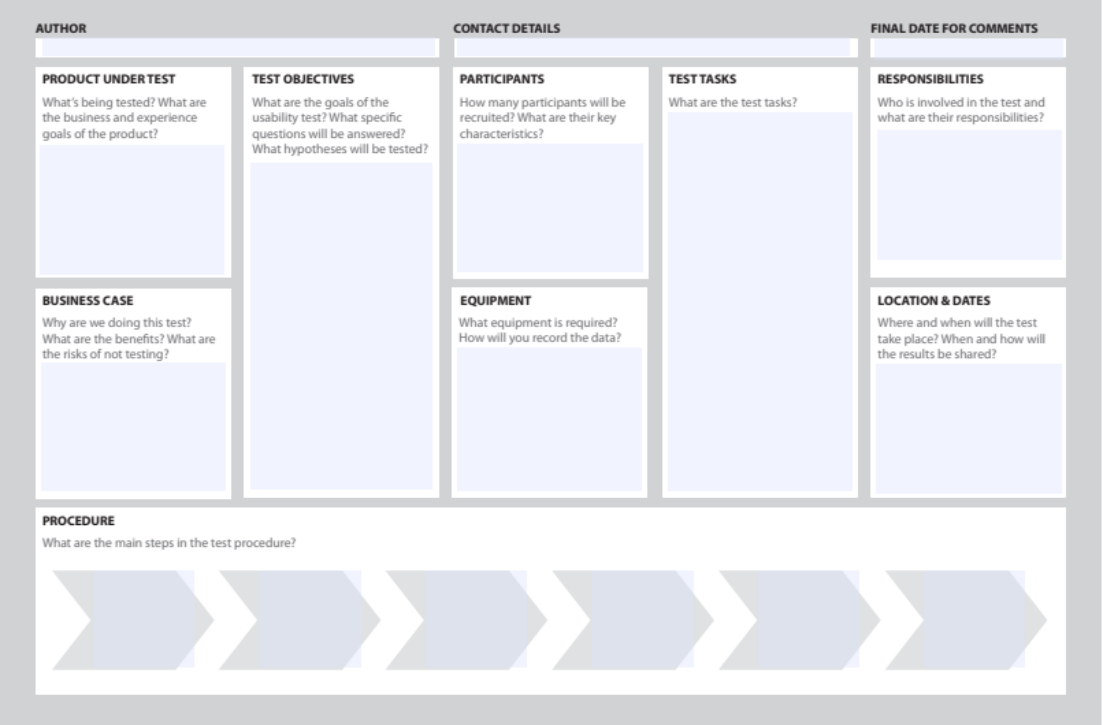
groups, six participants from each group (3 males and 3 females). The reason for choosing this number of members is due to precedent set by previous work.

Table 1: Profile of Participants

Group No	Age Limit	No of participants	Gender
G1	16 to 25	3	Male
		3	Female
G2	26 to 35	3	Male
		3	Female
G3	36 to 45	3	Male
		3	Female
G4	46 to 55	3	Male
		3	Female
Total : 4	Age: 16 to 55	24	Male-12, Female12

Figure 5: USABILITY TEST PLAN DASHBOARD [26]



3.2 Application Selection

The “HTML learning apps" are selected for research work as a case study. These apps are for HTML learning. Total 25 apps are available for HTML learning on an android-based application and iOS. Table 2 shows the selected apps for usability evaluation. Figure 4 shows the some screenshots of the HTML learning apps.

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Table 2: HTML Learning App Name for iOS and Android

Serial #	App's Name
1	HTML+CSS+JS-WEB
2	HTML VIEWER Q -LITE HTML
3	MIMO: LEARN CODING
4	HTML VIEWER PRO
5	HTML & HTML5 EDITOR
6	SOLOLEARN: LEARN TO CODE APPS
7	EASYHTML
8	LEARNING HTML
9	HTML LEARN
10	PROGRAMMING HUB
11	HTML TUTORIAL –ONEPERCENT
12	HTML5 BUILDER
13	HTML MASTER
14	CODECADEMY GO
15	TIME TO CODE - LEARN HTML
16	HTML CODE PLAY
17	LEARN HTML & WEB DEVELOPMENT
18	LEARN WEB DEVELOPMENT
19	HTML FOR BEGINNERS
20	W3SCHOOL: LEARN HTML
21	LEARN HTML
22	HTML QUIZ
23	LEARN WEB DESIGN
24	PROGRAMMING HERO
25	HTML TUTORIAL OFFLINE APP

3.3. Test Material

For usability evaluation, a questionnaire is created and filled by participants to test the selected HTML learning apps. Each participant completes one questionnaire for each app, for a total of 25 questionnaires completed by each user. The questionnaire is designed for evaluation as well-defined criteria for each app as cited in Table 3. In order to reduce extra stress caused by the high number of applications that need to be evaluated, we intend to finish the usability testing procedure in a few days. The slow learner's participants are monitored [27] by moderators during questionnaire filling and performing the test.

3.4. Usability Testing

The usability evaluation criteria contains features like interaction with product, learning and design elements, content, and other details are listed in Table 3.The Likert and Dichotomous scale questionnaire is distributed among the participants and expected to provide their answers. The scores are executed by taking the mode of the sub criteria in each of the groups considered.

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Table 3. Usability evaluation criteria for HTML learning apps for slow learners

Main Factors	Questions Descriptions
1- Efficiency	1. Is the application takes extended load time? 2. Does the App hang, crash and freeze. 3. Does time given to the user to respond is appropriate? 4. How much time is required in completing individual tasks? 5. How much effort is required in completing individual tasks? 6. Error message is easily understandable in case of wrong Input.
2- Effectiveness	1. Is it easy to interact with the UI? 2. Are options easy to use for slow learners? 3. Is the main menu or Home Page button available on all subsequent screens? 4. Does UI offer a visual representation of the loading process? 5. Does app offer audio instructions?
3-Navigation	1. Slow learner can easily navigate across the interface? 2. The navigation keys are well understandable? 3. Does UI specify easy scrolling if a lot of information is present? 4. Does UI provide easy main menu for navigation? 5. The navigating through this app is easy. 6. This app provides good navigation facilities to information contents.
4- Usefulness	1. This app makes me more productive. 2. This App is useful. 3. App gives me more control over the activities in my life. 4. The app makes it simpler for me to complete the tasks I want to. 5. When I use this app, it saves my time. 6. App satisfies my needs 7. The app performs all of the tasks I would need.
5- Ease of Use	1. This app is simple to use. 2. This app is simple to use. 3. This app is user friendly. 4. App requires the fewest steps possible to accomplish what I want to do with it. 5. The app contents are clear and easy to understand. 6. I don't notice any inconsistencies as I use this app. 7. I can recover from mistakes quickly and easily. 8. I can use this app successfully every time. 9. I find the graphic interface easy to use. 10. This app is flexible.
6- Learnability	1. I learned to use this app quickly. 2. I easily remember how to use this app. 3. I quickly became skilful with this app. 4. Are the icon used in the UI relates to the task? 5. Can the slow learner recognize the functions and their corresponding actions? 6. Is the UI using familiarized terms and easy language? 7. Does app provide easy ways to step back to previous activity? 8. Is UI correlates with other apps and hence easy to learn? 9. Is proper information provided for various functions? 10. It was easy for me to get started and to learn how to use this app. 11. The information provided by the app is easy to understand. 12. I was able to use the app without reading user manual. 13. Learning to operate the app is easy for me.

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7- Satisfaction	1- To the best of my ability, I followed the instructions telling me how to code the HTML 2- I am confident that I was able to write the code as instructed. 3- I found that coding on this app was unnecessary difficult. 4- I felt confident that I used this app correctly. 5- I am satisfied with this app. 6- I would recommend this app to a friend. 7- This app works the way I want it to work. 8- I think this app helps me being productive. 9- Are the user happy with the App layout? 10- Are all the screens consistent? 11- Does the UI provides features to engage the slow learners?
8- Operability	1- Does the app offer the ability to change colour? 2- Does the font used in the app is appropriate and readable? 3- Does the app provide background music? 4- Does the app provide options to mute the audio? 5- Does the main menu button easily operable? 6- Does the main menu contains link to all useful tasks? 7- Does the size of the icons are set appropriately to be operable easily? 8- Does the app provide easy access to the home screen of the mobile? 9- The login section was very easy and intuitive.
9-Help	1- The video tutorials on the app are useful and precise for help. 2- Does appropriate help is provided in UI where needed? 3- Is the app contains help icon, which is visible and understandable? 4- Whenever I make a mistake using this app, help tab will be appeared. 5- App helps to contact advisors.

4. RESULTS ANALYSIS

4.1. Comparison of the Primary Usability Criteria

First and foremost, we want to understand how the key criteria contribute to the general usability of an application. In the Figure 6, In general, the range of the subjective usability rating score is from 1 to 3. The highest score is found for “Navigation” whereas the lowest score is found for “Help”, “effectiveness” and “operability”. This graph also shows how developers focus more on an app's functional requirements while ignoring the app's usability elements. In the Table 4 we observed that age effect on the usability and learning, as age increased usability decreased.

Table 4: Regression

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	2.100325	0.15889	13.21871	2.79E-30	1.787314	2.413336	1.787314	2.413336
X Variable 1	0.180644	0.06418	2.814668	0.005291	0.054212	0.307077	0.054212	0.307077

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ANOVA					
	Df	SS	MS	F	Significance F
Regression	1	9.664458	9.664458	7.922354	0.005291
Residual	238	290.3355	1.219897		
Total	239	300			

4.2. Descriptive Statistics of Main Factors

Descriptive statistics are brief informational coefficients that summarise a given data set, which can represent the entire population or a sample of a population. Descriptive Statistics of main factors (ease of use and learnability) are given in the table 5 and table 6, which shows that slow learners are not able to learn effectively, and not feeling easy using apps.

Figure 6: Usability of the main factors

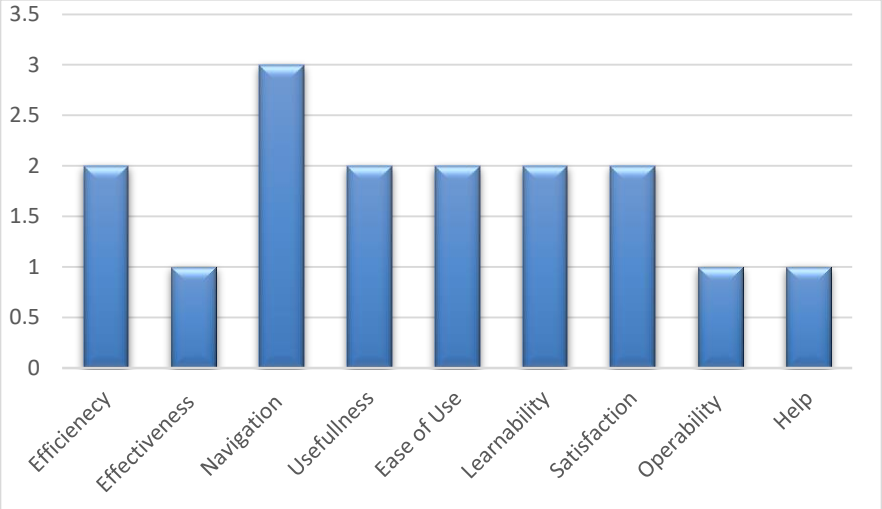

Figure 7: Histogram of Usability factors Operability and Help

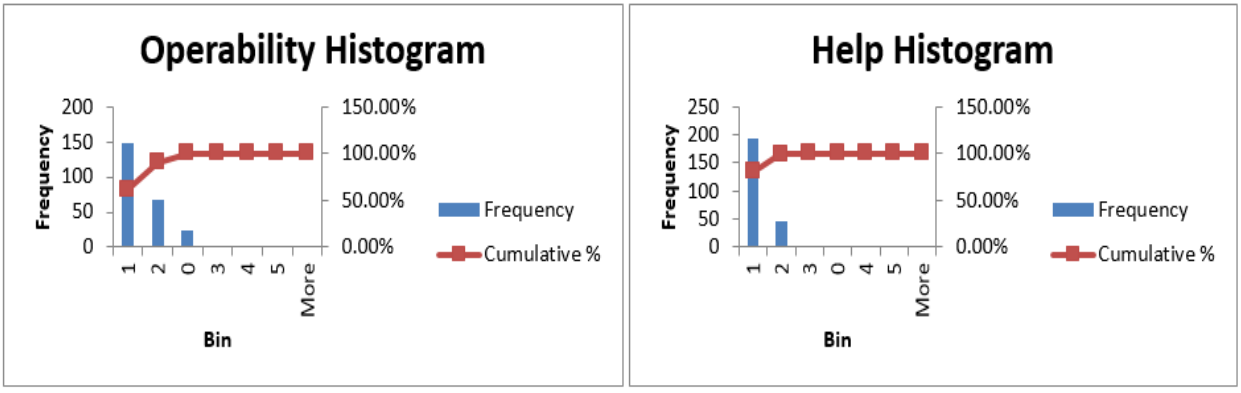

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Figure 8: Mean Score of the Questionnaire Analysis

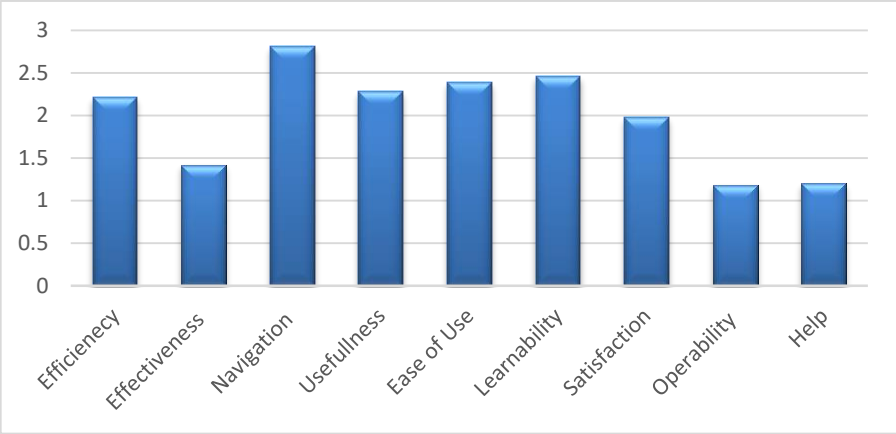

Table 5: Ease of Use

Mean	2.3875
Standard Error	0.035665
Median	2
Mode	2
Standard Deviation	0.552524
Sample Variance	0.305282
Kurtosis	1.340883
Skewness	1.206091
Range	3
Minimum	2
Maximum	5
Sum	573
Count	240

Table 6: Learnability

Mean	2.458333
Standard Error	0.0363
Median	2
Mode	2
Standard Deviation	0.56236
Sample Variance	0.316248
Kurtosis	-0.61968
Skewness	0.307593
Range	3
Minimum	1
Maximum	4
Sum	590
Count	240

Table 7: T-Test: Paired Two Sample for Means

	2	1
Mean	2.213389	1.41841
Variance	1.24419	0.622517
Observations	239	239
Pearson Correlation	0.084318	
Hypothesized Mean Difference	0	
Df	238	
t Stat	9.375748	
P(T<=t) one-tail	2.8E-18	
t Critical one-tail	1.651281	
P(T<=t) two-tail	5.6E-18	
t Critical two-tail	1.969982	

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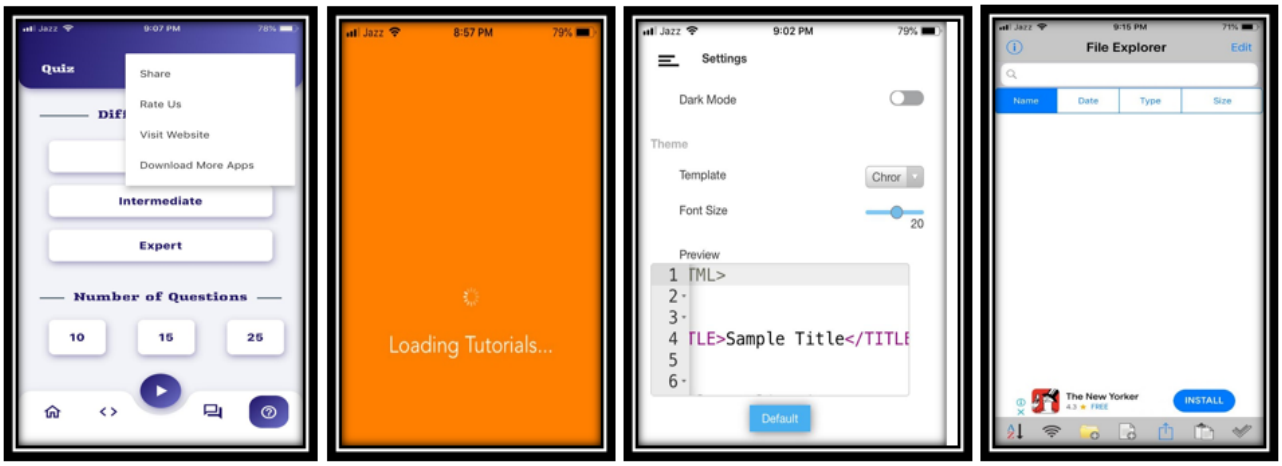
5. IDENTIFIED USABILITY ISSUES IN HTML LEARNING APP'S

The main objective of usability testing was to find the problems in user interface of the HTML learning apps available for Android and iOS platforms. Following problems are found in these apps and some screenshots are given in the figure 9:

- No appropriate help provided
- The help icon provided is not visible and understandable
- Not enough information about functions being provided
- It is hard to use the app for a long time
- Navigation problem
- Boring/poor interface
- No proper Learning assessments
- Wrong button presentation
- Scrolling issue
- Screen size /font size problem
- No proper feedback submission
- Inappropriate adds

Figure 9: Screenshots of Usability problems



6. CONCLUSION

In this research paper, we evaluated the usability of HTML learning applications for iOS and an Android system. We carried out a usability testing with participants of 25 HTML learning apps. Slow learners members are recruited for the usability evaluation of

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 55 Issue: 11: 2022
DOI10.17605/OSF.IO/URSNJ

particular apps to be evaluated under few well-defined principles using particular measurements. We found that age effects on usability and learning. We got that HTML learning apps required an improvements to improve the slow learner's experience. During the test sessions, all members were expected to perform the same set of the tasks for usability testing. However, it was difficult for the slower learners. There is a need to develop the usability model for the slow learners for effective learning. In future, we will develop a usability model for slow learners for learning so that these missing factors can be covered to make the educational apps more effective for the slow learners.

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