Usability Benchmarks for Interactive Whiteboards: Lessons Learned from Turkey's Fatih Project

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***Abstract*—** The use of interactive whiteboards is spreading rapidly in the educational settings. Turkey has initiated a project called "Fatih" to integrate interactive whiteboards to the public schools by spending huge budget. In the scope of this study, usability evaluation of the interactive whiteboard system used in Fatih Project is conducted by implementing a user test with the first group of teachers, who are inexperienced users of the system. In addition, a usability questionnaire has been applied to both experienced and inexperienced groups of teachers. The data has been analyzed with descriptive statistics. Problems about the sensitiveness of touch feature of the board, complex menu structure, incapability of the software for opening different file formats and inconsistencies about the software features have been revealed as the main usability problem. Finally, short evaluation checklist is formed to provide guidance on the assessment of usability issues, when adopting any interactive whiteboard system.

***Keywords*—** usability, usability evaluation, Fatih project, Starboard software, interactive whiteboard

1. INTRODUCTION

Nowadays, educational institutions are trying to integrate ICTs in their classrooms. The current trend is the integration of interactive whiteboards (IWB) in classroom settings. Many governments support this attempt of educational institutions. For instance, especially England has invested in the integration of IWBs at the nationwide level since 2002 [1-3]. According to the most recent report of McIntyre-Brown [4], IWB penetration rate in England is 73%, which is the highest in the world; whereas in Denmark it is about 50 % or in the US it is about 35 %. Other than these, many countries such as Australia, Italia, Mexico or South Africa are also following this trend [5, 6, 7].

Turkey has also followed this trend and initiated a project called "FATİH", which stands for "Movement of Increasing Opportunities and Improving Technology", in 2010 to integrate IWBs in primary and secondary public schools. In the scope of this project it was planned to install IWBs and Internet infrastructure to public schools at nationwide [8]. It was planned to train teachers on both the use of IWBs and its integration into their instructional settings. Then they were expected to use the special e-content prepared for their lessons as well as prepare their own materials. At the end of 2012, the installation of 85,000 IWBs was completed and the rest was planned to be installed until the end of 2013 [9-11].

IWBs are electronic forms of whiteboards which are generally touch-sensitive devices that can control a computer connected to a projector by the use of different sensors [2, 12]. This technology was primarily developed for office settings and its potential use in educational settings was acknowledged in the late 1990s [13]. IWB technology has developed rapidly and various features have been integrated into its recent versions. It integrates almost every tool, resource or material that can be used in a classroom setting in one device and enhances interaction among teachers and students as well as with their course materials [14].

Commercial IWBs generally consist of the devices that can be seen in Figure 1.a and they are operated with a device called smart pen. IWBs in FATİH project that can be seen in Figure 1.b were developed based on the specific requirements of Ministry of Education [15]. It is an interactive whiteboard of 65" LCD display with an embedded computer that runs Microsoft Windows TM 7 and Linux Pardus TM 2011 operating systems. It can be operated by hand or a pen. It can be run as a standard computer. It is also integrated with a traditional whiteboard and chalkboard. In addition, it has special educational software called "Starboard TM Software for FATİH" that enables teachers to create their own content by inserting files such as video, image, animations or make their own graphics by using drawing tools or accessories [16].



Fig 1a. Commercial IWBs



Fig 1a. Proprietary IWB for Fatih Project

Many researchers [2,7,17-19] have revealed that integration of such kind of interactive technologies in educational settings increase the motivation of students, effectiveness of teachers and have the potential of collaborative learning environments. In other words, integration of IWBs as in Fatih Project provides promising benefits to learning and instruction. On the other hand, for any project to be effective, it must be accepted by its targeted users. Based on Davis's [20] Technology Acceptance Model, users' positive or negative attitudes will affect the acceptance of a new technology and these user attitudes are mainly based on perceived usefulness and perceived ease of use of the technology. In addition, Folmer and Bosch [21] point out that if the system's learnability, responsiveness and efficiency are high, then this increases its acceptability. Aldunate and Nussbaum [22] emphasize the complexity of any technology would affect the technology adoption process of teachers. A new technology considered to provide promising achievements would be unsuccessful and waste of investment if it is not accepted by its users.

It was planned to integrate about 570.000 IWBs, each of which costs about 4000 TL (2000 $), in the scope of Fatih Project of Turkey [15]. Moreover, total budget assigned to this project was determined as 8 billion TL (4 billion $) [9]. This budget consisted of integration of IWBs to classrooms, establishment of Internet infrastructure, distribution of tablets for students and teachers' training on the use of IWBs as well as the development of e-contents. Considering that Fatih Project of Turkey has this huge budget, careful consideration of many dimensions such as providing in-service training for teachers and evaluation of the effective use of IWBs in classroom settings by teachers [23] is required for its successful implementation. In the scope of this study, usability evaluation of IWB hardware and software used in Fatih project is conducted to determine the problems that affect the performance of its targeted users; the teachers.

1.1. Usability and Usability Evaluation

There are many definitions of usability in the literature. For instance, Shackel [24] defines usability as the usage capability of an application to be used easily, effectively and satisfactorily by specific users, performing specific tasks, in specific environments. ISO [21] also defines usability based on the concepts of effectiveness, efficiency and satisfaction in the scope of specified users, specified goals and specified context of use in ISO 9241-11 standard. Effectiveness is the task completion of the user, efficiency is the time required for the completion, and satisfaction is the acceptance of the system by the user. Nielsen [25] defines five usability attributes as follows;

> "Learnability: The system is easy to learn so its users can rapidly perform work with the system
> Efficiency: System provides its users to perform their work quickly after they learn it so the productivity increases
> Memorability: Use of the system can be remembered after some period of time
> Errors: System has a lower error rate and enables its users to correct their errors.
> Satisfaction: System is pleasant to use and provides subjective satisfaction for its users"

Usability evaluation is very essential since it provides more humanistic use of systems by enabling increased user satisfaction, decreased development costs, and decreased negative attitudes to the system [26]. There are many evaluation tools and techniques to achieve usability by detecting usability problems. Zhang [21] has identified three types of usability evaluation methods which are testing based, inspection based and inquiry based methods. Similar to that, Çağıltay [26] has made a classification for usability evaluation methods based on types which are formative and summative evaluations and based on approaches which are design guideline, heuristics, experimental (user tests) and model-based approaches. Guideline based evaluation is conducted according to interface features of a system based on specific industrial guidelines (Apple Macintosh

Guidelines™, IBM Guidelines™, etc.). Heuristic based evaluation is the investigation of the system according to design heuristics like Nielsen's Ten Usability Heuristics TM by experts. In model based evaluation, behaviors of users are evaluated according to some physical or cognitive models and performance of users. Experimental usability evaluation is conducted with real users, and they are observed while performing real tasks with the system in order to gather their views as well as behavior styles and expectations. The main aim of this method is to determine the usability problems that hinder the effective interaction with the interface [27]. Questionnaires are also one of the tools in usability evaluation studies in order to gather users' satisfaction, opinions and understanding of systems. There are many evaluation questionnaires in literature that are used for these purposes [21].

1.2. Usability Evaluation Studies of IWBs

Many researchers [1,28,29] conducted studies related to the practical use of IWBs in classroom settings and their findings revealed the positive attitudes of teachers. Some of these studies investigated the usability issue of IWBs in its scope but with a limited view. For instance in Türel and Johnson's study [29], teachers' perceptions regarding the usefulness and usability of IWBs are found out as positive.

Saltan and Arslan [30] have studied teacher's acceptance and attitudes towards the use of IWBs by the use of a questionnaire that measures perceived usefulness, perceived ease of use and their attitudes. Overall results show that teachers have a positive attitude toward IWBs. On the other hand, perceived ease of use and attitude toward IWBs are lower than perceived usefulness because of some usability problems that distract teachers while performing their work.

Kirsch [31] conducted a usability evaluation of an IWB with five teachers. The IWB used in that study is formed of a projector, computer and a pen for interaction. It can also be manipulated by finger touch. Participants of the study performed specified tasks and answered a short survey. Participants generally had a positive experience with the board while some mentioned usability issues about the use of pen or finger interaction while calibrating finger or pen placement on the board. In addition, the setup of the projector which requires extra adjustments for the computer caused difficulties. The study showed that the participants who had better knowledge about the use of computers performed better than others.

In another study, Yıldız and Tüfekçi [27] have investigated the difficulties faced by users who have encountered or have not used an IWB before. The IWB in that study was similar to the one described above which is interacted through a pen. There were five participant teachers and two of them had a prior experience with an IWB while the rest had not used it before. Participants performed specified tasks and filled out a satisfaction questionnaire. The results of this study revealed that teachers enjoyed using an IWB. They thought the system was easy to learn since they performed as if they were working on a computer. On the other hand, the study revealed that help messages were insufficient and teachers could not perform the tasks in the required time. In addition, teachers who had more computer experience performed better than others.

Above mentioned IWB usability studies were all conducted with the commercial IWBs similar to the one that can be seen in Figure 1.a. On the other hand there are not many studies conducted with the IWB developed for Fatih project. The most recent study conducted by Bayrak, Karaman and Kurşun [32], investigated the IWB of Fatih Project and tried to determine the usability problems of it. This study was carried out with 16 participants who often used IWB in their lectures. Reported usability problems are grouped under the headings of software, hardware and environment based problems. These problems can be summarized as the close allocation of some data ports (USB or power ports) related with hardware; difficult calibration of the system based on sunlight or dust related with environment. Software related problems were based on different software that runs on the system like StarBoard TM, Adobe Reader TM or Pardus TM. For instance, some files could not be opened or sometimes ran slowly or opening more than one file could not be possible.

Fatih Project is one of the strategic projects of Turkey. It has many dimensions in addition to the IWB integration, like teachers' trainings as well as the development of content or materials that can be used with the IWBs. All these dimensions would affect the success of the project. However, since the issues related with the usability of a system determines the acceptability and effective use of a system by its users [21] and there are not many studies conducted on this issue, usability evaluation of the IWB of Fatih Project is essential. Therefore, this study aims to evaluate the usability of the StarBoard software and hardware component of the Fatih Project IWB. In addition, a usability evaluation checklist is formed to provide practical tool that will help decision makers while adopting an IWB based on the lessons learned from the usability evaluation.

2. METHOD

The study was conducted as an experimental user test which is one of the usability testing approaches that aims to determine the usability problems of any system [26]. User testing is an experimental method which is conducted with real users to determine whether they have any problems while using the system with real tasks [25].

2.1. Participants

The target population of IWB with Starboard software is teachers who work for Turkish Ministry of National Education (MoNE). Therefore, the study was conducted with the participation of 18 teachers. For the selection of teachers, purposeful sampling was used. Two groups of teachers were selected. First group was formed purposively based on the criterion that teachers had used the IWB with Starboard software in their lectures for some time and consisted of 12 teachers. In addition, they were selected from a group of teachers who teach various subject matter disciplines as presented in Table 1. Second group was formed of six teachers who had never encountered with the system before. In literature there is a conflict about the number of participants required for the usability studies. However, generally accepted number for usability tests is determined by Nielsen [25] as five since this number is adequate to identify the 75% of the problems in the system. The selection of appropriate participants, appropriate task and their relationship with the usability test design are more important than the number of participants [26]. Therefore, participants from different backgrounds as well as with different computer experiences were selected.

Demographic information was gathered from all participants in both groups. All participants were teachers at the MoNE schools. Participants' computer literacy level, computer experience level, weekly computer uses, ages, genders and their backgrounds can be seen in Table 1.

Table 1. Users' demographic information

Group#-Participant#	**Discipine**	**Age**	**Computer Experience Level (year)**	**Computer Literacy Level**	**Gender**
G1_P1	Biology	26	6-8	Good	Female
G1_P2	Mathematics	35	6-8	Good	Male
G1_P3	Mathematics	34	9-..	Good	Male
G1_P4	Turkish Philology	29	9-…	Good	Male
G1_P5	Biology	27	6-8	Good	Female
G1_P6	Turkish Philology	28	6-8	Good	Female
G1_P7	Chemistry	28	9-..	Good	Male
G1_P8	History	40	9-..	Good	Male
G1_P9	Information Technologies	28	9-..	Excellent	Female
G1_P10	History	32	9-..	Excellent	Male
G1_P11	Turkish Philology	33	4-6	Moderate	Female
G1_P12	English	25	9-..	Good	Female
G2_P1	Counseling	36	9-..	Moderate	Male
G2_P2	Science	25	6-8	Moderate	Male
G2_P3	Primary School Mathematics	35	6-8	Moderate	Male
G2_P4	Form teacher	26	6-8	Good	Male
G2_P5	Primary School Mathematics	26	6-8	Excellent	Male
G2_P6	Turkish	29	6-8	Moderate	Male

2.2. Data Gathering Tools and Procedures

In this study, a user test was applied to the second group and a questionnaire was applied to both groups of teachers. User test consisted of real tasks to be accomplished with the system. Think-aloud protocol, which is one of the most valuable usability engineering methods [25] was also applied during the user test.

2.2.1. User Test

For the first phase of the study, a user test was developed in order to evaluate the performance of the system with real users while they were performing real-life tasks with the real application environment. Therefore, tasks for the users were determined. Beauchamp and Parkinson [1] summarized the five different uses of an IWB as follows;

"Capturing images from other programs or software
Emphasizing important points in any text by underlining or highlighting

Storing the graphics drawn during class and re-use them whenever needed
Annotating and modifying the material by extra definitions of highlights
Linking to other materials on the computer or to Internet sites"

On the other hand, in the scope of the Fatih Project, operations that were expected from teachers to perform can be summarized as follows [16];

"Inserting image, video, sound or animation/simulation files into Starboard software
Inserting and modifying any text
Using the accessories of Starboard software such as spot light, timer, screen capture, dividers, and ruler.
Linking among the pages or with Internet sites
Saving the material in different formats"

Based on these general uses of IWBs and expected use of IWB in Fatih Project, Task List Form was developed with 27 tasks as seen in Table 2.

Table 2. Task List Form

#	TASK
1	Insert Flash Memory to IWB.
2	Copy "Course" folder into "MyDocuments/.StarBoardFavorites" .
3	Run Starboard software.
4	Insert image "Image1" into first page by using the image gallery.
5	Adjust the size of image for readability.
6	Center the image on the page.
7	Open a new page. Insert an animation from the gallery.
8	Open a new page. Draw a filled square into this page.
9	Hyperlink a web site to this square. Copy the hyperlink address from the word document in "Links" folder.
10	Return to the first page
11	Insert text onto image and write "Water Cycle" with "Normal pen" tool .
12	Go back to the page with animation and run the animation and then stop it.
13	Attach the video file in "MyDocuments/.StarBoardFavorites" folder into the document
14	Run and then resize, forward and rewind the video.
15	Go back to pages screen.
16	Run the video again and capture screenshots from the video and return to the board.
17	Re-arrange the pages you have created.
18	Use the capture tool of the software and cut text from the word file on the desktop.
19	Match screenshots captured before by the use of arrow tool.
20	Open a new page. And write "Happy Holidays" with pen tool. Change the size, font and color of text.
21	Open spot light tool.
22	Adjust the configuration of spot light tool and observe the changes.
23	Run the timer.
24	Adjust the timer to 1min 30sec and then start.
25	Just looking at the timer's clock without looking at the counter, tell how much time is left in 90 seconds. You have three options to predict.
26	Save this Starboard file onto desktop.
27	Save it as pdf on desktop, too.

This task list form was implemented to the teachers who had never used the IWB or the Starboard software before. Teachers were allowed to investigate and use the Starboard software that run on a Windows 7 installed laptop after they were provided brief information about the software for 30 minutes. This exploration time was given to participants since this system was planned to be used by its users after having some training. After ten minutes break, teachers were expected to perform the tasks in the task list form and were also asked to think aloud while performing the tasks. They were observed by the researcher and notes were taken related to their actions, feelings, mistakes, etc. In addition their task completion times were recorded.

2.3. Questionnaire

Questionnaire developed for this study consisted of three sections. First section was to gather information related to demographic characteristics of the participants. Second section was to investigate the usability of the IWB with Starboard software and the final section consisted of open ended questions to gather detailed information from the participants.

Demographic part of the questionnaire included general questions related with the participants. Usability evaluation part of the questionnaire consisted of 33

items, 28 of which were Likert scale items and five open ended questions. Twenty five of the Likert scale questions (items of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 15, 17, 18, 20, 21, 22, 23, 24, 25, 26, and 27) were mainly adapted from Lundt's [33] USE TM Questionnaire by directly translating the items into Turkish. Three items (items of 16, 19, and 28) were also added based on the experience of the researchers and the goals of the study. Moreover, in the third part of the questionnaire there

were five open-ended questions one of which (item 32) was adapted from Kirsch's [31] study. Questions were also grouped under the headings of usefulness, ease of use, ease of learning and satisfaction as in Lundt's [33] version. Questionnaire was checked by two experts and modifications were made based on their reviews in order to provide face and content validity [34]. Cronbach's Alpha coefficient was calculated as 0.803 based on the SPSS analysis for reliability.

2.4. Data Analysis

During data analysis process, first of all think-aloud protocol observation notes of the researcher were analyzed. These notes were subjected to descriptive analysis and then tasks were tabulated according to teachers' task accomplishment level. The questionnaire was analyzed using descriptive statistics and means and percentages were reported to reveal the usability problems of the system.

3. RESULTS

Results of the study are presented in two sections; results of the user-test and results of the questionnaire. Results of the questionnaire are based on statistical analysis while the results of the user test are based on qualitative analysis of the observations.

3.1. Results of the user-test

Participants in the second group were observed while they were performing the tasks in the task list form and they were rated as "easily accomplished", if they performed the task in a short time without any mistakes; "challenged", if they performed the task in longer duration or "can't figure out", if they could not accomplish the task without intervention. The frequencies of users' performance based on tasks can be seen in Table 3 below.

Table 3. Task Observation Frequencies

Task Number	Easily accomplished	Challenged	Can't figure out
1	6		
2	6		
3	6		
4	6		
5	5	1	
6	6		
7	6		
8	4	2	
9	3	2	1
10	6		
11	6		
12	6		
13	3		3
14	4	2	
15	4	1	1
16	5		1
17	6		
18	3	3	
19	5	1	
20	2	4	
21	5	1	
22	6		
23	6		
24	6		
25	1		5
26	5		1
27	0	2	4

Based on the results of task list form, it can be seen that participants easily accomplished the tasks of 1, 2, 3, 4, 6, 7, 10, 11, 12, 17, 22, 23 and 24. However, some of them were challenged or could not figure out how to accomplish the tasks in some other items. For instance, participants were required to "adjust the size of image" in task five. Participants should have first selected the "select icon" from the menu toolbar and then selected the object and adjusted the size. This task was challenging for one of the participants (G2_P3) since he was expecting the latest added object on the screen to be selected, but the pen was left in selected mode from the previous action. Therefore, he drew on the image by mistake. A similar problem was observed during task 12 although all of the

participants accomplished it. They drew on the animation in this task since the pen was left selected after the previous action.
For the eighth task, participants were asked to “open a new page and draw a filled square into this page”.

Participants could perform this operation in two ways. Normally, after drawing the square by using the “square icon” on the toolbar, participants should first select the “select icon” from the menu, and then select the square. Then a “menu” button is activated on the top right corner of the square and object properties including the fill color could be changed under this menu. Or after selection of the square object properties could also be changed from the tabs that could be found on either side of the screen. They were able to open a new page in 10 seconds. However, two of them (G2_P2, G2_P6) had difficulty while changing the features of the square although they could easily draw it. Similarly, the success rate of task 9 and task 20 were low because they hardly figured out how to change the features of a new or added object as in task 8.

Thirteenth task required the user to “attach the video file in ‘MyDocuments/.StarBoardFavorites’ folder into the document”. Half of the participants (G2_P2, G2_P3, G2_P6) easily accomplished the task while the other half (G2_P1, G2_P4, G2_P5) could not. Participants should have first selected the “Document” tab which was found on the side of the screen and accessed the “MyDocuments/.StarBoardFavorites” folder from the “attach” box and attached the video file. However, half of the participants looked for “insert a video item” under “Insert” menu like inserting an animation or an image and could not figure out how to perform.

Another task (task 14) was also about dealing with videos and participants were asked to “run and then resize, forward and rewind the video”. Video was attached through “attach” dialog box under the “documents” tab. It could be run by double clicking or by selecting the video and selecting “Open” option. Two of the participants (G2_P1, G2_P6) were challenged while performing this task and spent a lot of time. Participants generally figured out the functions of the buttons on the dialog boxes through the tooltips. While these two participants were performing this task, the documents tab was opened on the left side of the screen and when this happened, tooltips of the icons were not visible on the screen so participants could not understand the functions of icons.

One of the problematic tasks was task fifteen that required participants to “go back to active page from video page”. Participants could exit the video screen by selecting “smartboard” from “subject” menu item under the “menu” toolbar as seen in Figure 2. However, they first looked for “close” button on the right of the video page, then looked for “X” (close) symbol on the video toolbar and finally they looked for the video symbol on the task bar. Five of the participants exited by mistake by pressing “capture the screen image” button while one of them (G2_P5) made a dreadful mistake by closing the whole program through “menu” toolbar by selecting “exit” without saving anything on this task.

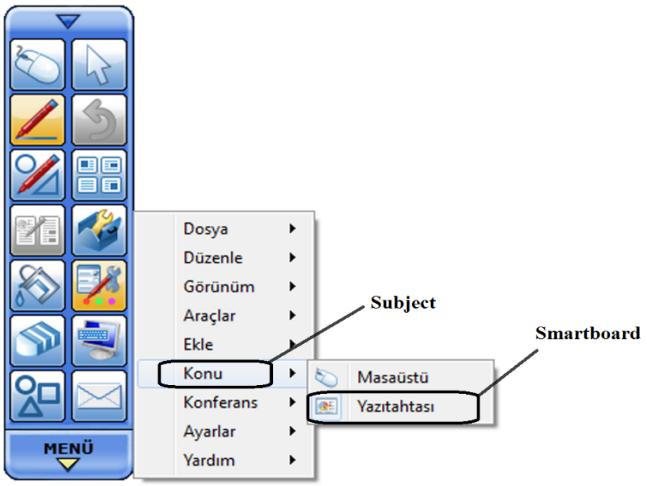


Fig 2. Screen shot that shows closing a video menu item

In task 18, participants were asked to “use the capture tool and cut text from the word file on the desktop”. Normally, participants should have selected the “desktop” icon on the “menu” toolbar and switched to desktop and then cropped the required section form the document by first activating “screen capture” toolbox through the “accessories” icon on the “menu” toolbar and selecting “partial screen capture” tool. Half of the participants (G2_P1, G2_P4, G2_P6) had difficulty to find the “show desktop” button which was used for switching among applications so they spent longer time. The screen shot taken in task 18 was used for the matching test task given on task 19. During task 19, participants were asked to “do matching on the screen shot by using an arrow tool”. Participants should have selected “arrow” item from the “drawings” icon on the “menu” toolbar and then drawn the arrows on the screen. One of the participants (G2_P2) had trouble with this task because the arrow or line could not be put on the exact spot on the screen shot of the image.

Timer of the software can be seen in Figure 3. If you press play at first, timer runs forward. However, when a predetermined value is entered then it runs backward. Participants were asked to “adjust the timer to 1 min 30sec and then start the timer” in task 24. All of the participants could perform this task successfully but it was observed that two of the participants (G2_P3, G2_P4) perceived the counter of “00:00:00”as “minute, second, millisecond” rather than “hour, minute, second”. In addition, five of the participants (G2_P1, G2_P2, G2_P3, G2_P4, G2_P5) had difficulty while adjusting the timer as 00:01:30 by trying to input with the keyboard and only one of them could realize that they could adjust the timer by touching the colored quadrants

and adjusted it. In task 25, participants were asked to "predict how much time was left on the timer without looking at the digital counter". They were allowed to make a mistake for three times and only one of them could predict the time left.

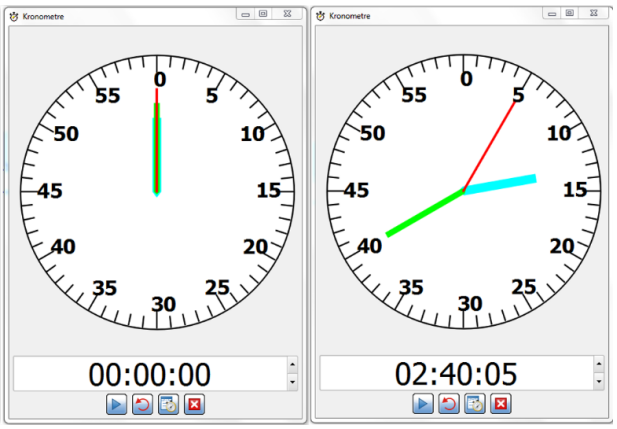


Fig 3. Initial and adjusted views of time

For the last task (task 27), participants were requested to "save all pages as a single pdf file". Four of the participants (G2_P1, G2_P2, G2_P4, G2_P6) were not able to perform this operation within the expected time. While one of the participants could accomplish the task after a long time (G2_P3), the other (G2_P5) could do it after a long time by mistake. He selected "send" mistakenly while trying to select "save as" which were listed one under the other as can be seen in Figure 4.

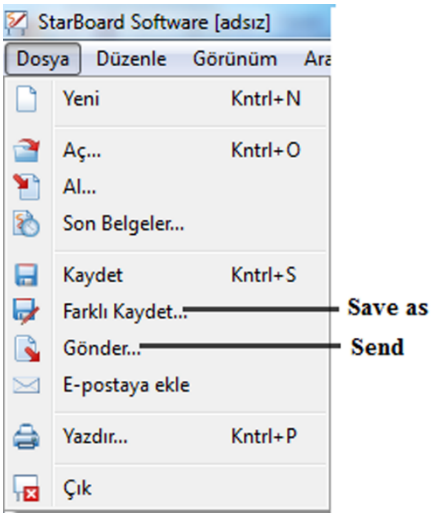


Fig 4. File menu

We can summarize the difficulties observed during the task analysis related with the participants as in Table 4. It can be seen that some of the participants faced difficulties in many of the tasks. These were G2_P1, G2_P2 and G2_P6. These participants had low computer literacy level.

A questionnaire was applied to both groups of teachers in the study. Likert scale questions were categorized based on the usability features; usefulness, ease of use, ease of learning and satisfaction. Percentages of participants' agreement levels are presented in two groups: agreeing (agree and strongly agree options), and disagreeing (disagree, strongly disagree and neutral) to provide a neat picture.

3.1.1. Usefulness

Participants responded to six statements about the usefulness of IWB with Starboard software as seen in Table 5. Participants were generally positive about the usefulness of the system. About 77.8% of them thought that the program is useful while only 22.3% of the participants did not agree with this.

Table 4. Difficulties observed during task analysis

Difficulty	**Task #**	**Participant #**
Difficulty in understanding the "selection" feature rather than the "select-use" mechanism	Task 5	G2_P3
	Task 8	G2_P2, G2_P6
	Task 9	G2_P2, G2_P6, G2_P4
	Task 20	G2_P1, G2_P6, G2_P2, G2_P4
Difficulty in adjusting the features of the objects	Task 8	G2_P2, G2_P6
	Task 9	G2_P2, G2_P6, G2_P4
	Task 20	G2_P1, G2_P6, G2_P2, G2_P4
Difficulty in attaching videos, since they cannot be attached through the "insert" menu but can be attached through an "attach dialog box"	Task 13	G2_P1, G2_P4, G2_P5
Spending too much time for running the attached video	Task 14	G2_P1, G2_P6

Difficulty in understanding double clicking for video to run it	Task 14	G2_P1, G2_P6
Losing tooltips when the dialogue box is adjusted to the sides of the screen	Task 14	G2_P1, G2_P6
Difficulty in closing the video	Task 15	G2_P5
Difficulty in finding "show desktop icon" which enables to use the program toolbar in other programs	Task 18	G2_P1,G2_P4, G2_P6
Appearance of blue lines of the partial screen capture tool	Task 18	G2_P1,G2_P4, G2_P6
Difficulty in spotting the drawings on the screen	Task 19	G2_P2
Difficulty in perceiving how to adjust the timer by touching quadrants on the clock	Task 24	G2_P3, G2_P4
Difficulty in saving the material as pdf since this can be done by "Send" menu item	Task 27	G2_P1, G2_P2, G2_P3, G2_P4, G2_P5, G2_P6

Table 5. Usefulness feature of IWB with Starboard software

	Mean	Disagree	Agree
1. It helps me more effective	4.16	16.7	83.3
2. It helps me more productive.	4	22.3	77.7
3. It is useful	3.94	22.3	77.8
4. It makes me things I want accomplish easier to get done	3.88	16.7	83.3
5. It saves me time when I use it	4.22	16.7	83.3
6. It meets my needs about my course	4.05	16.7	83.3

The results of the questionnaire were analyzed based on the computer literacy level (CLL) of the participants. 40% of the participants who had low CLL and 92% of the participants who had high CLL thought that the system was useful.

3.1.2. Ease of use

Under the ease of use category, 44.5% of the participants agreed that the system is easy to use while 55.5% of them disagreed with this idea. Half of the participants responded positively about the user friendliness statement while the other half responded negatively. The detailed results of this section of the questionnaire as seen in Table 6.

Table 6. Ease of use feature of IWB with Starboard software

	Mean	Disagree	Agree
7. It is easy to use	3.27	55.5	44.5
8. It is simple to use	3	72.2	27.8
9. It is user friendly	3.44	50	50
10. It requires the fewest steps possible to accomplish what I want to do with it	2.94	66.7	33.3
11. It is flexible	3.38	61.1	38.9
12. Using it is effortless	2.94	33.4	66.6
13. I can use it without written instructions.	3.05	55.5	44.5
14. I don't notice any inconsistencies	3.05	27.8	72.2
15. Both occasional and regular users would like it	3.66	33.3	66.7
16. Some features of the system is hard	3.72	16.7	83.3
17. I can recover from mistakes quickly and easily	3.38	55.5	44.5
18. I can use it successfully every time	3.83	22.3	77.8
19. Touch feature of the board is not sensitive enough	3.77	16.7	83.3

When results of the questionnaire were analyzed in terms of the computer literacy level (CLL), it was observed that only 20% of the participants with low CLL and 53% of the participants with high CLL thought that the system was easy to use. Only 20% of the participants with low CLL thought that the system was user friendly whereas 72% of the participants with high CLL thought in that way.

3.1.3. Ease of learning

Participants were asked about the learnability of the system. 83.3% of the participants thought that they learned to use the system quickly. However, only 50% of them thought that learning the system was easy and only 44.5% of them thought that they became proficient to use the system in short time. The detailed results of this part of the questionnaire can be seen in Table 7.

The results revealed that 40% of the participants with low CLL thought that they learned the system easily. However, all of the participants with high CLL thought that they learned the system easily. On the other hand, approximately half of both groups (40% of low CLL and 54% of the high CLL) thought that the system was easy to use. About this result, when the data was analyzed regarding whether the participants had used the system for the first time (group 2) or whether they had training before (group 1), it was seen that only 16.6% of the participants of group 2 users thought that the system was easy to learn while 66.6% of the group 1 participants thought like that.

Table 7. Ease of learning feature of IWB with Starboard software

	Mean	Disagree	Agree
20. I learned to use it quickly	3.83	16.7	83.3
21. I easily remember how to use it	3.66	38.9	61,1
22. It is easy to learn to use	3.5	50	50
23. I quickly became skillful with it	3.33	55.6	44.5

Table 8. Satisfaction feature of IWB with Starboard software

	Mean	Disagree	Agree
24. I am satisfied with it	4	22.2	77.8
25. I would recommend it to my colleagues	4.16	5.6	94.4
26. It is fun to use	4.22	11.1	88.9
27. It is wonderful	3.33	50	50
28. There are too many components on the interface	3.38	55.5	44.5

3.1.4. Satisfaction

As presented in Table 8, 77.4% of the participants thought that the use of the system was satisfactory. Almost all of the participants thought about recommending the system to their colleagues and 88.9% of them stated that using the system was fun.

The analysis of the open ended questions revealed that teachers had difficulties related to the touch feature of IWB, eyestrain caused by the system, complexity of the menu items, incapability of software to run all types of video files, disruption of resolution due to pdf files and freeze of the system while using touch feature. Teachers in both groups were not satisfied with the quality of touch feature of the IWB. For example G2_P5 stated that “Touch errors are frustrating”. All of the participants mentioned that the system would cause eye strain. For instance, G2_P5 stated that screen caused fatigue in his eyes although he was using special glasses. With regard to the complexity of the menu items, G2_P6 said “Program should be simple” and G2_P4 stated that menus of the system were complex.

The results were examined in terms of age, gender, computer experience level and discipline of the participants in addition to computer literacy level (CLL). However, no meaningful difference was found based on these comparison criteria among the groups.

3.2. Proposed checklist

In the scope of this study, usability of the Fatih Project IWB with its StarBoard TM software was investigated. Experimental user test was performed with the teachers who had never used the system before and a questionnaire was applied to both groups of teachers who first met the system for the first time and who had begun to use the system in their classes for almost a month. The results of the questionnaire showed that participants thought positively about the system in general as in other studies [27, 29]. Although they faced some difficulties in user test phase, they gave positive answers to the corresponding questionnaire items.

Ease of use and satisfaction of the system had higher scores than its learnability and usefulness features.When the data was analyzed with respect to participants’ computer literacy level, it was seen that all of the participants with high CLL thought they learned to use the system easily while only 40% of the participants with low CLL thought in that way. This data showed that participants who have low CLL could not learn to use the system as quickly as the other group. Therefore, trainings provided to the teachers should be arranged in two groups based on the computer literacy level and

teachers who have low CLL should have longer training sessions [35].

Open ended questions and task analysis also showed that both groups had difficulties regarding some technical problems such as touch feature of the IWB or some software features such as difficulties while opening some file formats. They stated that these problematic issues must be dealt with and improvements should be made for efficient use. These results were similar to the findings of Bayrak, Karaman and Kurşun's [32] study which also investigated the similar system. Similar to the results of Türel's study [23] participants reported calibration problems and screen visibility problems of the IWB. These errors and inconsistencies cannot be accepted in classroom settings.

This study revealed many usability problems such as invisibility of system status, inconsistencies with conventions, violation to minimalist design and failure to provide recognition rather than recall based on the experimental user test with 6 participants. Observations, conducted during system use, revealed that some menu bars could not be visible or some tool tips of menu icons were lost. As for the navigation of menus, teachers expected some features to be under different menu items which were inconsistent with their previous knowledge about other conventional software such as word processors. Since the location of the menu items were found through different flows especially the participants with low CLL had difficulty in learning the use of the system. There were many items on the interface and this affected the simple design of the system negatively. However, the same participants were generally satisfied with the system despite these problems. On the other hand, if these problems aren't solved, they might cause frustrations among the teachers while using the system in classroom settings in front of their students. This would cause stress on them and would affect the overall quality of their instructional process.

In the long term, teachers would abandon to use this system. Based on the revealed issues related with this IWB, a general evaluation checklist is formed to provide guidance for decision makers while adopting any IWB in their classrooms. The checklist contains items which are grouped in three categories as hardware, software and environment-related issues. They can be seen in Table 9 below.

Table 9. Usability evaluation checklist for IWB

Hardware-related issues	Sensitiveness of touch feature of the whiteboard
	Calibration issues while setup
Software-related issues	Minimalist design violation of interface
	Consistencies with conventions
	Provide adequate help
	Affordance problems of interface components
	Visibility of interface components
	Easy to learn to use the interface
	Support for different file formats
Environment-based issues	Clear eyesight from every angle

4. CONCLUSION

Especially for the developing countries like Turkey, successful accomplishment of investments in projects such as Fatih project is very critical when the cost of the installation of these instruments is considered. In addition, these instruments require extensive technical support and in-service trainings [36, 37]. Especially the usability problems based on both software and hardware issues would affect the use and acceptance of these systems [38].

Usability studies should have been integrated in the product development and procurement phases of these kinds of projects. In addition, it is believed that the lessons learned from this usability evaluation project would provide guidance for others by the provided checklist since that can be used as a cost-effective inspection tool when it is not possible to conduct user based usability studies [39].

In this study, the number of participants were very limited since the usability evaluation questionnaire was applied to 18 participants and usability evaluation test was conducted with 6 participants. This number is adequate for a usability evaluation test to determine the critical usability problems [25]. However, since this project is a nationwide project, more data should be gathered by applying the usability evaluation questionnaire to more teachers from all over the country by random selection strategy. In addition, the usability of IWB in this project would also affect the performance of the students; therefore a usability evaluation should be better conducted with students.

REFERENCES

[1] Beauchamp, G., and Parkinson, J. (2005). Beyond the 'wow' factor: developing interactivity with the interactive whiteboard. *School Science Review*, 86(3), 97–103.

[2] Smith, H. J., Higgins, S., Wall, K., and Miller, J. (2005). Interactive whiteboards: boon or bandwagon? A critical review of the literature.

[3] Tanner H., Jones S., Kennewell S., and Beauchamp G. (2005),

Interactive Whole Class Teaching and Interactive White Boards. In: *Proceedings of Building Connections: Research, Theory and Practice - MERGA28*.

[4] McIntyre-Brown, C. (2011). Understanding the next wave of technology innovation in education: UK. Retrieved September 5, 2015 from https://classtechnology.files.wordpress.com/2011/02/2011-01_futuresource-uk_understandingnext_wavetechnology.pdf

[5] Holmes, K. (2009). Planning to teach with digital tools: introducing the interactive whiteboard to pre-service secondary mathematics teachers. *Australasian Journal of Educational Technology*, 25(3), 351–365.

[6] Slay, H., Siebörger, I., and Hodgkinson-Williams, C. (2008). Interactive whiteboards: Real beauty or just "lipstick"? *Computers & Education*, 51(3), 1321–1341.

[7] Türel, Y. K. (2011). An interactive whiteboard student survey: Development, validity and reliability. *Computers & Education*, 57(4), 2441–2450.

[8] Fatih Project (2013a). Fatih Projesi [Fatih project]. Retrieved December 10, 2014, from http://fatihprojesi.meb.gov.tr/

[9] Akgül, M. (2013). Fatih Projesi: Sorunlar, Riskler ve Endişeler, BM Dergi, 2, Retrieved December 10, 2014, fromhttp://dergi.bmo.org.tr/sayi-2/fatih-projesi-sorunlar-riskler-ve-endiseler.

[10] Fatih Project (2013b). Fatih Projesi Sunumu [Fatih project presentation]. Retrieved December 10, 2014, from http://fatihprojesi.meb.gov.tr/icerikeklenti/e240912115330.pptx

[11] Uçar A., Onay Durdu P., "Akıllı Tahta Kullanılabilirlik Çalışması", **7th International Computer & Instructional Technologies Symposium,** Erzurum,147-148, 6-8 Haziran 2013.

[12] Yücel K., Orhan N., Mısırlı G., Bal G., and Sarın Y. G. (2010), An Improved Interactive Whiteboard System: A New Design and an Ergonomic Stylus. **Proceedings of the 2nd International Conference on Education Technology and Computer** (pp.148-152). Izmir.

[13] Higgins, S., Beauchanp, G., and Miller, D. (2007). Reviewing the literature on interactive whiteboards. *Learning, Media and Technology*, 32(3), 213–225.

[14] BECTA (2006). Teaching Interactively with Electronic Whiteboards in the Primary Phase. Retrieved December 10, 2014, from http://www.edubcn.cat/rcs_gene/9_teaching_interactively_whiteboards.pdf.

[15] Milliyet Newspaper (2011). Vestel akıllı tahtada en iyi fiyatı verdi, gözü sonuçta. Retrieved December 10, 2014, fromhttp://ekonomi.milliyet.com.tr/vestel-akilli-tahtada-en-iyi-fiyati-verdi-gozu-sonucta/ekonomi/ekonomidetay/03.12.2011/1470552/default.htm

[16] Fatih Project (2011). Fatih Projesi Eğitimde Teknoloji Kullanımı Kursu Eğitmen Kılavuzu [Fatih project technology use in education course guideline]. Retrieved December 10, 2014, from http://eogrenim.meb.gov.tr/SitePages/giris.aspx

[17] BECTA (2003). What the research says about Interactive Whiteboards.Retrieved December 10, 2014, from http://dera.ioe.ac.uk/5318/1/wtrs_whiteboards.pdf

[18] Brown, S. (2003). Interactive whiteboards in education. Retrieved December 10, 2014, from http://www.jisc.ac.uk/uploaded_documents/interactivewhiteboards.pdf.

[19] Wall, K., Higgins, S., and Smith, H. (2005). The visual helps me understand the complicated things: Pupil views of teaching and learning with interactive whiteboards. *British Journal of Educational Technology*, 36(5), 851–867.

[20] Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319–340.

[21] Folmer, E., and Bosch, J. (2004). Architecting for usability: A survey. *The Journal of Systems and Software*, 70 (2004),61-78.

[22] Aldunate, R., and Nussbaum, M. (2013). Teacher adoption of technology. *Computers in Human Behavior*, 29 (2013), 519-524.

[23] Türel, Y. K. (2012). Teachers' negative attitudes towards ınteractive whiteboard use: Needs and problems, *Elementary Education Online*, 11(2), 423-439, 2012.

[24] Shackel, B. (1991) Usability - Context, Framework, Definition, Design and Evaluation. In B. Shackel and S. Richardson (Eds.) **Human Factors for Informatics Usability** (pp. 21-38). Cambridge: Cambridge University Press.

[25] Nielsen, J (1993). *What is usability?* Academic Press, Boston.

[26] Çağıltay, K. (2011). **İnsan bilgisayar etkileşimi ve kullanılabilirlik mühendisliği: Teoriden pratiğe**. Ankara: ODTÜ Yayıncılık.

[27] Yıldız, C., and Tüfekçi, A. (2012). A Study on the Smart Board Usability In-Classroom Applications, *Sigma - Journal of Engineering and Natural Sciences*, 30(4), 381-391.

[28] Somyürek, S., Atasoy, B., and Özdemir, S. (2009). Board's IQ: What makes a board smart? *Computers & Education*, 53(2), 368-374.

[29] Türel, Y. K., & Johnson, T. E. (2012). Teachers' Belief and Use of Interactive Whiteboards for Teaching and Learning. *Educational Technology & Society*, *15* (1), 381–394.

[30] Saltan, F., and Arslan, K. (2013). Teachers' Acceptance of Interactive White Boards: A Case Study. *Mersin University Journal of the Faculty of Education*, 9 (2), August 2013, pp.353-365.

[31] Kirsch, B (2011). SMART Board Usability Test, Retrieved December 10, 2014, fromhttp://brkirsch.iweb.bsu.edu/pbr.html

[32] Bayrak, M., Karaman, A., and Kurşun, E. (2013). FATİH Projesi Kapsamında Kurulan LCD Panelli Etkileşimli Tahtaların Kullanılabilirlik Problemlerinin Tespiti. In: **Proceedings of the 7th International Computer & Instructional Technologies Symposium** (pp.388-391). Erzurum, Turkey.

[33] Lundt, A.M. (2001) Measuring Usability with the USE TM Questionnaire. STC Usability SIG Newsletter, 8(2).

[34] Black, J. A., and Champion, D. J. (1976). **Methods and issues in social research**. New York: John Wiley & Sons, Inc.

[35] Bakadam, E. and Sharbib Asiri, M.J. (2012). Teachers' perceptions regarding the benefits of using the interactive whiteboard (IWB): The case of a Saudi Intermediate School, Procedia. *Social and Behavioral Sciences* 64 (2012), 179-185.

[36] Kayaduman, H., Sırakaya, M., and Seferoğlu, S. (2011). Eğitimde FATİH projesinin öğretmenlerin yeterlik durumları açısından incelenmesi [Investigation of proficiency levels of teachers of FATİH project]. In: Proceedings of Akademik Bilişim'11 - *XIII.* **Akademik Bilişim Konferansı** (pp.123-129). Malatya, Turkey.

[37] Dündar, H., and Akçayır, M. (2014). Implementing Tablet PCs in schools: Students' attitutes and opinions. *Computers in Human Behavior*, 32 (2014), 40-46.

[38] Dillon, A. (2001) User Acceptance of Information Technology. In W. Karwowski (Ed). *Encyclopedia of Human Factors and Ergonomics*. London: Taylor and Francis.

[39] Costabile M. F., De Marsico M., Lanzilotti R., Plantamura V. L., and Roselli T. (2005). On the usability evaluation of e-learning applications. In Proc. of the **Hawaii International Conference on System Sciences** *(*pp. 6b). Big Island, HI, USA.