

Comparing Touch and Tilt Interaction using an iPhone Game for Children

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Abstract: In this paper, we present a study that compares tilt and touch-screen interaction in a 2D iPhone game for children. The trials involved 58 children from 8 to 10 years old. The results showed that the children found touch-screen interaction easier. With regard to engagement and fun, no significant differences were found between the two interaction methods. However, differences between boys and girls were found with the score given to the game. Another interesting result is that the children had no preferred interaction method.

1 INTRODUCTION

Mobile devices incorporate touch displays and other hardware features that let the consumers use bodily and gestural interaction. Touch sensitive screens let the users have precise control in their actions like other pointer interaction methods such as a mouse or a stylus (Schwarten et al., 2008). Touch-based interaction has received positive feedback from users, which has made possible to improve the user experience when using mobile devices (Dittenberger et al., 2009). Bodily and gestural interaction has become very widespread in the last years, possibly due to progresses that have made this technology cheaper and more easily integrated in mobile devices (Kratz et al., 2011). Bodily interaction that involves device movement, like tilting, has been successfully applied in gaming scenarios (Kratz et al., 2011). Tilt interaction method uses the inclination angle of a device. This kind of interaction let the users have intuitive manipulation since the device is at their hands (Schwarten et al., 2008).

1.1 Motivation and Objective

Studies about interaction methods that use mobile devices are centred primarily on scrolling web pages, panning maps or navigating in menus (Schwarten et al., 2008). These kind of studies are mainly focused on adults and not on children (Inkpen, 2001). Furthermore, not many studies examine gender dif-

ferences. For these reasons, we decided to conduct a study with the aim to investigate children's interaction experience, ease of use and their preference for the interaction method in an iPhone 2D game.

In order to obtain a better understanding of children's interaction experience, we tried to answer the following questions in our study: Will touch interaction be faster and easier to use for children as it is for adults? Will tilt interaction be funnier for children as it is for adults? Will gender have a significant effect on the interaction method used?

The paper is organised as follows. Section 2 discusses related work. Section 3 describes the game. Section 4 presents the study. Section 5 displays the results. Finally, in Section 6, a number of conclusions and areas for future research are identified.

2 RELATED WORK

In the last few years, the advances in mobile technology has made possible the popularisation of interaction forms that use the accelerometer and the touch-screen display. Since then, several interaction studies related to mobile devices comparing tilt or touch-screen interaction to other interaction methods have been presented (van Tonder and Wesson, 2010; Büring et al., 2008; Schwarten et al., 2008; Cho et al., 2007), but to our knowledge no work that compares tilt and touch-screen interaction for children has been submitted.

In van Tonder and Wesson and Büring, Gerken, and Reiterer studies map navigation applications were developed (van Tonder and Wesson, 2010; Büring et al., 2008). Schwarten et al., and Cho et al., developed image editing or manipulation applications (Schwarten et al., 2008; Cho et al., 2007). The results of these studies showed that tilt interaction presented some problems such as reflections or strained wrists. Despite this, tilting was considered funnier and more interesting than other interaction methods. Touch-screen was considered more precise and easier. Furthermore, all of these studies were centred on tasks (e.g., map navigation or image manipulation) that require to check which interaction method is the most efficient and usable, leaving the engagement and the preferences in a second place. But in our case, since we have developed a game, the engagement and fun and the preferred interaction methods are also important factors to take into consideration.

3 THE GAME

The game was aimed to test which interaction style (touch-screen or tilt) was preferred and felt more comfortable for children. During the game, the children had to clean a dirty sea (turning the sea's brown colour to a blue colour) using a soap that appeared in the centre of the screen (Figure 1). How they could use the soap depended on the interaction mode. If the game was in touch-screen mode, they had to touch-and-drag the soap around the screen to clean the sea. If the game was in tilt mode, they had to tilt the device to move the soap around the screen. There was no time limit for completing the task and tilt mode had a set calibration for all the children.



Figure 1: Almost cleaned blue sea.

4 STUDY

Fifty-eight children from 8 to 10 years old –with a

mean age of 9.14 ± 0.66 – took part in the study: 27 boys (47%) and 31 girls (53%). The children attended the Summer School of the UPV.

The children who participated in the study were randomly assigned and counterbalanced to one of two groups:

- A: Play the game with touch-screen interaction first and then with tilt interaction.
- B: Play the game with tilt interaction first and then with touch-screen interaction.

First, some instructions were given to the children about how to play the game. Then, the group A played the game with touch-screen interaction. After completing the game, they answered the post-game questionnaire Q1. Next, these children played the game with tilt interaction and filled in the ending questionnaire (Q2). The group B did the same but using first tilt interaction and then touch-screen interaction. The questionnaires were filled in in the same room where the activity took place. One person was in the activity room in order to clarify doubts to the children. During the trials, the children used an iPhone 3GS equipped with an external case to protect the device against shocks and falls (see Figure 1).

Two questionnaires were used for the validation. Table 1 shows the relation of questions for each questionnaire. Answers of questions 1, 3, 4 and 5 followed a Likert scale that ranged from 1 (strongly disagree) to 5 (strongly agree). Questions 2, 6 and 7 had categorical answers (answers in brackets were the possible choices). And questions 8 and 9 had hand-written answers. Questionnaires were kept short since they would be used by children.

The first questionnaire (Q1) was composed of questions 1 to 5 (see Table 1). The questionnaire was made to collect data about the ease of use and engagement the children had after using an interaction method.

The second questionnaire (Q2) was composed of questions 1, 3 and 5 to 9 (see Table 1). Some of the questions were the same as in Q1, which allowed us to compare if the order of playing affected the children's experience.

5 RESULTS

To measure how much fun the children had playing the game (question 1 in Table 1), we performed a mixed design ANOVA test to take into consideration several factors simultaneously. The significance level was set to 0.05 in all tests. No significant differences in any of the factors studied (gender:

Table 1: Numbered questions and their appearance in each questionnaire. The last two questions are hand written. Answers in brackets are a summary of the possible choices. The rest of answers follow a Likert scale.

#	Q1	Q2	Question
1	x	x	Did you have fun playing the game?
2	x		Would you like to play again? [Yes / No / Maybe]
3	x	x	Did you find it easy to play?
4	x		Would you like to use this system in other games?
5	x	x	Please, score the game from 1 to 10.
6		x	Which interaction method did you find it easier? [Touch-Screen / Tilt]
7		x	Which interaction method do you prefer? [Touch-Screen / Tilt]
8		x	Why?
9		x	What did you like the most?

F[1,54]=0.22, p=0.64; grade: F[1,54]=1.61, p=0.21; method: F[1,54]=3.05, p=0.09; order: F[1,54]=0.52, p=0.48). The global rating was high (4.59±0.56), which means that the children had fun playing the game with both interaction methods.

We performed another mixed design ANOVA test to measure how easy it was to play the game for the children (question 3 in Table 1). While the global rating was high (4.52±0.73), meaning that the children found the game easy to play with both interaction methods, the score given to touch-screen interaction was higher (4.71±0.53) than tilt interaction (4.33±0.84). We can see the results of the mixed design analysis in Table 2, which showed significant differences in the interaction type.

Table 2: Mixed design ANOVA for the ease of use. N = 58. The symbol * indicates significant differences.

Factor	d.f.	F	p	η^2
Gender	1	0.54	0.46	0.01
Grade	1	0.32	0.57	0.01
Interaction method	1	7.79	0.01	* 0.04
Order	1	0.02	0.88	<0.01
Factor Interactions	1	<1.53	>0.22	<0.01

Furthermore, we asked the children if they would like to use these interaction systems in other games (question 4 in Table 1). The score given was high, and both interaction methods obtained almost the same result (4.59±0.78 for tilt and 4.59±0.63 for touch). A multifactorial ANOVA was performed in order to observe if there were significant differences in question 4 responses. No significant differences were found in any of the factors (gender:F[1,50]=1.41, p=0.24; grade: F[1,50]=0.10, p=0.76; method: F[1,50]<0.01, p=0.96).

We performed a mixed design ANOVA to measure

the differences in the score given to the game by the children when playing with touch-screen or tilt interaction (question 5 in Table 1). We can see the results of the mixed design analysis in Table 3, which show significant differences in the gender and interaction type factors. The girls (9.40±0.88) rated the game higher than the boys (8.52±1.37) and tilt interaction obtained higher results (9.12±1.24) than touch-screen interaction (8.86±1.18).

Table 3: Mixed design ANOVA for the game scores. N = 58. The symbol * indicates significant differences.

Factor	d.f.	F	p	η^2
Gender	1	8.23	0.01	* 0.1
Grade	1	0.01	0.91	<0.01
Interaction method	1	4.15	0.05	* 0.02
Order	1	0.25	0.62	<0.01
Factor Interactions	1	<2.20	>0.14	<0.02

A Chi-squared test for question 7 in Table 1, revealed that the preference for the touch-screen or tilt was not affected by the order of play ($\chi^2[1, N=58] = 0.07$, $p = 0.79$, Cramer's $V = 0.07$). A total of 55.17% of the children in the group A chose touch-screen interaction and 51.72% of the children in the group B preferred tilting. We also performed a Chi-squared test to determine if there were differences in preference of the interaction types between boys and girls. The results showed that there were no differences ($\chi^2[1, N=58] = 1.11$, $p = 0.29$, Cramer's $V = 0.17$). Girls preferred slightly more the tilt interaction (58.06%) while boys favoured marginally the touch-screen interaction (59.26%).

Regarding the preference for the easiest interaction method (question 6 in Table 1), the children of both groups favoured touch-screen rather than tilt (group A: 63.33% and group B: 60.71%). The Chi-squared test showed no significant differences between the interaction types ($\chi^2[1, N=58] = <0.01$, $p = 0.95$, Cramer's $V = 0.03$). The same test was applied to determine if there were differences between boys and girls, but the results revealed no significant differences ($\chi^2[1, N=58] = 0.47$, $p = 0.49$, Cramer's $V = 0.13$). Boys (55.56%) and girls (67.74%) found easier touch-screen interaction than using tilting.

6 CONCLUSIONS

We have conducted a study with the aim to research on children's interaction experience and their preferences about their favourite and easiest interaction method. Fifty-eight children have participated in the trials.

The results have shown some interesting findings. Girls gave a higher score to the game. Girls seem to prefer to use computers for goal-oriented activities with meaningful contexts (Kay, 2008). The game developed provided a goal with a meaningful context (clean the dirty sea). This might have been the reason why the girls scored higher the game. With regard to the results about ease of use, we could see that both groups considered touch-screen interaction easier and more precise than tilt interaction. This is encouraging because it shows that children could adapt to different interaction types without major problems. With regard to engagement and fun, the results revealed that the children had similar enjoyment when playing with tilt and touch-screen interaction. With regard to the general preferences about the game, the analyses showed that the children did not favour one interaction over the other. Subjects also stated that they would like to use these interaction systems in other games.

When comparing our study to other studies with adult people, we can observe similar trends with regard to the ease of use, where touch-screen interaction was found easier and more precise (Schwarten et al., 2008; van Tonder and Wesson, 2010). In contrast, there are differences with regard to the engagement and fun. While, in our study, children considered equally fun playing with touch-screen or tilt interaction, adults usually found funnier using tilt interaction (Schwarten et al., 2008; Cho et al., 2007). It is important to note that in the studies of (Schwarten et al., 2008) and (Cho et al., 2007) the tasks performed were image manipulation and image navigation, respectively. In our case, the task performed was to play a game. Thus, it is possible that playing an engaging task (like a game) made that the children found the two interaction methods fun. A future study must be conducted in order to see how the children would rate the interaction types in an application that is not a game.

With regard to future work, allowing them to calibrate the accelerometer when using tilt interaction could enhance the experience. The game could also be improved by adding different levels where obstacles appear in the middle of the screen making the experience more difficult. We could also add other interaction methods to compare, like the use of buttons. In this study, using the device with or without an external case was not tested. Thus, it would be interesting to perform a comparison between using the device with the external case and using it without the external case, in order to observe whether or not the external case actually helps the children move the device.

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