Touch-screen Technology for Children: Giving the Right Instructions and Getting the Right Responses

Lorna McKnight
ChiCI Group
University of Central Lancashire
Preston, UK. PR1 2HE
+44 (0)1772 895152
lmcknight@uclan.ac.uk

Daniel Fitton
ChiCI Group
University of Central Lancashire
Preston, UK. PR1 2HE
+44 (0)1772 893277
dbfitton@uclan.ac.uk

ABSTRACT
While devices such as iPhones, iPads and Surface tables enable a wide range of interaction possibilities, we do not yet have a set of widely understood terminology that conveys the new and unfamiliar touch-screen gestures required for interaction. In this paper we explore terminology for touch-screen gestures and in particular the implications for child users. An initial study exploring touch-screen language with 6-7 year-olds is presented as an illustration of some of the key problems that designers need to be aware of. The children were able to perform a range of touch-screen gestures and transfer metaphors from other contexts but mistakes were observed. From this study we present a set of suggestions as to how designers of touch-screen applications can support children more effectively.

Categories and Subject Descriptors
H.5.2 [Information Interfaces and Presentation (e.g. HCI): User Interfaces – *Input devices and strategies/ training, help and documentation/ user-centred design*

General Terms
Human Factors

Keywords
Touch-screens, children, CCI, gestures, usability, language, instructions.

INTRODUCTION
Touch-screen and surface technologies are currently experiencing a popularity boom with products such as the Apple iPhone and iPad, the Microsoft Surface and the Nokia N900 dominating the media. These devices are often seen to be paving the way for a technological revolution [2]. However, while these technologies are exciting and create interesting new avenues for research, they also create new usability issues, such as the lack of physical feedback on 'soft buttons' [6] and the changes in interaction styles that the user needs to become familiar with.

One proposed use for the new surface technologies is as educational tools in schools [1], which means that the needs of child users must be considered. It is accepted that children can be viewed as a specialist user group requiring particular consideration, and it has been shown that they have different requirements, desires and expectations from adults (see for example [7], [3]). Recent research on children's interactions with touch-screen devices has already identified trends that may cause problems with surface and gestural computing. A range of studies indicated a strong preference for a stylus over finger interaction on resistive touch-screens, and the common occurrence of errors due to unintended screen-contact, while other studies showed a dislike for pen gestures, and difficulty distinguishing between a tap and a press-and-hold gesture on a touch-screen [8]. This could suggest potential difficulties on interfaces that do not support stylus interaction, and those that rely on a range of gestures. Previous work on developing gestures for interaction states that an appropriate gesture set must consider both the application and the needs of the user group [9], showing that more research is necessary on the needs and capabilities of young users with these technologies.

Another key issue is the terminology used in instructions. Clear instructions are critical for any users, but particularly for child users with a smaller vocabulary range and reduced reading abilities. Many guidelines for designing interfaces for children stress that language used in instructions needs to be age-appropriate and understandable in order to reduce confusion and distress (for example [3], [4]). However, touch-screen interaction and gestural computing both introduce a new range of terms that may be unfamiliar and confusing (see for example [11]), reusing terms from other contexts where the similarity may not be clear. For example, touch-screen software often instructs users to 'click' a soft button, despite the fact that no clicking action is made without a mouse – this terminology relies on users transferring knowledge from their use of desktop computers. Alternatively, new terms such as 'swipe' or 'slide' may not have been encountered before on a desktop

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computer, so users may not understand their meaning. Finding better terminology however may be difficult – it is harder to make a consistent link between a term and a gesture on a touch-screen as there are many different types of action and many possible terms to describe each.

Some studies have already suggested that children are unfamiliar with terms in use on touch-screens such as 'scroll' [10]. Kähkönen and Ovaska [5] state that well-designed software should not require instructions; however, they accept that instructions are often helpful, and, where used with children, suggest that they may be better understood in audio rather than textual form. Audio feedback does also have its disadvantages though, and experience has shown that it is often ineffective in a noisy classroom environment. Additionally, if the term is completely unfamiliar, audio instructions offer little assistance.

INITIAL STUDY

A short study was designed to perform an initial test of common touch-screen terminology with children, in order to identify issues that may occur, and to help inform a longer study on this subject. In this study, children used a touch-screen tablet PC (an HP Touchsmart tx2, in tablet mode without keyboard or touchpad visible). The device was explained to them, and they were told that they would have to use a fingertip in place of a mouse. They were not permitted to use a stylus or digital pen for this study. 13 children aged between 6 and 7 took part, all of whom were native English speakers from a primary school in the UK. Participants were allowed to complete the activity in their own time; in general, each trial took around 10 minutes.

The application created for this study was intentionally very simple. The screen showed a picture of a cartoon 'Pokemon' character, and displayed written instructions of how the user should interact with it (see Figure 1). This instruction was also played in audio form, and the experimenter was nearby to provide additional help.

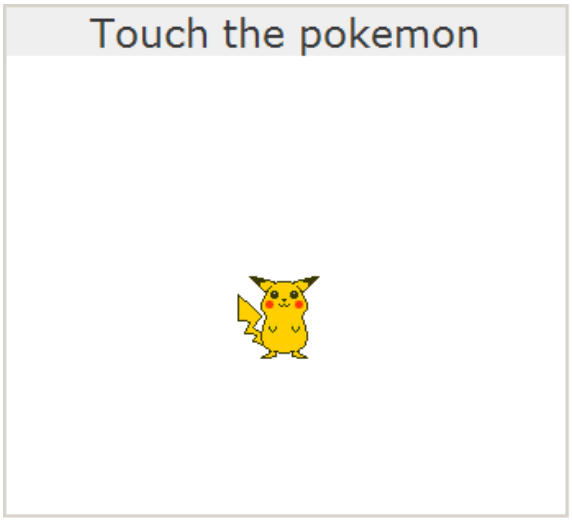

Figure 1: Example screen shown during the study

The application recognised 4 different actions: 1) single click (or touch), 2) double-click, 3) click-and-hold, and 4) click-and-drag. Each gesture caused a different animation of the character, before moving on to a new instruction. The application recorded the gesture performed, but did not inform the user that they were 'correct' or 'incorrect', so as to allow free interpretation of the instructions. The time taken to perform actions was also recorded, to provide a measure of how long it took a user to understand the instruction or decide which action to perform.

There were 30 instructions given in each trial, aiming to cover a range of possible words for each of the 4 interaction styles (as shown in Table 1). At the end of the trial the animated character was shown cheering, and the child was thanked for their participation.

Table 1: List of instructions given during the study

Touch the Pokemon	Double-click the Pokemon
Touch and hold the Pokemon	Drag the Pokemon
Press the Pokemon twice	Tap the Pokemon
Push the Pokemon	Poke the Pokemon
Click the Pokemon twice	Slide the Pokemon
Give the Pokemon two taps	Select the Pokemon
Do a long click on the Pokemon	Press the Pokemon
Tap the Pokemon twice	Move the Pokemon
Click and drag the Pokemon	Press and hold the Pokemon
Prod the Pokemon	Give the Pokemon a big push
Double-press the Pokemon	Touch and drag the Pokemon
Click the Pokemon	Select the Pokemon twice
Click and hold the Pokemon	Double-tap the Pokemon
Swipe the Pokemon	Do a long press on the Pokemon
Press and drag the Pokemon	Touch the Pokemon twice

Results and observations

To an observer, it seemed as though most of the children who took part in this study had little or no trouble understanding the majority of the instructions given to them, and completed the task easily and quickly. However, some important points could be noted from observations made during the session and from the results recorded by the software. The recorded results are shown in Table 2, showing the breakdown of interaction events recorded by the application for each instruction, and the median time taken for the users to respond to the instruction.

First, it is worth noting that presenting instructions in both textual and audio form proved useful. At this age, some children were less confident readers, so would wait to hear the instruction before completing the task, occasionally asking for it to be repeated. Some were more advanced though, so were keen to read instructions, and began gestures before the audio finished. However, this meant that their reading ability significantly affected the time data, and so a decision was made to focus more on observations and gestures than on timings when looking for effects across participants.

Table 2: Results from the study as recorded by the software

Instruction	Interaction Event				Median Time (ms)
	Single Click Detected	Double Click Detected	Click and Hold Detected	Click and Drag Detected	
Touch	8			5	4469
Double Click	5	6		2	3668
Touch and hold	2		3	8	6743
Press it twice	5	6		2	4175
Push	1	2		10	3267
Drag	1			12	3517
Tap	11			2	3329
Click it twice	6	5		2	3543
Slide	1			12	3152
Press	6			7	2569
Move	2	1	1	9	3246
Give it two taps	2	9		2	3826
Do a long click	3		6	4	5376
Tap it twice	1	10		2	3083
Select	5		2	6	4670
Click and drag	2		1	10	3832
Press and hold			2	11	4183
Prod	10			3	3737
Give it a big push		1		12	4049
Double-press	1	5	1	6	3505
Click	7			6	3311
Touch and drag	3			10	3854
Select it twice	3	4		6	3775
Click and hold	3		1	9	4234
Swipe		1		12	4202
Double-tap	3	7		3	3294
Do a long press	1	1	3	8	5124
Press and drag				13	3711
Touch it twice	1	6		6	3196
Poke	8	1		4	3531

Some of the terms used were clearly more familiar to the children than others. They had no trouble with the term ‘click’, responding quickly and correctly; despite the lack of a physical clicking action, this is perhaps because this is the term they are most familiar with though standard computer use. Surprisingly, though, less-familiar interaction terms such as ‘slide’ and ‘swipe’ were also well understood, perhaps because they are used more often to describe actions in the real world. The term ‘select’ was the least well understood, with several children pausing at this point until help was offered, or directly asking the meaning of the word. When the word ‘choose’ or ‘pick’ was suggested as an alternate meaning, they understood the word but still had difficulty seeing how they might perform this function through an action on the screen.

Timing of the actions was also occasionally an issue. Particularly noticeable was when the children were asked to perform a ‘long click’ or ‘press and hold’: they performed the action correctly, but several of the children had to be prompted to release their fingers after holding them down for a long time, even if the animation had already started playing. While they understood the instruction, the instruction provides no information about when they should release their hold, or how long a click it should be, and they seemed to be awaiting further instruction before releasing their fingers from the screen. Also, when asked to perform a double-click gesture, the children understood the terms used (‘double-click’, ‘double-tap’, ‘press twice’ and so on), and touched the screen twice, but often they failed to perform the two taps quickly enough, meaning that they were recognised by the system as two single clicks.

However, the most common source of error was not from the children misunderstanding the instructions, nor from performing the wrong sort of gesture, but from the software misinterpreting the children’s actions. Often when they pressed the screen for a ‘single click’ or a ‘press and hold’, they would move their fingers slightly as well, causing the software to recognise the gesture as a ‘click and drag’. These slight inaccuracies seem to indicate over-sensitivity in the underlying operating system or input hardware drivers rather than an error on the user’s part – while the system had been tested successfully with adults, it seems that less sensitivity and more robust error detection is required when designing for child users. Although the children may become more accurate with experience, this is something that the system could easily compensate for; for example the software could require a movement of at least a fingertip length before registering this as a touch-and-drag gesture. The extent to which this is likely to be a problem will also vary depending on the hardware used – a touch-screen that is more or less accurate may result in a different number of errors. However the issue is worth noting, so the software designers can compensate for the type of hardware being used.

Another issue also seen was the children’s tendencies to accidentally touch the screen with their other hand, or with the heel of their pointing hand, causing errors. Since the system accepted touches on any part of the screen, it registered an accidental touch from their other hand as a single click and would start the animation, even if they then performed their intended double-click or other gesture. On some occasions such unintentional touches were also seen to cause more serious problems, such as accidentally choosing a different application from the taskbar. This issue and children’s difficulty in seeing the cause of such errors has already been noted in previous studies [8] and while they may learn to avoid these mistakes with time, it is suggested that touch-screen software for children aims to compensate better for accidental touches. A device such as a Microsoft Surface that uses a camera to recognise touches can ignore screen contact that does not appear to come from a fingertip, whereas a simple solution for capacitive or resistive touch-screens might be to simply give clear visual feedback on all screen contact so that at least the source of errors can be identified.

DISCUSSION AND FUTURE WORK

The initial study discussed here has helped to identify a number of important points which we intend to explore further. First, it has shown that even children from the age of 6 can be comfortable with touch-screen technology and distinguish between a range of common on-screen gestures. The language used in instructions may affect their ease of understanding tasks given to them, but terms that are familiar from desktop computers can be transferred to a touch-screen environment with little difficulty. For this age-group, a mixture of audio and textual instructions seems suitable to support the different levels of ability or preference.

A more important issue is that the system needs to be designed to compensate for minor errors that the children may make, particularly including accidental touches on the screen. This is likely to be an issue for adult users as well to some extent, but perhaps accentuated more in children who have not yet developed the fine motor control of adults.

In particular, the children struggled with the timing of their actions, and the instructions given did not assist with this – indeed in the case of the 'press and hold' instruction, this confused them and did not indicate that they should release it at any point. Perhaps in this case animations would prove more useful than textual instructions, or where the gestures are critical a training phase could be used. In a classroom scenario a new or important action could be demonstrated by a teacher or assistant, but naturally this is not possible in all cases.

Following on from this study, the next step will be to extend the investigation to a wider range of ages, and to take advantage of emerging surface technologies in order to explore a greater variety of interaction styles. In particular, it will be interesting to explore children's ability to perform more complex multi-touch gestures such as the 'pinch' or 'two-finger rotate', and their understanding of the functions available with such technologies. As these technologies become more pervasive, and gesture sets become more standardised it is likely that users will become more familiar with them; nevertheless, as each new device is introduced to the market they bring a new set of interaction styles, meaning that at present there is still a great scope for research in this field.

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