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# *Touching the screen: issues related to the use of touchscreen technology in early childhood education*

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**Abstract**

This paper reports on a research project that investigated the use of touchscreens by children in early childhood and junior primary settings by introducing touchscreens in five classrooms in Melbourne. Several methods to obtain information about how children interacted with the touchscreens were used including observation, journals and field notes, and interviews. The research identified five key themes, relating to developmental issues, input device preference, technical issues, individual differences in children's use of the touchscreen and issues of collaboration.


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## Introduction

The computer has become a recognised tool in the education of young children, particularly where it is used to promote problem solving skills and social interaction amongst children (Anderson, 1999). Early on, the use of such technology in these settings prompted fears that the abstract nature of the computer would prove damaging to young children's cognitive and social development (Brady and Hill, 1984). Later, the application of constructivist approaches of teaching and learning using computers displaced many of these fears (Haugland and Wright, 1997; Henninger, 1994). The role and importance of computers in young children's lives, and by extension their educational lives was recognised in 1996 with the publication by the highly influential (American) National Association for the Education of Young Children's (NAEYC) position statement on the use of technology by young children. It argued that computers could be best utilised in early education when combined with a constructivist or open-ended approach to learning. It suggested that young children be provided with opportunities to actively engage with the computer and its supporting software, rather than simply responding to drill and practice software, and stressed that children's engagements with technology should be developmentally appropriate (NAEYC, 1996). Whilst it is now generally agreed that young children can benefit intellectually and socially from the use of developmentally appropriate and constructivist based software (Clements and Nastasi, 1993), research into the appropriate use of computer hardware has not been so conclusive. The mouse and keyboard have traditionally been the main input devices used by young children; however, advances in technological development have meant that touchscreens can now be added to this list. How children utilise such input devices and in particular the developmental appropriateness of one device over another has generated little research.

Prior to this project, the limited research available on young children's uses of input devices suggests that touchscreens are potentially easier for young children to operate, allowing them to complete simple tasks (ie, moving a cursor) without having to achieve the level of mastery required by other input devices (Batternberg and Mebler, 1989). This was further demonstrated by Scaife and Bond (1991), who studied the use of touchscreens by children and adults, finding that there was "little developmental change in performance with the device (touchscreen) and the performance of a five-year-old typically was comparable to that of an adult" (Scaife and Bond, 1991). While children and adults learned to use the touchscreen at similar rates, the younger children had much more difficulty learning to use a mouse or keyboard in comparison to the touchscreen than did adults. This finding was possibly due to the more direct relationship between a user's hand movement and the on-screen effect when using a touchscreen as compared with other input devices. Similarly, the mouse has a closer physical relationship between action and effect than the keyboard, suggesting in turn that from a developmental perspective that the mouse would be an easier input device to utilise than the keyboard. This relationship has been supported by studies that have suggested that the mouse is a more effective input device for young children than is the keyboard (King and Alloway, 1992, 1993; Scaife and Bond, 1991). In contrast a study evaluating several input devices as used by adults found that the touchscreen was the fastest

and most preferred input device, although it was also found to be the most inaccurate (Ostroff and Shneiderman, 1988). There have also been studies examining the use of touchscreen devices by children with additional developmental needs (see for example Durfee and Billingsley, 1999).

However, none of the studies cited above have examined how well children are able to use a touchscreen to complete more complex tasks, such as selecting objects on screen or dragging and dropping icons. With modern touchscreen technology users are able to select an icon on the screen with their finger as they would using the mouse. The user can then drag the icon across the screen with their finger. If single or double clicks are required to execute commands the user simply taps the screen once or twice. Examining how young children respond to these actions within the classroom context was considered a viable area of investigation.

This study aimed to explore a series of questions related to the developmentally appropriate use of touchscreens in early childhood and primary education:

- What are the developmental issues associated with the use of the touchscreen as an input device?
- Which input device do the children appear to prefer when operating the computer?
- As an input device, what influence does the touchscreen hold over children's social interactions and/or collaborative behaviours when two or more children are working at one computer?

This study was funded by touchscreen manufacturer *MicroTouch Australia*.

**Methodology**

The main data collection strategies employed within this framework included semi-structured interviews of the teachers and observations of the children's interactions with the touchscreen. The observations were conducted across two early childhood educational settings and included five early childhood classrooms.

**Setting description**

The early learning centre was part of an independent school and consisted of three separate groups (three year-olds and two groups of four year-olds), each comprising approximately 15 children. Each group was in a separate room containing a number

*Table 1: Study settings and classroom breakdown*

| *Setting* | *Classrooms* |
|---|---|
| 1. Independent School Early Learning Centre | • 1 reception class (three year-olds)<br>• 2 pre-preparatory class (four year-olds) |
| 2. Government Primary School | • 1 preparatory class (five year-olds)<br>• 1 grade one class (six year-olds) |

of activity areas, including a single stand-alone computer (PC). The touchscreen was installed on each of these computers. The preparatory (five year-olds) and grade one (six year-olds) classrooms were part of a government primary school. The preparatory class, comprising one teacher and 24 children, had touchscreens attached to three of the five Apple (iMac) computers. The year one class comprised one teacher and 26 children and contained five Apple (iMac) computers with touchscreens fitted to three. The software used in the study included *Jumpstart*, *Humphrey's Counting House*, *Blast Junior* and *Pirate Adventures* (Early Childhood setting), *KidPix*, *MicroWorlds*, *James Discovers Maths*, *Desert Quest*, *Inside Stories* and *ClarisWorks* (Primary setting).

Altogether five teachers were involved in the study—three from the early learning centre, one from the preparatory class and one from the year one class. The five classrooms were selected for inclusion in the study because:

- The five teachers responsible for the teaching in the selected classrooms had a range of experiences in using computers in early childhood education
- The classrooms represented both the independent and government school sectors
- The classrooms included children within the age range (three to seven years) that spans the recognised early childhood period (Bredekamp, 1987)

**Data collection**

Qualitative instruments were used including observation schedules, teacher and researcher journals and semi-structured individual interviews. The range of data collection instruments employed increased the researchers' ability to examine the nature and frequency with which certain issues arose from a range of perspectives. The specifics for each of the four data collection instruments used in the study are as follows:

- Observation schedule—Researchers observed each classroom prior to implementation, noting the features of the learning environment and use of computers.
- Researcher observation journals—Researchers maintained observational journals during the seven-week period in which the touchscreens were operational, noting the children's behaviour and interactions with the touchscreens, teacher engagements with the children and comments on the children's use of the input device.
- Teacher observation journals—Teachers maintained observational journals during the seven-week operational period, noting children's use of, and interactions with the touchscreen as well recording reflective comments in relation to their observations.
- Semi-structured interviews—Individual semi-structured interviews were held with each teacher before and after the implementation period. All interviews were taped and transcribed.

**Data Analysis**

The data from each of the data collection procedures was collated and analysed by each researcher. Individual researchers identified a series of themes or categories that were recognisable in each form of data collected. The most frequently occurring themes identified by individual researchers were noted.

*Table 2: Identified themes and major findings for each theme*

| *Theme* | *Major findings* |
|---|---|
| Developmental issues | • Children became more familiar and competent with the touchscreens over time<br>• Children's responses to the touchscreen were influenced by:<br>  • Children's level of motor-skill development influenced the ease with which they could operate the touchscreen<br>  • The way in which the touchscreen and the computer were positioned in the classroom |
| Input device preferences | • The type of software being used was a major determinant of children's preference for a particular input device<br>• Most children preferred the mouse to the touchscreen |
| Social interaction and collaboration | • Collaboration was common but often not constructive<br>• The simultaneous availability of more than one input device increased the amount of negative collaboration |

## Findings

Three main themes were identified within the data, and a number of main findings were distilled from the array of observations and comments collected on that theme.

## Developmental issues

The developmental use of the touchscreen refers to the manner in which the children's behaviour relating to the touchscreen as an input device was observed to change over the seven-week observational period. This development appeared to be related to two main factors, including the level of the children's motor skills and the positioning of the touchscreen and computer in the room.

### *Motor skills*

The children in this study were in early childhood and junior primary settings and aged between three and seven years of age. It was noticed that across all of the year levels, children had difficulty in selecting, dragging, and generally moving around the touchscreen using their finger as a pointing device. A similar difficulty was noticed when children tended to use more than one finger and, indeed, their whole hand, when attempting to activate the touchscreen. These difficulties can, at least, be partly attributed to the relative stage of the children's perceptual-motor development and the development of their fine motor skills. The children's ability to control the mouse was comparably less affected by this level of skill development. There are at least two possible explanations for this finding. First, the mouse may be a more appropriate input device for children at this stage of their development, especially where icon size and complexity are an issue. Second, the children are more familiar, and have had more practice, in using the mouse as an input device. Without further investigation it is difficult to determine which of these two explanations is more valid. As more demands are made on children requiring finer motor skills in interacting with complex computer

interfaces, the more difficulties they experience. If touchscreens are to be used in early childhood and junior primary settings, teachers and software designers, need to consider both the level of children's perceptual motor development and the fact that children require a period of time to become competent users of input devices.

*Positioning of the computer and touchscreen*

The teachers' personal beliefs about the role of computers in early childhood education influenced the positioning of the computer and touchscreen in the classroom. For example, in one early learning classroom (four year-olds), the computer was placed, often under a cover, on the teacher's desk in her office, indicating that this teacher did not believe that the computer was a part of the mainstream equipment of the class. Throughout the study this teacher saw the computer as a magnet or major distraction for the children who found it hard to *"stay away from it"*. She saw the computer as a facility to be used with some reservation and with considerable control. Whilst all areas in the classroom, such as the toy corner and the book corner, had rules associated with them, perhaps the most enforced rule observed during the period of the study was two people only at the computer at a time.

Conversely, in another classroom (three year-old) in the same early learning setting, the computer was treated as another activity area and was located on the children's rather than teacher's furniture and was left on for most of the day. In the third room (second four-year old group) the computer was also located on children's furniture within the classroom. It was turned on during the free play times, often with the sound being turned down so that it did not disturb other children in the class. It was covered when not in use. In the primary classrooms the computers were also located on children's furniture within the main teaching area. Hence the location of the computer within the learning environment and, in particular, the ease of access to the children is an important factor in how children interact with the touchscreen over a period of time.

In all the settings, including those in which the computer was appropriately placed to facilitate access, the children had physical difficulties reaching the touchscreen. One of the early learning centre teachers expressed a concern raised by several teachers that *"reaching up to the screen was a 'turn off' for the kids. They are too small to reach"*. Teachers using touchscreens need to consider the ergonomic features associated with the traditional placement of the monitor. Lowering and tilting the monitor may well enable easier access for young children.

## Input device preferences

Two main factors were identified as influencing most children's preference for the mouse over the touchscreen. These factors related to the effectiveness of the relationship between the software user interface and the input device and the children's prior experience in using the mouse to operate the computer.

*Software interface*

Using the touchscreen with software that had a complex user interface was somewhat problematic, and tended to influence the children's preference for a particular input device over another. All of the software that the teachers were using in the context of this study had been previously developed on the assumption that the mouse and keyboard would be the only input devices used to operate the program. A consequence of this was that screen icons tended to be small and required accurate navigation of the mouse pointer in order to effectively execute a command. This made the use of the finger as the pointing tool less effective. Some children (primarily from the grade one class) initially reacted to the inappropriate icon size, and to the computer's apparent lack of response to their finger touch, by performing multiple touches with their finger. When that failed, they used the rubber tip of a pencil. We assume that this second solution was chosen because the children realised that a finer, more accurate selection device was needed. The ingenuity of this discovery by the children should not be underestimated. The fact that all of the software used in the project was designed with the mouse and the keyboard in mind led to widespread user difficulties such as inaccurate selections, clicking and dragging problems, and initiating unintended commands. In addition to difficulties caused by relatively small icon size, we noted difficulties due to the placement of icons on the screen and the proximity of icons to each other. Some software appeared to be more suited to the touchscreen than others. Software such as *Inside Stories* that have large icons and uncomplicated input requirements were most compatible with the touchscreen. However, software such as *KidPix* and *MicroWorlds*, with their smaller icons and more complex user interfaces, were less suitable to the touchscreen and caused more difficulties for children. Teachers need to be aware that much of the software currently used in the classroom has been designed with mouse and keyboard in mind. This may well make children's use of the touchscreen more difficult than it might otherwise be.

*Prior experience with existing input devices*

Children's choice of either the mouse or the touchscreen as the preferred input device appeared to have been influenced by their prior experience, familiarity and opportunity for skill development with the mouse. In this study, which commenced in the final term of the school year, children at all year levels were already familiar with using both the keyboard and mouse. In addition, many of the children had used the mouse and keyboard in the home environment. Given the fact that the touchscreen was introduced after the children were already demonstrating some proficiency with the mouse and keyboard, the data was analysed to determine the extent to which their familiarity with these input devices affected their use of the touchscreen. This is illustrated in the following example where the teacher from the reception class (three year-olds) was observed asking one child, "*Why don't you want to use your finger?* [Referring to the use of the touchscreen] *Do you like the mouse better?*" The child responded to this questioning with an emphatic and affirmative nod. Researchers' observations, teachers' diary entries and interview comments relating to the three and four year-old classes are littered with similar reference to children's preferred use of the mouse. The same prefer-

ence for the mouse was also clearly evident in the primary school classrooms. However, what was increasingly evident at these higher year levels was that in addition to the order, in which input devices were introduced to children, the children's preference for the mouse was also tied to their more extensive experience with this input device. The prep teacher (five year-olds) explained to researchers why she thought that most children reverted to using the mouse:

*I think it's because they were such accomplished mouse users and when they sit down at their computer, their reaction is to use the mouse and they can do everything using the mouse. I think had it been given to them earlier in the year, I had a few kids who hadn't been using computers to start with, and I think that would have been very different because if you think they wouldn't have had any experience with computers, well not to the extent that they have had now, I think that they would have learnt to use the computer using a touchscreen and it would have been very different.*

All teachers noted this tendency for the children to return to the input device with which they were more familiar after an initial exploration of the touchscreen. The teacher quoted above speculated that if the touchscreen had been introduced to the children first, then they might have subsequently favoured it over the mouse. This is possibly explainable in terms of interference, where performance on a prior task interferes with subsequent learning (Reed 1994). In all classrooms, the mouse and keyboard had already been introduced to the children prior to the touchscreen. This suggests that their prior learning with the mouse may have interfered with their ability to learn to use the touchscreen, although it should be noted that the level of interference in this situation was different for particular individuals.

**Social interaction and collaboration**

Collaboration between children working at the computer and using the touchscreen appeared to be influenced by the teachers' beliefs regarding the role of collaboration in children's learning and the children's level of social development. Overall, the touchscreen tended to promote negative rather than positive collaborations, with the presence of the touchscreen allowing children to pursue their individual goals as opposed to encouraging them to cooperate and achieve a common goal via one available input device.

Prior to introducing the touchscreens, the primary teachers believed that they would increase the ability of groups or pairs of children to interact with a particular program. The observations recorded by the researchers and the teachers indicate that these expected benefits were not overwhelming. Only two positive interactions between children using the touchscreen were reported. One of these was in the primary setting where the teacher recorded an example of two students employing both the mouse and touchscreen effectively in order to operate a program. The other instance of effective collaboration between children using the touchscreen was recorded by a researcher who noted that *" 'R' and 'A' begin taking turns to press the object matching the program directions using the touchscreen"*. These observations are contrary to the majority of reported interactions between the children.

Researcher observations from both settings recorded many more instances of "negative collaboration" between the children, where children other than the designated "operator" tried to gain control over the program using the touchscreen. In these classrooms, two chairs were placed in front of the monitor, one for the user and one for the observer.

The following example illustrates the manner in which the touchscreen allowed confident users to retain control even when they were supposed to be observing and assisting another less experienced user:

*A boy ("D") and a girl ("J") were working together using The Desert Quest. D was initially the main user and had control of the mouse. He used the touchscreen only once. D was in control of the program and was making all the decisions with very little discussion with his partner. J had very little input and soon lost interest. She made no attempt to touch the screen or keyboard. It came time for the two to swap seats. J now had the mouse and control of the program. D suggested, "let use the touchscreen now" and retained control over the program even though J now had control of the mouse and keyboard.*

Before the touchscreens were installed the teachers predicted that they would be beneficial in promoting collaboration between children at the computer. By the end of the observation period, their opinions had changed and the teachers expressed concern about conflicts between confident and non-confident users, and between boys and girls.

There were slight differences between the early childhood and primary aged children in the way the touchscreen was used to obtain control over the program. The pre-school children tended to use the touchscreen autonomously to operate the program as they wished, with little regard for the wishes of the other children. The primary children were slightly more aware of the others, changing their language as D did and suggesting *"let's use the touchscreen now"* in an attempt at inclusive discussion. This difference is possibly due to developmental differences in the children. This is particularly so for the pre-school children, who developmentally may be considered egocentric in their thinking and social development. This would explain the finding that two or more pre-school children tended to use the touchscreen at the same time to operate a program, almost in parallel. For example, in the following observation by a researcher, two pre-school children use the touchscreen in order to achieve their own goals with little regard for the aims of the other child.

*D uses the touchscreen to operate the computer from the "waiting chair". N continues using the mouse. D touches the screen again and moves the icon to the desired location. N pushing D's hand away shouts "No!" N touches the screen to move the icon to where he wants it and then uses the mouse to click. D touches the screen. N uses the mouse. N touches the screen to change frames.*

D and N's disagreement as to how the program will be operated appears to have occurred primarily because two input devices are available for their use. In other words, the touchscreen itself is not responsible for the difficulties they experience; the problem may be that the children's level of social development does not allow them to realise that the other child may posses a different aim to their own. This suggests that the

negative interaction occurring between them may be a result of having two input devices available for their use.

The primary children tended to be a little more considerate in their use of the touchscreen than the pre-school children. The older children were more inclined to accept a common goal, and tended to work in tandem to achieve this goal, even when one child used the touchscreen to dominate the actual control of the program. Children in the two age groups used the touchscreen differently, although in both instances such use tended to result in a negative collaboration for at least one of the users. For the preschool children, the touchscreen simply provided the means for the observing child to operate the program as s/he wished whilst the operating child continued to attempt operating the program as s/he desired using the mouse. For the primary aged children, the nature of the collaboration was slightly different in that both children were focussed on completing the same task even though the observer was keen to use the touchscreen to hasten the process when he believed the main user was working too slowly. It would be interesting to note the pattern of behaviour and interactions in both age groups if the touchscreen was the only input device available since the presence of both the mouse and touchscreen might be the cause of those negative collaborations observed rather than the nature of the touchscreen itself. In addition further research could be conducted in order to determine how the presence of one or more input devices such as the touchscreen alters the social dynamics of children's interactions and collaborative behaviours. In this instance the role of the teacher in establishing rules for the use of the input devices should also be considered.

## Conclusion

The findings suggest that touchscreens do not significantly assist computer use by young children who have already learned to use a mouse. Children who have not learned to use a mouse may find learning to use a computer easier if they are able to use a more direct input device such as the touchscreen, but such children did not form part of this study. The study suggests that teachers intending to incorporate the touchscreen in their early childhood classroom will need to select software that utilises large icons and simple input requirements and to position computer screens to enable easier access for students. The findings from this study also indicate that teachers will need to establish clear rules for young children working together if they are sharing touchscreens in group settings. As there is more likelihood of one student interfering with another's opportunity to effectively operate a program when using a touchscreen rather than a mouse, teachers will need to model and train children in group dynamics including turn-taking, decision-making and problem-solving. Further research is needed to assess children's use of touchscreens in classrooms where these successful measures have been implemented.

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