

# A study of the usability of handwriting recognition for text entry by children

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## Abstract

This paper describes a pilot study that investigated the usability of handwriting recognition for text entry in a free writing activity. The study was carried out with eighteen children aged 7 and 8; each used three different writing methods to construct short pieces of text. The methods used were; pencil and paper, the QWERTY keyboard at a computer, and a pen and graphics tablet. Where the pen and graphics tablet was used, the handwritten text was recognised by the software and presented back to the children as ASCII text. Measures of user satisfaction, quantity of text produced, and quality of writing produced, were taken. In addition, for the handwritten work, the recognition process was evaluated by comparing what the child wrote with the resulting ASCII text. The results show that the children that took part in the study generally produced lengthier texts at the graphics tablet than at the QWERTY keyboard but that the non-technical solution, the pencil and paper was, in this instance, the overall best method for composing writing. To further the debate on the possibilities for digital ink and tablet technologies, key usability problems with the handwriting recognition interface are identified and classified, and solutions to these usability problems, in the form of design guidelines for both recognition-based and pen-based computer writing interfaces, are presented. Additionally, some reflections on how studies of text input and free writing composition can be evaluated are offered.

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## 1. Introduction

Writing is a skill learned in childhood alongside reading and it is a skill that is much used during the school years when written texts are used to assess knowledge, to store information and to convey meaning. The term ‘writing’ can be used to describe processes; the psychological process of constructing a piece of literature, or the physical process of constructing letters (sometimes called the verb approach (Bearne, 1998)), or products; the end product of either of these two processes (sometimes called the noun approach (Bearne, 1998)). The physical process of constructing letters is traditionally done by hand using a pen or pencil,

but for accomplished writers, writing is often constructed at a computer.

Many adults compose their writing using a QWERTY keyboard and use word processing software to assist with spellings and punctuation. Once the text is entered, the word processor is also used to make revisions and edits of the written work. When young children (typically aged between 6 and 10) compose writing, the predominant composition mode is handwriting using a pencil and paper in which case, editing and fixing is often enabled with an eraser.

Despite using pencil and paper for much of their school work, children are known to also be significant users of computer technology, both in the school, and in the home. In the UK, all schools now have Internet access and there are currently less than 8 children to each computer in primary schools (Department for Education and Science

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(Dfes, 2003). There are several studies that report that children have access to a wide range of technology in their homes; in a survey carried out for the Department for Education and Science in July 2002, it was reported that 81% of households in England have access to a personal or laptop computer, of these, 68% have Internet access. Ninety eight percent of the children surveyed reported that they used computers at home, school or elsewhere. At the time of this paper being written, it can be hypothesised that these figures will have risen considerably.

One of the main uses of computer technology, for all ages, is the production of writing. It is common to associate writing with word processing, but many writing tasks at the computer are carried out using other software, these activities include writing emails, corresponding in chat rooms and entering search terms into Google©. The effects of the use of technology on the writing process have not been especially well researched. One of the most interesting studies is from (Hartley et al., 2001) which investigated how writing changed over time when constructed in the early days with a pen, later with a QWERTY keyboard and eventually (30 years later) with a speech recognition system. Regrettably, this work looked only at adult writing with writers that were accomplished at the craft of writing and had therefore only to deal with the changing demands of the different technologies whereas children would have had to also deal with the complexity of the writing task. The study found that the different technologies changed the way the writers worked but had almost no effect on the writing style which remained constant over time.

Many of the studies into the use of technology for writing focus on the effect that the word processor has on the writing process. Several old studies that have been carried out with adult users indicate that word processor use is associated with greater motivation and enthusiasm (Hawisher, 1987) and that users of word processors are more willing to write more and have less anxiety (Kurth, 1987; Teichman and Poris, 1985). How relevant these studies can be considered to be in the modern era with much more sophisticated word processing software is an area for debate, there has been much less interest in the effects of word processing on writing in recent years. In addition, where studies report increased motivation and efficiency it is not always clear whether this is a result of having the word processing software, whether it is an effect caused by the keyboard input, or whether it is about the use of the computer.

There are also a number of studies on the use of word processing with children, but again, most of these studies are quite old and several of them contradict one another. A study by (Jones and Pellegrini, 1996) concluded that children wrote more cohesively at the word processor than when using pencil and paper; observational work by (Fisher, 1994) showed that children could compose work together at the computer and during this, their talk was task focused and cooperative. (Monahan, 1984) and (Hult, 1986) both reported that children used few of the features

of word processors and that revision of work was unusual with inexperienced writers generally only revising their work if prompted and even then, only making word changes, rather than carrying out substantial rewrites. (Nash and Schwartz, 1985) carried out an observational study of children writing using a word processor that was followed by them reverting to a pencil and paper interface, at which point, some had become dependent on the word processor features and became demoralised with the low tech environment.

There are other, more recent studies that shed some light on the effect of word processing on the way children write. Some of the studies have only small cohorts and the additional features that certain word processors offer can cloud the results. One such example is work by (Beck and Fetherston, 2003) that made claims for the effectiveness of word processing but had only seven children and the word processing included many features including drawing and story starters.

The literature on word processing does not generally consider the process of entering text into the software, it tends to focus on the revision and spell checking aspects of the software. For young users, text entry is generally the most laborious part of the word processing process, in a small observational study by (Read et al., 2000) one child took 12 min to enter 55 characters at the QWERTY keyboard. A later study (Read et al., 2001) that had 16 children copying small phrases at a QWERTY keyboard revealed average input times in the region of two words per minute which compares poorly to novice adult typing speeds in the region of 15 wpm as reported by (MacKenzie and Soukoreff, 2002b).

There are several different methods that can be used for text input, one of these, handwriting, has not been well researched. The aims of the study described later in this paper were to see how handwriting fared for text input with children and to compare it with writing using pencil and paper and writing at a QWERTY keyboard. There have been two similar studies, one, by (Murchie and Kenny, 1998) compared keyboards, light pens and voice input for clinicians entering patient admission data. This study found that the keyboard was the most efficient of the three and that voice input resulted in many errors. Earlier work by the author (Read et al., 2001) had also discovered that speech recognition was problematic. This study, that compared voice, mouse, QWERTY keyboard and handwriting, identified that the use of a mouse with a soft keyboard had no advantages over QWERTY entry or handwritten entry and that speech input, whilst highly efficient (15 wpm) was woefully inaccurate with less than 50% accuracy. The same study identified some potential in the handwriting recognition software with accuracy levels approaching 80% on average and with a similar input time to the QWERTY keyboard. A comparison between the pencil and paper and the computer was made by (Lam and Pennington, 1995) with secondary school children learning English as a second language. In this study, measures of writing qual-

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