DEVISING THE DEVICE:

microcomputer input decisions for young children

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This article reports on research relating to the efficiency of use of the mouse, joystick and keyboard by children from preschool through to grade three. The results indicated an increasing efficiency of use for the task set from keyboard to joystick to mouse for all the grade levels investigated. Efficiency of use improved significantly between preschool and grade one and then levelled off, while the order of efficiency of use of the three devices remained constant across age levels. Preference for particular devices varied according to grade level, with the older two grades showing a clear preference for the mouse, the most efficiently used device. The preschool children preferred the least efficiently used device, namely the keyboard.

INTRODUCTION

The use in society of microcomputer input devices has evolved from a somewhat exclusive use of keyboards to one in which, for most purposes, some combination of the mouse and keyboard is used. While this has been a feature of Macintosh computers for a decade, it has only more recently become common for other PCs following the introduction of 'windows' environments. Of late, a further evolution has occurred in the notebook computer market with the introduction of built-in trackballs in one brand.

Upper primary and secondary school students have been provided with microcomputers containing input devices identical to those used in the workplace on the basis of what appears to be two assumptions: firstly, this type of student needs to become proficient in the use of these tools in order to develop work-related skills; and secondly, it is assumed that they possess the motor skills necessary to use them effectively. The question of the suitability of particular input devices for use with young children, however, is more problematic.

The input requirements of young children are significantly different from those of older students and adults. The ability of young children to input text, for instance, is severely restricted or non-existent. Hence the requirements for keyboarding can be confined to some combination of the return key, the 'arrow' keys and in some cases, the Space Bar and Escape keys. This has had the effect of marginalising the keyboard as the preferred input device. Also, because extensive use is made of the motivational features of electronic games in programs for this age group, the operation of the software lends itself to the use of game peripherals such as the joystick and mouse, as well as 'iconic' input devices such as the concept keyboard. However, the literature is somewhat divided on the suitability or otherwise of particular devices for young children. On the one hand, we see statements by Clements (1987) claiming that 'Using the standard keyboard is not a problem for young children, and is often superior to other devices such as a joystick' (p. 34); and then statements of the opposite kind such as Blemings's (1988) assertion that the keyboard was designed for adults...
and for some children contains ‘an overwhelming amount of distracting and irrelevant information’ (p. 74). Other information has been contained in surveys of such devices as Muppet Learning Keys and photonic wands, as well as Education Department sponsored investigations which have tended to report at the level of observer reflection on children’s interaction with the device.

Research evidence on adult usage of input devices has been available for some time and is exemplified by that of Card, English and Burr (1978) who found that continuous movement devices, such as the mouse and joystick, are used more efficiently than key-operated devices. Empirical studies with young children are far less common and more recent. In an investigation of the use of computer-based pointing devices by 6-, 8- and 10-year-old children, Jones (1990) carried out four experiments requiring children to point to and click on screen targets. The children were required to make horizontal, vertical and orthogonal moves with the devices, and were timed for different trials. These experiments provided information on, among other things, the relative efficiency of use by these children of the mouse, joystick and trackball. For the 6-year-olds, the order of efficiency of use in terms of lowest times across all four experiments was: joystick, mouse, trackball. For the 8- and 10-year-olds, the joystick enjoyed five of the eight lowest times, with the mouse taking three.

King and Alloway (in press) found in a study with preschoolers that the mouse was more efficiently used than the joystick which in turn was more efficiently used than the keyboard for the set task which involved selecting, moving and deselecting an icon on the screen. This finding corroborated results for adult samples mentioned previously, in that the continuous movement devices, namely the mouse and joystick outperformed the keyboard for the set task, but differed from Jones’s result in relation to the measured order of efficiency of the joystick and mouse. Since the task requirement in the present study involved unrestrained movement of an icon compared to the Jones procedure where the children were required to point and click on targets in specified directions, it seems reasonable to explain the conflicting result for the joystick and mouse in terms of the difference in the task requirements. Jones, however, argues for more research in the area to determine:

... which configurations will prove to be the easiest to manipulate, the most efficient to use and the least demanding on their processing capabilities ... (p. 75)

The present study extends the scope of investigation of the use of input devices by young children from preschool to grade three. While a number of studies (e.g., Thomas [1980]), have reported an increase in motor performance over time with young children, the paucity of specific research in the use of input devices across different age groups suggested this as an area of useful investigation. Hence this study has focused on the question of whether the efficiency of use of particular input devices varies across grade levels from preschool to grade three and whether the order of efficiency of use of input devices is maintained across these grade levels. It was also of interest to the researchers to further investigate young children’s preference for input devices, as this has rarely been undertaken (King & Alloway, in press) and to discover whether gender is a factor contributing to the efficiency of use of input devices. While there is no suggestion in the literature that there are gender differences in motor development in early childhood, data on the relative efficiency of boys’ and girls’ use of input devices could inform the debate on the gender construction of microcomputer activities.

**CONTEXT OF THE STUDY**

Students used in the study were drawn from the morning and afternoon sessions of a preschool centre and from a multi-age group of 6- to 8-year-olds at a primary school. The developmental groups of primary students identified, henceforth referred to as grades one, two and three, had average ages of 6.7, 7.8 and 8.5 years which are approximately one year apart. The preschool group were two years younger than the grade one group, with an average age of 4.7 years. This difference resulted from data being collected at the beginning of the year for the preschoolers and at the end of the school year for the other students.

Most of the primary students had some previous experience with a microcomputer as one had been situated in the classroom for the year, although not all students had used it. No input peripherals additional to the keyboard were available. Some preschoolers alleged previous use of computers, but no accurate indication of their experience with specific input

<table>
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<th>GRADE</th>
<th>N</th>
<th>MOUSE</th>
<th>JOYSTICK</th>
<th>KEYBOARD</th>
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<td>15</td>
<td>9.0</td>
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*Table 1: Means of efficiency of use of input devices for the performance of a set task as time in seconds*

The software used for the study was Rosie, The Counting Rabbit (Learningways 1987). It was chosen on the basis that: it allowed the use of either the keyboard, joystick or mouse; it was considered suitable for the developmental level of the age range involved; and it lacked aggressive and competitive characteristics.

**PROCEDURE**

Data were collected in the same manner for all children, other than for the time of collection as mentioned previously. Three Apple IIe microcomputers were used for data collection, one each for the keyboard, joystick and mouse. Students were given the same practice time for each device using a similar set of tasks for which they were to be tested. At the end of the practice time, they were timed for the set task which involved the selection, movement and deselection of a screen icon. The task was timed for a second trial and the average of the two times used as a measure of the efficiency of use of the device. Students were tested only once in any half-day period and were randomly assigned to the devices.

**RESULTS**

The efficiency of use data were initially analysed by taking into account gender, grade and device type. As this analysis
indicated that gender was not significant as a factor, the final analysis considered only grade and device type and is reported as means in table 1. Statistical tests of significance on the means indicated that the mouse was more efficiently used than the joystick which in turn was more efficiently used than the keyboard across all grades. Statistical tests on the grade level factor indicated that the preschool group differed significantly in efficiency of use for each device type from each of the other three grade levels. The primary grades showed no significant differences among themselves for any input device even though some apparent variation between the means is indicated in table 1. Further tests revealed that both the joystick and keyboard, in comparison with the mouse, were less efficiently used to a greater degree by preschoolers, than by the other three grades.

All children were interviewed after having used all three devices to determine their preference for a device. From the results obtained, it was ascertained the preschoolers generally opted for the device which they used most inefficiently, namely the keyboard. For the grade one children, no distinct pattern was discerned. However, for grades two and three, the general preference was for the mouse, the device they used most efficiently. Inferences will be drawn from this result in the next section.

DISCUSSION

Consideration will firstly be given to the result that, for all grades, the order of increasing efficiency of use of the devices was keyboard, joystick, mouse. That these children found the mouse more efficient to use than the joystick may be explained by the presence of non-orthogonal movements in the task requirement for this study compared to Jones's (1990) study, a point alluded to previously. It may be that the mouse offers a greater facility than the joystick where unrestricted movement is involved because greater control is achieved by moving the whole device in the desired direction, rather than part of it as is the case for the joystick.

The reason that these two continuous movement devices offer a greater efficiency of use than the keyboard may relate to the fact that they offer children a direct relationship between the direction of movement of their hand and the intended direction of movement of the screen icon. Speed of hand movement is also directly related to the speed of the icon movement. By contrast, the connection between the anticipated screen movement of an icon and the choice of orthogonal arrow key movements is somewhat more abstract. Also, movement of the icon to the desired location must, of necessity, be non-diagonal or 'ladder-like' and hence involves a longer trajectory. While the results indicate that the preschool group operated with a significantly lower level of efficiency in relation to employment of all devices than the group of primary children, no such significant differences were found between grades one, two and three children. This suggests a developmental discontinuity in motor skill proficiency between preschool and early primary grades. It needs to be recalled, however, that in this study, the age gap between the preschool and grade one sample was two years because of the difference in time of year of data collection.

The fact that most primary children had some keyboarding experience during the data collection year clouds the interpretation of the result in terms of enhanced motor proficiency and may suggest a practice effect. That the primary students also significantly outperformed the preschoolers using the joystick and mouse without organised prior experience, lends credence to the claim for greater motor proficiency in the primary group and a marked developmental progression in the two-year gap between the preschool and grade one group.

The lack of a significant effect for gender when initially included as a factor in the analysis of the extended age range data supports previous results for preschoolers alone reported by Alloway and King (1991). This clearly indicates that girls and boys in all grades used in this study were equally efficient at manipulating all the devices in order to complete the set task. While not central to the study, this result is useful in interpreting findings made elsewhere which suggest that young boys access and participate in computer activities to a greater extent than girls. Lack of performance differences in computing activities lends weight to the social, rather than a biological interpretation of access and participation differences.

In terms of expressed preference for a particular input device, it seems that the younger the child, the less clear was the association between preferred option and ease of use of the devices. In fact, most of the preschoolers who expressed a preference chose the device that they employed least efficiently. Preschoolers seem to form a more intimate association between the keyboard and computer than older groups. The keyboard's greater exploratory potential may also have been a decisive factor in their preference for it over the less elaborate devices. This is evidenced by the need to cover the keyboards of the machines containing the mouse and joystick during the experiment to stop the preschoolers regressing to the keyboard. For the grade one sample, no clear pattern of preference for a device emerged, with children choosing a particular device for reasons that bore no particular relationship to ease of use. However, grade two and three children chose the device which empowered them to carry out the set task most efficiently. This suggests an increased concentration on task accomplishment rather than play for these two oldest groups.

CONCLUSIONS

This study clearly demonstrates that boys and girls from preschool through to grade three experience the same order of efficiency of use of the input devices investigated. It also reveals that the efficiency of use of all devices increases with age. Results suggest that not all children will be attracted to a particular device on the basis of ease of use; the younger the child, the more likely it is that the least efficient device will be preferred. Preschool children appear to view the keyboard as an integral part of the computer, rich in exploratory possibilities and to be preferred to the exclusion of the more efficient devices. Whether a detachable keyboard, as distinct from the built-in keyboards used in this study, would retain the same fascination remains unknown.

Teachers need to be aware of the above differences in planning computer experiences and should consider the aims of the activity when making a choice of the input devices available. Also of interest to teachers is the finding that by the end of grade one children can use input devices with a proficiency equal to that of children two years their senior. These older grades can be viewed as a single group in this respect. Finally, armed with the knowledge that girls display equal competence in using input devices, teachers must challenge the construction of computer activities as male when faced with access and participation rates favouring boys.

As the proliferation of alternative input devices into educational settings continues, additional research which goes beyond the level of observer reflection will be necessary to help teachers ensure that all children are given appropriate opportunities to
interact, at their level of development, with the electronic tools that are now so persuasive in everyday life.

REFERENCES


