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# CHILDREN'S INTERACTIONS AND LEARNING OUTCOMES WITH INTERACTIVE TALKING BOOKS

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**Abstract**—How do pairs of children interact when using a multimedia CD-ROM storybook (''talking books''), and do their patterns of interaction reflect the gender composition of the pair? Do different types of pairs interact differently and remember the activity differently? These questions were addressed with a classroom experiment in which 8 year old boy/boy, boy/girl and girl/girl pairs worked through the screenpages of a CD-ROM storybook prior to completing a cued-recall comprehension test and a free-recall story writing exercise. During the storybook activity measures of computer interface use and measures of verbal interaction were recorded. Differences between pairs of children were recorded in the use of the computer interface, and verbal interactions were related to interface activity. The comprehension test delivered no differences between pairs, but the free-recall story writing exercise found superior performance for girls who had previously worked together. The measures of verbal interaction taken during the storybook activity did not predict subsequent performance, although disputes over the control of the mouse were related to free-recall story writing. © 1998 Elsevier Science Ltd. All rights reserved

## INTRODUCTION

What do children learn from interactive talking books, and is their learning influenced by their activity while working? This form of multimedia presentation, which includes text, graphics, sound, still and animated images, is highly motivating to children, and in the authors' experience, to adults as well. This paper presents an investigation of the collaborative use of interactive books by pairs of children, and the learning gains made through this use.

There have been extensive claims of the educational benefits of multimedia and the summary provided by Perzylo [1] is one of many enthusiastic endorsements that talks of ''effective and efficient means of improving the quality, delivery and presentation'' of education. There have been few studies of children's use of interactive books, however, with one of the exceptions being the study by Miller *et al.* [2] in which four case studies did suggest benefits for reading skills. Although the ''play-way-to-learn'' certainly has merit in generating children's motivation, it is questionable whether such ''edutainement'' packages always promote learning, and, if children do learn, what is it they are acquiring from interacting with such material? The current study employed a software product which is very much ''edutainement'', the Brøderbund *Living Books* CD-ROMs, aimed at both the home and education markets. The *Living Books* version of the application is interactively rich, but shares the feature in common with other talking books of providing a spoken form of the text that is displayed on the screen. This spoken representation is available to the user on demand, and is available either as a single word or the whole paragraph. In addition, *Living Books* present an illustration to accompany each paragraph (i.e. each ''page'' of text), and the components of the illustration may be animated on demand by clicking the mouse when the pointer is in certain parts of the screen. The animated illustrations act to develop the depth of the story, but can also act as distractions from the principal storyline. Users typically spend a large proportion of their time activating parts of the illustration to discover the extent of the animation, and this observation holds for both the children for whom the application is designed and for adults who take an interest. As well as being engaging, the animation can act as a distraction, however, and limit the amount of attention paid to reading

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and understanding the text and to developing spelling-to-sound relationships. The study here investigates the relationship between the animation interactions and the story understanding that develops. Do children who spend their screen time activating the illustrations understand the story, or is their understanding limited to surface-level features that have activated?

There are a number of reasons for suggesting that educational benefits may accrue through the use of interactive books. Reading storybooks aloud to children is recognized as a crucial component in total literacy development and these interactive books are designed to provide both individual and small group support. Their use is also supported by the Piagetian notion of learning as an active process, whereby the child constructs his or her own understanding of the world through direct interaction with the immediate environment. Interactive books make use of a number of symbol sets to represent information to the learner (i.e. orthographic, pictorial and audio-linguistic). Different symbol systems are processed in different ways, and may be represented differently in memory, and the use of multiple symbol systems in learning media may not only mean that the information has more chance of being absorbed by the learner, with more routes into memory, but also that multiple representations of the same information are generated by the learner. Accordingly, it is more likely that the information will be understood, remembered and recalled by the learner. It also follows, if this assertion is valid, that investigations of learning with multimedia tools should look for memory effects with a number of different measurement instruments.

An educational medium which incorporates text, animation, voice with active exploration and on-line help has the potential to bring together in a single instructional environment the advantages afforded to the learner of books, television, computers and teacher–pupil tutoring situations, thereby enhancing comprehension and recall. In the domain of reading instruction, the availability of a regular pronunciation of new words, additionally, may provide enhanced access of sight vocabulary. On the other hand there may be limited educational gains with the use of interactive talking books, because much of the animation is not central to the story and it may therefore act as a distracter. For example, the text may have little correspondence with the illustration that attracts the user's attention. The study was designed partly to observe which features of the display gained the reader's attention, and which features were remembered, and partly to observe gender differences during interactions.

A number of previous studies have reported differences between pairs of children working on computer-based tasks according to the nature of the specific task, and according to the gender composition of the pair. Where gender differences in performance do emerge, they are often associated with differences in the style of the collaboration. In one of the earliest reports of these differences Hughes *et al.* [3] found that a performance deficit, for pairs of girls programming a LOGO-based floor turtle, was associated with greater emotionality, relative both to pairs of boys and to mixed pairs. This result has not remained unchallenged, however, with a series of studies failing to find gender differences in pairs of children engaged in programming tasks [4–7]. Other tasks continue to show gender-specific effects, with mixed pairs performing less effectively than single gender pairs on language-based problem-solving tasks [8, 9]. When mixed groups work together their performance is often related to patterns of discussion. With a computer-based problem-solving task Lee [10] found that in mixed groups boys tended to become more verbally active and that girls tended to be less verbally active. The change was explained in terms of theory of status characteristics that suggests that males have, or are expected to have, greater influence through their higher social status. Differences in status, if they do exist, may be inherited from a task that is accepted as being within the domain of expertise of one or other gender group. Computer tasks in general are often thought of as being activities at which boys will have superior performance, independently of any actual performance differences [11, 12], and this attribution may be responsible for asymmetric patterns of interaction.

In the present study we extended our investigation of gender differences in group working, using a popular interactive CD-ROM "book" intended for primary school children [6, 8, 13, 14]. Pairs of children worked with "Arthur's Teacher Trouble", a highly interactive program designed for use in the reading classroom. The 24 "pages" of the "book" contained a short written text which is initially read aloud by the program, and then users can activate an entertaining graphic that portrays the events in the text. Activation is through a mouse click. Characters can

be activated, and will have something more to say or to do, as can inanimate objects, and the words of the text can also be activated to produce their pronunciation. The program is popular with children and adults alike. The study asked whether there are any learning gains made following working through the CD-ROM, with a comprehension task and a free recall (story writing) task, and related these gains to dialogue interaction measures taken from the pairs as they worked through it.

## METHOD

### *Subjects*

Sixty-two 8 year old children (31 boys and 31 girls) took part in the study. They were in attendance at a suburban primary school near the University campus. The mean reading age of the sample was 8 years 5 months (SD = 11.0 months). No member of the sample was considered by their teacher to have learning difficulties, and all had English as their first language. All were familiar with the operation of desktop computers prior to the study, and none had used the CD-ROM storybook previously.

### *Apparatus and materials*

A CD-ROM storybook developed by Brøderbund and based upon a children's story by Mark Brown called "Arthur's Teacher Trouble" was presented with a Macintosh LCIII computer. The 24 screen-pages of the storybook follow the main character, Arthur, through a school spelling competition. At the start of each screen-page part of the text of the story is displayed and read aloud by the program. The words remain on the screen until a page-turn is activated. In addition, a rich illustration of an appropriate part of the text is displayed. The user may then interact with different aspects of the display by a mouse-click. Both words and illustrations can be activated by clicking on them. Clicking on a word results in its pronunciation, either in isolation or together with other words. Clicking on a feature of the illustration results in an animation. Most of the objects in the illustration could be activated in this way—characters may provide dialogue or perform actions, and objects such as doors, toys and cookies perform some animated action. A video camera was used to record the children's actions and conversation while they worked through the screen-pages.

### *Procedure*

The children were then allocated to pairs on the basis of their reading ages according to McLeod's GAP Reading Comprehension Test [15]. The members of each pair had similar recorded reading ability. The children were to use the computer program in one of three dyadic groups—boy/boy, boy/girl or girl/girl—and so these three sets of pairs were also matched. The mean reading age of the 20 children in boy/boy pairs was 8 years 5 months (SD = 11.0 months); for the 22 boy/girl pairs the mean was 8 years 6 months (SD = 11.0 months) and for the 20 girl/girl pairs the mean was 8 years 4 months (SD = 10.4 months). Comparison of the reading ages of these three sets of scores with an analysis of variance established that there was no reliable difference ($F < 1$, df = 2, 59).

Each pair was observed individually, and their interactions with the screen and with each other recorded. Each pair worked with the storybook for 20 min on two occasions separated by up to 2 weeks.

One week after work with the storybook had finished, a story comprehension test lasting 30 min was administered. The items in the comprehension test asked about the story plot, the characters described in the story, and about the actions of objects that could be animated by clicking on them. There were 10 items in each of these three categories, and all 62 children participated in this test.

Four weeks after the comprehension test the children were invited to write a short story about Arthur. They were given 20 min. This story was used to assess their free recall of the events in the CD-ROM storybook. At this point in the study 53 of the children were available—the remainder had either left the school or were absent through illness.

Table 1. Collapsed verbal interaction categories, based on Bales (with standard deviations)

| | Boy/boy | Boy/girl | Girl/girl |
|---|---|---|---|
| Positive socio-emotional | 52.2 (20.0) | 32.3 (21.6) | 44.7 (20.2) |
| Gives task specific help | 36.3 (19.6) | 32.4 (27.5) | 32.4 (23.9) |
| Requests task specific help | 4.5 (5.4) | 4.6 (5.0) | 7.5 (7.2) |
| Negative socio-emotional | 1.4 (1.3) | 2.0 (2.9) | 2.7 (8.9) |

## RESULTS

Analysis of the video-taped work with the CD-ROM storybook was used to obtain measures of interaction with the computer and between the two members of each pair. In addition, each verbal statement was coded into one of 12 categories according to the Bales [16] process interaction analysis used in previous studies [6, 14]. Because there were small numbers of comments in some of these categories, all "positive socio-emotional" comments, all "task specific helping" comments, all "task specific requests", and all "negative socio-emotional" comments were classified together, to reduce the 12 categories to just four. The means of these four interaction categories, for the three gender pair types, are presented in Table 1. An analysis of variance found a main effect of interaction categories ($F = 129.8$; df = 3, 177; $P < 0.001$), with high numbers of positive socio-emotional comments and task-specific suggestions. There was no main effect of gender pair type ($F = 1.56$; df = 2, 59), but there was an interaction between the two main factors ($F = 2.7$; df = 6, 177; $P < 0.02$). An analysis of the simple main effects was used to inspect this interaction, and found an effect of pair type for the number of positive socio-emotional comments ($F = 5.0$; df = 2, 59; $P < 0.01$), with a *post hoc* comparison indicating more of these comments between pairs of boys than within mixed pairs ($P < 0.05$). No other comparisons were reliable.

The number of mouse-clicks on animated characters, animated features, and words were recorded during the course of the study, together with the click necessary to turn the page. These data were recorded separately for each member of the pair. It was noticed that there were occasional disputes concerning possession of the mouse, and so these were also recorded. Disputes were usually verbal, but sometimes involved the mouse being taken from the hand of the other child without obvious agreement. These disputes were coded as mouse-fights, and the mean numbers of all interactions with computer interface (screen and mouse) are presented in Table 2. These data were submitted to separate analyses of variance, and also to regression analyses that attempted to predict interface interactions using the dialogue measures.

There were no gender-group effects in the anovas applied to character-clicks ($F < 1$; df = 2, 59), feature-clicks ($F = 1.1$; df = 2, 59), word-clicks ($F = 2.2$; df = 2, 59), clicks to turn the page ($F < 1$; df = 2, 59), or with the total number of mouse-clicks during the study ($F < 1$; df = 2, 59). Within the mixed pairs there was a noticeable difference between the boys and girls in the control of the mouse when turning the page, and so a *post hoc* analysis was performed. In this analysis the data from the boys (mean number of page turns: 9.5) and the data from the girls (mean: 4.5) were separated, and a reliable difference found ($F = 3.8$; df = 3, 58; $P < 0.02$). Pairwise comparisons found that the only difference was between the boys and the girls working in the mixed group ($P < 0.05$), suggesting that in mixed groups it was the boys who tended to be in control of the overall pace of activity.

Table 2. Interactions with the computer interface: mouse activity was recorded over the total period of interaction with the CD-ROM storybook (clicks on different screen objects, and disputes over control of the mouse) for each of the pair types (with standard deviations)

| | Boy/boy | Boy/girl | Girl/girl |
|---|---|---|---|
| Clicks—characters | 19.2 (9.6) | 20.3 (13.8) | 16.2 (7.2) |
| Clicks—features | 59.5 (20.5) | 57.2 (22.9) | 49.9 (22.4) |
| Clicks—words | 0.2 (0.5) | 5.5 (11.3) | 3.6 (8.7) |
| Clicks—page turn | 7.0 (3.5) | 7.0 (4.6) | 6.7 (2.9) |
| Total mouse-clicks | 85.9 (33.5) | 90.0 (36.0) | 76.3 (33.1) |
| Mouse-fights | 2.5 (3.8) | 1.5 (2.1) | 2.0 (7.6) |

Multiple linear regressions were then used to predict mouse-click activity with the collapsed Bales measures of verbal interaction. The purpose of these analyses was to determine whether interaction with the computer was associated with the quality of the discussion within the pair working with it. Each of the measures of computer interaction delivered a reliable regression model, but the models found different predictor variables to be associated with different activities. The number of clicks on characters was inversely predicted by the number of task specific requests ($\beta = -0.28$), giving $r^2 = 0.07$ ($F = 5.1$; df = 1, 60; $P < 0.05$). The number of clicks on animated features was inversely predicted by incidence of mouse-fights ($\beta = -0.26$), giving $r^2 = 0.07$ ($F = 4.2$; df = 1, 60; $P < 0.05$). The number of clicks on words was predicted by the number of negative socio-emotional comments ($\beta = 0.41$), giving $r^2 = 0.17$ ($F = 12.4$; df = 1, 60; $P < 0.001$). There were no predictors of the number of page-turning clicks. The total number of mouse-clicks was predicted by the number of negative socio-emotional comments ($\beta = 0.25$) and by the reduced incidence of mouse-fights ($\beta = -0.29$), with $r^2 = 0.14$ ($F = 4.8$; df = 2, 59; $P < 0.02$). Although these are all reliable models, they each account for only small proportions of the variance.

The numbers of disputes over control of the mouse were also entered into an analysis of variance, which showed that these mouse-fights occurred just as often among each of the gender-pair types ($F < 1$; df = 2, 59). The means for the pairs are presented in Table 2. A stepwise regression model that attempted to predict mouse-fights on the basis of comments between the children found that they were predicted by the number of task specific requests ($\beta = 0.39$), giving $r^2 = 0.15$ ($F = 10.8$; df = 1, 60; $P < 0.002$).

Following the appearance of a difference in the behaviour of boys and girls working in mixed pairs, over control of the pace of the task, subsequent analyses separated the data from these pairs accordingly. The analyses of performance measures therefore compare the comprehension and recall of boys working with boys, boys working with girls, girls working with boys, and girls working with girls.

Comprehension of the story was assessed with a written test presented to each participant individually, and these means are presented in Table 3. Analysis of variance indicated no difference between groups ($F < 1$; df = 3, 49). To determine the predictors of comprehension from the activity measures taken while working through the CD-ROM storybook, a linear regression analysis was applied. In the first step each child's reading age was entered, to remove any variance associated with the principal individual ability that was expected to predict reading comprehension. Reading age ($\beta = 0.61$) was indeed a reliable predictor ($r^2 = 0.37$; $F = 35.2$; df = 1, 60; $P < 0.001$). The interaction variables (verbal interaction and screen/mouse activity) were then offered in a stepwise process, but none were accepted, indicating that interactions during the activity do not predict story comprehension.

Recall of the story was assessed by inviting the children to write their own story about Arthur, and points were awarded by mentioning story events, the actions of animated features, the names of the characters, and the relationships between the characters. These mean recall scores are also presented in Table 3. An analysis of variance found a difference between groups ($F = 11.9$; df = 3, 49; $P < 0.001$), and pairwise comparisons found that the girls working with girls outperformed each of the other three pair types (all $P < 0.05$). As with comprehension performances, a linear regression was applied, with reading age as the first variable entered

Table 3. Memory for the story: memory was assessed directly with a comprehension test presented 1 week after the CD-ROM activity, and 1 month later with a free recall test

| Performance by: | Boy | | Girl | |
|---|---|---|---|---|
| Co-worker: | Boy | Girl | Boy | Girl |
| Comprehension (max. 30) | 12.4 (7.0) | 12.7 (5.7) | 12.2 (5.8) | 11.4 (5.4) |
| Recall by writing | 4.7 (2.3) | 4.8 (3.6) | 6.5 (4.0) | 12.8 (6.0) |

Means of the scores gained for correct answers to comprehension questions and for mention of storybook events in recall are presented here for four pair types (with standard deviations)

($\beta = -0.01$). This variable did not predict story recall ($F < 1$; df = 1, 51). The interaction variables were then offered in a stepwise process. The only predictor variable accepted was incidence of mouse-fights ($\beta = 0.37$), resulting in a reliable model ($r^2 = 0.14$; $F = 3.9$; df = 2, 50; $P < 0.05$). Because the story writing exercise was conducted after the comprehension test, there is a possibility that the memories described in the stories would be a reflection of the memories prompted by this direct test. To test this possibility a second regression analysis was performed, with each child's comprehension test score being the first predictor entered. This variable was an unsuccessful predictor of recall during guided writing ($\beta = -0.04$, with $r^2 = 0.00$; $F < 1$; df = 1, 51).

## DISCUSSION

One purpose of this study was to determine whether there were any effects of the gender composition of pairs when children work together with a commonly available computer-based storybook. The study observed pairs of children as they worked through the storybook, collecting verbal and non-verbal activity measures. These measures were then used as potential predictors of story retention, with the aim of determining whether the types of interactions were related to learning gains.

When interacting with the system, there were minimal effects of the gender composition of the group. Pairs of the boys enjoyed working together more than mixed pairs, on the basis of the number of positive socio-emotional comments made during the activity (e.g. joking, making exclamative remarks in response to screen animations and other mutually supportive comments), and in the mixed pairs it was the boys who controlled the pace of the activity. Otherwise there were no observable effects. Perhaps surprisingly there were no gender effects in the choice of screen object to be activated. Boys and girls selected similar objects—words, people and animated features such as toys—when they had control of the mouse. Although there was a preference for clicking on animated features (screen objects) and to a lesser extent on animated characters (actors, including Arthur), there were no gender differences in these preferences.

Just as surprisingly there were no gender differences in the incidence of arguments over control of the mouse. Previous observations have recorded male dominance in the control of the input device [17], and a similar pattern might have been expected here.

The absence of gender effects continued in the scores gained from the comprehension test conducted a week after completion of the computer-based activity. This absence of a difference is all the more surprising given that a gender effect did emerge 1 month later when the children were asked to write a story about the main screen character, Arthur. It is worth noting that both the comprehension test and the story writing activity were performed by individuals—the paired group structures were used only during activity at the computer keyboard. The writing activity was designed as a free recall task in which the children's most prominent memories of the storybook would be relayed. The memories described in these stories were not related to the memories prompted by the comprehension test however, and a strong gender effect appeared. Pairs of girls recalled approximately twice as many facts about the story of Arthur than either of the other types of pairs. Given that the story writing exercise was conducted some 5 weeks after the computer activity, and given that writing was performed individually, the effect is remarkable. The difference between girls working with another girl, and girls working with a boy, is perhaps worthy of further consideration. The comprehension and recall scores in Table 3 suggest that the girls understood the story just as well whether they worked with a boy or with another girl, but that their memories were less durable when they had worked with a boy. The boys in mixed pairs tended to take control of the pace of the task, by making twice as many page-turning decisions as their partners, and this imbalance in control may have contributed to diminished enthusiasm for the task, for example. The higher scores gained by girls were not a product of girls being more compliant with the request that a story be written about Arthur, otherwise the girl/boy pairs would have performed at a similar level to the girl/girl pairs. This is a residual effect of the working partnership.

Interestingly, the interactions with the screen were predominantly with the animations, but extensive descriptions of the animations did not appear in the stories that were written. For

example, in one page set in a kitchen, clicking on the cookies causes them to perform a song-and-dance routine, and most of the children discovered this and made positive remarks about it. They did not, however, write about it, suggesting that they had either formed shallow memories, or that they had remembered it but did not choose to write about it. An informal analysis of the answers given in the comprehension test suggests that they did remember the activities of animated features and that the children had decided that there were more appropriate things to describe when writing stories. Their stories concerned higher-level story events rather than descriptions of incidental features indicating that the children had an awareness of what is required when asked to re-tell a story. One of the questions posed by the study was whether the engaging but largely peripheral animations would act to distract the children from their understanding of the story, and the absence of these descriptions suggests that children are capable of separating these features from the essentials of the story. These children showed awareness of writing for a specific audience, and that audience was a teacher.

The regression analyses found relationships between various types of interactions made while working through the storybook, and different screen activities. For example, the total number of screen words activated was predicted by the number of negative socio-emotional comments, and the total number of animated features activated was predicted by reduced occurrence of mouse-fights, but these relationships generally accounted for relatively small proportions of the variance, and were inconsistent between analyses. Interactions between the children were not a convincing predictor of their interactions with the storybook.

What were the predictors of learning gains? Only reading ability predicted performance in the comprehension test, and the recall of memories of the storybook was associated only with the gender composition of the pair and with disputes over control of the mouse. Comments made during the computer-based activity did not predict recall. For example, pairs of boys clearly enjoyed participating in the activity more than mixed pairs, but this enjoyment was unrelated to performance on either the comprehension test or the free recall test. Looking from the opposite direction, pairs of girls recalled more of the story than pairs of boys, but there is little in their dialogues to differentiate their interactions during acquisition of these memories. Disputes over control of the mouse helped predict story recall, and this is possibly an indicator of motivational involvement with the events unfolding in the storybook. An eagerness in wanting to know what will happen next is perhaps apparent in these arguments over which part of the screen should be activated, and, eventually, in stronger memories of those events.

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