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Using ICT to Foster (Pre) Reading and Writing Skills in Young Children

ABSTRACT. This study examines how technology can support the development of emergent reading and writing skills in four- to five-year-old children. The research was conducted with PictoPal, an intervention which features a software package that uses images and text in three main activity areas: reading, writing, and authentic applications. This article reports on the effects of the PictoPal intervention on pupil literacy and communication skills. Two small-scale studies were conducted. Observation results from the first study showed that children are able to work independently with the program after a few instruction sessions. The second study showed a statistically significant learning effect of experimental versus control group scores after two months of using PictoPal in the classroom under the guidance of a parent volunteer. Further research is needed to arrive at a better understanding of these learning gains with a larger group of pupils. doi:10.1300/J025v24n03_06 *[Article copies available for a fee from The Haworth Document Delivery Service: 1-800-HAWORTH. E-mail address: <docdelivery@haworthpress.com> Website: <http://www.HaworthPress.com>*

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Interest in early development of emergent reading and writing skills has gained momentum in recent years. This is evidenced by the growing trend to set state standards for literacy development (Neuman & Roskos, 2005). The study described in this paper took place in the Netherlands, where national early literacy standards have been established (Verhoeven & Aarnoutse, 1999) for ages four through six. In the Netherlands and abroad, the implementation of early literacy standards in educational practice has proven to be demanding for teachers. While this remains true for more homogeneous classrooms, an increasing proportion of Dutch primary schools are facing additional challenges due to growing populations of Dutch-as-second-language learners. Teachers of kindergarten (which includes both 4- and 5-year-old children in the Netherlands) and first grade frequently struggle to offer more individualized approaches to teaching emergent reading and writing skills. The study described in this article aims to address such challenges by exploring how technology can play a role in fostering the development and implementation of literacy and communications skills in kindergarten.

While critics express concerns that computer use by young children will inhibit language development and encourage social isolation (Cordes & Miller, 2000), research has shown otherwise. In their study on the effect of an adaptive program for improving children's vocabulary development, Segers and Verhoeven (2002) found that young children can extend their vocabulary with the help of an adaptive and interactive software program. Similarly, studies have shown that technology use can positively affect both cognitive and affective learning outcomes for reading (Lewin, 2000; Mioduser, Tur-Kaspa, & Leitner, 2000) and spelling (Van Daal & Reitsma, 2000). And according to Clements, Nastasi, and Swaminathan (1993), young children working collaboratively at computers tend to engage in higher levels of dialogue and cooperation, such as turn-taking and peer collaboration.

While the research mentioned above offers valuable insights in the potential of technology for literacy development, it does not provide much information about the way technology can be integrated into daily classroom activities. Plowman and Stephen (2003) state that a pedagogical model is needed for appropriate integration of technology in early childhood education. According to NAEYC (1998), computer programs that are appropriate for use with young children are open-ended and allow for active learning, with pupils making decisions. Software should involve many senses and contain sound, music, or voice. Computer software should be controlled by the children and allow them to explore

without fear of making mistakes. It should respond to children's exploration in ways that encourage further investigation, while reflecting and building on what children already know. Applications to real-life problems with real-life consequences should be emphasized, and the programs should elicit excitement and thereby encourage language use. In addition, the importance of connecting computer activities with other classroom projects and themes, are emphasized (Davis & Shade, 1994; Haugland, 1992; Van Scoter & Boss, 2002).

This study examines how the development of literacy and communication skills in the kindergarten classroom can be fostered with the support of technology. A technology-supported environment, called PictoPal, aimed at promoting early literacy skills, was created and iteratively refined (see McKenney & Voogt, 2005). This article explores evaluation data pertaining to the effects of PictoPal on early literacy skills of kindergarteners.

PictoPal

The PictoPal environment was developed at the University of Twente based on the Dutch national goals for early literacy (Verhoeven & Aarnoutse, 1999). Core elements of these national goals emphasize

- Strategic writing: Materials should primarily support the development of functional reading and writing where written language (letters, lists, etc.) is used for communicative purposes.
- Function of written language: The software should help children to (better) understand the importance of reading and writing.
- Nature of written language: The materials should support language consciousness of children including the ability to discern different language elements (word, sentence, reading direction, etc.), to link written and spoken language and to read and write with comprehension.

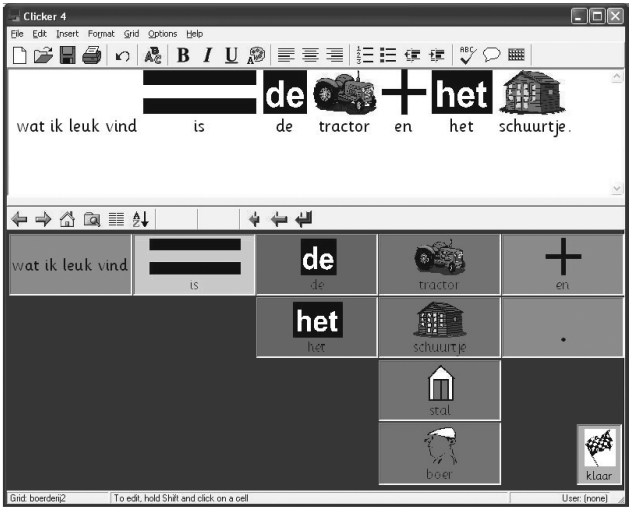
Other important notions that structured the PictoPal environment are the belief that children want to express themselves in print, even before they are able to read and that the computer can help them to do so. This belief is supported by the evidence-based conclusion of Walsh (2003), who states that visual texts in print or nonprint mode are powerful mediums

for learning and can equally assist [second language] learners' literacy development. The PictoPal environment was designed by the researchers in close cooperation with the participating teachers and experts in language arts. It was developed using a software package called Clicker® which features images and text supported by audio. The PictoPal environment supports three main activity areas: reading (picture-word relations, listening memory, reading direction, word manipulation, and sight-word recognition); writing (active vocabulary, self-expression, and understanding of different writing formats/target audiences); and authentic applications (sharing at circle time, publishing on the Internet, and mailing letters). The software is used for creating the reading and writing assignments. Pupils create their own products, such as little stories, a letter to grandma, or a shopping list, which can be printed and shared with their classmates. PictoPal was developed in close collaboration with teachers of 4-5 year olds as well as language and technology experts. An essential characteristic of the software is that teachers can easily adapt or develop activities for their pupils, and by doing so integrate PictoPal into classroom practices and themes.

FIRST STUDY

Several prototypes of PictoPal were developed. The first study reported here was conducted using the second prototype, PictoPal (v2). In this prototype, closed activities as well as semi-open activities were offered to the pupils. The closed activities were very structured and made use of pre-determined pictograms, which were also used in a common paper-based method (this method has its roots in special education but is also used in schools with large numbers of second-language learners). The activities emphasized recognition of the images and using them to "read" sentences composed of pictograms. The semi-open activities were less structured. They focused on "writing" and authentic applications in classroom practice and were similar to the activities shown in Figure 1. The PictoPal activities were designed by the researchers, based on ideas and themes from the cooperating teachers. Two research questions guided the study: (1) Do 4- and 5-year-old pupils possess the skills needed to work with PictoPal (v2)? and (2) Does PictoPal (v2) contribute to fostering early literacy skills in 4- and 5-year olds? To answer the first question, pupils were observed while working with PictoPal

FIGURE 1. PictoPal (v3).



(v2). To answer the second question, a pre-post test control group design was used.

FIRST STUDY METHODS

Kindergarten children from the participating schools were divided into experimental ($n = 21$) and control groups ($n = 19$), matched for age, gender, language skills (based on a national language test for kindergarteners), and remediation offered. One of each pair was randomly assigned to either the control or the experimental group. The experimental group worked with the PictoPal environment four times over a period of five weeks. Pupils from the experimental group were observed during their PictoPal (v2) sessions. During the observations the researcher charted low, medium, or high pupil ability to work independently, comprehension of the computer voice, and ability to operate the mouse. In addition a pre and a posttest were given to the experimental and the control group. The 16-item Early Literacy Skills Test was developed by the researchers and validated by an early language expert. The items were based on a selection of the standards for early literacy (Verhoeven & Aarnoutse, 1999). The reliability of the test was acceptable (Cronbach's alpha = 0.85). Sample items from the test are shown in Figure 2.

FIGURE 2. Test items examples from the Early Literacy Skills Test.

RESULTS

Because teachers had indicated that they were not able to work very often with children at the classroom computers, there was a strong practical desire for the children to be able to work independently in the PictoPal environment. The evaluation data (see Table 1) showed that learners were able to work independently with the program after some initial help. Kindergarteners possessed sufficient motor skills to use the mouse. With a brief introduction, they adjusted to the computer voice as well. After three to four sessions, most pupils were able to grasp the assignments and carry them out independently. As presented in Table 1, the effect size (Cohen's *d*) between sessions 1 and 4 showed that pupils particularly improved in their understanding of the semi-open assignments and in using the mouse when working with these assignments. This was encouraging, because it also showed that pupils can learn to work independently with the less structured assignments. In the short trial of five weeks, children were able to improve their understanding of the exercises and to increase their computer skills.

Table 2 presents the mean scores and standard deviations of the experimental and control group pre and posttests. The learning gain (learning

TABLE 1. Ability of Experimental Group Pupils to Independently Understand Assignments and Operate the Mouse

	Session 1 *M/SD*	Session 2 *M/SD*	Session 3 *M/SD*	Session 4 *M/SD*	Effect size sessions 1-4
Understands closed assignments	1.71 (.78)	1.81 (.68)	1.57 (.75)	1.33 (.66)	0.53
Understands semi-open assignments	2.14 (.57)	2.14 (.73)	1.90 (.77)	1.67 (.58)	0.82
Mouse use (closed assignments)	1.52 (.75)	1.38 (.67)	1.33 (.66)	1.24 (.54)	0.43
Mouse use (semi-open assignments)	2.00 (.63)	1.62 (.74)	1.71 (.72)	1.43 (.60)	0.93

Note. Scored on a three-point scale: 3 = needs a lot of help; 2 = needs a little help; 1 = needs no help

TABLE 2. Mean Scores, Standard Deviation of Pre and Posttest Scores, Learning Gain, and Effect Size on the Early Literacy Skills Test, Experimental and Control Group, Study 1

	n	Pretest *M(SD)*	Posttest *M(SD)*	Learning Gain *M(SD)*	Effect size
Experimental group	21	9.19 (3.91)	10.38 (4.07)	1.19 (1.71)	0.30
Control group	19	10.26 (3.68)	11.21 (3.17)	0.95 (1.27)	0.28

gain is defined as posttest scores minus pretest scores) was slightly higher for the experimental group, but based on a Mann-Whitney U test no significant differences in learning effects could be determined between the experimental and control group ($Z = -0.775$; $p = 0.452$). The effect size for the experimental group is slightly higher compared to the control group. After four computer sessions with PictoPal, no convincing evidence was found to indicate that the intervention improves emergent reading and writing skills. However, the results as shown in Table 1 also indicated that in the first study positive effects probably could not be confirmed, because of the short duration and incidental use of PictoPal. Further research was deemed necessary to study the effect of PictoPal when used more frequently and over a longer period of time.

SECOND STUDY

In the first study, the closed questions were deemed to be useful to teachers because children could work independently without the need for much introduction. However the findings from the first study also showed that pupils learned to work with the semi-open assignments in PictoPal quickly. This implied that initial teacher investment would be needed but that it could fade after three to four sessions. Additionally, all participants (children, teachers, and experts) agreed that the semi-open assignments featuring real-world applications were more interesting, motivating, challenging, and meaningful. Perhaps, on some level, they realized that children learn a first or second language best by using it to communicate rather than studying it in isolation (Garcia, 2000). For these reasons version 3 of PictoPal, which was used in the second study, contained only semi-open assignments. The PictoPal activities for this study were designed by the cooperating teacher together with the researchers and were related to a current classroom theme. In contrast to the extremely brief treatment in the first study, the second study doubled the number of PictoPal sessions, from four to eight. Children used PictoPal in weekly sessions. To address the need for adult guidance, the decision was made to explore the use of parent volunteers when the children used PictoPal. This is common practice in many Dutch primary schools. The research question guiding the second study was–"What is the effect of PictoPal (v3) on early literacy skills of 4- and 5-year olds?" Comparable to the first study, a pre-post test control group design was applied.

SECOND STUDY METHODS

Kindergarten children from the participating school were divided into an experimental (n = 7) and control group (n = 7). As in the previous study, the pupils were matched for age, gender, language skills (based on a national language test for kindergarteners), and remediation offered. One of each pair was randomly assigned to either the control or the experimental group. The experimental group worked once a week with PictoPal, in total eight times. The Early Literacy Skills Test was slightly revised (Cronbach's alpha = 0.87) and again administered to pupils from the experimental and control group before and after the treatment.

RESULTS

Table 3 presents the mean scores and standard deviations of the experimental and control group and shows a learning gain of 3.86 for the experimental group compared to 0.71 for the control group. Using the Mann-Whitney *U* test, a significant difference in learning effects was determined for the experimental versus the control group ($Z = -2.256$, $p < .024$). The effect size for the experimental group was considerably higher compared to the control group. After eight computer sessions with PictoPal, evidence was found to indicate that the PictoPal intervention improves emergent reading and writing skills.

A closer examination of these results is presented in Figure 3. In this figure, the learning gain mean scores and the 95% confidence interval from the first and second study are presented. This shows a large learning gain for pupils in the experimental group in the second study. What is remarkable is the huge variation in the learning gain of the control group in the second study. A few pupils from the control group gained as much as students in the experimental group, while other pupils from the control group had a negative gain. Further research is needed with a larger group of students to arrive at a better understanding of these results.

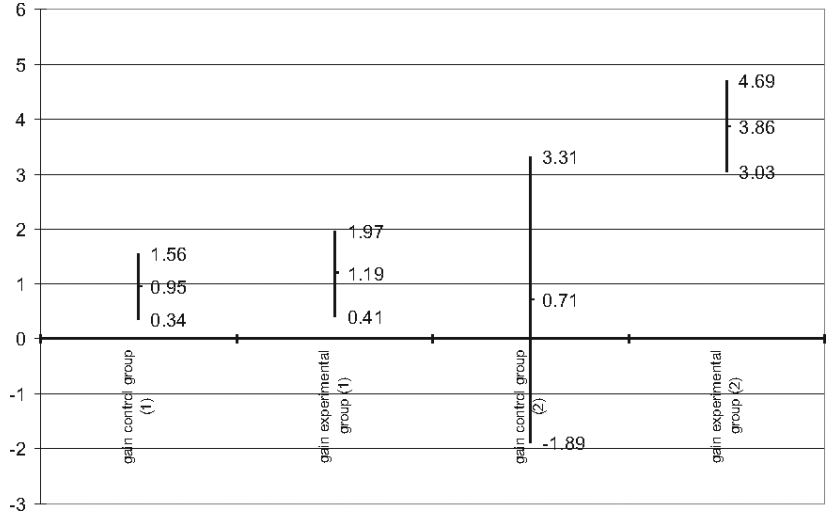
DISCUSSION

Promoting language and literacy development can be a major strength of technology use with young children through the opportunities and motivation it provides (Van Scoter, Ellis, & Railsbeck, 2001). Natashi and Clements (1994) found that through computer use, young children not only improved their fine motor skills, but also improved their creativity,

TABLE 3. Mean Scores, Standard Deviation of Pre and Posttest Scores, Learning Gain, and Effect Size on Early Literacy Skills Test, Experimental and Control Group Study 2 ($Z = -2.256$, $p < 0.024$)

	N	Pretest *M(SD)*	Post test *M(SD)*	Learning gain *M(SD)*	Effect size
Experimental group	7	9.57 (2.76)	13.43 (2.93)	3.86 (0.90)	1.36
Control group	7	7.71 (4.38)	8.42 (3.35)	0.71 (2.81)	0.18

FIGURE 3. Learning gain on the Early Literacy Skills Test in control and experimental group in first (1) and second (2) study (learning gain mean scores and 95% confidence interval).



problem-solving and critical thinking abilities, along with their self-confidence. Although further research is necessary, the results from this study do support these findings.

In exploring how ICT should be implemented in a developmentally appropriate fashion, literature indicates that children aged 3-5 frequently use computers for short periods, and they are more interested and less frustrated when an adult is present (Van Scoter, Ellis, & Railsbeck, 2001). This is also consistent with the findings from this study. Children were always eager to use the computer, but even more so when guided by an adult. The interaction between parents and pupils fostered dialogue and reflection and reinforced the feedback mechanisms, which were present in the software. Computer use facilitated or mediated by an adult is consistent with best practice at this age level (Clements, Nastasi, & Swaminathan, 1993). A follow up study will focus on a deeper understanding of these interactions and of the adults' role.

Reading and writing skills relate to nearly every domain in the curriculum. This, combined with the fact that reading and writing performance is known to be a substantial determinant of later academic performance,

emphasizes the importance of providing children with well-honed emergent reading and writing skills, early on in their schooling. This study contributes to understanding by describing one approach to fostering essential skills. Since research in the area of literacy and technology is severely lacking (Kamil, Intrator, & Kim, 2000), and even more radically so within the 0-8 age range (Lankshear & Knoebel, 2003), it also speaks to a clear need. As a study that involves 4- and 5-year olds using technology to write and generate meaning (as opposed to reading and receiving text), it is one of a few.

CONCLUSIONS

With the aim of fostering literacy and communications skills in kindergarten classrooms, this study set about to learn how technology-supported lesson materials for this age group can be designed and implemented. Results of the study showed that regular and frequent use of technology can have a positive learning effect on literacy development of 4-5 year olds, at least in cases where adult facilitation is present. Further research with a larger group of students is needed to strengthen confidence in the results.

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