

Reading Competencies of Fourth-Grade Students: Comparing Print and Hypertext Literacies

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ABSTRACT

This text presents an outline of research and publications on two studies comparing print and hypertext literacy of fourth-grade students. This set of studies, entitled *Reading at the Computer* (RaC), consists of two consecutive assessments: a pilot study (RaC–2001), conducted in 2001 as a supplement to the *Progress in International Reading Literacy Study* (PIRLS–2001), and an advanced study (RaC–2003), conducted in 2003 in the context of the first cycle of a longitudinal assessment in the Federal State of Hamburg, called *Kompetenzen und Einstellungen von Schülerinnen und Schülern – Jahrgangsstufe 4* (KES–4)¹. KES–4 applied, among other instruments, some of the tests and background questionnaires from PIRLS–2001.

Keywords: Reading literacy, print and hypertext reading, reading at the computer, PIRLS, ICT, item response theory

1. INTRODUCTION

With more than 1.6 billion users worldwide, the internet is clearly an important medium for information and communication (1.66 billion users as of March 31, 2009 [1]). The fact that the number of internet users has increased consistently over the past years mirrors its growing importance as a source for current and spatially independent information. One effect of the widespread use of the internet is a change in the text format that is produced and read: the internet is substantially based on hypertext, a non-linear text format which now appears next to conventional, linear print text as a new text format for presenting and retrieving information. From the viewpoint of reading research, the extent to which this new medium alters the processes of text production and text reception needs to be determined. With regard to the reception process, reading research should reveal if, and how, the comprehension of hypertexts differs from the comprehension of print texts.

Up to now, little research in hypertext comprehension has been conducted with younger readers, whose reading ability is still in its developmental stage.

The *Reading at the Computer* studies (RaC), conducted in Hamburg, Germany, address this lack of research on younger students and focus specifically on the age group of fourth-grade

students. The studies are intended to gain insight into the differences between, and interrelations of, print and hypertext literacy at this comparatively early stage of reading development, which is, or should be, of essential interest for educational research and didactics. The RaC studies have a threefold aim: to assess comprehension processes specific to hypertext reading, to compare these processes with those specific to print texts, and to identify variables influencing both print and hypertext reading abilities. To do so, the studies take into account the different levels of sophistication of the reading comprehension processes required as well as the two types of text used in the PIRLS assessment, literary texts and informational texts. Thus, the results of the RaC studies may serve as a foundation for developing concepts for teaching reading comprehension in a way that incorporates both print and hypertext media.

The RaC studies assess the print and hypertext reading comprehension of fourth-grade students. The studies consist of two consecutive assessments: a pilot study (RaC–2001), conducted in 2001 as a supplement to the *Progress in International Reading Literacy Study* (PIRLS–2001)², and an advanced study (RaC–2003), conducted in 2003 in the context of the first cycle of a longitudinal assessment in the Federal State of Hamburg, called KES–4. KES–4 applied, among other instruments, some of the tests and background questionnaires from PIRLS–2001. The pilot study was conducted in two stages, as the test instruments were field-tested prior to the main assessment.

2. METHOD

Test design and scope of research

The RaC studies are exploratory in nature. The studies' instruments, which were taken from the PIRLS assessment, have been developed from the research goals of the RaC. Along with these instruments, the RaC studies have also adopted the theoretical framework of the PIRLS assessment. This framework is based upon the linguistic model of text comprehension of

1 The title of this study translates *Competencies and Attitudes of Students in Grade 4*.

2 The *PIRLS 2001 Framework and Specifications* contain the idea to include in PIRLS–2001 an exploratory study on the ability to read electronic texts. For further information consult the framework's section on the *Electronic Text Study* [2: p. 44]. This study, however, was not implemented for financial and technical reasons.

Kintsch and van Dijk and distinguishes between different aspects of reading comprehension [2,3].

The RaC studies are designed to supplement PIRLS–2001 and KESS–4. This design allows for the RaC sample, which is comparatively small in size, to be anchored into the large-scale PIRLS–2001 and KESS–4 studies with the former being conducted in Germany at national level and the latter as a census in the Federal State of Hamburg.

The pilot study (RaC–2001) consisted of a pretest, which was conducted at one school, the main test, which was conducted at two schools, and a supplementary video study, conducted at three schools.

The pretest of the pilot study was carried out to field-test the validity of the newly developed hypertext test instruments. The main test then consisted of four elements: the print and hypertext reading tests, a test of cognitive abilities, and background questionnaires administered to students, parents, teachers, and principals in accordance with the PIRLS test design. For the print reading test, two PIRLS–2001 test instruments were selected: the literary text *The Upside Down Mice* by Roald Dahl and the informational text *Nights of the Pufflings* by Bruce McMillan. For the hypertext reading test, two further PIRLS instruments were selected and converted into the hypertext format: the literary text *Hare Heralds the Earthquake* by Rosalind Kerven and the informational text *River Trail*.

The supplementary, qualitative video study was conducted subsequent to a first basic evaluation of the (quantitative) data of the main test by means of situated interviews. For the video study, a subsample of the children was selected in view of their test results. These children were then asked to read the text *Puppy Walking* by Janice Mariott in the hypertext format at the computer and then answer a number of test questions. The video study obtained information in two ways. First, the children were observed while they were working on the text. Then they were asked a number of questions on this text at the end of the test. The observation was intended to reveal the extent to which the children were able to independently cope with the test requirements, and if they made use of the help offered by the test administrator [4]. The inquiry should shed light on the decisions the children made while carrying out the reading tasks as well as on the difficulties they encountered during the course of the test. The testing sessions of the video study lasted 60 minutes. In addition to videotaping, the logfiles of the children’s reading and navigation patterns at the computer were stored.

In the RaC advanced study (RaC–2003), which was conducted as a supplementary study to the KESS–4 assessment, the sample size was considerably greater. In total, 655 fourth-grade students participated in the RaC–2003. This study consisted of two hypertext reading tests and short background questionnaires administered to the participating students and their teachers. The hypertexts used were the *Hare* hypertext, and a second, informational hypertext on earthquakes, which were specifically developed for the advanced study (see Table 1 below).

Table 1: Participants and assessment instruments of the pilot study (RaC–2001)

Participants	Reading tests (Hypertext)	Background questionnaires
16 schools with 33 classes in total	<i>Hare</i> (adapted from PIRLS-2001) <i>Earthquake</i> (self-developed)	Short questionnaires for students and teachers (based on those used in the RaC pilot study)

Conversion of PIRLS assessment instruments into hypertext format

The reading tests of the RaC studies were developed in order to produce a comparative analysis of print and hypertext reading achievement. Therefore, a number of PIRLS reading tests were selected, of which some were converted into the hypertext format, while others were adopted in the original print version.³

The original PIRLS instruments proved to be suitable for the conversion into hypertexts. Therefore it was decided to use these instruments for the hypertext tests instead of developing the hypertexts from scratch. The *River Trail* leaflet was ideally suited for this conversion as it already had a non-linear structure. The linear, informational text *Puppy Walking* was also quite suitable as it consisted of several text sections which are to a certain extent self-contained and could therefore be converted to hypertext nodes. The conversion of the literary *Hare* text was however, not as straightforward. This text is a coherent story with a fixed text base. It therefore does not offer the same opportunities of chunking the text into nodes as one has when designing a literary hypertext from the beginning. In the latter case, a researcher would define several text sections which are each tagged with a choice of links. These links then offer readers of such a hypertext the possibility to assemble different, individual stories. In terms of story grammar, a single hypertext would potentially contain a number of different settings, conflicts, and resolutions. In a test situation, reading achievement would be measured by assessing the extent to which the test participants are able to select matching text sections, identify the sequence of events, and solve corresponding tasks. Such a test design would reveal whether the test participants are able to identify or construct the recurrent theme of the text. To do so, a reader needs to be able to select and summarize the main ideas in each text section, and to connect these across the text sections [3,4].

3. DATA ANALYSES

The data derived from the RaC studies were analyzed in a number of research studies. In a PhD thesis, the data of the pilot study (RaC–2001) was anchored in the data of PIRLS–2001. Based upon reading theory and using psychometric methods, this thesis examined if the print and hypertext reading abilities assessed in RaC–2001 are two separate abilities [3]. In addition, it aimed to determine the factors that significantly influence the reading comprehension of the children tested. The study design of PIRLS–2001 allowed this thesis to test not only possible differences in reading ability induced by the text format (print vs. hypertext) but, at the same time, to assess possible differences induced by the text types used (literary vs. informational). The level of reading comprehension addressed by the test items could also be analyzed. The probabilistic methods applied in the data analysis of this thesis allowed for a direct comparison of the text formats and provided an indication of the level of reading ability of the students tested in RaC–2001 within the German PIRLS–2001 results. However, in order to scale and analyze the RaC–2001 data this way, it was necessary to rescale the German PIRLS–2001 data beforehand, as the PIRLS results to that date had been reported on the basis of two- and three-parameter item response theory (IRT) models [9: p. 152].⁴ The rescaling procedure was based on the Rasch one-parameter IRT model which, in comparison to multi-

3 For more detailed information on the conversion of PIRLS–2001 texts to hypertexts, consult earlier publications on RaC [3,4,5,6,7,8].

4 For further information on the differences between one-parameter and multi-parameter models see Voss [3].

parameter models, has the advantage of less parameters to be estimated, thus raising the precision of the estimated parameters (for information on data modeling, see King [10]; for information on item parameter estimation for IRT models, see Wright [11: p. 4–5]). The rescaling of the RaC–2001 data was primarily necessitated by the sample size of the study which was small in comparison to large-scale studies such as PIRLS [12].⁵

In addition to this first PhD thesis that used data from RaC–2001, a second PhD thesis [14], currently in progress, analyzes data from RaC–2003 and examines which strategies of navigation and orientation the students use when performing the hypertext tests and how the data from RaC–2003 relate to the KESS–4 test results in mathematics and science.

4. RESULTS

The following sections present selected results from the two RaC studies. The quantitative analysis of the RaC data was chiefly concerned with the question of whether the test items of both the print and the hypertext reading test can be described using one common dimension of reading ability or whether the modeling of the data necessitates two separate dimensions with specific subscales for each text format. The research analyses to date, however, do not offer a final answer to this question. The results of the data analyses of the pilot study suggest the assumption of two separate reading abilities for print and hypertext which are, nevertheless, interrelated. Two models were analyzed: the first, one-dimensional model did not distinguish between the text formats, while the second, two-dimensional model did. A comparison of the goodness-of-fit of these two models, based upon the models' deviance statistics, reveals that the two-dimensional model caused a significantly better fit with the data of the pilot study than the one-dimensional model. This raises the question of how these two reading abilities relate to one another. The latent distributions of the proficiency parameters and item parameters for the two subscales of print and hypertext reading ability shed light on this matter.

The mean scores of the item parameters in this scaling run were restricted to the value of 0 which means that the item difficulties of both scales are comparable in their means. The distributions of the student proficiencies are slightly offset against one another: the average student proficiency on the print text scale is .89 (dimension 1), while the average proficiency on the hypertext scale is 1.08 (dimension 2). The dispersion of these latent distributions reveals an even greater difference: the variance of the variable "reading ability (print)" is .69 while the variance of the variable "reading ability (hypertext)" is 1.04.

For a comparison of the test results on an individual level, the covariances of the values of the test data can be considered. The correlation of the adjusted attenuations of the subscales "reading ability (print)" and "reading ability (hypertext)" is .76, which corresponds to a common proportion of total variance of slightly less than 60 percent. In comparison, the correlations between the subscales for the different text types (or purposes for reading, respectively) exceed both in PIRLS–2001 [15: p. 79–84] and in PISA–2000 [16: p. 80–84] by and large at a level of .90. The correlations between the interdisciplinary subscales 'reading', 'mathematics', and 'science' in the PISA–2000 study have values in the range between .77 and .89 [17: p. 152–154] and are

consequently also higher than the correlations between the print subscale and the hypertext subscale found in RaC–2001. This result is, however, only of preliminary nature due to the small sample size of the RaC–2001 study [3].

A comparison between the results of the two RaC studies reveals that the reading scores for both text formats, print and hypertext, are quite similar. However, while in the pilot study (RaC–2001) the hypertext reading score is 6 percent higher than the print score, it is 2 percent lower in the advanced study (RaC–2003).

5. CONCLUSION

The design of the RaC studies was exploratory. Therefore this conclusion does not wager far-reaching claims on the influence of variables determining the reading ability with hypertexts. Such propositions would not be statistically sound.

The quantitative analyses of the RaC studies to date have shown that print and hypertext reading abilities are interrelated. At the same time, however, the variability of the reading achievement is far greater than it is with hypertexts than with print texts. This would suggest the influence of further variables on hypertext literacy. As the analysis of the background questionnaires has shown, one important influence might be an out-of-school variable: systematic computer activities that students do with their parents, which have a significantly positive effect on the students' hypertext reading achievement. In further analyzes, this interrelation will be examined in more detail.

Due to the exploratory nature of the RaC studies, the analyses to date do not offer a valid answer to the question whether hypertext literacy is substantially different from print literacy and needs therefore be an independent learning target, or whether students can transfer their reading abilities from print texts to hypertexts. The results discussed in this text do however suggest that good readers of print texts can transfer their abilities to the hypertext format. In addition, the hypertext format can motivate students to read, as its flexible, self-determined structure corresponds with the self-determination of actions seen as one central basis for motivation.

In conclusion, we assume that both print literacy and hypertext literacy are interrelated and that the instruction of, and the research on, both types of literacy profit from transfer processes in both directions.

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