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Abstract

The purpose of this study was to investigate how computer-assisted use of Reading-through-Writing (RtW) method relates to the level of literacy and reading motivation of school children in grades 1 and 2 (N = 261–385). The research also explored the extent, to which the RtW method was perceived as useful among teachers and by school children with lower reading and writing skills. The research was implemented as a quasi-experimental two-year follow-up study. The experimental group (N = 34–35) was taught by applying the RtW method, as defined by Trageton (2007). The control data (N = 227–350) were sourced from the first phase (2006–2011) of the *First Steps Study: Interaction and Learning within Child-Parent-Teacher Triangle*. This research employed the embedded mixed methods research design. The quantitative data were obtained from 7 literacy tests and 3 reading motivation tests. The qualitative data were gathered from the study diaries filled by the teachers (N = 3), the interviews carried out with the school children (f = 19) and videos recorded during the lessons (f = 6). The results of this study have shown that the use of RtW method enriched the children's experience of learning to read and write, although it did not have significant enhancing effect on technical literacy or reading motivation in the experimental group.

Introduction

Relatively little research has been done so far into computer-assisted use of Reading-through-Writing (RtW) method in teaching (Andersson & Gustafsson, 2013; Karlsson, 2015; Takala, 2011; 2013; Tyrén, 2013). A few studies and publications have addressed the subject, but most of them were undergraduate or master's thesis (Turunen, 2018). The working method was developed by Norwegian pedagogue Arne Trageton (2007) who integrated the Nordic research experience with the influences from *Writing to Read (WTR)* program widely used in the United States during the 1980s.

With the development of digitalization, the use of computers and other smart devices have become common also in schools. In Finland, for instance, targeted practice of digital literacy and keyboard typing starts already from pre-primary and primary education (Opetushallitus, 2014, 2016). Also at international level, computer-assisted interventions supporting literacy development have been widely applied with promising results (Blok, Oostdam, Otter & Overmaat, 2002; van Daal & Reitsma, 2000; Foster, Erickson, Foster, Brinkman & Torgesen, 1994; Heikkilä, Aro, Närhi, Westerholm & Ahonen, 2013; Hultin & Westman, 2013a, 2013b; Magnan & Ecalle, 2006; Nicolson, Fawcett & Nicolson, 2000; Regtvoort & van der Leij, 2007; Richardson & Lyytinen, 2014; Saine, Lerkkanen, Ahonen, Tolvanen & Lyytinen, 2010, 2011). This article discusses computer-assisted use of Reading-through-Writing (RtW) educational method and its relation to the level of literacy and reading motivation of school children in grades 1 and 2. The paper also evaluates the extent, to which RtW method is perceived as useful among teachers and by those children with lower reading and writing skills (Turunen, 2018).

Use of Computer in Teaching to Read

The previous studies suggest that digital games and computer-assisted teaching has somewhat promoted reading and writing skills' development (Blok et al., 2002; van Daal & Reitsma, 2000; Foster et al., 1994; Heikkilä et al., 2013; Hultin & Westman, 2013a, 2013b; Magnan & Ecalle, 2006; Nicolson et al., 2000; Regtvoort & van der Leij, 2007; Richardson & Lyytinen, 2014; Saine et al., 2010, 2011). Favorable results have been demonstrated in many studies (Blok et al., 2002; van Daal & Reitsma, 2000; Folkesson & Swalander, 2007, 2010; Foster et al., 1994; Genlott & Grönlund, 2013; Heikkilä et al., 2013; Hultin & Westman, 2013a, 2013b,

2015; Lyytinen, Erskine, Kujala, Ojanen & Richardson, 2009; Lyytinen, Ronimus, Alanko, Poikkeus & Taanila, 2007; Magnan & Ecalle, 2006; Nicolson et al., 2000; Regtvoort & van der Leij, 2007; Richardson & Lyytinen, 2014; Saine et al., 2010, 2011), but the sample sizes are often too small and hence these results can be only regarded as preliminary.

It has been observed that reading and writing skills can be effectively promoted by regular use of learning game GraphoLearn that allows to practice matching up letters with sounds (Heikkilä et al., 2013; Richardson & Lyytinen, 2014; Saine et al., 2010, 2011). GraphoLearn is learner-centered, because the tasks become more complex depending on the learner's individual capabilities and instant feedback on the learner's knowledge is given immediately along with rewards for achievements and offers to undertake new challenges. Phonological awareness and ability to decode syllables and words are often practiced through repeating exercises (Lyytinen et al., 2007, 2009). According to Foster et al. (1994), the phonological skills in 5–8 years old children ($n = 27$ and $n = 69$) develop successfully in a computer-assisted manner when DaisyQuest software is used on regular basis. Literacy increase can be achieved by using the software to practice rhyming, recognising of characters, separating the words into phonemes and combining syllables into words. The studies have shown that computer-assisted goal-oriented training can strengthen the phonological abilities of those children who are at higher risk for inherited language difficulties ($n = 31$) (Regtvoort & van der Leij, 2007) and may promote the nascent literacy of children with existing reading difficulties (Magnan & Ecalle, 2006). In the case of RtW method, practicing phonological skills is less targeted, less guided and less repetitive in the same way than it is the case with programs described above. The aforementioned research into computer-assisted reading (Foster et al., 1994; Heikkilä et al., 2013; Lyytinen et al., 2007, 2009; Magnan & Ecalle, 2006; Regtvoort & van der Leij, 2007; Richardson & Lyytinen, 2014; Saine et al., 2010, 2011) has shown that regular and targeted practicing of phonological skills can support successful development of literacy.

The use of RITA (*Readers' Interactive Teaching Assistant*) application for computer-assisted teaching has proven to facilitate faster learning-to-read track among school entrants ($N = 175$) and the literacy improvement in children around 8 years of age ($N = 97$) (Nicolson et al., 2000). Van Daal and Reitsma (2000) have suggested that individualized computer-assisted teaching of 6–7 years olds ($N = 21$) can strengthen their literacy-related independent learning abilities much more effectively than the traditional approaches to group teaching. It has also been found that the use of computers increases motivation of primary school pupils for self-directed learning (Folkesson & Swalander, 2010) and facilitates the process of learning to write (Hultin & Westman, 2015, p. 83–83).

RtW Method

In RtW method, the computer-assisted writing provides the basis for learning of reading: the keyboard typing starts earlier in the child's life than the acquisition of reading skills (Trageton, 2007). As Takala (2011, p. 68) points out, RtW method comprises both synthetic and analytical approaches to teaching of reading skills, because the learner can tell the teacher those letters, which he/she has *read* with the help of an adult. *In synthetic methods*, teaching of reading starts with review of small units such as sounds, letters and syllables that the learner has to master for being able to make words (Høien & Lundberg, 1999). *In analytical methods*, the reading skills are acquired in the reverse order: by looking at entire words or phrases first and then gradually moving to smaller units (Høien & Lundberg, 1999).

According to Trageton (2007), this method emphasizes the child's *natural language, early learning of writing and self-realized spelling* as important aspects. The method suggests writing in pairs and writing in standing position. Linguistic impulses received from the environment in the form of interactive speech and written language also provide support for improvement of reading and writing skills. According to this method, the path of literacy development can be depicted as follows:

$$\text{Understanding} \times \text{Encoding} \times \text{Decoding} = \text{Writing/Text Comprehension}$$

As Trageton (2007) explains, understanding is followed by encoding process that relies on the person's thinking and reasoning system, and the encoded objects can later be decoded. These are then followed by writing and understanding as the next steps. According to RtW method, learning to read may be started when the child is 6 years old or later, depending on school starting age, and acquisition of reading skills must proceed in phases. RtW is applicable either as the sole method of teaching of reading read or integrated with other methods in appropriate manner.

Phases

During the First School Year

At the beginning of the first semester, according to Trageton (2007, p. 88–112), the learners are asked to name randomly selected letters (*the letter test*), this allows finding out, which letters are not yet mastered. Computer typing is first learned by getting familiar with the keyboard, then by practicing the *ten-finger techniques* and typing *strings of letters*. When doing exercises for typing letter strings, the learners are asked to write as many letters as possible during limited time. Then they count the letters and pick out the familiar ones. At the beginning, only capital letters are used for practicing. Letter typing assignments are often given to the children during the first year because these exercises form a part of the pupil's first report. The children illustrate these reports with their own drawings or find pictures matching the content. When the report is ready, they 'read' their story with the help of an adult. The results of lettering exercises are collected in *letter books*, which is the most important output of the first school year, because no ready-made books are used yet. As the next step, the letter strings gather into words, and those are assembled into dictionaries. The first dictionary may contain the keywords from the story told in the report, or the words that learner can remember. However, for the next dictionary, which is considered the correct one, children are asked to choose words with the same initial letter. Dictionaries can be compiled in a learner-centered way, for instance, including alphabet letters that correspond to the learner's level of knowledge. The next phase focuses on *self-realized spelling*. The children continue to practice writing, for example, they use common thematic texts. In addition to computer typing, handwriting of capital letters is also practiced, but handwriting of capital and lowercase letters is taught in a more targeted manner in the third school year.

During the Second School Year

Individual progress of reading and writing skills is mapped, as suggested by Trageton (2007, p. 124–150), during the *letter test* that is given to the children at the end of grade 1 or the beginning of grade 2. Continuous literacy improvement during the second school year includes learning to *write letters, poems, texts for magazines and reading books*. This method suggests that writing letters together with the right recipient encourages the learner's capacity for independent and continuous writing. Poems are written playfully, imitating the role models, magazines and reading books are created individually or working in pairs.

During the Third and Subsequent School Years

According to Trageton (2007, p. 154–170), increasingly more goal-oriented practice in writing is necessary during the third and subsequent school years, because the level of literacy increases, and the texts written by the learner need to improve in quality. They become longer in size and start to include more diverse sub-categories of texts such as *essays, fiction and fantasy texts*. The teachers encourage children to experiment with different genres and to choose various topics. Thematic writing is enriched with other classroom activities, e. g. tours, dramatizations and reading the topic-related literature. The children can collectively produce their *own magazines and books*. Regarding the language revision, individual correction of the texts is still considered important and requires more attention than before. The process writing is implemented in phases: 1) the full text and its context, 2) selection of the text type, 3) composition (structure) and 4) sentence level, word level and spelling. The third school year includes regular *practice in handwriting* of capital and lowercase letters. Improvement of process writing continues during the subsequent school years, thus strengthening the skills described above.

Method

Data

The research data were collected in the period from spring of the first-grade year to spring of the second-grade year, quantitative and qualitative methods were used for the collection purpose. Differences between the experimental and control groups were identified by using the methodology of semi-experimental set-up of the non-equivalent groups (Cook & Campbell, 1979, p. 98–124; Metsämuuronen, 2006b, p. 1180–1182). The research was focused on school children in grades 1 and 2 (N = 261–385). The number of pupils who participated in this study was 385 in spring of the first-grade year and 261–374 in spring of the second-grade

year. The data for the control group of the study (N = 227-350) were taken from the first phase (2006–2011) of the *First Steps Study: Interaction and Learning within Child-Parent-Teacher Triangle* (N = 2096). The control group was randomized and accounted for approximately 10.8–16.7 per cent of the original data.

The experimental group of the study (N = 34–35) consisted of three classes of children and their teachers. Invitations to participate in the study were e-mailed to grade 1 teachers, who had attended Trageton's training at Palmenia Center for Continuing Education at the University of Helsinki. One class came from Eastern Finland, the other two were from Southern Finland. RtW method, which is the subject of this research, was applied to aforementioned classes starting from autumn of the first-grade year. The data on reading and writing skills in the experimental group were collected in spring 2014 for the first grade and in spring 2015 for the second grade. Data on reading motivation (2014–2015) in the experimental group were collected in spring of the first-grade year, autumn of the second-grade year and spring of the second-grade year.

There were equal number of girls and boys in both groups: the boys accounted for 51–53 percent and the girls made up 47–49 percent. In spring of the first grade, the control group (N = 350) had 170 girls and 180 boys, and the experimental group (N = 35) included 17 girls and 18 boys, respectively. In spring of the second grade, the control group (N = 340) counted 160 girls and 180 boys, and the experimental group (N = 34) included 16 girls and 18 boys, respectively. During the productive writing assessment, which was carried out in spring of the second-grade year (N = 261), the control group (n = 227) included 107 girls and 120 boys, and the experimental group (n = 34) counted 16 girls and 18 boys, in the same proportion. The control group was smaller than in other measurements, because the productive writing data (N = 281) sourced from the first phase (2006–2011) of *First Steps Study: Interaction and Learning within Child-Parent-Teacher Triangle* was not large enough to form a random sample for the study.

The embedded model of the *mixed methods* study was used as the underlying approach in this research. According to Creswell and Plano Clark (2011, p. 90–96), an embedded model means that the research data is collected and analyzed using traditional settings and methods, but one research material is 'embedded' inside another. Such model can be applied in a manner where both materials are equal or in a manner where the other, i. e. the 'embedded' material supports the primary material. The qualitative research data were embedded for the purpose of achieving more profound results based on the quantitative data. The qualitative data of the study were collected only in the experimental group and came from *study diaries filled by the teachers* (N = 3), *interviews with the school children* (f = 19) and *video recordings of the lessons* (f = 6).

As Denzin (1988) has explained, *four-dimensional triangulation* means that the same phenomenon is investigated in different ways in order to confirm its reliability. The triangulation of this study was implemented by employing multi-method and multi-data approach, thus the data from the experimental group were collected through combined application of the quantitative and qualitative methods during spring of the first-grade year, autumn of the second-grade year and spring of the second-grade year (2014–2015), i. e. 25 times in total.

Data Collection Methods

Levels of reading and writing skills and reading motivation rates were explored using the same quantitative measurement methods as during the first phase (2006–2011) of the *First Steps Study*. Non-word dictation writing skills (Lerikkanen, Poikkeus & Ketonen, 2006) were analysed between the groups and genders by applying the setup of *Untreated control group design with pretest and posttest* (Cook & Campbell, 1979, p. 103–115; Shadish, Cook & Campbell, 2002, p. 136–137) in spring of the first and second grade years. For data collection in other experimental and control groups, the setup of *Posttest-only design with non-equivalent groups* (Cook & Campbell, 1979, p. 98–99; Shadish et al., 2002, p. 106–107) was used.

Reading and writing skills were assessed through *technical literacy exercises, reading and listening comprehension tasks* (Lindeman, 1998), *productive writing assignments (word count and error count)* (Wäre, Töllinen & Koskipää, 2004) and word dictation tasks (Lerikkanen et al., 2006). Reading motivation was investigated through assignments related to *task-specific evaluations* (Nurmi & Aunola, 1999), *task strategies (task-avoidant strategy and task-orientation)* (Onatsu & Nurmi, 1995) and the *learner's self-concept* (Lerikkanen & Poikkeus, 2006; Nicholls, 1978). *Repeated-treatment design* setup (Cook & Campbell, 1979, p. 123–124) was also used to collect data on the level of reading motivation in the experimental group, and qualitative methods were applied with regard to the data from *the study diaries kept by the teachers* (N = 3), *interviews with the learners* (f = 19) and *video recordings of the lessons* (f = 6).

Measuring Indicators

Levels of literacy were measured (see Table 1) by seven different indicators. *Listening comprehension* skills were assessed using *Pelle Pullero* exercise included in Primary Reading Test (ALLU) elaborated by Lindeman (1998). The assignment consisted of eight questions that had to be answered after listening. The story was read aloud twice, and then the learners had to select the correct answer from the four given options. Listening comprehension was measured in both groups in spring of grade 2 ($\alpha = 0.860$).

Phonological awareness (Poskiparta, 1995) was assessed using the exercise where the learners had to recognize the words pronounced loudly and to select the correct answer that corresponded to the picture. This assignment was practiced with a training word, and later the children heard nine words of the task pronounced loudly only one time each. Phonological awareness skills were mapped in both groups in spring of grade 1 ($\alpha = 0.465$).

The mapping of word dictation writing skills was performed using *word dictation and non-word dictation* assignments (Lerkkänen et al., 2006). In word dictation tasks, the children were asked to listen to five meaningful words (1. *kiekko* ‘a puck, a disk’, 2. *pumppu* ‘a pump’, 3. *tirskua* ‘to titter, to chirp’, 4. *sänky* ‘a bed’, 5. *langat* ‘yarns’) and then write them down. This measuring of word dictation writing skills was done in both groups in spring of grade 2 ($\alpha = 0.666$). In non-word dictation assignments, the learners were asked to listen to eight meaningless words (1. *kirk*, 2. *vuil*, 3. *märstö*, 4. *saihd*, 5. *raalsku*, 6. *voistoa*, 7. *hiuruutti*, 8. *seivolssi*) and write them down. Non-word dictation skills were examined in both groups in spring of grades 1 ($\alpha = 0.788$) and 2 ($\alpha = 0.700$).

Technical literacy (Lindeman, 1998) was measured using certain parts of Primary Reading Test (ALLU). The learners had to read four words from each section of the assignment and to match the correct word to the corresponding picture as quickly as possible. Two minutes were allowed to complete the entire task. Technical literacy was measured in both groups in grade 1 (as TL2A reading test) and grade 2 (as TL2B reading test).

In *reading comprehension* assignments (Lindeman, 1998), the children had to read text excerpts and choose the correct answer from four given options or arrange the events in the correct order based on what they just had read. The time allowed for completing this task was half an hour. These data were collected from both groups in spring of grade 1 (information text ‘Judo’, LY1) and in spring of grade 2 (information text ‘Gymnastics Guide’, LY3: 2).

The writing literacy of both groups were also mapped through *productive writing* assignments in spring of grade 2. Comparisons of both groups were made while analyzing the word count and error count in the stories ($\alpha = 0.713$). The learners received a task to write a narrative story based on six consecutive pictures. The time limit for completing this assignment was one lesson (45 mins) (Wäre et al., 2004). The stories were written down by hand only in the control group, while the experimental group documented them by typing on the computer. The lessons of the experimental group were recorded on video.

Reading motivation was examined (see Table 1) in both the experimental and the control group ($\alpha = 0.703$ – 0.802) in three aspects during spring of grade 2. The reading motivation of the experimental group was investigated in spring of grade 1 ($\alpha = 0.548$ – 0.792), autumn of grade 2 ($\alpha = 0.548$ – 1.000) and spring of grade 2 ($\alpha = 0.588$ – 0.803). The first aspect of reading motivation measurement, the *task-specific evaluation*, was based on theory of Eccles et. al. (1983) on subject-specific interest for learning (Nurmi & Aunola, 1999) and was measured by applying the indicator *Task Value Scale for Children (TVS-C)*. The learners were asked to answer six questions, which described how interesting the reading and writing related tasks seemed to them and how happy they felt about completing such tasks at school and at home. To express their attitude towards the task, the learners were encouraged to show the corresponding value from the smiley face scale (1–5), which was prepared based on Likert five-point scale. The following questions were used for mapping: how much do you like the reading related tasks given to you at school, how much do you enjoy completing the reading tasks at school and how much do you enjoy completing the reading tasks at home? The following question was used to assess the *writing* motivation: how much do you like the letter-related tasks given to you at school, how much do you enjoy completing the writing tasks at school, how much do you enjoy completing the writing tasks at home?

The second aspect of the reading motivation measurement, the *task strategies*, was investigated by applying *Strategy Test for Children (STC)* elaborated by Onatsu and Nurmi (1995). The learners were asked to evaluate their own performance strategies in relation to 15 provided statements and to answer to the researcher’s questions about whether those statements were true or not. The statements looked like the following examples:

- Sometimes I hesitate or delay starting the completion of a task.
- If something seems too difficult at school, I leave it unfinished.
- I think it's nice to complete even more difficult tasks that are given to me at school.

The examination focused on the *task avoiding* and *task-orientation* concepts in their original structure that was used for measurements already in the *First Steps Study* (2006–2011).

The third aspect of reading motivation measurement, *the learners' self-concept*, was mapped by applying the self-assessment method proposed by Nicholls (1978) and successfully deployed by Lerkkanen and Poikkeus (2006) during data collection in the first phase (2006–2011) of the *First Steps Study*. The learners were asked to evaluate (1–10) their own reading and writing skills in comparison with their classmates. The evaluation was carried out using a *pearl necklace*: the top pearl (1) of the necklace corresponded to the group member whose reading and writing skills were the best, and respectively, the lowest pearl (10) corresponded to the opposite.

Table 1. Quantitative Data Measurements both in the Experimental and the Control Groups in Spring of Grades 1 and 2 (N = 261–385)

Time	Grade 1, spring		Grade 2, autumn	Grade 2, spring
Group	Experimental and control groups	Experimental group	Experimental group	Experimental and control groups
	N = 385	N = 35	N = 34	N = 261-374
Measuring indicators				
Reading and writing skills				
Phonological awareness	x	x		
Non-word dictation	x	x		x
Technical literacy	x	x		x
Reading comprehension	x	x		x
Word dictation				x
Listening comprehension				x
Productive writing				x
Reading motivation				
Task-specific evaluations		x	x	x
Task strategies		x	x	x
Learner's self-concept		x	x	x

The *qualitative data* of the study (see Table 2) was collected from *the study diaries* filled by the teachers of the experimental group (N = 3), the *interviews with the learners* (f = 19) and the *video recordings of the lessons* (f = 6). The purpose was to map how useful RtW method was found to be among the teachers who had been using this method and also from the perspective of the learners with lower literacy skills. Prior to the start of this study, the teachers received oral and written instructions for keeping the study diary during the entire period of the data collection. These guidelines emphasized that regular use of RtW method and accuracy in empirical description are essential.

Semi-structured thematic interviewing frames were used for the interviews with the learners, and they were interviewed during normal school days outside the classrooms, in separate facilities. The children were selected for the interviews individually on every occasion, the selection was based on the results of reading and writing tasks completed in spring of the first and second grade. The children who participated in the interviews were the least successful at the tasks, some of them (f = 6) had difficulties to learn reading and writing.

Five pupils (2 girls, 3 boys) were interviewed in spring of the first grade, five interviews (2 girls, 3 boys) took place during autumn of the second grade and nine children (4 girls, 5 boys) were interviewed in spring of the second grade. Video material was recorded in spring of the first grade, in autumn of the second grade and in spring of the second grade. Two video recordings (videos 1 and 2) have documented the use of the RtW method, other videos recorded the process how the learners were completing productive writing tasks in autumn (videos 3 and 4) and spring (videos 5 and 6) of the second grade.

Table 2. Measurements of the Qualitative Data in the Experimental Group in Spring of Grade 1, Autumn of Grade 2, Spring of Grade 2

Time	Grade 1 spring	Grade 1 autumn	Grade 2 spring
Measuring indicators			
Study diaries of teachers (N= 3)	x	x	x
Interviews with learners (f = 19)	x	x	x
Video recordings (f = 6)	x	x	x

Data Analyses

The *quantitative* data were analyzed employing the methodology of Independent samples t-tests, Pearson product-moment correlations, K-means cluster analysis, Chi-squared tests, analyses of covariance (ANCOVA), Repeated measures analysis of variance, Paired t-tests, Friedman two-way analysis of variance and Wilcoxon signed-rank test (Metsämuuronen, 2006a, 2006b). For analyses of covariance, the initial measurement test points were used as covariates for spring of grade 1 and the gender dimension.

The *qualitative* data were examined by applying the methodology of data-driven content analysis, which involved reduction, grouping and abstraction of the research material (Miles & Huberman, 1994; Morgan, 1993; Morse & Field, 1995). Depending on the research task, the collected data may have been reduced, for example, by encoding important expressions. In clustering of the coded expressions, attempts were made to find the differences and similarities that are based on the coded expressions and make up the categories and subcategories in the manner described by Coffey and Atkinson (1996). Study-relevant information was differentiated pursuing the approach defined by Morse and Field (1995), based on simplified and grouped data, and this led to new theoretical concepts and conclusions. According to Downe-Wamboldt (1992, p. 314), data-driven content analysis can provide information and understanding of the underlying phenomenon of the research.

Research Questions

1. What relation exists between the computer-assisted use of RtW and the development of reading and writing skills of children in grades 1 and 2? Are there any gender differences? The associated hypothesis # 1: the reading and writing skills in the experimental group develop significantly better than in the control group.
2. Are there any differences in reading motivation between the experimental group and the control group in spring of grade 2? How does the reading motivation develop during the intervention in learning process of the experimental group? The associated hypothesis #2: the reading motivation develops significantly in the experimental group during the intervention.
3. To what extent RtW method is perceived as useful?
 - 3.1 What experiences do the teachers have regarding RtW method?
 - 3.2 What experiences do the children with lower reading and writing skills have regarding RtW method?

Results and Discussion

Development of Reading and Writing Skills

The level of literacy development was examined by performing analysis of covariance in the experimental group and the control group, including the aspect of comparison between genders, also by applying the analysis of variance to the repeated measurements. Research data, which were assessed for the same indicators in both groups in spring of the first grade and spring of the second-grade year, referred only to the phonological awareness and non-word dictation. Longitudinal examination was possible only for non-word dictations, because the phonological research assignment resulted into ceiling effect (9 p.) in both groups (estimated mean in the control group = 8.43; estimated mean in the experimental group = 8.77) as early as in spring of the first-grade year. To apply the analysis of covariance to non-word dictations in spring of the second-grade year, test points for initial measurement were standardized first (the following difference was identified between the

groups: $p = 0.001$, Cohen's $d = -0.41$), and it was found that the initial measurement had highly significant main effect (see Table 3).

Table 3. Non-word Dictations: Analysis of Covariance on Group and Gender Differences in the Final Measurement in Spring of Grade 2, with the Initial Measurement Indicator of Non-word Dictations Used as Covariate (N = 385)

As covariate: Initial measurement of non-word dictations, N = 385						
Time	Spring, grade 2					
Factors	SS	df	MS	F	p	η^2
Covariate: initial measurement	355.530	1	355.530	167.823	0.000	0.313
Group	0.656	1	0.656	0.310	0.578	0.001
Gender	3.929	1	3.929	1.855	0.174	0.005
Group x gender	0.286	1	0.286	0.135	0.713	0.000
Error term	781.718		2.118			
		369				

After standardizing the initial measurement and gender (see Table 4), the initial measurement had a highly significant main effect and the gender dimension possessed an indicative impact in favor of the girls. The results of the analysis of covariance concluded that the intervention had no significant relation to non-word writing skills.

Table 4. Non-word Dictations: Analysis of Covariance on Group Differences in the Final Measurement in Spring of Grade 2, with the Gender Measurement Indicator of Non-word Dictations Used as Covariate (N=385)

As covariate: Gender and initial measurement of non-word dictations, N = 385						
Time	Spring, grade 2					
Factors	SS	df	MS	F	p	η^2
Covariate: gender	7.000	1	7.000	3.313	0.070	0.009
Covariate: initial measurement	355.020	1	355.020	168.030	0.000	0.312
Group	0.683	1	0.683	0.323	0.570	0.001
Error term	781.752	370	2.113			

The results of variance analysis for repeated measurements (see Table 5) showed that the time factor had a highly significant main effect and the gender possessed an almost significant main effect. It was also observed that the group's main effect and the interaction between the time and the group were indicative. Other interactions related to the analyse of variance, were not statistically significant.

Table 5. Non-word Dictations: Analysis of Variance for Repeated Measurements, Spring of Grade 1 – Spring of Grade 2 (N = 374)

Non-word dictations, N=374						
Factors \ (Huynh-Feldt)	SS	df	MS	F	p	η^2
Time	111.487	1	111.487	54.635	0.000	0.129
Time x group	7.056	1	7.056	3.458	0.064	0.009
Time x gender	0.362	1	0.362	0.177	0.674	0.000
Time x gender x group	2.335	1	2.335	1.145	0.285	0.003
Error term	752.973		2.041			
		369				
Group	11.448	1	11.448	3.397	0.066	0.009
Gender	21.101	1	21.101	6.261	0.013	0.017
Group x gender	3.450	1	3.450	1.024	0.312	0.003
Error term	1243.657	369	3.370			

When comparing the estimated means at baseline (see Table 6), the level of non-word writing skills was 1.36 points lower in the boys than in the girls. Improvement of the boys' literacy during the period from spring of the first-grade year to spring of the second grade was somewhat higher than the same indicator of the girls: the development scored an average of 1.92 points for the boys and an average of 1.42 points for the girls.

Table 6. Reading and Writing Skills: Compared Means between Genders in Spring of Grade 1 and 2 Year (N = 261–385)

Measurements of reading and writing skills (N = 261-385)	Girls (n = 123-187)			Boys (n = 138-198)		
	n	mean	SD	n	mean	SD
Listening understanding (0–8 p.)						
Spring, grade 2	176	5.19	1.59	198	4.48	1.62
Technical literacy (0–80 p.)						
Spring, grade 1 (TL2A)	187	18.98	9.24	198	16.39	9.96
Spring, grade 2 (TL2B)	176	24.41	7.44	198	22.67	8.61
Reading comprehension (0–12 p.)						
Spring, grade 1 (Judo)	187	5.46	3.10	198	4.62	3.40
Spring, grade 2 (Gymnastics Guide)	176	8.59	2.79	198	7.51	3.04
Words dictation (0-5 p.)						
Spring, grade 2	176	4.37	1.06	198	3.92	1.31
Non-word dictation (0-8 p.)						
Spring, grade 1	187	5.48	2.11	198	4.12	2.63
Spring, grade 2	176	6.90	1.31	198	6.04	2.01
Productive writing						
Word count. spring, grade 2	123	69.23	21.64	138	52.14	28.48
Error count. spring, grade 2	123	0.23	0.24	138	0.36	0.54

Development of Reading Motivation

The differences in reading motivation were first examined by applying the Independent samples t-tests in order to compare the estimated means between the experimental group and control group (N = 374). The results showed that attitude towards reading and related tasks were significantly more positive in the experimental group ($|d| = -0.53$) than in the control group. The reading motivation was also significantly more task-oriented in the experimental group ($|d| = -0.45$) than in the control group. Comparing between genders, the girls had higher appreciation for the reading ($|d| = -0.22$) and writing ($|d| = -0.50$) assignments more frequently than the boys.

Then, different aspects of reading motivation were explored using Pearson product-moment correlations in the experimental group and control group (N = 374). It was found that the correlations between the variables of reading and writing motivation fluctuate between -0.27 – 0.58 and explain about 7.3–33.6 percent of the results. It was also observed that poor learner's self-concept had relation to the task-avoidant strategy and, respectively, strong learner's self-concept had association with task-orientated approach. Poor learner's self-concept and poor reading motivation were interrelated. Next, the reading motivation was examined by applying K-mean cluster analyses (see Table 7) and Chi-square test (see Table 8) methods to the data from spring of grade 2 year. The cluster analysis (see Table 7) allowed to derivate the following class centers for the reading motivation: 1) *Rather well motivated and having a rather good learner's self-concept*, 2) *Task-oriented and having a strong learner's self-concept*, 3) *Low-motivated and possessing a poor learner's self-concept*.

Table 7. Reading Motivation: Group Centers Derived by Applying K-means Cluster Analysis in Spring of Grade 2 Year (N = 374)

Measurements of reading and writing skills				
Group,	All data	Group 1	Group 2	Group 3
Spring, grade 2	(N = 374)	(n = 155)	(n = 150)	(n = 69)
Variables	mean (SD)	mean	mean	mean
Task specific evaluations (1-15 p.):				
Reading	11.13 (2.78)	10.72	13.39	7.10
Writing	10.57 (2.85)	9.92	13.05	6.67
Task strategies (0-1 p.):				
Task-avoidant strategy	0.25 (0.30)	0.27	0.19	0.31
Task-orientation	0.73 (0.43)	0.67	0.84	0.60
Learner's self-concept (1-10 p.):				
Reading and writing	4.19 (1.93)	4.12	3.75	5.29

Note:

Group 1 = Rather well motivated and having a rather good learner's self-concept

Group 2 = Task-oriented and having a strong learner's self-concept

Group 3 = Low motivated and possessing a poor learner's self-concept

In comparison between both groups, the results of Chi-square test (see Table 8) indicated that there was a significant difference in the aspect of group membership. Reading motivation was significantly "more task-oriented and the learners' self-concept was stronger" in the experimental group (67.6%, Adjusted res. = 3.4) than in the control group. In turn, "poor motivation and poor learner's self-concept" was admitted significantly more often (19.7%, Adjusted res. = 2.0) in the control group than in the experimental group.

Table 8. Reading Motivation Groups: Chi-square Test on Distribution between the learners in Spring of Grade 2 (N = 374)

Clustered groups				
Group	Group 1	Group 2	Group 3	In total
Spring, grade 2				
Experimental group (n)	9	23	2	34
%	26.5 %	67.6 %	5.9 %	100.0 %
Control group (n)	146	127	67	340
%	42.9 %	37.4 %	19.7 %	100.0 %
In total (N)	155	150	69	374
$\chi^2(2) = 12.297, p = 0.002, C = 0.178$				

Note:

Group 1 = Rather well motivated and having a rather good learner's self-concept

Group 2 = Task-oriented and having a strong learner's self-concept

Group 3 = Low motivated and possessing a poor learner's self-concept

Comparing between genders, Chi-square test results (see Table 9) revealed a noteworthy difference in favour of the girls. They were represented significantly more frequently (46.6 %, Adjusted res. = 2.4) among the learners in the group "Task-oriented and having a strong learner's self-concept". The boys formed a majority (24.2%, Adjusted res. = 3.1) in the group "Low motivated and having a poor learner's self-concept".

Table 9. Reading Motivation Groups: Chi-square Test Results on Distribution between the Girls and the Boys in Spring of Grade 2 (N = 374)

Clustered groups				
Group	Group 1	Group 2	Group 3	In total
Spring, grade 2				
Girls (n)	73	82	21	176
%	41.5 %	46.6 %	11.9 %	100.0 %
Boys (n)	82	68	48	198
%	41.4 %	34.3 %	24.2 %	99.9 %
In total (N)	155	150	69	374
$\chi^2(2) = 11.139, p = 0.004, C = 0.170$				

Note:

Group 1 = Rather well motivated and having a rather good learner's self-concept

Group 2 = Task-oriented and having a strong learner's self-concept

Group 3 = Low motivated and possessing a poor learner's self-concept

Development of Reading Motivation in Experimental Group

Examination was done in the experimental group (N = 34) to find out *how the reading motivation developed during the intervention*. Measurements were taken in spring of the first-grade year, autumn of the second grade and spring of the second-grade year. The results of Friedman two-way analysis of variance (see Table 10) indicated that, out of all measured aspects of reading motivation, highly significant difference was observed only between the measurements of literacy-related learner's self-concept.

During the period from the first-grade spring to the second-grade autumn, the learner's self-concept lowered by an average of 0.53 points. From the first-grade spring to the second-grade spring, the learner's self-concept deteriorated by an average of 0.97 points. In the learner's self-concept assignments, the lowest scores corresponded to the best results, unlike in the other measured aspects.

Table 10. Reading Motivation: Friedman Two-way Analysis of Variance in Spring of Grade 1 – Spring of Grade 2 (N = 34)

Measurements of reading motivation, N=34								
Measuring indicators	Spring, grade 1		Autumn, grade 2		Spring, grade 2		χ^2 (df = p)	2)
	mean	SD	mean	SD	mean	SD		
Variables								
Task-specific evaluations (1–15 p.):								
Reading	11.68	2.77	12.50	1.94	12.44	1.81	4.389	0.115
Writing	11.41	2.45	12.26	2.08	11.59	2.77	4.512	0.107
Task strategies (0–1 p.):								
Task-avoiding strategy	0.24	0.26	0.19	0.24	0.17	0.24	1.942	0.386
Task-orientation	0.91	0.26	0.91	0.29	0.90	0.30	0.421	0.909
Learner's self-concept (1–10 p.):								
Reading and writing	3.41	2.09	3.94	1.54	4.38	2.05	13.390	0.001

As shown on Figure 1, the data from spring of the first grade revealed a more negative learner's self-concept in the boys than in the girls. However, the data of the second grade demonstrated that the boys had more positive learner's self-concept than the girls. During the intervention, the learner's self-concept lowered in both genders, more in girls than in boys.

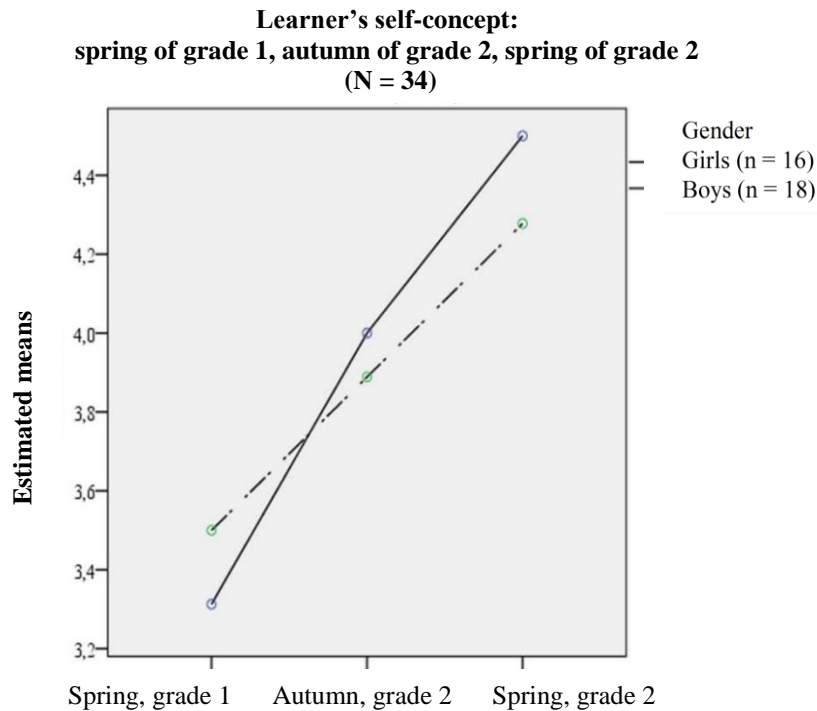


Figure 1. Development of the Learner's Self-concept in Spring of Grade 1 – Spring of Grade 2 between the Genders in the Experimental Group (N = 34)

Perception of RtW as a Useful Method

The third research question of this study analyzed *how useful RTW-method was considered* by the teachers and also from the perspective of learners with lower literacy. The data were collected from the study diaries kept by the teachers (N = 3), interviews carried out with the learners (f = 19) and video recordings made during the lessons (f = 6). *The analysis of the study diaries* revealed the teachers' perception of pair working as a form of learning that developed social skills and led to effective results in most cases. From the pupil's point of view, RtW method facilitated independent learning, increased motivation and encouraged creative writing. Application of this method also enabled versatile and functional forms of work, strengthened development of the learners' IT skills and improved differentiation of teaching. However, the teachers also indicated that use of RtW method was not problem-free: working in pairs did not always prove to be effective, the splitting into pairs was challenging, adoption of peer support work mechanism required practicing, children would compete for writing the longest text and there were technical problems with the use of equipment.

The analysis of the interviews with the learners showed that the children's attitude to reading and writing was mainly positive. The learners perceived writing on the computer as a beneficial way or writing in many aspects such as a simpler and easier way of writing, correction of errors, higher writing speed, better productivity potential, clean appearance, development of typing skills and other IT-related proficiency. Some children found handwriting to be particularly useful for writing longer texts while others indicated handwriting as a better way to learn reading and writing. Some interviewees felt that handwriting was more enjoyable than typing while others had an opposite opinion. The interviewed school children were unable to answer whether writing on a computer or the support received from the teacher helped increase their reading motivation.

The *video analysis* concluded that peaceful working atmosphere existed during the lessons, helping the learners show their enthusiasm for writing. Based on the videos, the children's word processing skills could be described as rather good, the teachers' guidance helped the learners while fulfilling the task independently. The completion of assignments always started after listening to the common topic and hearing instructions for the task. The children and their pairs would print the finished outputs independently or with the help of an adult outside the classroom. The learners would be motivated to write, and external distractions could not impede their performance. No differences were observed in the gender comparison of reading motivation.

Conclusion

Concluding Statements

The first research question asked *how the use of computer-assisted RtW was linked to development of reading and writing skills for the learners in grade 1 and grade 2 and whether any gender differences existed*. To find the answers, mapping was done by using non-word dictation assignments. The associated hypothesis #1 stating that *the reading and writing skills develop significantly better in the experimental group than in the control group*, was not supported by the results of analysis of covariance, because the non-word dictation writing skills of the experimental group did not develop significantly during the intervention, when the baseline test points and genders were standardized. The non-word dictation results of this study are partially supported by previous researches, which indicated that the use of the RtW method was not linked to improved reading and writing skills (Liberg, 2014; Lundqvist & Andersson, 2013; Takala, 2011).

The obtained non-word dictation results are partly determined by application and rather little use of RtW method in the experimental group. The method was applied to the experimental group more extensively during the first grade than during the second grade: RtW method was implemented on regular basis at a frequency of 1–2 full lessons per week (20–40 per cent of all lessons of the week) or every other week (10–20 per cent of all lessons of a two-weeks period) during the first-grade year. In the second grade, RtW method was applied every other week, with one full lesson per week (10 per cent of all lessons held during a two-weeks period). At other mother tongue lessons, the number of which amounted to 3–4 per week (60–80 per cent of all lessons of the week), KÄTS method developed by Karppi (1983, p. 86–91) was used instead. The actual effect of RtW method could be demonstrated better if it was applied more regularly in the experimental group of this study.

The significant amount of practice in phonological awareness, from the perspective of learning to read, is also small in this method. Insufficient practicing of phonological skills is likewise described in the previous studies (Takala, 2011, 2013), where teachers (N = 21) regarded hyphenation training and handwriting as important aspects of reading to read. The deficiency of these aspects was observed in RtW method, which therefore could not be considered as a sufficiently effective educational method for literacy. The research results obtained in the present study are also supported by the analysis of the qualitative data collected from the study diaries filled by the teachers (N = 3): two out of three teachers did not perceive the use of RtW method as essential for the development of learner's reading and writing skills.

The second research question asked *whether any differences existed in terms of reading motivation between the experimental group and the control group in spring of grade 2 and how did the reading motivation develop during intervention in learning process of the experimental group*. The results obtained on three reading motivation aspects did not support the associated hypothesis #2, which presumed that *the reading motivation of the experimental group developed significantly during the intervention*. Contrary to the hypothesis, the learner's self-concept of the experimental group lowered highly significantly during that time. The results of the present study were not supported by the findings of the previous research (Andersson & Gustafsson, 2013; Dahlberg & Petersson, 2016; Karlsson, 2015; Liberg, 2014; Takala, 2013; Tsouria Belaid & Tsouria Belaid, 2016), where RtW method was seen as a unique and learner-centred approach and the use of this method was stated to increase the learner's writing motivation.

Lowering of the learner's self-concept is partially explained by the relation of temporal and environmental factors to the reading motivation (Wang & Eccles, 2013; Wigfield & Eccles, 2000). Reading motivation is interactively linked with 1) the teacher's values, goals and attitudes, 2) the learner's individual psychological factors, 3) the learner's academic performance, 4) the learner's social relationships, and 5) support the learner receives at home (Turunen, 2018, p. 33–34). Feedback from the environment (Bandura, 1986, 1997; Nurmi & Aunola, 2005) is related to the individual's self-efficacy beliefs and experiences of trying (Pajares, 2009). Decline of learner's self-concept in the experimental group may be caused by the fact that, with development of skills over time, the environment's expectations for the learner's knowledge also increased. On the other hand, poor self-concept of the learners can also be regarded as an ethical challenge from the teacher's point of view, because, according to Poikkeus, Lerkkanen and Rasku-Puttonen (2011), the children's learning motivation, academic progress and social skills are related to the guidance practices applied by the teacher and quality of teacher-learner interaction. Child-centred guidance practices support increase of the learner's reading motivation (Lerkkanen et al., 2012) and literacy growth (Lepola, Salonen & Vauras, 2000; Lerkkanen et al., 2016).

The third research question of this article explored *to what extent RtW method was perceived as useful*. The answer was sought by mapping the experiences of teachers and those children who had lower levels of reading

and writing skills. Also, analysis of the study diaries led to an observation that the teachers' experiences tended to vary, but good experiences were in line with a number of previous studies (Andersson & Gustafsson, 2013; Karlsson, 2015; Takala, 2011, 2013; Tsouria Belaid & Tsouria Belaid, 2016). The results of the interview analysis showed that there were opinions for and against the use of computers for writing. These findings were partially supported by previous studies (Connelly, Gee & Walsh, 2007; Crook & Bennett, 2007), which stated that computer-based writing did not replace handwriting fluency. On the other hand, the video analysis of the present study revealed that the learners had a good motivation for use of computer for writing, because the lessons were held in peaceful atmosphere and most of the learners stayed focused while writing. No differences were found in the gender comparison, even though, based on the previous research, higher task-orientation and self-direction (van der Aalsvoort, Lepola, Overtom & Laitinen, 2015; Meece & Painter, 2009), and more positive attitude towards reading and writing (Hadjar, Krolak-Schwerdt, Priem & Glock, 2014; Lepola, 2004; Lerkkanen et al., 2010; Merisuo-Storm & Soininen, 2013) might have been possible in girls than in boys.

RtW method has been insufficiently researched until now, especially there is a lack of longer-term follow-up on this topic (Andersson & Gustafsson, 2013, p. 20; Karlsson, 2015, p. 25; Takala, 2011, p. 79; 2013, p. 22; Tyrén, 2013, p. 45–47). The present study has shown that computer-assisted use of RtW method may complement the process of learning to read and write, although it did not significantly strengthen the phonological awareness skills of children in grades 1 and 2, nor increased the reading motivation in learners of the experimental group. Phonological skills should be trained using a more targeted and regular approach than the current method, to enable the technical literacy (Gough & Tunmer, 1986; Hoover & Gough, 1990) rise.

Regarding the teaching of reading, the results of this study provide a contribution to national and international research on computer-assisted teaching, because with the evolution of digitalization, computer-assisted teaching and smart devices are here to stay in schools. The benefit from using computers or other digital writing devices and their importance to growth of literacy or reading motivation have not been clearly shown for now, despite the extensive research done on the subject and the promising results obtained so far (Blok et al., 2002; van Daal & Reitsma, 2000; Folkesson & Swalander, 2007, 2010; Foster et al., 1994; Genlott & Grönlund, 2013; Heikkilä et al., 2013; Hultin & Westman, 2013a, 2013b, 2015; Magnan & Ecalle, 2006; Nicolson et al., 2000; Regtvoort & van der Leij, 2007; Richardson & Lyytinen, 2014; Saine et al., 2010, 2011). A targeted practice of handwriting is still necessary for children to learn reading and writing (Connelly et al., 2007; Crook & Bennett, 2007), although meaningful use of information technology plays an important role in creating learner-centred teaching environment (Norrena, Kankaanranta & Nieminen, 2011, 79–84).

It would be useful to explore relations between the use of RtW method and literacy and reading motivation by carrying out a longitudinal study on teaching the children from pre-school to the third grade, because such study could provide more generalized information. A longer-term follow-up research on RtW method based learner-centered teaching and its relation to reading motivation would also be necessary, as it has been stated that child-centered teaching and learning methods enhance development and maintenance of positive learning motivation (Hamre & Pianta, 2005; Stipek et al., 1998), and also support the raise of reading motivation (Lerkkanen et al., 2012) and improvement of reading skills in novice readers (Lepola et al., 2000; Lerkkanen et al., 2016).

Limitations

The results of this study would be more generalized, if the baseline situation of the experimental group and the control group were known before the intervention began in all aspects of literacy and reading motivation. The data collected in the control group placed some limitations on group comparison, as they did not involve all aspects of literacy and reading motivation: the control group data either were not available or, if provided, did not enable longitudinal comparisons because the measuring indicators for the same aspects were different.

The theoretical background of this research also somewhat reduces the reliability and generalizability of this study, because there has been relatively little scientific research on RtW method until now and some of the previous studies were reports or university thesis. Thus, the current work has a character of a pilot study and its results are therefore preliminary.

Notes

This article is partly based on Inka Turunen's doctoral dissertation defended at University of Eastern Finland on 18 December 2018. Her doctoral thesis is printed in *Publications of the University of Eastern Finland*

Dissertations in Education, Humanities, and Theology (128). The supervisors of the doctoral dissertation were Pertti Väisänen, EdD, Professor of Education, and Martti Siekkinen, EdD, Senior University Lecturer. The opponent was Marjatta Takala, PhD, Professor of Special Education. Inka Turunen, author of this article, has 15 years of pedagogical experience in teaching reading to children. She is a primary school special education teacher for grades 0–6 and takes part in pedagogical planning at a recently established school in Kuopio, Finland.

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