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Even in the 21st century, the need of support in literacy acquisition around the world remains huge. Data presented in a UNESCO-commissioned report (Education for All, 2014) estimates that 250 million children worldwide need reading support, with the largest number of countries in need located in Sub-Saharan Africa. Having poor reading skills is a huge problem for the individuals themselves as well as their societies. In today’s information societies, the majority of learning materials are mediated via written text. Thus, literacy is vital for individuals’ quality of life, their educations, career choices, and thus to the world economy and the development of democracy.

In all societies and in all age groups, the implications of poor reading skills are both personal and societal. Yet although the outcome (poor reading skills) is the same, the root causes are varied and complex. Research has shown convincingly that deficiencies in reading skills run in families (e.g., Wood & Grigorenko, 2001). This means that many, if not the majority, of individuals with serious difficulty in acquiring fluent reading skills (i.e., people with dyslexia) have genetic foundations to their vulnerability toward a deficit in reading and spelling skills. Around the world up to 15% of people suffer from this genetic reading difficulty (e.g., Shaywitz & Shaywitz, 2003). Furthermore, many individuals fail to learn to read as the result of environmental factors: no access to schools, inadequate instruction, and/or limited or no access to reading materials. These are specific problems facing developing countries. Yet no matter the root of reading difficulties, in most cases, targeted intervention, supported with learning technologies, can improve the level of reading skill over time.

The foundation for understanding the learning process for reading has its roots in Finnish research that began in the early 1990s at the University of Jyväskylä (JYU), in collaboration between the university’s Department of Psychology and the Niilo Mäki Institute (NMI). The initial research involved the study of children with familial risk for dyslexia. The JYU researchers followed 100 children with the familial risk from birth to puberty and compared their research findings against a similar number of children without such risk. The results of...
the Jyväskylä Longitudinal Study of Dyslexia (see Lyytinen et al., 2008; Torppa, Lyytinen, Erskine, Eklund, & Lyytinen, 2010) for more recent reviews of this research) showed that children who faced reading problems in first grade could be identified years earlier. The outcome of this conclusion was the initial and ongoing development of preventative support for these young readers. The goal of such support was that these at-risk children would be less likely to face learning difficulties in school—challenges that may affect not only their motivation to learn but also their perceptions of themselves as learners.

With financial support of Finland’s Ministry of Education in 2007 and the expertise of researchers at NMI, the JYU researchers began to develop a technology to be provided to all Finnish children in need of support in acquiring literacy, no matter what the root cause. The output of this focus was a Finnish-language game-based learning environment called Ekapeli. Over time, as the JYU researchers began collaborating with researchers at other universities and in regard to other languages, the learning environment became known as GraphoGame.7

From the very beginning, we researchers fully understood that children with dyslexia faced quite severe difficulties to overcome, difficulties that required persistent training toward success. Therefore, a game-like format made the learning process an enjoyable experience for most students. A game environment is instrumental in keeping learners interested in remaining engaged in the needed training over a long period. In many cases, the young learners needed support to address any or all reading challenges: for example, decoding skills (i.e., skill to sound out letter sequences), word identification, and sufficient fluency to remember the beginning of a long sentence when reaching its end.

Although the initial intent of the language learning environment was to support and train children with specific reading/language issues, over time it became clear that the technology also could document and support all children in the process of developing reading skills. These very same basic steps of learning must be followed by anyone who wants to learn to read, that is, whether the reader is a typical or atypical learner. Only the time needed to reach the goal differs. In following how children developed reading skills through this learning environment, we researchers came to realize that this Grapholearning environment, with its research-based acquisition regiment as currently formulated using phonics, provided teachers and others involved in a reading skills intervention with access to the optimal integration of reading/language training and assessment. The opportunity to observe dynamic assessments of struggling readers provided a window through which the trainers could identify whatever bottleneck might be challenging or frustrating the learner. From the research perspective, being able to observe and identify roadblocks to learning—such as the compromised perceptual differentiation of acoustically similar phonemes—allowed for the continued development of supportive tools or training for overcoming or bypassing the difficulties faced by the learner. Eventually, the effort to address these difficulties opened avenues for guiding learners to grasp the basic principles of reading skills even before problems surfaced.

As a result, the Grapholearning technology has expanded its application and assistance to any individual working toward reading competency. In developing countries, in particular, many typical learners need support to gain reading skills. Thus, research into new cultures, new languages, and new applications continues to expand and refine the Grapholearning technology. At this time, researchers in more than 20 countries are applying the technology and analyzing outcomes of focused research in almost as many languages. In this special issue of Human Technology: An Interdisciplinary Journal on Humans in ICT Environments,
the first of two, we focus on how the GraphoGame technology is supporting typical reading learners in Africa, where children are in urgent need of literacy support.

The papers we have chosen for this first issue provide the context and background of the GraphoGame technology, with some focus on the Zambian educational and home environments. This issue includes three original papers. The authors of the first paper explore the family environment as a support for reading acquisition by first-grade Zambian students. Tamara Chansa-Kabali and Jari Westerholm’s paper adds to the growing evidence that the family environment, particularly the parents’ attitudes toward and encouragement for reading, significantly impacts a young reader’s ability to grasp two key foundations for reading: orthographic awareness and decoding competence. Robert Serpell, who for many decades has worked with the historical and current challenges of language learning in Zambia, writes about the progress of the country in addressing literacy within a multilingual environment. In particular, he demonstrates how a collaboration between JYU and the University of Zambia, through the auspices of the Centre for the Promotion of Literacy in Sub-Saharan Africa (CAPOLSA), has enhanced the research efforts and educational interventions in reading acquisition by Zambian children. Finally, Ulla Richardson and Heikki Lyytinen provide an overview of the GraphoGame technology, the principles behind the GraphoGame method, and the impact of training with GraphoGame. This issue also includes a commentary by Heikki Lyytinen regarding one technological means to assure reading skills support for all young learners.

Because literacy is tied so closely to ongoing social and economic development, it is essential that quality research is conducted and disseminated in a systematic way. The research presented in this issue, and the upcoming special issue on a similar topic, demonstrates the importance of well-researched interventions for the benefit not only of the individual learners but also their extended families and communities. The next special issue on Grapholearning is planned for 2015. In that compendium, the focus will rest more specifically on the empirical validation studies of the GraphoGame-based training not only in Zambia but also in other African countries, such as Kenya and Tanzania.

ENDNOTES

1. The Niilo Mäki Institute is a third sector research unit funded by the Niilo Mäki Foundation, whose goal is to support children with learning difficulties. For more information, consult www.nmi.fi

2. Information on the GraphoGame is available at www.graphogame.com

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THE ROLE OF FAMILY ON PATHWAYS TO ACQUIRING EARLY READING SKILLS IN LUSAKA’S LOW-INCOME COMMUNITIES

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Abstract: This paper reports findings from the study that examined the role of family in children’s acquisition of early reading skills. We recruited 72 first-grade learners and their parents from low-income Zambian families for the study. In response to a home literacy questionnaire, parents reported on their reading attitudes and family literacy environment. Children’s early reading skills were assessed using two early reading tests (orthographic awareness and decoding competence), both conducted at two different points during the year. Regression analyses of pretest and gain scores revealed that parental reading attitude and family literacy environment significantly predicted early reading skills. These findings suggest that the family is an important element in the children’s process of learning to read. Implications of the findings are discussed.

Keywords: parental reading attitude, early reading skills, family literacy environment, low-income families, Zambia.

INTRODUCTION

This study focused on the role of family in children’s acquisition of early reading skills. Research indicates that the formal learning process of reading starts only when children enter the first grade (Reese & Gallimore, 2000). This is demonstrated in how the Latino parents in Reese and Gallimore’s study conceptualized reading as something that is learned through repeated practice in formal schooling when children are 5 or 6 years of age. However, evidence demonstrates that this process starts long before the child enters school (Cunningham & Stanovich, 1993; Leseman & de Jong, 1998; Storch & Whitehurst, 2001; van Steensel, 2006; Weigel, Martin, & Bennett, 2006; Whitehurst & Lonigan, 1998; 2001). Several researchers have illustrated how family factors play a key role in the acquisition of reading skills in young children. Apart from being the earliest environment in which children gain access to written material, the family provides children with initial socialization into the literate world (Dickinson © 2014 Tamara Chansa-Kabali and Jari Westerholm, and the Agora Center, University of Jyväskylä
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Although the home literacy environment has been defined using broader socioeconomic conditions, research indicates that parent–child interactions affect the transfer of skills from parents to children as they socialize within their families (McBride-Chang, Chow, & Tong, 2010). Consequently, the number of interactions, their effectiveness, and the efficiency of the skill transfer are dependent on the parents’ knowledge, attitudes, expectations, and availability.

In the formal process of learning to read, decoding is a paramount skill. Despite its importance, most first graders in Zambia do not achieve the mastery of reading skills by the end of that year, and similar challenges have been recorded for pupils in upper primary classes (Hungi et al., 2010). In the search for a comprehensive understanding of reading acquisition, researchers have attributed both family and school factors as key contributors to the success rates of the mastery of reading skills among children (Calfee, 1997; Howie, 2010; Serpell, Baker, & Sonnenschen, 2005). However, these contexts (school and home) are not without challenges. In schools, challenges include poorly resourced infrastructures, inadequate reading materials, large class sizes, and low teacher motivation. In the family, the lack of children’s books and parents’ level of education, employment status, and reading attitudes can compromise reading attainment. Children experiencing both limited literacy interactions at home and under-resourced learning environments in schools are likely to be profoundly challenged in their learning-to-read process. Since the family is an important context for human development, the aim of this study was focused on the role of family in the reading development of first-grade children in relatively low-income communities in Zambia.

Bronfenbrenner’s (1979) ecological theory of human development was employed in this study through an exploration of children’s early environments: the home (microsystem) and the school (mesosystem). This theory addresses a totality of aspects that children experience in these environments. According to Bronfenbrenner and Morris (1998), individual life experiences, not only in childhood, are a function of who we are, what we anticipate to be, what we do and anticipate doing, and with whom we interact, have interacted, and anticipate interacting. Process, person, context, and time are interacting elements in the environment that facilitate development. Process encompasses forms of interaction between the individual and the environment (objects and symbols), called proximal processes. These processes operate over time and are posited as the primary mechanisms to advance human development. Nevertheless, the power of such processes to influence development varies substantially as a function of the characteristics of the developing person, of the immediate and remote environmental contexts, and of the time periods in which the proximal processes take place (Bronfenbrenner & Morris, 1998). These experiences underscore the interrelatedness of people and their physical, emotional, and cognitive behaviors as they occur in relation to specific environmental contexts. Embedding the study in this framework signifies the important connection and interrelatedness between the child and his/her social environment and the interaction between them. These aspects, taken together, produce both constancy and change in the characteristics of the person over his/her life course. As a context that hosts factors that support reading development, this study explored the home environment. In addition, because reading is a mechanism through which children come to understand their environments, this study aims at identifying family factors that affect children’s orthographic awareness and decoding competence, which are skills pertinent to reading development. To achieve this aim, the study was guided by the question, “What family factors significantly explain variation in children’s early reading skills?”
METHODOLOGY

This research utilized a mixed method (quantitative and qualitative) design in exploring the home environment to envisage an understanding of factors important to children’s reading acquisition in Zambia. The weight of the design was mainly on the quantitative methods, with the qualitative paradigm offering a supportive role (Creswell, 2009).

This study was part of the larger project called Reading Support for Zambian Children (RESUZ) and was conducted in Lusaka, Zambia’s capital city. The city has a population of slightly over two million with an average household size of 5.2 people (Central Statistics Office, 2010). Important to note is that many families host extended family members that increase the household size. Zambia’s educational system is divided into primary (Grades 1–7), secondary (Grades 8–12), and tertiary levels. Children throughout the country begin their education at age 7, most often taught in one of seven local languages from Grade 1 through Grade 4, with English introduced as a subject in Grade 2 and used as the language of instruction from Grade 5 onwards (Use of Local Languages, 2013). In Lusaka, the local language is called ciNyanja.

Subjects

Child participants comprised 72 learners who were randomly selected from nine schools in Lusaka. The parent participants, which at times included aunts or grandparents who provided primary care to the child, were recruited automatically in connection with their child’s inclusion in the study. These parents were aged between 25 and 61 years old ($M = 35.67$, $SD = 6.65$). The study was designed in a way that the sample of parents would represent at least 10% of the total number of child participants of the RESUZ project, and this was achieved. Initially, we selected 80 parents whose children are in nine out of 42 schools that participate in the RESUZ project. Although random sampling was conducted for school selection in the overall project, purposive sampling was desired for this study because the goal was to reach children in diverse communities. From the 80 parents who were contacted, 72 reported to be available and were recruited as participants for the study. Typically, each of the 72 children represented one family. There were no cases of more than one child in a classroom representing a family or parent. Although both parents were aware of the study, only the available parent, typically mother, consented to participate in the study at the time of data collection. This consent was given orally or in written form. It is important to note here that the typical respondents to the questionnaire were mothers because they were easily accessible and available. In addition, mothers were more likely participants because a substantial number of families were single-parent (mother) households. In the very few cases where both parents were available, fathers preferred that the mothers respond because the mothers were with the child most of the time.

Consent for children’s participation in the study was done through the schools. First, the research received approval from the Zambian Ministry of Education and, before research commenced, ethical clearance was received from the University of Zambia Ethics Committee as approval of the research. Using the inclusion criteria supplied by the researchers, teachers were able to identify in their classrooms the children who were eligible to participate in the study. After random selection, children who were above the stipulated age of 9 years or presented health problems were excluded. Parents were informed that their child was recruited for the study, and none of the 72 parents objected or withdrew their child from
participation. The sample of learners for this study comprised 32 boys (45%) and 40 girls (55%), with a mean age of 7.15 years ($SD = .62$).

Descriptive results on the characteristics of the families obtained from the Home Literacy Questionnaire revealed that all families were from the low-income bracket as assessed by parental education and occupation. From these results, 85% of the mothers and 57% of the fathers had attained no more than 9 years of education. In terms of employment, 40% of the mothers were stay-at-home mothers; 60% were engaged in income-generating activities, often in the service industry (e.g., maids, cooks, waiters). Of the fathers, 72% were engaged in income-generating activities in the service industry (e.g., janitors, bus conductors, shopkeepers, fuel attendants), administration (e.g., office clerks), or the trades (e.g., electricians, welders, carpenters, construction workers). The marital statuses of the parents in the study are recorded as follows: married and living together, 69.4%; single, 11.1%; divorced, 8.3%; and widowed, 11.1%.

**Measures for Reading Skills**

Two measures were employed to assess the children’s reading skills. All procedures in the assessments of these measures were conducted in ciNyanja, the language of reading instruction and one of the seven local languages approved by the Ministry of Education for use in Zambian schools. The instructions for assessment, as well as the measures, were translated from English to ciNyanja by a specialist from the Ministry of Education’s Curriculum Development ciNyanja the RESUZ team. This process included back-and-forth translation of the materials from English to ciNyanja and from ciNyanja to English until consensus was achieved. All children reported familiarity with ciNyanja and there was no record of any child who did not understand the language.

The Orthographic Awareness Test was developed in 2010 by the RESUZ research team, based on pilot work with Zambian children led by Ojanen (2007). Test items comprise letters, syllables, and simple words in the ciNyanja writing system, as well as non-ciNyanja letters, syllables, and words, which served as distractors. This measure served as a letter, syllable, and word recognition test. Children were asked to choose items that would help them to read. It was entirely up to the child to choose these letters, syllables and words in the presence of distracting, nonconventional letters and characters. This test achieved a moderate test–retest reliability, $r = .67$ ($N = 22$).

The Decoding Competence Test was developed originally by Ojanen’s research team based on their aforementioned pilot work and modified in 2010 by the RESUZ research team. The test comprised letter–sounds, syllables, and simple words in the ciNyanja writing system. Children were asked to match the sound that they heard to the corresponding letter, syllable, or word that was on the paper. The purpose of the test was to measure the child’s ability in spelling. This test showed a high test–retest reliability, $r = .86$ ($N = 22$).

**Measures for the Family Literacy Environment**

A structured questionnaire was used to quantitatively assess the family and reading environments of this study. Specifically, the questionnaire explored aspects of parent academic achievement, family economic condition, literacy activities, and the availability of reading materials. The parental reading attitude (PRA) of the 72 mothers (or adult caregiver) was assessed through the Home Literacy Questionnaire (HLQ), with some items adopted from the Progress in International
Acquiring Reading Skills in Low-income Families

Reading Literacy Studies (PIRLS) Questionnaire (Mullis, Martin, Kennedy, & Foy, 2007). The PIRLS PRA measure had seven items, measured on a 5-point Likert scale, with a reliability of .81. The PRA measure in this study comprised 10 items, similarly measured on a 5-point Likert scale and reported a high internal consistency, $\alpha = .94$ ($N = 72$). Parents indicated how much they agreed with the statements. The scale ranged from 1 (strongly disagree) to 5 (strongly agree), with reverse coding applied to negative statements. Lower scores indicate less favorable reading attitudes. The individual scores from each parent’s responses to the 10 items were added together to create that parent’s aggregate score for the index. The measure included statements such as “I spend my spare time reading,” “I talk about what I read,” and reverse-coded negative statements such as “I find reading boring,” “I find reading difficulty,” and “I read only when I have to.”

The same HLQ was used to assess socioeconomic (SES) aspects of the family literacy environment (FLE), inquiring about parental education and occupation, family possessions, reading materials, and literacy activities. Parents indicated their highest completed education level from the following scale: 1 (no formal schooling), 2 (primary), 3 (junior secondary), 4 (senior secondary), and 5 (college or higher). Occupation was on a scale representing 1 (no occupation), 2 (nonskilled), 3 (semiskilled), 4 (skilled), and 5 (professional).

Additionally, the HLQ measured the frequency or presence of several specific items within the household. To assess family possessions, parents indicated whether their household had a television, electricity, running water, a flushable toilet, a stove, or a car. Parents also were queried about the quantities of specific types of reading materials (e.g., children’s books) that the family possessed. Finally, the literacy measures encompassed presence and frequency of exposure to print, oral language, and reading and writing activities. The frequencies of components in the household environment were on an ordinal scale and measured on a four- ($1 = \text{once a month}$ to $4 = \text{daily}$) or five-point ($1 = \text{not at all}$ to $5 = \text{daily}$) Likert scale. Items on this measure reported a high internal consistency, $\alpha = .91$ ($N = 72$). The 4-point Likert scale was preceded by a Yes or No question; the 5-point scale was a stand-alone question. In essence, the 4-point scale was treated as a 5-point scale with the addition of the preceded Yes or No question. In the composition of the family literacy environment composite score for each family, global constructs of the family environment were identified (i.e., parental education, occupation, and possessions formed the SES measure; presence of reading materials data formed the Reading Materials measure; and literacy activities formed the Family Literacy Activities measure). The use of the global constructs was desired for gathering items that belonged together within one construct. Then these constructs were correlated in order to determine their association before they were aggregated to form one measure—the Family Literacy Environment. Correlations revealed that the global constructs strongly correlated with each other (SES with Literacy Activities and Reading Materials, $r = .64$ and $r = .52$, respectively; Reading Materials with Literacy Activities, $r = .46$), all significant to $p < .001$.

To further explore the families’ everyday experiences with literacy, qualitative research was employed. Semistructured interviews were conducted with only those parents ($n = 12$; all mothers) whose children had ceiling or floor baseline scores on the reading tests. Questions that guided the interview were related to daily family routines, with the purpose of examining differences that exist in the children’s literacy experiences. The decision to include the qualitative paradigm was motivated by three key desires: (a) to increase validation of our conceptualizing the home literacy environment, (b) to understand more fully the daily literacy routines of high- and low-achieving child readers, and (c) to facilitate discussing the quantitative findings. All data were coded by the
first author and a postgraduate trainee, and reported a 90% inter-rater agreement. In all cases of disagreement, consensus was reached after re-examining the original data.

**Testing Procedure**

The team that assessed reading skills comprised the RESUZ project leaders (doctoral students) and 12 undergraduate psychology- and education-major students as research assistants. The research assistants were trained over a 3-day period that included a pilot testing of the measures in a comparable school. We assessed the children’s reading skills by testing orthographic awareness and decoding competence. These tests were conducted individually with each child at his/her school and the testing time was typically 20 to 30 minutes. The children’s reading assessments were conducted on two occasions: The pretest (Time I) in the second term, followed by the posttest (Time II) in the third term of the same school year, with an intervention between the collection times. This intervention involved children playing a literacy game (GraphoGame), developed in Finland, for learning letter–sound correspondences.

For the Orthographic Awareness Test, the child was introduced to the session that they were going to talk about learning to read. This reading was centered at the child recognizing the conventional and nonconventional, letters, syllables and words. With the assistance of the assessor, the child worked through two sets of sample items for each stage (Stage 1–letters, Stage 2–syllables, and Stage 3–words) to identify the correct and incorrect letters, syllables and words when learning to read. The child then independently completed a 3-minute session of the actual test without assistance. The child was asked to underline the correct responses, and was awarded one point for every correct response and minus one for incorrect responses. The test had an objective scoring system ranging from -54 to 54.

The Decoding Competence Test was administered without a time limit. After two sample items, the assessor dictated 20 items, which included 5 letters, 5 syllables, and 10 words. This process was done one by one, repeating each item three times, more if the child requested. The child was presented with four options and was required to underline the letter, syllable, or word that corresponded with the spoken item. The test scoring ranged from 0–20, with the child receiving 1 point for every correct response and nothing for incorrect responses.

For the home environment assessment, home visits were scheduled with each parent, with the help of the child’s teacher. The first author of this paper and four of the RESUZ-trained research assistants participated in the data collection. The research assistants were trained by the first author on collecting data with families. Administration of the questionnaire in which the PRA and the FLE data were collected lasted 35 to 45 minutes. The questionnaire was structured and the assessors followed an interview process in which the assessor read aloud the statements and recorded the responses. These interviews were conducted in the parents’ preferred language. The language preference was determined at the time the assessors called each parent to introduce the research, confirm the parent’s willingness to participate, and obtain the schedules and directions for the home visit. This was done so that if the assessor’s competence in the parent’s language was not good, then another assessor, competent in that language, would collect the data instead. We had no cases in which the assessor was not competent in the preferred language. Although the language was determined during the phone conversations, the competent use of a language on the parent’s part was addressed before the
Further, a qualitative exploration of the day-to-day experiences with literacy was scheduled with a few parents. This selection was based on children’s pretest results on both the reading measures. These in-depth interviews were scheduled and conducted separately from and after the HLQ administration. These interviews were conducted by the first author of this paper and typically lasted from 45 to 90 minutes. Similarly, the language of use for the in-depth interviews was predominantly ciNyanja, with only one case of iciBemba. IciBemba is the language of reading instruction in the Northern Province of Zambia. The interviewer was competent in iciBemba and the code switching was between iciBemba and English for both the interviewer and interviewee. The 14-question interview explored the children’s typical day, parental educational goals, and literacy experiences of the family and children. These foundational questions often resulted in follow-up probes to clarify and obtain further information on particular and/or interesting aspects relevant to the study.

**DATA ANALYSIS**

Statistical analyses were computed using the Statistical Package for the Social Sciences software (SPSS 19.0). To show associations among the variables, Spearman’s Nonparametric Correlation Test was used for all the variables. The correlations were basically employed to determine the associations of the variables forming the predictor indices (PRA and FLE). This was necessary to establish their shared variance in the aggregated index. Similarly, associations between the predictors and outcome variables were performed in the correlation analyses. In addition, hierarchical regression analysis was employed to examine the influence of family variables.

Data from the qualitative inquiry were first transcribed by the first author of this paper in the language(s) in which the interviews were conducted and were later translated to English. Codes for identification were given to the children, and the parents were also identified by the child’s code with an addition of \( p \) to indicate the parent’s data. These codes identified the child by sex, school, classroom, and a unique number. To this code, LA (low achieving) or HA (high achieving) were added. Although names were used in the actual interview, these were replaced in the transcriptions: For example, instead of the child’s name, the phrase *your child* was used to uphold the anonymity that was guaranteed in the beginning of the interview. The analysis of this inquiry followed the pattern of thematic analysis. Themes were derived from the maternal narratives regarding daily routines that were then categorized into broader themes that reflected the literacy experiences in the families. For each interview, the recurrent themes, concepts, or activities mentioned by the mothers of the high and low achievers were identified.

The qualitative data offers support for discussing quantitative findings. As such, the analysis presents only important highlights from the interviews.

For all of the data and their analyses, the focus was on the effect of family variables on pretest and posttest results (i.e., gain scores, obtained by subtracting the baseline pretest scores from the post test scores). It must be noted here that hierarchical regression analyses for the gain presents a reduced sample size of 58 child participants. The reduced sample size was necessitated by the children’s absenteeism at the time when post tests were administered.
Analyses of other data (i.e., the role of the intervention in children’s reading gains, or the nature of the learning skills explicitly) are outside the scope of this paper.

**Bivariate Correlations**

Data for the predictors were ordinal in nature and, as such, the Spearman Rho’s Nonparametric Test for correlations was appropriate. After computing the bivariate associations among the predictor and outcome variables, results revealed significant correlations, \( p < .01 \). Table 1 presents the descriptive statistics and bivariate correlations.

**Regression Analyses**

Hierarchical regression analyses were computed to determine the impact of family variables on the reading skills baseline and gain scores. The variables were entered into the regression, starting with PRA and then the FLE index. Due to some biases associated with strong correlations among predictors (Field, 2013), the multicollinearity of the two variables of the home data was explicitly examined. Based on the Variance Inflation Factor (VIF) the assumption of multicollinearity was not violated. However, these home variables are correlated in moderation, thus showing some shared variance.

Results for the pretest in Table 2 showed that when PRA was put in the analyses as the only predictor, it significantly explained 40% variance, \( F(2, 69) = 48.80, p < .001 \). In Model 2, the FLE was added, and it significantly explained 12%, \( F(2, 69) = 16.88, p < .001 \). For the gain scores, PRA alone significantly explained 17% of the variation, \( F(2, 58) = 12.80, p < .001 \) while adding FLE in the second model resulted in explaining a significant effect of 6%, \( F(2, 58) = 4.48, p < .05 \).

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<td>.36**</td>
<td>.28*</td>
<td>.37**</td>
<td>1</td>
</tr>
<tr>
<td>M</td>
<td>28.65</td>
<td>63.07</td>
<td>16.80</td>
<td>8.36</td>
<td>3.71</td>
<td>2.70</td>
</tr>
<tr>
<td>SD</td>
<td>12.59</td>
<td>27.92</td>
<td>7.43</td>
<td>3.53</td>
<td>6.70</td>
<td>5.13</td>
</tr>
</tbody>
</table>

*Note. *\( p < .05 \); **\( p < .01 \); ***\( p < .001 \).*
Pretest results for decoding competence presented in Table 3 show that PRA significantly explained 32% of the variation, $F(2, 69) = 34.70, p < .001$, and when FLE was added, it additionally explained 11%, $F(2, 69) = 13.75, p < .001$. For the gain scores, PRA significantly explained 9%, $F(2, 58) = 6.90, p < .01$; with the FLE data added, there was a significant effect of 8%, $F(2, 58) = 5.79, p < .05$.

### Thematic Analysis

One concept that emerged quite significantly from the analysis of parental narratives was that parents were more concerned with education as catalyst for enhancing their children’s lifestyle regardless of the child’s performance (low or high achieving). As such, all academic activities were encouraged, fostered, and supported in the home. Parents perceive formal education as the channel through which their children can alter their future living conditions for the better. Successful completion of formal education allows for a better lifestyle for the child and his/her family. With this conceptualization, reading activities were encouraged and fostered because reading was seen as the foundational skill for school success. This is clearly evident in this extract from a parental narrative, in response to the question, “Why do you encourage your child to read?”

*Often my daughter asks me, “Mommy, why can we not shift [move] and go to live in a nice house? This house is not nice.” So I tell her that, “When you go to school and complete your studies, we will move. You, yourself, will make us shift from here to go to a better house.” I tell her that, “You cannot be able to complete your studies if you cannot read. So you need to know how to read for you to complete your studies, and then you will make us shift to a better house.” (Parent of a female high-achieving learner)*

Therefore, the approach to learning to read from this perspective seems to produce a chain reaction that not only helps in other studies but also improves the lifestyle of the household after completion. Thus, the key motivator for the parents in encouraging their children to read appears to be economic in nature. Although all parents were inclined to mention the economic benefits of education, mothers of the high-achieving learners were seen to involve their children in extra literacy-enhancing activities. These parents encouraged their children to attend to school work even in the absence of teacher-mediated homework. Hence, the parents of high-achieving learners reported additional literacy experiences in the absence of classroom homework. These mothers also reported encouraging their children to participate in reciting poems, memorizing Bible verses, and retelling stories learned from television. Specifically, one parent mentioned that she would pretend not to understand a film showing on the television and ask the child to retell it to her. A couple of parents of the high achievers indicated that they pretend to their children that they do not know things because they are not educated; they tell their child that they depend on the education of the child to help them learn. With this motivation, children shared what they learned from school with their parents. Other aspects of differences between low and high achievers were that the high achievers possessed more reading-enhancing materials than the ordinary books (e.g., alphabet books and charts). Similarly, the parents of high achieving students seemed to explicitly know how to engage in literacy-enhancing activities at home. Mothers of high-achieving learners took their children’s literacy learning, in part, as a responsibility of the family. For them, school is seen as a driving force that needed the support of the family.
Table 2. Hierarchical Regression Analyses of Family Variables Predicting Orthographic Awareness at Time I and Time II.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Time I (Pretest), N = 72</th>
<th></th>
<th>Time II (Gain Scores), N = 58</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b</td>
<td>SE b</td>
<td>β</td>
<td>R</td>
</tr>
<tr>
<td>Model 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>5.98</td>
<td>1.69</td>
<td>.64</td>
<td>.41</td>
</tr>
<tr>
<td>Parental Reading Attitude</td>
<td>.38</td>
<td>.05</td>
<td>.64</td>
<td>***</td>
</tr>
<tr>
<td>Model 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>2.07</td>
<td>1.80</td>
<td>.73</td>
<td>.53</td>
</tr>
<tr>
<td>Parental Reading Attitude</td>
<td>.30</td>
<td>.05</td>
<td>.51</td>
<td>***</td>
</tr>
<tr>
<td>Family Literacy Environment</td>
<td>.10</td>
<td>.02</td>
<td>.36</td>
<td>***</td>
</tr>
</tbody>
</table>

Note. *p < .05; **p < .01; ***p < .001. β is the standardized regression coefficient, b is the unstandardized regression coefficient, and SE b represents the standard error of the unstandardized regression coefficient. The adjust R² was used as the appropriate proportion because it takes into account the sample size.

Table 3. Hierarchical Regression Analyses of Family Variables Predicting Decoding Competence at Time I and Time II.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Time I (Pretest), N = 72</th>
<th></th>
<th>Time II (Gain Scores), N = 58</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b</td>
<td>SE b</td>
<td>β</td>
<td>R</td>
</tr>
<tr>
<td>Model 1</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>3.72</td>
<td>.86</td>
<td>.58</td>
<td>.33</td>
</tr>
<tr>
<td>Parental Reading Attitude</td>
<td>.16</td>
<td>.03</td>
<td>.58</td>
<td>***</td>
</tr>
<tr>
<td>Model 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>1.90</td>
<td>.93</td>
<td>.66</td>
<td>.44</td>
</tr>
<tr>
<td>Parental Reading Attitude</td>
<td>.13</td>
<td>.03</td>
<td>.45</td>
<td>***</td>
</tr>
<tr>
<td>Family Literacy Environment</td>
<td>.04</td>
<td>.01</td>
<td>.36</td>
<td>***</td>
</tr>
</tbody>
</table>

Note. *p < .05; **p < .01; ***p < .001. β is the standardized regression coefficient, b is the unstandardized regression coefficient, and SE b represents the standard error of the unstandardized regression coefficient. The adjust R² was used as the appropriate proportion because it takes into account the sample size.
DISCUSSION

This study examined the role of the family in the acquisition of early reading skills. Although interactive processes within the home have been found to facilitate reading acquisition (Arnold, Zeljo, Doctoroff, & Oritiz, 2008; Baker, 2003; Bennett, Weigel, & Martin, 2002; Bus, van Ijzendoorn, & Pellegrini, 1995; Sénéchal, 2006; Sénéchal & LeFevre, 2002; Sénéchal, LeFevre, Thomas, & Darley, 1998; Serpell, Sonnenschen, Baker, & Ganapathy, 2002; Storch & Whitehurst, 2001), such processes differ from home to home. This study highlights the experiences of acquiring or encouraging learning in low-income families in a developing nation, a reality that needs consideration when assessing the influence of family on reading development. This paper reports findings from an exploration of two constructs in the home environment: the PRA and the FLE.

A significant observation from the current study is that family variables explain substantial variation in the reading outcomes at both pretest and posttest scores. However, these variables are less influential in explaining the gain scores. Data show that family variables explain a total of 53% at pretest on orthographic awareness but that decreases to 24% on gain scores. A similar pattern is shown on decoding competence, where the variables explain 44% at Time I but that declines to 19% at Time II. These findings are similar to those of Storch and Whitehurst (2001), who reported a large impact of the home environment on children’s reading development. The impact seems to be higher at the beginning but decreases when children become fully immersed in school activities. In the same vein, Sénéchal (2006) reported that home literacy variables only indirectly affected the reading comprehension of third graders. The results of this study confirm that a literate home environment is a strong antecedent for the acquisition of reading skills.

When PRA was assessed, findings in this study confirm that the parents’ attitudes are a major component in the home environment, explaining variation on reading outcomes. Despite the low-literacy levels among the parents, the qualitative inquiry revealed that over 60% of the parents provided children with reading opportunities. This finding mirrored the findings that are reflected in the quantitative results, in the articulated differences in how these parents provide and support literacy experiences in the home. However, these opportunities and resources were most often tied to the external benefits that the child would receive after completion of formal education. As such, the belief that formal education would improve the lives of the children enabled the parents to make an effort toward providing literacy artifacts within the home. Apart from buying books, some parents whose children were high achievers reported buying charts with the alphabet because they believed the charts facilitated literacy learning through the visual connection of what the child was seeing and hearing. This is in line with the findings by Juel, Griffith, and Gough (1986), who demonstrated that improvement in visual word recognition from first to second grade was associated with corresponding growth in spelling ability. Although the parents may not be aware of the strong scientific connections between what they are offering the children and the outcome, these parental behaviors need to be encouraged.

In addition, parents encouraged their children to retell the stories after watching television, an activity that can be said to influence oral language (Castro, Lubker, Byrant, & Skinner, 2002; Dickinson & Tabors, 2001; Isbell, Sobol, Lindauer, & Lowrance, 2004; Schneider, 1996). The differences in the way the children experienced literacy in their families can be explained as a consequence of parental attitudes, and this could be noted from the way the
parents facilitated the organization and structuring of the physical and social contexts (DeBaryshe, 1995; Reese & Gallimore, 2000). As a socially mediated process, reading within the home is affected by the propensity of the parents towards it. It can be argued that parents who possessed a more positive attitude toward reading invested a little more in reading materials, as well as encouraged reading activities in the family and community. Support for this claim is revealed from the thematic analysis of maternal narratives, where some parents encouraged their children to act as young teachers to other children within their communities. In some cases, the parents asked the children to teach them.

This finding echoes other research illustrating the significance of the PRA in school achievement (DeBaryshe, 1995; Lynch, Anderson, Anderson, & Shapiro, 2006; Reese & Gallimore, 2000; Sonnenschein, Brody, & Munsterman, 1996). In identifying aspects of the home environment that relate to literacy acquisition, Baker, Sonnenschien, Serpell, Fernandez-Fein, and Scher (1994) revealed 10 factors that influence the reading development of children, among which is the PRA. It can be argued therefore that, despite lower levels of reading experience, education, and occupation, parents still influence the reading development of their children through their own reading experiences and attitudes. This finding is in line with some of the studies that have been conducted in South Africa and other countries, such as Taiwan, on the role that PRA plays in the acquisition of reading over and above the language used or parental education and employment (Chen & Ko, 2009; Howie, 2010). However, this finding also contrasts with studies from industrialized countries, where contextual factors sharply explain variability. Most parents in industrialized countries, having attained higher levels of education, tend to possess positive attitudes towards reading, thereby accounting for the PRA’s lower significance on child reading acquisition (see Howie, 2010). In South Africa, Howie’s (2010) study that investigated more than 16,000 children found that PRA emerged as the strongest predictor. This illustrates that parents with more positive attitudes toward reading create learning environments for their children that are supportive toward the acquisition of reading skills.

The second, broader construct that the paper reports is the FLE. This research began with the presumption that families that scored higher on this measure would have children performing better on reading outcomes. The results confirm this assumption. Analyses revealed significant positive effect on pretest and gain scores: FLE accounted for 12% variance at pretest and 6% for gain scores on orthographic awareness and 11% at pretest and 8% for gain scores on decoding competence. An explanation for this finding is related to the family’s differential involvement in literacy activities. Families differed significantly in how they engaged with their children’s reading work. Maternal narratives revealed that, although most parents’ engagement with reading work was initiated by the school through homework, some parents assigned literacy work to their children in the absence of school-mediated assignments.

This finding is in line with Sénéchal et al. (1998), whose home literacy model emphasized parental involvement as key to helping children attain reading skills. They differentiated two aspects of the home environment: the shared book experiences, which afforded children’s enhanced vocabulary, and direct parental teaching, related to specific reading skills, such as decoding and print awareness. Sénéchal and colleagues (1998) identified shared book reading as key to vocabulary development. Other studies have revealed that common activities, such as playing games and singing songs, were keys to enhancing oral language and undisputedly enhance early reading (see also, Bradley & Bryant, 1983; Cunningham & Stanovich, 1993; Dickinson & Tabor, 2001; Hammer & Maccio, 2006; Snow, 1991). Interpretation of the
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current findings underscores the expectation that reading-enhancing experiences are part of the children’s lives in their families.

It must be acknowledged that we expected the FLE would account for more variation on the reading outcomes than it did because some literacy activities directly teach reading skills. However, this measure contained multiple variables captured in the family environment, and when these environmental factors were analyzed separately, the results did not yield significant effects on the reading outcomes. Therefore, this reality could have offset the impact that literacy activities have on the reading outcomes. In other words, by separating the various environmental factors that had previously been subsumed with one overarching term into either the PRA or the FLE for this study, the FLE showed a lower direct impact on the children’s test scores at Times I and II.

Finally, this study brings out an important finding for Zambian families that is in line with other studies of the important role that family plays in supporting children’s reading skills despite the context (Aram & Levin, 2002; Cairney, 1997; Delgado-Gaitan, 1987; Phillips, 2010; Purcell-Gates, 1995). Thus, the findings of this study help point toward an important aspect of intervention within the home that supports the interventions within the schools for the advancement of reading skills in low-income children.

CONCLUSIONS

This study confirms that family influences the overall development of the child in addition to his/her educational attainment, of which reading is the foundational skill. The findings highlight the role of the family in a child’s learning process in Zambia. The first implication of these findings is that families should be incorporated more explicitly within the educational agenda of the children. This can be achieved through raising awareness of the significant contribution the family can make in the learning process. Second, family involvement in a child’s learning process should go beyond the physical provisions of uniforms, books, and food. This could be done by actively promoting a learning environment at home, such as creating space and time for reading and providing learning opportunities for children at home. Similarly, there is need to consolidate home–school/parent–teacher relations to go beyond the collection of school reports at the end of each term. This may be a partnership that represents the communicative behaviors between parents and school personnel about the child’s educational experiences and progress. Active parental and family engagement in the child’s learning process may yield a confidence in literacy teaching at home. As Phillips (2010) noted, “It is imperative that we teach parents how best to develop their children’s literacy” (p. 126). In guiding low-income parents to mediate joint-writing activities with their children in Israel, Aram and Levin’s (2002) research yielded results of significant effects (20–36%) on reading and writing measures. The impact of parent-mediated joint writing was reported despite the participants being from low-SES families.

Aram and Levin’s (2002) results challenge the persistent view of homogeneity associated with low-income families. This study, as well, revealed that literacy experiences within families are not restricted to contextual factors. Rather, the physical and social settings are manipulated by psychological processes, such as attitudes. Interpretation of these results strongly suggests that parents and families play a critical role in the learning process of children. Therefore, parents and families need to be made aware of their responsibility to teach their children in informal settings.
Such activities within families and communities are part of the child’s experience that enhance cognitive development and, in particular, the acquisition of reading skills.

This study supports Bronfenbrenner’s (1979) contention that the process, person, context, and time elements interact within the environment. With the proximal processes, children experience progressively more complex reciprocal interaction because of active, evolving individual interactions with objects and symbols in the immediate external environment. The proximal processes in which children are engaged, such as literacy activities, must occur on a regular basis for the development and consolidation of reading skills. Bronfenbrenner identifies activities such as playing with other children or reading as mechanisms through which children come to understand their world and formulate ideas about their place within it (see also, Tudge, Mokrova, Hatfield, & Karnik, 2009). The children who play as teachers of reading for their peers exemplify a reading-interactive process in this study. The personal factors that influence the process of learning recognized in this study include PRAs, access to educational opportunities through the parents, and access to resources (i.e., reading materials). Each of these factors found within the ecological system influences the process of acquiring reading skills in the context of the home environment. Moreover, these elements work closely together to enhance the acquisition of reading skills.

This study is not without limitations. The first limitation is that the study did not include, in the analysis, the parents’ reading level. If this aspect had been included, it would have given insights of the connection between the reading level, attitudes, and the organization of the literate home. Another shortcoming is the heavy reliance on self-reports. Parents reported on these aspects of the home environment and the results should be treated cautiously as they may be skewed by the social desirability effect. Further research in this area should consider assessing parental characteristics in totality. We recommend that while self-reports may be easy to administer, standardized tests could be useful in collecting information about parents’ actual reading level. Second, widening the SES base in investigating literacy acquisition may offer a well-represented population rather than interpreting the results from one context. However, this limitation arose from the restricted sampling strategy of confining the overall RESUZ study to families of children enrolled in public schools. Hence, incorporating families who enroll their children in private schools may provide a wider SES base. Finally, comparing the PRA and FLE for children in other SES groups may open further discussion regarding how parents and families can contribute to their children’s learning development or how schools and communities can support families in what appears to be an essential aspect of children’s learning process. Yet, although these findings are indicative of the importance of the FLE in poor families, the influence of the school on literacy acquisition can not be overemphasized.

ENDNOTE

1. GraphoGame is the registered trademark of the University of Jyväskylä and Niilo Mäki Foundation. For more information, consult the GraphoGame Website (https://graphogame.com) or see Richardson and Lyytinen (2014; this issue) or Lyytinen, Erskine, Kujala, Ojanen, & Richardson (2009).
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PROMOTION OF LITERACY IN SUB-SAHARAN AFRICA: GOALS AND PROSPECTS OF CAPOLSA AT THE UNIVERSITY OF ZAMBIA

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Abstract: The convergence of two complementary agendas motivated collaboration between two universities (in Zambia and Finland) to establish the Centre for the Promotion of Literacy in Sub-Saharan Africa (CAPOLSA), focused on initial literacy learning in indigenous languages. The project’s mandate and activities are closely related to Zambia’s national context of literacy and educational provision, emerging trends in information and communication technology, and the University of Zambia’s institutional context of research and development on literacy, child development, and education. CAPOLSA has afforded opportunities for enhancing the working relations between the national university and government and for contributing to the development of institutional linkages and consultative forums. Collaboration between various disciplines, institutions, and economic sectors characterizes CAPOLSA’s activities. Important areas of progress envisaged include institutional development, growth of a sustainable community of researchers whose collective efforts will increase the scale of Africa’s contribution to international knowledge, and evidence-based planning at the interface between humans and technology.

Keywords: initial literacy learning, indigenous languages, evidence-based planning, collaboration, Africa.

INTRODUCTION

Promotion of literacy is a widely endorsed agenda for progressive social change in sub-Saharan Africa. This region of the world has suffered from multiple disadvantages over the past two centuries, including political oppression, armed conflict, economic exploitation, a massive burden of disease, and widespread material poverty. Low levels of literacy place a significant constraint on effective participation in societal progress and economic growth by most of the region’s rapidly growing population. Recent advances in technology have the potential to contribute to the success of the education sector to overcome that constraint. The North–South collaboration described in this paper has focused on fulfilling that potential under the auspices of the new...
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Centre for the Promotion of Literacy in Sub-Saharan Africa (CAPOLSA), established at the University of Zambia (UNZA), to promote support for children’s acquisition of literacy in Zambian languages.

I begin this paper by reflecting on the convergence of two complementary research agendas, one emanating from the North, the other from the South. Next I provide an outline of Zambia’s national context of literacy and educational provision, within which CAPOLSA’s institutional mandate and activities are situated. Two other dimensions of context are then presented: Zambia’s current national uptake of information and communication technologies (ICTs) and UNZA’s institutional emphasis on research and development in literacy, child development, and education. Reflecting on CAPOLSA’s first 3 years of experience, I describe how it has contributed to the working relations between Zambia’s national university and government, as well as to the development of institutional linkages and consultative forums in close collaboration with other organizations. To conclude, I identify some important growth points for CAPOLSA and reflect on some lessons learned about evidence-based planning at the interface between humans and technology.

COLLABORATIVE NORTH–SOUTH CONVERGENCE OF TWO COMPLEMENTARY AGENDAS

CAPOLSA was born out of a convergence of interests between researchers in Zambia and Finland. For UNZA, the key motivating agenda has been the search for effective strategies, methods, and resources to address the challenge of poor literacy outcomes in mass basic schooling (a widely acknowledged social problem in Zambia and in many countries in sub-Saharan Africa). For the University of Jyväskylä in Finland, a major goal has been to test and extend universalistic theories and principles of professional practice for the optimization of initial literacy acquisition. The convergence of these different overarching goals on the CAPOLSA collaboration is more than a matter of convenience. As Cole and Engeström (2007, p. 484; italics in the original) have noted, following Vygotsky, “the implementation of theory in practice is not a marginal scientific goal in the study of human development—it is essential to understanding the complex interplay of different life processes, ‘in life,’ not just in theory.”

The longitudinal study of dyslexia by Lyytinen and his colleagues (for the latest extensive reviews, see Lyytinen et al., 2008) in Finland gave rise to a computer-based instructional phonics game (GraphoGame;1 Lyytinen, Erskine, Kujala, Ojanen, & Richardson, 2009), whose educational effectiveness has since been empirically confirmed for samples of school-going children in Finland (Saine, Lerkkianen, Ahonen, Tolvanen, & Lyytinen, 2011) and in England (Kyle, Kujala, Richardson, Lyytinen, & Goswami, 2013). Building on those findings, the collaborative intervention study of Reading Support for Zambian Children was designed to test the generalizability of a scientifically grounded, technologically sophisticated, instructional resource as an effective educational intervention in an African society where linguistic and educational conditions differ from those in which its effectiveness had been established in Western Europe (Lyytinen et al., 2012). The project was welcomed by researchers and policymakers in Zambia as a promising response to growing dissatisfaction in Zambian society regarding the very limited success rate of government efforts to achieve
Goal 6 of the Education for All movement, namely “improving all aspects of the quality of education, and ensuring excellence of all so that recognized and measurable learning outcomes are achieved by all, especially in literacy, numeracy and essential life skills” (World Education Forum, 2000, Item 7, vi).

The multisectoral collaboration that has ensued can be understood as a case of “design-based implementation research.” This research approach calls for four complementary elements:

- a focus on persistent problems of practice from multiple stakeholders’ perspectives;
- a commitment to iterative, collaborative design;
- a concern with developing theory related to both classroom learning and implementation through systematic inquiry; and
- a concern with developing capacity for sustaining change in systems. (Penuel, Fishman, Cheng, & Sabell, 2011, p. 332)

ZAMBIA’S NATIONAL CONTEXT OF LITERACY AND EDUCATIONAL PROVISION

Many of the challenges facing Zambian society revolve around a felt need for broader and more equitable distribution of resources: not only material wealth and political power, but also knowledge. Access to formal education is often claimed in the public domain as a fundamental human right. Over the past 5 decades, considerable progress has been achieved in the expansion of educational facilities and in student enrollment. Yet it is widely recognized that the outcomes of basic schooling fall far short of expectations (Examinations Council of Zambia, 2013), with a majority of enrolled learners failing to attain minimal standards of literacy or numeracy by Grade 6 (Hungi et al., 2010).

If education is to realize its potential as a resource for progressive social and economic change, the outcomes must include an increased proportion of the population who are sufficiently literate to (a) understand documentation of their civic rights and duties and the consequences of development projects, (b) contribute to critical and constructive analyses of local and national projects, and (c) express their locally felt needs in forms that command the attention of policy makers and administrators. Currently, such applications of individual literacy to activities that might lead to economic empowerment and civic engagement are largely inaccessible to the majority of youths graduating from the public system of basic schooling. The national Grade 7 school-leaving certificate guarantees the individual’s ability to read and write in English. However, that level of competency falls far short of the demands of reading an in-depth newspaper article or composing a coherent position paper about a local community problem and how it might be addressed.

Zambia participated in a regional exercise conducted by SACMEQ² in 2007 that administered carefully standardized tests of literacy and numeracy to a large, representative nationwide sample of pupils enrolled in Grade 6. Reading skills were assessed at 8 levels, with Levels 1–3 representing prereading, emergent reading, and basic reading, respectively, and Levels 4–8 represented reading for meaning, interpretive reading, inferential reading, analytical reading, and critical reading, respectively. The results showed that only 27% of Grade 6 pupils were able to read above the very rudimentary Level 3 in their penultimate year of primary schooling. The distribution of reading skills was uneven across social strata: 52% of the children from high socioeconomic status (SES) families achieved the upper-level skills, compared with
only 17% of those from low SES families; 38% of pupils enrolled in urban schools achieved the upper-level skills compared with only 22% of those in rural schools. The study also took an inventory of “pupil learning materials” and computed an index of “possession of at least one of each of eight important learning materials: an exercise book, a notebook, a pencil, a sharpener, an eraser, a ruler, a pen, and a file” (Hungi, 2011, p. 32). This index was predictive of a small but significant proportion of the variance in average reading level achieved across schools in a multiple regression analysis of the Zambian data (Hungi, 2011).

The SACMEQ study provided rigorous and disturbing evidence that the average level of literacy achieved by children in Zambia’s mainstream primary schools is very low and that it is heavily influenced by family income and residential setting. The results also suggested that access by children to instructional resources makes a difference in the level of literacy they achieve. Interpreting these findings calls for recognition of the sociolinguistic complexity of Zambian society (Serpell, in press). Children in Zambia and many other African countries grow up in a setting where most adults are competent in three or more language varieties. Moreover, as in many postcolonial states, the language of former colonial administration, English, is generally used in Zambian society for many high prestige social functions, while the indigenous languages predominate in the domain of “hearth and home.”

The indigenous languages all belong to the Bantu taxonomic group within which varieties share a strong core of grammatical and lexical commonalities and the borders between them are porous. Initial literacy instruction has had a checkered history in Zambia. During the colonial period, mission schools and government schools favored the use of the indigenous African languages as the media of instruction in the early grades. However, shortly after independence in 1964, the Government introduced the English Medium Scheme under which children received initial literacy instruction from Grade 1 in the medium of English, a language used by very few families as the medium of everyday communication with children. Gradual reform of this policy, as explained below, has been an important backdrop to the establishment of CAPOLSA.3

**CAPOLSA’S INSTITUTIONAL MANDATE AND ACTIVITIES**

CAPOLSA was established at UNZA in May 2011, in cooperation with the University of Jyväskylä, Finland, with financial support from the Government of Finland through its Ministry of Foreign Affairs. The mandate of CAPOLSA specifies the following goals:

(a) to promote support for children’s acquisition of literacy in Zambian languages among parents, families, and preschool teachers;

(b) to provide technical support in curriculum and instruction to the various training institutions mandated to prepare teachers for initial literacy instruction in the nation’s lower primary school grades;

(c) to create, collate, and disseminate child-friendly reading materials in the Zambian languages used as media for initial literacy instruction;

(d) to develop guidelines for the harmonization of orthographies across the various Bantu languages as used in the various countries of sub-Saharan Africa; and

(e) to offer specialized, advanced education to create a critical mass of expertise at UNZA for conducting research in support of those goals.
During its first 3 years of operation, CAPOLSA has achieved progress towards its target outcomes of (a) increased professional expertise in Africa for conducting and disseminating research evidence on optimal ways of promoting literacy; (b) increased availability of child-friendly reading materials in African languages; (c) demonstrated effective deployment of computer-mediated learning resources in Zambian public primary schools to support children’s mastery of foundational literacy skills; and (d) dissemination of research evidence relevant to effective promotion of literacy in sub-Saharan Africa. The following planned activities were implemented in 2013:

- Technical support for local scholars in statistical data analysis and sponsorship of their international travel to disseminate the findings of ongoing research on initial literacy learning in Zambia;
- Support for the African regional GraphoLearning Diploma Programme;4
- Publication of Early Grade Readers in four of Zambia’s indigenous languages and editorial preparation of Readers in three other Zambian languages;
- Logistical planning for effective dissemination of the Readers in print and digital format;
- Professional development workshops for writers of child-friendly reading materials in Zambian languages;
- Production of audio–visual learning aids and instructional videos for teachers;
- Field testing of digital (android) tablets in Lusaka public primary schools for shared use by multiple early-grade learners as a platform for disseminating GraphoGame, child-friendly texts in local languages, and other learning resources; and
- Various stakeholder sensitization activities.

Steps were taken in 2013 to facilitate the project’s sustainable integration within UNZA. Synergies were achieved with the literacy programs of the Zambian government’s Curriculum Development Centre and the Read to Succeed project. Partnership with the Government was strengthened by its launch of a new National Literacy Framework.

**ZAMBIA’S NATIONAL CONTEXT OF INFORMATION AND COMMUNICATION TECHNOLOGY**

Africa has been a relative latecomer by global standards to the world of ICTs. For instance, in 2008 only 4.2% of the population of Africa were Internet users, compared with 23% worldwide (International Telecommunication Union [ITU], 2013). Within the region, Zambia was an early leader, if not “the pioneer of Internet services in the Sub-Saharan Africa” (Bwalya, 2010, p. 4). The number of Internet users in Zambia per 100 population was estimated to be 13.47 in 2012, more than double the estimate for 2009. Even so, at less than 14%, the level of access is quite low as compared to 91% in Finland, 87% in UK, 81% in USA, 41% in South Africa, 33% in Nigeria, and 32% in Kenya. Yet Zambia remains well above the level in neighboring countries Congo, Malawi, Mozambique, and Tanzania (all less than 5%; ITU, 2013).

One dramatic growth point in ICT utilization in Zambia has been the use of personal cell phones. Internet service providers make up a conspicuously prosperous sector of the economy and provide coverage to almost all areas of this large, sparsely populated country. In a country roughly the size of Finland and Norway combined, 40% of Zambia’s 14 million people live in
urban areas, and the rest are unevenly distributed across rural areas. Although a cell phone was considered a luxury item in Zambia a decade ago, the majority of urban adults today, many of whom live below the poverty line, now own a cell phone, and at least one can be found in almost every village. The significance of this development for the spread of literacy is increased by the fact that the cost per word for text messaging is considerably less than the quite high cost of audio communication. Thus many users prefer text messaging for economic reasons. Although the style of spelling in text messaging is often abbreviated, as elsewhere around the world (Bushnell, Kemp, & Martin, 2011), a minimal level of literacy is essential for communication via this highly affordable and popular technology.

In the spheres of research and higher education in Africa, modern ICT has been recognized as a powerful resource for linking the region to the rest of the world, enabling Africans to access the rapidly expanding body of knowledge and to contribute to it (Twinomugisha, 2007). At UNZA, ICTs have been a major focus of capital investment, and both students and researchers manifest a very positive appreciation of their value. For instance, in the 6 years since the Web-based network ResearchGate was founded, 178 UNZA researchers from 20 academic departments have become registered members. Even though the cumulative impact of their uploaded publications remains modest, it compares favorably with other universities in the Southern African Development Community subregion outside South Africa and is growing rapidly.

The Reading Support for Zambian Children (RESUZ) intervention study, results of which are expected to be published in 2014, sought to leverage the growing availability of cell phone technology as a platform for disseminating the GraphoGame to children learning to read in the low-resource settings of government primary schools. The study found that urban children were quick to learn how to handle smartphones with touch screens, and teachers appreciated the instructional support provided by the game’s explicit programming of letter–sound correspondence rules. Further research is needed to evaluate how the cognitive benefits of the technology mesh with economic and cultural constraints to determine the effectiveness of ICTs across the full range of the nation’s educational activities.

THE UNIVERSITY OF ZAMBIA’S INSTITUTIONAL CONTEXT OF RESEARCH AND DEVELOPMENT ON LITERACY, CHILD DEVELOPMENT, AND EDUCATION

UNZA is Zambia’s largest and oldest university and has a track record of significant research and publication. Established at the time of political independence as a national, public institution with the motto “Service and Excellence,” the university is mandated to provide quality higher education to address the human resource needs of the nation, to generate new knowledge and understanding through systematic research, and to provide technical support for the application of knowledge for the benefit of Zambian society. Most of the professional personnel within Zambia’s Ministry of Education (including the vast majority of secondary-level school teachers and the staff of specialized support units, such as the Curriculum Development Centre) received their tertiary education from UNZA or one of its affiliated colleges.

In addition to offering its own degree programs, UNZA provides superintendence and certification services to a number of other tertiary-level educational institutions in the country that are formally affiliated with the university, including 10 secondary-level teacher training colleges, a number of teacher training colleges dedicated to the preparation of teachers for professional
service in basic schools (Grades 1–9), and the Zambia Institute of Special Education. However, the quality control for which the affiliation scheme is designed seldom extends beyond the review of curricula and moderation of examination results into the domain of research.

UNZA’s Strategic Plan (2008–2012) focused on the theme of “Restoring Excellence in Teaching, Research and Public Service.” A key strategic objective towards that end was that the university should strengthen its human and financial capacities for producing quality research by the end of 2012. The following strategies were identified as means for attaining that objective:

(a) improving the research competences of academic and research staff;
(b) increasing the participation of junior staff in research activities;
(c) strengthening the financial base of research programs; and
(d) promoting collaborative research with other institutions within and outside the region.

Thus the university was very receptive to the proposal in 2010 for Finnish support to establish CAPOLSA as a collaborative project. CAPOLSA combined a capacity-building agenda (postgraduate training) and a felt need of the Zambian government for policy-oriented research and development in a priority field of public education (promotion of universal basic literacy) with an emerging program of international research collaboration (i.e., optimizing conditions for initial literacy acquisition). The Psychology Department in the School of Humanities and Social Sciences was established when UNZA was founded and continues to hold one of the School’s strongest records of published research, particularly in the field of human behavioral development. Thus, the department was an ideal base for CAPOLSA. From 1967 to 1989, the department housed the Human Development Research Unit (HDRU), which, as stated by Heron in an unpublished document cited by Serpell, 1982, was formed with the explicit goal of generating scientific data on children’s development that could form the basis for teaching developmental and educational psychology at Zambia’s newly established university. HDRU achieved international recognition for its output, much of which was published in peer-reviewed international journals (e.g., Deregowski, 1968, 1972; Serpell, 1969, 1982). In the 1980s, several scholars in the Psychology Department provided technical support to the Government’s multisectoral National Campaign to Reach Disabled Children, which aimed to lay the foundations of nationwide health and education services for disabled children (Serpell & Jere-Folotiya, 2011; Serpell, Nabuzoka, Ng’andu, & Sinyangwe, 1988).

Along with other UNZA scholars, researchers in the Psychology Department also contributed to the national educational reforms debate (1975–77) and submitted a formal proposal to reintroduce seven of the indigenous languages as instructional media within the early grades (1–4). Theoretical and empirical research across many different nations and speech communities has shown fairly consistently that initial literacy instruction is more effective if it is offered in a child’s mother tongue or first/dominant language (Cummins, 2000; Heugh, 2000), and the limited amount of empirical research on the subject in Zambia supported, and continues to support, that position. But, UNZA’s proposal was rejected by the Ministry in its final policy document (Serpell, 1978), and the policy of teaching initial literacy in English remained in place for another 20 years. However, in 1996, the Government published a landmark policy document, Educating our Future, stating that “all pupils will be given an opportunity to learn initial basic skills of reading and writing in a local language” (Government of the Republic of Zambia [GRZ], 1996, p.40). Over the next decade, systematic field testing by the Ministry, with the support of international consultants and UNZA staff (Tambulukani, Sampa, Musuku, &
Linehan, 2001), led to the formalization of a new initial literacy curriculum and instruction policy by the turn of the century and, still more recently, a strengthened commitment to the use of indigenous languages as media of early-grade instruction. This has greatly facilitated cooperative communication between CAPOLSA and the Ministry of Education.

**WORKING RELATIONS BETWEEN UNZA AND ZAMBIA’S MINISTRY OF EDUCATION**

Despite UNZA’s history of conducting rigorous research on educational topics and providing technical support to a number of important educational initiatives, the Zambian government, like many others in the region, often overlooked the potential value of its local expertise when entering into international agreements for strengthening the nation’s programs for education provision. For instance, a multimillion dollar program funded by the World Bank (2007), the Basic Education Sub-Sector Investment Program (1999–2001), relied heavily on international experts to advise on its design and implementation, with only minimal participation by scholars based at Zambia’s national university.

More recently, the United States Agency for International Development (USAID) entered into a substantially funded agreement with the Zambian government to launch a new initiative in the field of early literacy instruction (Read to Succeed), much of which is being implemented through subcontracts with various US-based consulting agencies (including Research Triangle Institute/RTI International, Creative Associates, and O’Brien Associates) that have engaged their own expert personnel rather than building an institutional link with a Zambian university. As a result, UNZA’s academic staff have provided only piecemeal technical support for the initiative through consultancies on specific aspects of the program.

One such contribution was initiated by CAPOLSA in relation to the assessment of Zambian children’s early literacy skills development. RTI International developed a system for designing rapid surveys of the prevailing literacy levels in the early school grades of various countries around the world. This Early Grade Reading Assessment (EGRA) was applied in Zambia in 2012 to generate baseline data against which the impact of the Read to Succeed initiative could be measured in subsequent years. CAPOLSA entered into an agreement with the Read to Succeed organizers whereby some student research assistants recruited and trained in assessment techniques within the RESUZ project in 2011 would be engaged and trained by the Read to Succeed personnel to administer the Zambian EGRA to samples of Grade 2 and Grade 3 children selected for their baseline study. These examiners then administered the same test battery to children who had participated in the RESUZ project in 2011, when they were in Grade 1.

This mutually beneficial agreement provided the Read to Succeed project with a pool of excellent trainees experienced in testing young children and enabled the RESUZ research team to collect longitudinal follow-up data in Grade 2 on a sample of the cohort whose initial literacy learning they had documented in Grade 1. Subsequent analyses have generated significant insights for both projects, based on the correlations and contrasts between the RESUZ test scores in Grade 1 and their scores on the EGRA test battery, as well as on cross-sectional comparisons of Grade 2 EGRA scores between the RESUZ urban school children and relevant samples of the Read to Succeed baseline study.
CAPOLSA’S CONTRIBUTION TO THE DEVELOPMENT OF INSTITUTIONAL LINKAGES AND CONSULTATIVE FORUMS

The CAPOLSA Project established from the outset both a Project Board, which provides accountability for the management of activities and budget to the administration of both partner universities, and a high-level multisectoral Advisory Board, which reviews project outcomes and plans and shares ideas about priorities. The Project Board is cochaired by CAPOLSA’S two coordinators, and members include the deans of UNZA’s participating schools, the head of UNZA’s Psychology Department, and representatives of the Government’s Curriculum Development Centre. In addition, three members of UNZA’s academic staff who also are enrolled in doctoral study programs within the scope of CAPOLSA’s operations and a representative of the Government’s Teacher Education Directorate participate as adjunct members of the Board.

The Advisory Board is chaired by UNZA’s Vice Chancellor, who is the executive head of the university. Also serving on the board are the Finnish Ambassador to Zambia; chief executives of the UNICEF country office, the National Commission for UNESCO, the National Arts Council, two local publishing houses, the Zambia Institute of Special Education, the USAID Read to Succeed project, and Zambia’s Ministry of Education; and senior representatives of the National Broadcasting Corporation, the Ministry’s Curriculum Development Centre, and Teacher Education and Specialised Services Directorate. The other members of the board are from UNZA: the deans of the School of Education and the School of Humanities and Social Sciences; the heads of the Departments of Educational Psychology, Sociology, Special Education, and Language and Social Sciences Education; the head of the Zambian Languages section in the Department of Literature and Languages; all professors of African languages; and representatives of the academic staff responsible for teaching courses in literacy and developmental psychology.

At its 2012 and 2013 annual meetings, the Advisory Board received detailed reports on the activities of CAPOLSA (outlined in the CAPOLSA’S Institutional Mandates section, above), discussed their successes and constraints, and offered suggestions for additional, complementary strategies and activities within the scope of CAPOLSA’S mandate. In several instances, those deliberations fed into collaborations that have further strengthened CAPOLSA’S integration within UNZA, its partnership with the Ministry, and mutual understanding between CAPOLSA and other stakeholders, such as the Read to Succeed project, the national broadcasting corporation, local publishing houses, and the National Arts Council.

One particular field of endeavor that has proven to be quite challenging is that of orthographic reform. Zambia’s indigenous languages all belong to the Bantu group and share many grammatical commonalities in phonology and morphology, as well as a certain amount of root vocabulary. But because of accidents of history in Zambia’s missionary and colonial past, these languages were committed to written form in an uncoordinated way, resulting in unnecessary diversity that reflects the variations across standard orthographies of different European languages (Banda, 2008, 2012; Harries, 2007). In a number of cases, this diversity of spelling has resulted in anomalies, such as a given letter of the Roman alphabet representing different sounds in two of the Zambian languages, or even the same language being spelled differently on opposite sides of an international border. Such anomalies pose unnecessary challenges for literacy learners.
A consultative workshop of experts convened by CAPOLSA (see Maumbi & Serpell, 2012, for a report) discussed the best way forward. The collaboration resulted in guidelines for the spelling in CAPOLSA’s first edition of Early Grade Readers written in the four most widely spoken Zambian languages: ciNyanja, chiTonga, iciBemba, and siLozi. The rationale for these guidelines has since been articulated in a public education leaflet (Serpell, 2013) and summarized in each of the languages in the Preface of each of the published Readers. The rationale invokes several complementary considerations. The first and most important is simplicity and transparency, for ease of learning by young children. An additional concern is harmony across the different indigenous Zambian languages adopted as the media of initial literacy instruction in Zambian government schools. Facilitating the transfer of literacy skills from one language to another is essential, given the prevalence in Zambian society of geographical mobility and the demand for individual multilingualism. Another, longer term goal is harmonization across the Bantu languages of the South, East, and Central regions of Africa, given the national differences in spelling of cross-border languages. On the other hand, reforms need to ensure the acceptability of new spelling conventions to parents and teachers of children currently enrolled in early grades.

An invited presentation of the rationale was given at a workshop convened in November 2013 by the Bible Society of Zambia, an organization with its own distinctive reasons for wishing to improve the harmonization of Bantu language orthographies. The Ministry of Education’s Curriculum Development Centre also was represented at this workshop. Arising from the ensuing discussions, an agreement was reached in 2014 between the Ministry and CAPOLSA to collaborate on a systematic evaluation of stakeholder perceptions and responses to the simplified spelling system adopted by CAPOLSA for the Readers.

### CAPOLSA’S COLLABORATIVE ACTIVITIES

CAPOLSA’s activities have involved a variety of collaboration types: researcher–teacher collaboration in the conduct of applied educational research under the RESUZ project; public–private partnership in publication of the Readers and in the production of audio–visual educational resources; interdisciplinary theoretical discourse around the process of editing creative texts in Zambian languages to make them “child-friendly”; and multidisciplinary scholarly cooperative communication with creative writers in the design and conduct of the writers’ workshops.

The guiding principle in each of these collaborations has been mutually respectful attention to differences in perspective and priority concerns. The RESUZ research team has invested considerable effort in discussing with early-grade teachers how their philosophical and personal interests relate to the effective implementation of GraphoGame technology in their professional work, resulting in reciprocal insights about the challenges of designing an effective application of the GraphoGame within the prevailing conditions in government schools.

Collaborating with a commercial publisher on the production of the Early Grade Readers introduced CAPOLSA to concerns of an economic nature that dominate the pricing of publications in the African region, especially texts in indigenous languages (cf. Edwards & Ngwaru, 2011a, 2011b). It also afforded an opportunity to engage in co-constructive discussions with graphic artists about the portrayal of themes in the stories and poems that highlighted the elusive but important role of “excess meaning” (cf. Reese & Overton, 1970) in...
pictorial representation. One audio–visual learning aid produced by CAPOLSA is a musical video that maps the sounds of the alphabet onto various common words in Town Nyanja, the lingua franca of Lusaka. This called for close collaboration with a local media company in which musical and computer-graphic skills and creativity of its personnel were deployed in response to tightly focused guidance from the CAPOLSA team, to ensure compliance with principles derived from linguistics and psychology.

The educational policy of delivering initial literacy instruction in the indigenous Bantu languages reflects more than just the instructional logic of grounding the learning task in a medium that builds on children’s existing oral language competence. The languages familiar to Zambian children entering Grade 1 are part of a broader cultural heritage informing their socialization at home. Thus acknowledging the cognitive potential of those languages as media for promoting communicative competence is linked to a broader sociopolitical agenda of building bridges of understanding and cooperation between the public schools and the communities they aspire to serve. From that perspective, CAPOLSA’s workshops for writers in the Zambian languages can be understood as opportunities to promote a renaissance of indigenous literature. Therefore, the evaluation criteria for editorial appraisal and refinement of original texts for publication as educational resources needs to be sensitive to aesthetic and ethical considerations identified within the humanistic disciplines as well as to the cognitive and socioemotional factors emphasized in developmental psychology. Collaboration among literary, linguistic, and psychological scholars in the design and delivery of the workshops has highlighted the diversity of stakeholder perspectives on problems of educational practice and thus has broadened the range of CAPOLSA’s interests.

GROWTH POINTS

Certain areas within the broad mandate set for CAPOLSA at its inception have especially rich potential for making a valuable contribution to the achievement of higher order goals, such as egalitarian distribution of resources and respect for evidence. The initial impetus of CAPOLSA’s efforts was somewhat narrowly focused on practical matters, such as recruitment of linguistic experts to handle translation, securing authorization to implement research plans, and explaining technical aspects of initial literacy learning to teachers. However, the process of performing those tasks has contributed to our understanding of much broader challenges, and the success with which CAPOLSA manages to address them may carry the greatest weight in determining its long-term impact.

The project’s successful negotiation of institutional support in the form of complementary resources from the Department of Psychology and the School of Humanities and Social Sciences may serve to inform future efforts to maintain continuity in projects launched at UNZA with external funding. Looking ahead, we hope to see this complemented by the incorporation of key CAPOLSA positions into the university’s mainstream staff establishment. The selection and editing of texts for inclusion in the Early Grade Readers, the articulation of principles for orthographic reform, and the design and implementation of the writers’ workshops have all necessitated interdisciplinary communication and collaboration. The mutual enlightenment this has delivered may inspire future scholars at UNZA to step out of their
departmental “silos” and cross the barriers that so often impede the generation of new and relevant knowledge (cf. International Dialogue on Education-Berlin, 2011).

Two-way communication between policymakers and researchers also has been essential to CAPOLSA’s efforts to explore ways of improving the fit between its products and the pre-existing curriculum and teaching practices of Zambian schools, as well as the affordability in taking those products to scale. The collaboration envisaged between the Government and the university in conducting a systematic evaluation of how CAPOLSA’s innovations are perceived by multiple stakeholders may help to pave the way for the adoption of evidence-based practices and policies and thus the growth of a knowledge society in Zambia.

The scientific focus of the RESUZ project has afforded a structured opportunity for a group of five Zambian nationals to develop and implement research plans leading towards the completion of a doctoral degree. Their certification as experts will contribute in its own right to the building of national human resource capacity. An even more significant outcome may be their active participation in the international collaborative generation of knowledge. They have embarked on the transition from studentship to scholarship by presenting their research plans and findings at international scholarly conferences of the International Society for the Study of Behavioural Development in 2012–2014, the Society for Research in Child Development in 2013, the Society for the Scientific Study of Reading in 2013, the 2012 International Congress of Psychology, the 2013 European Congress of Psychology, and the 2013 Eastern Africa Regional Conference of Psychology. Moreover, they have coauthored, with their supervisors papers for publication in international, peer-reviewed journals, and, increasingly, they are single authors or lead authors of multiple-authored research reports.

Another related growth point of CAPOLSA’s activities is multinational collaboration in the African region. The University of Jyväskylä has engaged other early-career scholars in Kenya, Namibia, and Tanzania in the field testing of the Grapholearning technology through study sponsorship, regional workshops, and technical support in the field of statistical data analysis. Coming together within the region has enabled a growing network of early-career African scholars to benefit from exposure to one another’s research processes and outcomes. The comradeship emerging from that shared learning holds the potential for creating a sustainable community of researchers whose collective efforts will increase the scale of Africa’s contribution to international knowledge. Perhaps more importantly, it may begin to redress the imbalance that currently tends to perpetuate dependency of the region on external technical support and the brain drain of African intellectuals to work in more affluent countries abroad (cf. Lututala, 2012). CAPOLSA’s mandate includes the coordination and support of such regional collaboration on the many challenges facing the promotion of literacy that are shared among countries in the region.

EVIDENCE-BASED PLANNING AT THE INTERFACE BETWEEN HUMANS AND TECHNOLOGY

Innovations in ICTs have received a great deal of attention in recent years in scientific, economic, and administrative circles, due to their conspicuous potential to increase efficiency. The impact of ICTs on democratization has been a more contested area. Some advocates have celebrated the role of the Internet in holding powerful agencies, such as state
governments and private corporations, accountable to the general public. Others, more
critical, warn that the growing “digital divide” threatens to exacerbate the marginalization of
historically disadvantaged countries, sectors, and communities. Ideally, the introduction of
ICTs into mainstream education may serve to mitigate that threat, by including an increasing
proportion of the world’s citizens in the community of distance communicators and
empowering them to make their voices heard.

One benefit of the RESUZ project’s focus on testing sharply defined hypotheses has been
to conform to the rigorous criteria for scientific evidence favored by many advocates of
“evidence-based” policies and practices. The currently widespread enthusiasm for randomized
control trials as a “gold standard” for establishing reliable evidence is rooted in the paradigm of
controlled experimentation that underpins many of the most remarkable advances in the natural
sciences. However, the importance of ecological validity highlighted by behavioral scientists,
such as Bronfenbrenner (1979), has alerted design-based implementation researchers to the
danger of introducing so many environmental controls into the design of interventions that the
statistically significant findings have little or no relevance in the conditions that prevail in the
real world. Rather than construing the impoverished and often chaotic conditions in
government primary schools as extraneous, incidental features to be controlled, the RESUZ
team tried either to randomize the influence of these conditions on children’s learning or,
alternately, to systematically examine it. CAPOLSA is likewise seeking to engage with the
economic and administrative constraints currently faced by the public school system, by
inviting teachers to collaborate actively with researchers in designing optimal ways of
deploying GraphoGame and other educational resources in their classrooms.

One theoretical framework that seeks to explain the conditions that support or frustrate the
successful implementation of scientifically designed intervention in the real world is the
developmental work research (DWR) perspective developed by Yrjö Engeström (2007). The
framework is built upon the cultural–historical activity theory that emanates from ideas first
propounded by Vygotsky, Leontiev, and Luria. In a recent report of an international
cooperation project focused on promoting ICTs as a resource in Botswana, Ritva Engeström
and colleagues (2014, p. 130) affirm that the developmental work research framework
explicitly sought to distance the project from “top-down bias and limitations of direct transfer
of models and practices from more economically developed countries to developing ones” by
“empower[ing] local actors to manage, for themselves, the collective transformation processes
involved.” Yet, disappointingly, the authors concluded that, in their project, “the view from
below captured concrete disturbances but it did not generate ideas productive in solving ICT
implementation problems” (Engeström et al., 2014, p. 143).

A notable oversight at the inception of this politically sensitive North–South collaboration
appears to have been the importance of “buy-in” to the project’s agenda by national, sectoral,
and institutional authorities. Reflecting on its limited impact, the authors concluded that “policy
analysis or what comes from the top should be taken into consideration within DWR
methodology in approaching changes. This observation also includes analyzing the relationship
between the new learning activity and the organizational vision of policy makers” (Engeström et
al, 2014, p. 143). As I have noted elsewhere (Serpell, 1999), even when policymakers or
practitioners explicitly aspire to follow the implications of research, programs in the real world
tend to deviate in a number of ways from the precise implications of any given theoretical
model. The authors of such models often attribute such deviations to either insufficient
understanding of theory or eclecticism. But, as explained by Korten (1980), organizational adaptability may be a necessary pragmatic requirement of scaling up a model that works well in one particular location into a general cultural practice sustained by public policy.

In Zambia, CAPOLSA is currently able to invoke national policy (GRZ, 2013) to legitimize its emphasis on the indigenous Bantu languages, despite contrary pressures from a powerful local elite (Williams, 2013) and resistance from various international corporations (Rassool, 2013). Nevertheless, in the longer term, it is possible that larger scale social processes, such as class formation and economic globalization, will constrain the current national movement to acknowledge the intrinsic cultural value of the local languages. CAPOLSA’s advocacy for their validation is grounded in appraisal of the current sociolinguistic environment and in relatively universal scientific principles of cognition, learning, and child development.

The asymmetry in global distribution of resources for the design and propagation of new technology implies a danger that the parameters that receive most attention may reflect sociocultural priorities of the world’s more affluent nations, and designs responsive to those priorities may be imposed in hegemonic fashion on poorer societies under the guise of “development assistance” and “modernization.” In this regard, CAPOLSA’s approach to North–South cooperation has been to foster cooperative communication and co-constructive collaboration at all levels, from hands-on instruction, curriculum development, and teacher training to scientific research and policy formulation. In this way, when technological inventions originating in the global North are appropriated in the South, they are mediated by modes of participation that prioritize systematic adaptation to local human needs.

ENDNOTES

1. GraphoGame is the registered trademark of the University of Jyväskylä and Niilo Mäki Foundation. More information can be found at https://graphogame.com/


3. More information on CAPOLSA is available on the University of Zambia’s Website (www.unza.zm), listed under the School of Humanities and Social Sciences and the Department of Psychology.

4. A training program for teacher educators from four African countries (Zambia, Kenya, Namibia, and Tanzania) was launched by the Niilo Mäki Institute in 2012 and is funded by the Finnish Ministry of Foreign Affairs. The focus of the GraphoLearning Diploma Program is to offer teacher educators the latest scientific knowledge and best practices on teaching and on the process of learning to read. Through this diploma program, trainees also familiarize themselves with the GraphoGame and how it can be used to support reading skills.

5. The URL for ResearchGate is www.researchgate.net

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THE GRAPHOGAME METHOD: THE THEORETICAL AND METHODOLOGICAL BACKGROUND OF THE TECHNOLOGY-ENHANCED LEARNING ENVIRONMENT FOR LEARNING TO READ

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Abstract: This paper provides an overview of the GraphoGame method. Both theoretical and methodological aspects related to the method are presented. The method’s guiding principles are based on the prevailing theories and experimental research findings on learning and teaching basic reading skills in alphabetic languages, especially from the point of view of a struggling reader. Because the nature of the target language and its relation to its writing system play central roles in the GraphoGame method, this approach requires the method to be flexible in order to be valid for learners of different languages and orthographies. Thus, the aim of the developed technology is to provide an appropriate reading support tool for all learners—from struggling learners to typical learners—in any language environment. We present an overview of results gained from GraphoGame intervention studies as well as challenges for the usability of the method.

Keywords: technology-enhanced reading support, educational game, reading skill, letter knowledge, phonology, orthography, GraphoGame.

INTRODUCTION

In this article, we provide an overview of GraphoGame,1 a technology-enhanced learning environment for learning to read. The aim is to shed light on the theoretical and methodological issues that guide the ongoing development and use of the technology. In addition, the impact of using GraphoGame is described, as well as the possible challenges confronting GraphoGame as a feasible tool in different contexts.

GraphoGame is a computerized learning environment for training reading skills efficiently. Initially, the impetus for developing such a support tool came from a need to help specific children identified via the Jyväskylä Longitudinal Study on Dyslexia (JLD) as struggling to learn

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basic decoding skills. For the tool to provide the most efficient support, the GraphoGame method was designed by taking into account the prevailing theories on reading development and the specific research findings of the JLD. The design, implementation, programming, and research have been conducted by a multidisciplinary team from the University of Jyväskylä and the Niilo Mäki Institute, a local nongovernmental organization specialized in research and development work on learning disabilities.

On the surface, the game appears to be like any other digital game, or rather educational game, aimed at children in the early stages of their formal education. Figure 1 shows a child playing GraphoGame. The outward appearance of the game is simple, with only a few visual elements displayed at a time, accompanied by short segments of speech. The main tasks include both time-restricted and untimed multiple-choice trials in which the player is to pair an audio segment (phoneme, syllable, word) with the appropriate visual representation (a letter or longer text segment). Mixed in with these reactive types of trials are the more active tasks of constructing written words from smaller components to match the spoken target words. The game provides immediate feedback on the player’s accuracy. In the case of an inaccurate response, the game immediately guides the player to make the correct mapping, thereby teaching the player. After a short sequence of item mappings, the player is provided performance rewards in the form of game tokens, virtual stickers, and the like. The turnaround in a game is very short, providing rewards after approximately one minute of training time. Some elements in the game can be manipulated by the player, thus giving the player a sense of choice, for example, choice involving the outward appearance of the game characters, the selection of tasks to play next, or the direction the game character moves on a map. One feature

Figure 1. A child, wearing headphones, plays GraphoGame on a laptop computer, one of many devices that can host GraphoGame.
supporting the maintenance of engagement is that the game adapts to the player’s learning, providing positive feedback while progressing to increasingly complex levels of reading acquisition. Appropriate algorithms were incorporated to keep the learner interested in continuing to play. In short, the game provides learning opportunities in connecting speech elements to written elements in an efficient game-like environment.

Beyond the simple surface of the game, a rather complex set of algorithmic systems and principles operate. Before introducing these guiding principles, we will review some underlying theoretical issues and research findings regarding reading development, which will pave the way to explaining the principles on which the GraphoGame method is based.

**BASIC ASPECTS OF LEARNING TO READ**

To learn to read written texts, one needs to understand how the visual symbols correspond to spoken language. This task differs considerably from the task of acquiring spoken language skills. Infants acquire spoken language skills from their natural surroundings. They learn by observing, in social situations, those who use spoken language to convey meanings. In general, infant-directed expressions typically are clearly enunciated (in “Motherese”) in close social contact, accompanied by eye contact, facial expressions (e.g., smiling), and physical gestures (e.g., pointing). The close proximity of the face provides the opportunity to observe the movements of the mouth while simultaneously hearing the vocal expressions accompanying the other media of communicating. At the same time infants typically are exposed to other registers of fluent speakers in the vicinity who provide the overall context of the spoken language with its many features (stress patterns, intonations, rhythms, frequently used sound qualities, etc.). Often infant-directed expressions involve few words, are repeated frequently, and begin with concrete relations to the environment and move toward more abstract and complex expressions over time.

The typically developed, highly attuned perceptual system provides a natural starting point for learning to process surrounding sounds in general. Quickly the perceptual system focuses toward meaningful spoken language expressions and, with the accumulating experience, observations start to focus on the points in the spoken language that seem to maximally carry meanings. Also, infants tune into features that are meaningful for differentiating expressions from each other. At the same time infants themselves spontaneously start to experiment with producing speech sounds from which they will receive immediate feedback in different forms (mainly auditory and tactile) as well as feedback from the people around them.

Learning to speak happens naturally by children through their observing and participating in shared communicative situations with other speakers. Broadly speaking, by the age of 5 or 6, children have mastered all the basic tools of spoken language both to be understood by others and to understand other speakers of their native language. They have developed a relatively wide vocabulary, mastered the syntactical relations of their language, and attained a fully developed phonological system (see, e.g., Bates & Goodman, 1999; James, 1990). Typically children have encountered written language in some form, for example, in books read to them and/or through exposure to written language in their surroundings (e.g., in signs, magazines, printed advertisements, TV, etc.) well before age 5. However, from around this age onwards, they are guided actively to take notice of the visual symbols of written language.
The foundation for cracking the written code relies heavily on the mastery of spoken language. However, some general but fundamental differences between spoken and written language may affect one’s learning to read and write, regardless of the mastery level of the spoken language for communicational purposes. First, spoken language in its informal mode typically has many varieties (e.g., regional dialects, idiosyncrasies), with words, syntactical forms, and pronunciations that can differ considerably from the relatively formal and standard forms expressed in the written language. Thus, children less exposed to the type of language used in a written format will have to learn this new code and, at the same time, understand how to modify their spoken expressions for spelling and in forming new mental representations of words. Second, spoken language is basically composed of acoustical streams that often do not have clear pauses between words, whereas, in written language, words are distinctly separated by empty spaces. Even within the words themselves, the different components (e.g., letters) are clearly separated.

The aforementioned differences between the two language modes can have an effect on spelling but, more important, it is vital for the learner to understand that the acoustical stream is not made up of individual speech sounds appearing in an orderly sequence but must be actively analyzed and segmented into separate items in order to make sense of how the two modes of communication are connected. This task is cognitively demanding and, subsequently, some learners will have difficulty in managing this task. In written language, letters do not overlap: They are distinct visual units, sequentially placed one after another. Speech, on the other hand, is a complex multilayered signal in which sounds are interwoven to each other. In other words, due to coarticulation, the context (i.e., the neighboring sounds) affects the way a sound can be produced and, therefore, affects how it sounds. In fact, every time a speech sound is produced, multiple characteristics that can affect the sound quality, including prosody beyond the sound itself (i.e., suprasegmental features), make this sound unique. Figure 2 shows waveform and spectrograph representations of a spoken expression that highlights the stream-like character of the speech signal.

For conceptualizing and managing the variation in the actual realizations of speech sounds, the abstract concept phoneme² is often used the same way as the concept grapheme³ is used for written language (Shankweiler & Lundquist, 1992). The abstractions in phonemes facilitate the focus on distinguishing speech sound features that affect the meaning within the context that the sounds appear and that usually are represented in the written language form. Therefore, the same phoneme can represent a relatively wide range of actual speech sounds. At this point it should be noted that typically only a limited number of features related to spectral information of speech signal are represented in written forms, thus leaving, for instance, a variety of suprasegmental features of speech (e.g., stress, duration, pitch) unmarked in the written format. People create mental representations of speech sounds for facilitating organization, categorization, and accessing them. For learning to read, these representations play a crucial role in order for learners to be able to organize and categorize the huge range of variations of speech features. We will return to the concept of representations when reviewing some theoretical issues of reading development.
Figure 2. Speech wave and spectrogram representations of the naturally produced utterance “Put on the headphones.” This image illustrates the nature of spoken language, which is stream-like and without clear gaps between words. Note that individual phonemes are not clearly distinguishable.

Whereas mastery of spoken language skills develops through conveying meanings, the first step in learning to read, at least in alphabetic languages, needs to be approached from the opposite direction—from connecting small meaningless items (e.g., letters) in order to make up meaningful chunks (i.e., a combination of words). To understand how spoken words can be segmented into something as small as phonemes, which should correspond to written letters, a child is required to make a conscious effort to metalinguistically approach the already-mastered spoken language mode. Researchers (e.g., Bradley & Bryant, 1991; Duncan, 2010) argued that children do not necessarily become explicitly aware of a segment size as small as the phoneme before starting to learn to read. This is based on observations indicating that a phoneme is not psycholinguistically the most accessible segment size of spoken language. Instead children often prioritize, in their language games and songs, larger segments such as syllables and rhymes, which seem to be rather easily accessible and useful in the early development of spoken language communication. As a child’s vocabulary expands, particularly when an increasing number of words are very similar in form, the child also might become aware of phoneme-size features of speech in order to be successful in communication. In fact, Metsala and Walle (1998) argued that the typically rapid vocabulary expansion forces children to pay attention to smaller segment sizes of spoken expressions in order to place the new words into their existing lexical systems.

The mastery of spoken language in typical social contacts is acquired through natural communication, effortlessly, through concentrating on conveying meaning without needing to pay any specific attention to the actual productions. Learning to read and write, on the other hand, is a skill that requires deliberate effort and training, and the way written language maps to
spoken language needs to be specifically taught. Cognitively, the learner needs to have intellectually developed to the point in which abstract and rather demanding, memory-taxing operations can be performed in order to learn to crack the written code. In the upcoming section, we review prevailing theoretical aspects on reading development supported by research findings.

THEORETICAL ISSUES AND RESEARCH FINDINGS REGARDING READING DEVELOPMENT

The Effect of the Orthography in Learning

In simple terms, learning to decode written text in any type of language entails discovering what the written symbols represent. A learner must be shown the principles of how a certain written symbol (e.g., a letter) connects to something that the learner already knows (i.e., a speech sound). In transparent orthographies (e.g., Finnish, Italian, Greek, the Bantu languages), where in principle one letter connects to only one specific speech sound, cracking the code can be considered easy, straightforward, not extensively taxing on memory and, as such, a relatively quick skill to learn. Once the learner has memorized the connections between the letters of the alphabet and the unique phonemes connected to them, the learner will be able to decode and pronounce all words in that language, as well as invented, meaningless words (pseudowords). After only a few months (sometimes just weeks or even days) of formal training, typically developing children who have been exposed to letters prior to school (e.g., in learning to write their names) have mastered this basic technical reading skill. In less transparent (opaque) orthographies, single letters are connected less consistently to specific sounds but rather the connections depend on larger linguistic context (e.g., the surrounding letters or the letter’s position in a word). Therefore, mastering the alphabetic principle provides only a part of the key for decoding. A substantial part of learning requires experience with the specific written formats, including irregular spellings. This may require learners to practice the word formats by heart or to connect larger strings of letters to specific sounds. For example, in English no single letter always corresponds consistently to the very same sound. However, larger chunks are much more consistently connected to specific sounds in English (e.g., rimes5), and knowledge of these connections facilitates reading acquisition (Ziegler & Goswami, 2005). Therefore, children learning to read in English need ongoing exposure to different types of contexts to understand how letters or combinations of letters represent different speech sounds.

As can be seen, learning to read in an opaque orthography (e.g., English, French, Hebrew; see, e.g., Katz & Frost, 1992) is clearly a more complex task than learning to read in a transparent orthography. One main challenge at the beginning of reading training is how to segment the speech flow in such a way so that a spoken unit could be connected to a written unit, which is the core of learning to read. It is not surprising, then, that cross-linguistic studies have provided evidence that it takes considerably more time to learn to decode words in languages with opaque orthographies (i.e., several years instead of several months; Seymour, Aro, & Erskine, 2003). Therefore, the nature of the orthography plays a significant part in the means by which reading is learned. This leads to our upcoming brief description on some prevailing methods of instruction, which vary according to the target orthography.
**Methods of Instruction**

Research has shown that for transparent orthographies, meaning those with consistent connections between letters and sounds, it makes sense to concentrate on teaching exactly these connections (Holopainen, Ahonen, & Lyytinen, 2002; see also Landerl, 2000, for a review see Perfetti, Beck, Bell, & Hughes, 1987). For typically developing readers, this provides a simple and quick way to learn to decode. Instructional methods vary in the extent to which these connections are utilized.

The instructional methods using phonics can be divided into two main categories: analytical and synthetic. The analytical phonics method uses an approach in which the quality of the speech sounds are referred to in the context of words. Learners are tasked with analyzing the similarities and differences between words in terms of the sounds they contain. They need to infer from, for example, the spoken words *pet* and *pat*, that the words have similar sounds apart from the sound in the middle, which alone changes the meaning of the whole word. In the method using the synthetic phonics approach, speech sounds are introduced separately before starting to combine sounds into larger chunks that can carry meaning. The idea is to teach the sound-based tools first, which can then be utilized for decoding anything that includes these letter sounds, without taking into account the context in which they occur.

The crux of the instructional methods using either of these phonics approaches lies in the employed sounds. Basically, the choice is made between using either the phonemes or names given to the letters. Using letter names leads to using analytical and deductive approaches because languages vary in the extent to which the given names of letters include the actual phoneme within its phonetic representation. In languages with transparent orthographies, the sounds of letters are typically represented quite well via their names, with an additional vowel or consonant sound, depending on the letter. As an example, the Finnish name of the letter *h* is pronounced 
[ho:\], the consonantal part of which solely forms the phoneme sound [h] for the letter. Thus, children would have a chance to infer that this particular part of the sound in the name matches its phoneme /h/. In English, the name of the letter *h* is pronounced /eɪtʃ/, which does not contain the typical glottal fricative /h/ that is often represented by the letter *h*. By pronouncing the name of the letter *h* alone, the specific phoneme sound is impossible to deduce. These examples underscore that the pronounced letter names can be useful for deducing the letter sounds, but this is not always possible in the case of nontransparent orthographies such as English, where none of the letters represent the same sound in all contexts.

Using the letter names might also lead to problems in reading and writing. Sometimes struggling learners make mistakes by relying on the letter names. For instance, they can make mistakes by stringing together the letter names when trying to read an unfamiliar word (e.g., seeing the letters for the word *stop*, /es//ti://ou//pi://, and pronouncing /esti:oupi:/), an error avoided when stringing together phoneme sounds. Thus, it makes sense for at least transparent orthographies to use phoneme sounds in instruction—easy with vowels but more difficult with some consonants. Also, the use of appropriately chosen syllables, where different vowels are connected to the consonant, can be very helpful for introducing specific consonants to early learners. This is because it is impossible to audibly produce, for example, a stop consonant (e.g., [p]) without a release of the consonant into some vowel sound. When a stop sound or any other type of consonant sound is the target sound, the vowel part is produced in as insignificant
manner as possible, which usually is realized as short schwa sound. This can be challenging for anyone without specific phonetic training.

Although using letter names for teaching decoding can cause particular problems, a learner’s letter knowledge (whether letter names and/or letter sounds) has been found powerful as a predictor of reading acquisition within the first years of formal education (e.g., Lyytinen et al., 2008). In order to memorize and utilize the more or less systematic relationships of such abstract meaningless units (letters and how they are connected to speech sounds) that form the core element of the written code (at least in alphabetic languages), learners need to have such tools to rely on in progressing in their technical reading ability.

Apart from the phonics approach, especially in the case of opaque orthographies, larger chunks than letters are used in instruction (Goswami, 1986, 1988; Walton, Walton, & Felton, 2001). One such method focuses on decoding by analogy. It is expected that learners can use their knowledge of the previously learned orthographical units to work out how unfamiliar words are read and spelled. For example, in learning to read in English, the frequent spelling patterns of phonological rime “neighborhood families” are highlighted (e.g., *sit*, *pit*, *wit* or *rime, lime, time*) to focus attention to the orthographical systems of the consistent language units, which, in the case of more opaque orthographies, are units larger than single letters. It should be noted that in the analogical method, phonics is employed as well.

The only instructional approach that does not focus on the sublexical units is the sight word (i.e., whole word) method. The learner’s task in this method is to learn by heart the full orthographical sequence (i.e., a word, or words in short sentences), which places the focus on the meaning of the words. At first glance, this method might seem to be useful and a quick way of making learners read for meaning. However, research has demonstrated that exclusively following this instructional approach places high demands on the memory, and learning new words in new sentences is not facilitated (Ehri, 2005). Noteworthy, however, is that in English, for example, successfully sounding out the first sounds of some words is impossible without seeing the whole written word. As a result, a certain limited number of words have to be learned by sight and some can work as the initial introduction to reading English. But in general, reading and spelling accuracy does not develop efficiently using this method alone.

Further comment is in order in light of our own experience. We have found that some foreign language learners, at the early stage at least, learn to read English by employing a grapheme–phoneme correspondence strategy similar to how they learned to read their first language with a possibly more transparent orthography. They might not have much knowledge on how to pronounce the English words, but they can read and spell them with relative ease. The difference between native speakers of English and these foreign language learners is in the pronunciation of the decoded words: The English words pronounced by foreign language learners might very well be unrecognizable to native speakers. This is an example of decoding skills without any connection to the phonology or even semantics of the target language. Thus, the exposure to the orthographical forms and whole words prior to developing phonological skills might not be a hindrance for developing good reading skills in English for some foreign language learners who already have reading skills in another language. Yet, only when the phonological system of the foreign language learners develops to resemble that of native speakers do these foreign language learners start experiencing interferences from their developed phonological skills, so much so that, for example, their spelling skills in English deteriorate at least slightly (especially with homophones).
In summary, for languages with transparent orthographies, the synthetic phonics method seems to be the most efficient. For languages with less transparent orthographies, an approach that takes into account the psycholinguistic grain size (see Ziegler & Goswami, 2005) of the specific target language and that uses sublexical information for teaching (often mixing different phonics methods) is the most successful way for teaching technical reading skills.

Learning to read does not happen all at once. The tools for decoding and for spelling need to be learned first, after which further training is needed in order for these skills to be automatized. One is ready for the effortless and quick reading of words (i.e., is literate) only after a substantial amount of practice. When reading is automatized, the cognitive load associated with the reading process is minimized, leaving resources for reaching the ultimate aim of reading—comprehension. Due to the main focus of this article, we limit our review on the technical stage of reading development to focus on the apparent variations in learning development that are independent of the instructional method employed.

Learners with Varying Abilities in Learning to Read

Reading skills need to be learned and are not just effortlessly acquired, as is the case with spoken language skills. Fortunately, most learners will gain sufficient reading skills with practice if they are provided with adequate learning opportunities (i.e., appropriate instruction, practice opportunities with reading material, etc.), have no significant sensory deficits, and their cognitive capacity is not severely compromised. Unfortunately, some children, despite having the aforementioned prerequisites, find reading extremely difficult. They have a developmental disorder, dyslexia, related specifically to the development of reading skills. Research has shown that more than 20% of early readers are struggling (e.g., Scarborough, 2009). A small portion of children can be defined as suffering from dyslexia, a severe hindrance to even optimal training in reading (Snowling, 2000). Typically individuals with dyslexia make a significant number of mistakes in reading and spelling, which hinders progress toward fluency. The types of difficulty that individuals with dyslexia experience depend on the orthography of the target language. Whereas those learning to read in a language with an opaque, inconsistently behaving orthography have both accuracy and fluency problems, those learning a transparent orthography typically manage to learn, possibly due to the straightforwardness of the grapheme–phoneme connections, although their reading tends to remain significantly slow and effortful.

Although this developmental condition has been investigated widely over the years (e.g., Orton, 1937; Snowling, 2000; Stanovich, 1988), researchers have not yet come to an agreement on the root of the matter. Research cannot identify a single cause of the condition. Instead, several competing theories have been posited on the possible causes. One prevailing theory, supported with experimental evidence across languages, is that dyslexia has its roots in cognitive difficulties to process phonological features, which is manifested in the individual having difficulty processing written language (e.g., Stanovich, 1988, Ziegler, 2006). In practice this means that individuals with dyslexia have difficulties to various extents with tasks that require the ability to manipulate speech sounds, even in tasks not involving written language, whereas typically developing children have no such problems. The reasons for the phonological deficit are not clear. Researchers have speculated that the quality of mental representations (i.e., poorly specified or indistinct) and/or the quality of access to these representations might explain the link between phonological awareness and reading skills (e.g., Elbro, Borstøm, &
Petersen, 1998; Elbro, Nielsen, & Petersen, 1994; Fowler, 1991). It could be that the nonsegmental, multilayered nature of the speech signal, as we described above, makes it difficult for individuals with dyslexia to distinguish the features that can be reduced into something that is an approximation of the actual sounds produced and/or perceived. Whereas some evidence indicates that some individuals with dyslexia actually perceive smaller differences in sounds and speech sounds than typical reading individuals (Bogliotti, Serniclaes, Messaoud-Galusi, & Sprenger-Charolles, 2008), other studies have shown that these challenged readers require greater differences between sounds in order to categorize them (e.g., Richardson, Leppänen, Leiwo, & Lyytinen, 2003). In fact, a deficit in any of the basic acoustical features (i.e., spectral, temporal, or amplitude) has been connected to poor reading skills to some extent, with the temporal deficit being most frequently related to dyslexia. A unifying feature of the studies on auditory perception (of both speech and nonspeech sounds) is that only some, but not all, individuals with dyslexia performed significantly differently from typically developing readers. Thus, differences in auditory perception do not offer a single causal explanation for the conditions. It should be noted also that, apart from phonology, there are studies on other levels of linguistic analysis (mainly on morphology and syntax) in connection with poor reading skills, but the research thus far is relatively scarce and findings too limited for drawing conclusions.

A significant number of people struggle with reading all through their lives, which significantly impacts their quality of life. Much of formal education is based on written language, as is the case with significant amounts of information conveyed outside education. If children, from the start of their educational careers, feel they are not coping with the core element of learning as well as their typically developing peers, they can easily become discouraged and frustrated, which might lead to, for example, avoidance behavior and low self-esteem issues. Although struggling readers would benefit from having access to appropriate and usually long-lasting professional support for improving reading skills after they have been struggling during the first years at school, early intervention programs for alleviating or even preventing dyslexia are, however, considered to be the most beneficial approach for providing efficient support. Therefore, to enable early intervention, researchers have begun looking for indicators of dyslexia in the period before children normally receive instruction in reading. These kinds of investigations have been made possible due to the convincing evidence that dyslexia is genetic (for a review, see Wood & Grigorenko, 2001).

The evidence that dyslexia runs in families also was the premise for the Jyväskylä Longitudinal Study on Dyslexia (JLD), in which parents and/or immediate family members with dyslexia, and their children in particular, have been studied for 2 decades now. In the JLD, the investigations started from the birth of infants to parents with and without dyslexia. As a result of our multidisciplinary investigations, various markers of dyslexia have been observed from the early development of these children, starting from the first statistically reliable sign recorded at the age of 3–5 days (e.g., Guttorm, Leppänen, Hämäläinen, Eklund, & Lyytinen, 2010). Apart from the auditory perceptual atypicalities and difficulties in phonological skills, the JLD investigations provide strong evidence that letter–sound knowledge at the age of 5 (2 years prior to children entering school in Finland) is the single strongest predictor of reading acquisition at the early stages of education in virtually all cases (e.g., Lyytinen et al., 2008). Similar evidence has been gained from many studies across languages in connection with poor reading skills (e.g., Scarborough, 2009). Thus, assessing letter knowledge skills prior to school entry provides a
simple and solid basis for predicting the reading outcome of children. Through a dynamic assessment of the child’s knowledge of letter names, assessors can gain objective evidence of the child’s ability to connect graphemes and corresponding sounds. With this information, extra support can then be directed toward those children who are likely to suffer from poor reading skills even before they encounter problems with reading. This finding is the core motivation for developing the GraphoGame method, the features of which we will describe next.

**BASIC FEATURES OF THE GRAPHOGAME METHOD**

The GraphoGame method was designed to facilitate children learning to connect written language segments with the corresponding speech sounds. Initially, the game was developed for children learning to read in the Finnish language and, more specifically, for those who showed early signs of reading difficulty at the end of kindergarten (typically 6.5 to 7 years of age), just months before entering the first grade. The method is meant to be used as a support tool for learning: It is not a replacement of teaching but rather provides preventive help.

The design of the training content used in the GraphoGame method is based on research findings. For languages with transparent orthographies, the nature of the training materials is straightforward. Because each letter represents a specific phoneme and vice versa, the game starts with introducing these correspondences. Using the synthetic phonics approach, the game starts by presenting phonetically and visually distinct grapheme–phoneme correspondences as a group (e.g., \(a, s, t\)) after which it moves to present correspondences that are phonetically less distinguishable (e.g., \(m, n, l\)). Next it introduces psycholinguistically relevant larger sublexical units of the target language, such as syllables or rimes, before introducing words. The expectation is that word decoding is basically achieved by knowing what sound the individual letters represent and simply combining them in an order to arrive at the written words. More interesting, we have heard that typical learners of transparent orthographies often remember the specific day they learned to read, that is, conceived their own mental system of connecting the sounds of subsequent letters while attending to the meaning of a text.

For languages with less transparent orthographies, the approach depends on the type of connections the written units have with spoken language units. For example, both synthetic and analytical phonics approaches have been used in the GraphoGame in English (Kyle, Kujala, Richardson, Lyttinen, & Goswami, 2013). In using this mixed-method instructional approach, the sublexical written language elements (rimes) that most consistently and frequently represent specific sounds and combination of sounds are utilized. For the GraphoGame English Rime version, the learning content is structured into streams with several levels that explicitly instruct learners on orthographic rime units (see details in Kyle et al., 2013). First, the game introduces the specific grapheme–phoneme connections that can be combined to form specific rhyming word families. The game immediately allows the learner to play with rime units, thus providing opportunities to reinforce the newly acquired grapheme–phoneme connection skills. This, in turn, facilitates the player’s recognition of psycholinguistically relevant reading and spelling units in English. The last phase in this stream is to play with other words that contain the rime units learned in the previous levels. The order in which the rime units are introduced is based on the phonological neighborhood density of the rime units, in line with the database constructed by De Cara and Goswami (2002). Also the frequency and consistency of these rime units.
units are taken into account in the presentation order. The selection of high-density neighborhood rime units begins with the most frequent and consistent items and moves toward those in low-density rime neighborhoods.

The GraphoGame method takes into account the way in which specific written and speech sound units are systematically connected in a specific orthography. In addition to phonologically based connections, morphology and semantics can play a decisive role in the game design for orthographies in which these particular linguistic aspects are important (e.g., in French and Mandarin Chinese). Thus, the GraphoGame method’s approach is to provide training with the most functional sublexical units of the specific orthography. This entails that training is focused on the most frequently and consistently used connections between the smallest distinguishable parts of the written and spoken language for learning the mappings of the particular orthography to the spoken language form. Through this process, the method aims to provide learners the opportunity to use sublexical units as building blocks for reading and spelling words. In addition, although the game usually offers implicit learning opportunities, some game versions also provide, to varying extent, some explicit instructions and demonstrations on particular issues, such as specific orthographical rules and irregularities that should be learned.

The produced sounds presented in the GraphoGame play an important role in the method. Because struggling readers have been found to differ in their speech perception skills from the typically developing readers, specific attention has been paid to the quality of the sounds used in the game. In the GraphoGame method, only naturally spoken sounds are employed. For achieving a high quality for the sounds, only recorded speech by trained native speakers is used. In addition, recordings are done in professional recording studios, which provide noise-free sound quality. The speakers are instructed to use a specific standardized pronunciation style representative of the language in question. Although the sounds are enunciated clearly, the sounds should illustrate natural characteristics of each specific target language, such as the typical speech rhythm, pitch, and intonation of the language. In addition, the speakers are instructed to try to control the durational and spectral characteristics of the productions. Special attention is paid to the way individual sounds are produced so that the majority of the produced sounds demonstrate the distinguishing characteristics of the target sounds. Thus, for identification reasons in some consonantal sounds, for example, the necessary formant transition to the accompanying vowel is also present in the sound. The reason for the specific requirements for the quality of the sounds is to provide learners opportunities to construct good, distinct mental representations of speech sounds. This is important because it has been argued that dyslexia involves fuzzy, indistinct phonological representations (e.g., Elbro, 1998).

The nature of the presented speech sounds is also taken into consideration in determining the order in which they are presented in the game. Sounds that clearly differ acoustically from each other are presented first. Once these have been learned, acoustically similar sounds are presented within the same game level. In this way, learners are guided to pay attention to the specific distinguishing characteristics of sounds. This is believed to offer learners the opportunity to reconstruct and refine the way they identify speech sounds. Also, the use of headphones is vital when playing the game: Because of the brevity and quality of the single speech sounds, headsets allow learners to hear the sounds properly. Additionally, several speakers’ voices can be utilized in the game, providing a further opportunity for learners to develop their speech sound categorization skills. This is important because the speech
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categorization skills have been showed to be different in struggling readers (e.g., Steffens, Eilers, Gross-Glenn, & Jallad, 1992).

The intention with the multimodal (i.e., visual and auditory) stimuli presentation is to provide support for constructing clear mental representations of specific features of both speech and written stimuli independently. At the same time, the method provides immediate connection between the two stimuli types, which in turn facilitate reading skills development. The method provides plenty of repetitions of exactly the same stimuli in different contexts (i.e., visually, auditorily), thus providing learners the necessary opportunities to build the representations and learn concretely the connections needed at the first stages of the learning-to-read process. Outside this kind of technological learning environment, this number/frequency and quality stability of repeated stimuli is not feasible.

One key feature of the GraphoGame method is that the game progression varies according to a learner’s current skills. The game continually logs the player’s performance with both accuracy and time measures. For the different types of game versions, several specially designed adaptation mechanisms are employed. The unifying feature for the various adaptation systems is that, according to the performance in each particular trial, the game is able to provide learning material in subsequent trials or levels aimed at the player achieving about 80% correct responses on each level. This simultaneously provides both sufficient challenge and ample opportunity for success, which together facilitate engagement in the game. Moreover, similar game levels are presented in several graphically different settings in order to keep players interested in repeating the same type of activity hundreds of times. In this way, each learner is exposed to the same connections with sufficient repetition for learning to occur.

One key principle in the GraphoGame method is to provide immediate feedback for each action. Typically, a player is presented a sound and must connect it to its written counterpart from a set of alternatives. Immediately upon the selection, the player is presented with either positive auditory and visual feedback on the correct response, or visually for an incorrect selection. Typically, the incorrect selection is displayed in red, whereas the correct response is highlighted in green. The significant point is that, following an incorrect response, the player must actively demonstrate learning by selecting the correct response before moving on to the next trial. In this way, the method emphasizes the correct correspondences of the spoken and written forms. By highlighting only positive feedback, the method aims to not discourage the learner by paralleling any negative feedback that the learner might be receiving in other learning contexts. Another way of accessing feedback on progression in the game, apart from the immediate feedback within the training levels, involves the game-provided static assessment levels of basic reading-related skills. Typically provided at various points in the training, these tasks assess the learner’s letter–sound knowledge and word and pseudoword recognition, as well as sentence processing. The players see their numeric progress at the end of each completed task; these assessment tasks provide an additional means for the teachers and parents to gain information on learners’ progress.

The above provides the general framework within which the GraphoGame method operates. Due to the linguistic and orthographic constraints and the varying background characteristics and starting skill levels of learners, dozens of GraphoGame versions have been developed. This prompts us to next summarize the effect of training with GraphoGame revealed in several experimental studies.
AN OVERVIEW ON THE IMPACT OF THE GRAPHOGAME METHOD

Several efficacy studies have been conducted on the GraphoGame method. Here we briefly review the main findings of some of the controlled experimental investigations that focus on supporting the first steps of reading development. Some GraphoGame intervention studies showing its effectiveness have focused also on fluency training (e.g., Heikkilä, Aro, Närhi, Westerholm, & Ahonen, 2013; Huemer, Landerl, Aro, & Lyytinen, 2008). However, because these fall outside the focus of this paper (basic decoding skills), we will not review them here.

Several experimental intervention studies have been conducted in Finland, whose language (Finnish) is one of the most transparent orthographies. Mönkkönen et al. (2014) studied kindergarten children just before they entered school (avg. 6.5-year-olds) in a cross-over intervention design in which about half of them played GraphoGame Reading \((n = 58)\) and others \((n = 52)\) played the GraphoGame Math (the same game but with math content) as a control game for 6 weeks each, for an average of 3.5 hours total per child per game. In addition, children who did not participate in any intervention \((n = 41)\) were included in the study as nonplaying controls. All the children were prereaders whose letter knowledge could be categorized as poor, meaning they knew fewer than 12 letter–sound connections or letter names at the preintervention stage. The data showed that children who played GraphoGame Reading improved their letter knowledge and pseudoword reading significantly in comparison to both the GraphoGame Math and the nonplaying control groups. Saine, Lerkkanen, Ahonen, Tolvanen, & Lyytinen (2010) conducted a longitudinal intervention study using the GraphoGame method with native speakers of Finnish. Two cohorts of children from four schools from the same district \((N = 166)\) were followed. At the start of the study, the participants were first graders (7 years of age); they were followed until the first term of Grade 3. The participants were divided into three groups. One group \((n = 25)\) comprised children who needed extra support in decoding skills according to their performance on several reading-related assessment tasks during the first weeks of school. They received regular remedial support in groups of five for 45 minutes, four times a week, for 28 weeks beginning at the 7th week of school. The second group \((n = 25)\) was otherwise similar but they received GraphoGame training during the first 15 minutes of their remedial lessons (i.e., the time used for playing the game replaced the face-to-face remedial instruction that these children were receiving). All the children in these two randomly assigned groups represented the lowest 30% achieving students in the assessment tests. The third group of children \((n = 116)\) were the classmates of the children in the reading remedial intervention groups. Their reading assessment scores were good enough at the beginning of the school that they did not need any extra support for improving decoding skills. The results of this longitudinal study indicated that at-risk children who received the GraphoGame intervention improved their readings skills to a level similar to their nonintervention mainstream peers and were significantly better readers on most measures than the children of the group receiving only traditional remedial teaching. As can be seen from the results of these two studies, the GraphoGame method brings significant positive results for struggling readers learning to decode in a transparent orthography.

The encouraging results from the Finnish studies have been extended to other language environments with similarly transparent orthographies. In the richly diverse language environment of the Sub-Saharan African country of Zambia, the first language of residents is typically one of the several local Bantu languages. The alphabetic orthographies of the Bantu...
languages are almost as transparent as that of the Finnish language—symmetrically transparent in both reading and writing directions the result of the languages only recently being committed to script. No changes to the spoken languages have taken place since the written language forms for the target languages were developed, and the missionary-developed orthographies were based on a Latin model, similar to Finnish. Thus, logically, we could expect the GraphoGame method to be as efficient for learning to read Bantu languages as it has been demonstrated to be in the Finnish environment. However, whereas the language environment of the Finnish speaking children in Finland is extremely homogenous (approx. 90% of the population speaks Finnish as their mother tongue; Tilastokeskus, 2014), the language situation in Zambian schools is much more diverse. Throughout the country, several different Bantu languages are spoken, as well as English, the lingua franca of the nation. Most children, however, do not speak English and may not have been exposed to it in their surroundings before they enter school. The recently-implemented Zambian language policy followed in education specifies that although initial teaching in the first four grades should be provided in one of the seven official local Bantu languages, English will be used from the fifth grade onwards as the language of instruction (Use of Local Languages, 2013). This diverse language situation alone, apart from the fact that languages with both transparent and nontransparent orthographies are being taught in schools, makes this learning environment significantly different from that of Finland. A second very important difference is that most Zambian children get little or no exposure to written texts (in any language) in their home environment before starting school. Thus, due to the obvious differences between the learning environments in Finland and Zambia, several intervention studies have been conducted in CiNyanja, one local Zambian language with a transparent orthography, to see whether the GraphoGame method would be an efficient training tool in such a diverse language environment. The review by Ojanen, Kujala, Richardson, & Lyytinen (2013) shows that indeed significant improvement in the assessed spelling skills and orthographic knowledge was evident in the first- to fourth-grade CiNyanja-speaking children after approximately 2 hours of training time over a 4-week period. A more recent result from Jere-Folotiya et al. (in press) documents how the effects of the GraphoGame method are reliable only if the teachers receive appropriate information on synthetic phonetics in the target language in advance of the intervention.

The GraphoGame method also has been applied to languages with nontransparent grapheme–phoneme correspondence. Kyle et al. (2013) conducted a controlled experimental intervention study with English-speaking second graders (6- to 7-year-olds) in the United Kingdom. In this study, a specific interest was in the training content used in the GraphoGame method. Two game versions, GraphoGame Rime and GraphoGame Phoneme, were developed for this purpose according to two different theoretical approaches on reading instruction in English. The data show that after about 11 hours of training over a 12–week period, children who played either version of the GraphoGame improved their decoding skills significantly in comparison to a nonplaying control group. However, of the two approaches, training with GraphoGame Rime produced more significant improvements in comparison to GraphoGame Phoneme. This study indicates that technology-enhanced training method such as GraphoGame can be an efficient tool for training basic reading skills in languages with nontransparent orthographies.

Apart from significant changes in reading behavior, some studies indicate that the effects on training with the GraphoGame method also can be seen in brain physiology. Brem et al.
Richardson & Lyytinen (2010) conducted an intervention study in Switzerland of German-speaking kindergarten children with the same research design as Mönkkönen et al. (2014), described above. The nonreading children \( N = 32; 6–7 \) years of age) played the game, on average, 3.5 hours in total over an 8-week period. The data on the behavioral assessments indicated that these children’s letter–sound correspondences in a slightly less transparent orthography than Finnish and ciNyanja improved significantly after playing GraphoGame. More interesting, the functional magnetic resonance imaging (fMRI) data on some of these children \( n = 16 \) show that learning outcomes indicated by the behavioral data had a significant effect on a neural level. The posterior areas of the brain that specialize in visual processing, including written language, became significantly activated while merely training with letter–sound correspondences. In addition, the electroencephalography (EEG) recordings revealed that in only a quarter of a second after visual presentation of either written words or symbol strings (no letter shapes), the learners’ brains could differentiate these two types of visual symbols. Thus, these results indicated that training such as that provided by the GraphoGame method has a significant neural-level effect on written language processing. Similar, neural-level evidence is apparent on the Finnish kindergarten children participating in the Mönkkönen et al. (2014) study (see also Guttorm, Alho-Näveri, Richardson, & Lyytinen, 2011).

This has been a very brief overview of some of the controlled experimental studies in which the GraphoGame method has been utilized. Because one key principle behind developing the GraphoGame method is to provide an evidence-based support tool for decoding skills, new language versions of GraphoGame are being developed for different types of orthographies for use in various cultural environments. In addition, more large-scale studies are needed for investigating the efficiency and usability of the GraphoGame method in terms of, for instance, learning nonalphabetic languages, languages with nontransparent orthographies, and tonal languages, as well as second languages. In the final section of the paper, we provide a summary on some of the most significant challenges facing the GraphoGame method.

**CHALLENGES OF THE GRAPHOGAME METHOD AND WAYS TO OVERCOME THEM**

Although the GraphoGame method shows promise as an effective support tool for developing and improving decoding skills, several theoretical, methodological, technological, and environmental challenges may hinder, to some extent, the usability and feasibility of using the method.

Possibly the least problematic issue is the theoretical approach of the method. The intervention studies so far have demonstrated that even if the language in question has a nontransparent alphabetic orthography, the type of training that the GraphoGame method offers in providing learners with psycholinguistically relevant, consistent, and frequent segment sizes may well suffice to significantly support learners in their reading development. However, a possible foreseeable challenge could be in creating a systematic way of providing an appropriate game-like training environment for learning irregularities in the given orthography. This is especially important for orthographies that do not provide clear indications on smaller segment-level phonological features but, instead, on morphological and semantic features of the language. To overcome such challenges, the GraphoGame method probably needs to evolve somewhat so as to rely not only on the form, but also to take into account the meaning of the
segments. For instance, for languages with logographic orthographies (e.g., Mandarin Chinese), apart from the obvious challenge of the huge number of individual characters to be learned, the numerous homophones need to be presented in a manner that clearly provides sufficient clues to the meaning of the word. To accomplish this, larger contextual and semantic cues may need to be included in the training method.

Another theoretically and environmentally challenging issue concerns how to train learners with apparently disparate spoken language backgrounds. The basic principle of the GraphoGame method is to provide training on the strongest native language of the learner so that the learner has the necessary awareness of the different features (mainly phonological, but also semantic and morphological) of the language. Once the game version has been developed for the language of the learner, the language background is not a problem. However, there seems to be an increasing number of learners whose language background and living environment include several spoken languages. Moreover, a lack of appropriate reading material in the target language, as well as instances when the teachers do not know sufficiently the language that their pupils speak and are learning to read, further complicates the situation. These challenges, for both the learner and the teacher, can be overwhelming and might present an ideal situation to start testing the GraphoGame method as a training support, provided that the appropriate language version of the game has been developed.

One possible methodological challenge for using GraphoGame as a reading support is that learning skills and strategies can vary greatly between players. Obviously this challenge is most likely shared with many reading-support methods. Some struggling learners might require more explicit instructions, training content related to their specific problem areas, and/or advice and feedback than the game environment currently provides. Another potential challenge might come from the game being easy to use even without adult supervision. Thus, children can be left alone in their training for however long they want to play. Obviously, when children are not tired and have enough time to concentrate, they may prefer playing for extended sessions. However, this is not recommended. Our view is that playing sessions of 8–12 minutes seem to be the optimal for children’s concentration during training. Longer playing sessions lead to an increased likelihood of the learner losing interest in the tasks—as may happen also if the children start using the game when they are too young or not intellectually mature enough. Our experience tells us that the optimal age for starting to use the game is close to 7 years.\(^8\) At that age, children’s brains are mature enough, even if some learners may be slightly delayed in maturation, which may be typical among struggling readers.

The overall training period must be extensive enough to see significant improvement in skills. Some children might need to have someone overseeing their progress and possibly providing motivational support. In fact, the game developers have received feedback from parents and teachers that some children seem to concentrate and perform better in the game with adult supervision and encouragement. However, the opposite feedback also has been received: Some players progress and concentrate well independently, and prefer this opportunity. Additionally, it is easy to understand that concentration cannot be optimal if other sounds (e.g., people talking) are audible when a child is training with GraphoGame. Effective learning via GraphoGame requires an undisturbed opportunity to concentrate fully on the sounds presented. Even adults who have tested the method in various settings have noted the need for a quiet environment and good quality headphones during GraphoGame use.
Another methodological challenge, yet probably an advantage of GraphoGame as well, is that it is available online; thus the progression of the player in the game can be synchronized so that the player can continue from where he/she last stopped, even if using a different connected device. Naturally, in order to take advantage of this feature, the device needs to be connected to the online network, at least at the beginning and end of each playing session. With only online access, when the connection is lost or unavailable, the game is inaccessible to players. The game can be downloaded to work offline, but with the disadvantages that playing time and progression cannot be easily monitored, feedback to learners is limited, and automatic updates of the game are not available.

Because GraphoGame is a digital game environment, technological challenges are evident. This technological learning environment has been developed so that it can be played on various platforms. Players can use the PC versions using Windows, Mac, or Linux operating systems. Recently, the game has been developed for Android operating systems used in computer tablets and smart phones. The constant changes in technology (i.e., new devices, changes in the displays, changes in the operating systems, etc.) make it challenging for the game developers to maintain the game to function with newly developed trends. One source of extra development work recently results from the fact that the game had been using the Java engine by Oracle. However, due to the unreliability and constant changes of the Java engine, GraphoGame developers are currently developing a new version that uses the Unity game engine by Unity Technologies. Thus, the new game will be more self-contained and users will not be required to download and/or update other software to run GraphoGame. The added benefit is that it eliminates the need for game developers to continually supply adjustments due merely to the changes to the game engine. The other advantage of using the Unity game engine is that it facilitates multiplatform publishing.

A different technological challenge might be how teachers and teacher education are tuned into using technology-enhanced methods in the classroom, and specifically for supporting struggling learners. Naturally, the fact that such technology-enhanced methods could be sensibly integrated into teaching practices depends on the condition and accessibility of suitable equipment in schools. In addition, cultural and age- and gender-specific issues may play a role here. Younger, digital-age teachers, who most likely have experience using technology outside their work environment, might have fewer mental obstacles toward employing technology as a part of their classroom work. By integrating technology into teacher education, however, the possible negative attitudes might diminish, thus enabling the effective use of technology in a supporting role in classroom work.

In describing the possible challenges for using the GraphoGame method, we note that not all challenges are necessarily insurmountable and may not affect all users. Perhaps the most challenging obstacles for the usability and feasibility of the GraphoGame method, therefore, are those that come from outside the method itself. The most fundamental obstacle might be in how learners gain access to the game. Although the number and spread of digital devices around the world is increasing rapidly, even developed Western societies still lack sufficient devices in schools. The lack of devices is even more consequential in the developing countries. However, the prices of sophisticated technological devices and online network fees seem to be decreasing continually, and the devices are becoming more durable. Thus, we may see in the near future that all school children will have access to sophisticated online devices and, hopefully as well, a wide diversity of technology-enhanced learning tools when they enter school.
In Finland, the Ministry of Education and Culture supports the delivery, maintenance, and user support for the Grapholearning technology (both technical and content) to address reading and math difficulties in young learners. The Finnish versions of GraphoGame (known as Ekapeli) are provided via the specialized LukiMat service, which is run by the Niilo Mäki Institute. The LukiMat service offers a technological learning environment not only for those learning to read but also for those needing special support for developing their basic numeracy and math skills. The financial support from the Ministry makes it possible to provide this service within Finland at no charge. Currently the game seems to reach all the learners for whom it was originally designed, that is, the struggling learners at the end of kindergarten and in the two first years of school. In Finland, each age cohort has, on average, 60,000 children. Data from the player logs indicate that more than 20,000 children are playing the language training version regularly. Such numbers indicate that the target group—the struggling readers—has been reached. Moreover, GraphoGame offers versions for training fluency skills aimed at children who already have basic decoding skills, offering further practice in automatizing their skills. Altogether, the GraphoGame has supported nearly 200,000 young readers in Finland since it was launched.

When the support is extended beyond the Finnish context, we first seek to gain evidence on the effectiveness of the game in the various language environments and cultural settings. A prerequisite is that experts who are well informed about the language and its orthography, the local reading instruction practices, and the target culture in general are involved in developing the new language version of the game, in collaboration with the developers of the GraphoGame method. Additionally, local experts are needed to provide ongoing user support when the game is delivered and implemented, particularly after the game versions are extended beyond the research context. All this highly ambitious effort takes time and resources. Without a significant joint collaboration, successfully developing and spreading this scientifically grounded technological learning environment would be impossible. Intensive cooperation between researchers, practitioners, policy makers, and foundations is vital. Therefore, an international organization, the GraphoWorld Foundation, is being formed specifically for this purpose.

ENDNOTES

1. GraphoGame is the registered trademark of the University of Jyväskylä and Niilo Mäki Foundation for a noncommercial computerized game aimed at learning to read.

2. The phoneme is a concept that refers to the smallest speech unit, meaningless on its own but by using, omitting, or replacing it with another phoneme the meaning of the word can change. Phonemes are the abstract representatives of many different concrete sounds that share similar features. Thus, phonemes as such do not exist concretely—they are abstract concepts similar to graphemes in written language. One can say they may exist only because we have invented writing systems.

3. The grapheme refers to the smallest unit of written language that can change the meaning of the context in which it appears but that is not meaningful on its own.

4. Alphabetic languages are those with orthographies that use alphabetic symbols to convey or represent the pronunciation of the language.

5. The concept rime refers to a linguistic unit—that is, a spelling pattern of a word—that consists of the vowels and the subsequent syllable/word final consonants that maintains its sound in any context. Rhymes refer to pronunciation of the word with final vowel or vowel–consonant units that sound the same independently, no matter how they are spelled.
6. In presenting the linguistic elements of this paper, we use the following linguistic standards: Square
brackets are used for indicating phonetic transcription (i.e., pronunciation), slashes are used for
phonemic transcriptions, and letters, syllables, or words are italicized.
7. It should be noticed that this literacy policy was announced in 2013 and implemented in 2014.
Previously, literacy instruction was provided in the local languages only in the first grade, with
English-language instruction beginning in Grade 2. Now the local language is the medium for
instruction from first through fourth grades, with English introduced as a subject in Grade 2.
8. The age at which children enter schooling varies by country. In some countries, children may be just
5 years old in first grade, and thus beginning their reading lessons before the optimal mental maturity
age of 7. Therefore, the GraphoGame researchers and designers are currently developing different
types of game activities appropriate for younger children (5 year olds).
9. More information on the LukiMat service is available at www.lukimat.fi

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